ISSUE: 4
A HUMANE EDUCATION RESOURCE

ISSN: 117-3804

ANIMALS&US

ANIMALS IN SCIENCE

ETHICAL ARGUMENTS AND ALTERNATIVES TO ANIMAL EXPERIMENTS

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and film clips.

51 images

ideal for students as
visual aids.

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invaluable free information for both teachers and students

enhancing critical thinking about the relationship between humans and animals.

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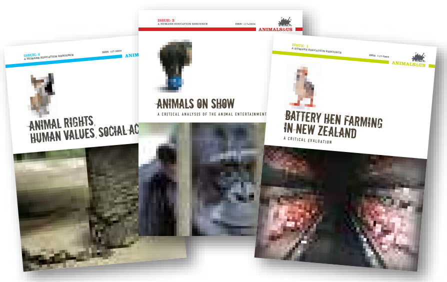
ISSUE 1 – **Battery Hen Farming in New Zealand: A Critical Evaluation**

ISSUE 2 – **Animal Rights, Human Values, Social Action**

ISSUE 3 – **Animals on Show: A Critical Analysis of the Animal Entertainment Industry**



ANIMALS IN SCIENCE

ETHICAL ARGUMENTS AND ALTERNATIVES TO ANIMAL EXPERIMENTS

RESOURCE MATERIALS

Suitable for Years 9-13 in Science and Biology

ANIMALS IN SCIENCE

ETHICAL ARGUMENTS AND ALTERNATIVES TO ANIMAL EXPERIMENTS

ISSN: 117-3804

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FLIGHTLESS

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FOREWORD

I will never forget sitting down for a term exam as an undergraduate biology student in Canada. As the bell rang to start, each student was handed a dissecting tray on which was pinned a freshly killed adult bullfrog. We were to cut open the frog's body, identify and label various body parts, and describe their functions. I remember looking at my frog and thinking what a waste of a life it was. I never wanted an animal to die for my education.

Sadly, animal dissections are still common in many parts of the world. In addition to harming the animal, the exercise reinforces the old mindset that animals were put here for us and we can do with them as we please. In an age of biodiversity loss, extinctions and climate change, that's the last thing we should be teaching.

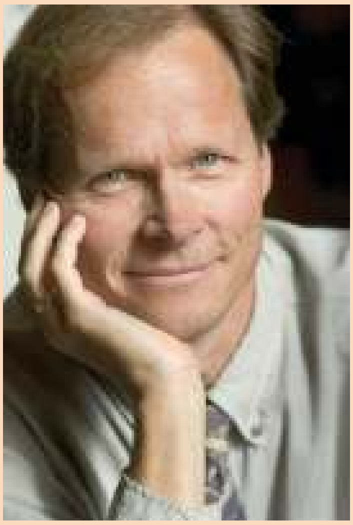
The same 'might makes right' attitude is used to rationalise harming and killing animals in cruel experiments and product testing.

Fortunately, a revolution is under way in our understanding of animals. Today, scientists are discovering aspects of animal minds, emotions and perceptions that would have been thought fantasy a generation ago. Rats laugh, elephants keep mental tabs on dozens of others, caged birds become pessimistic, reef fishes line up for a spa treatment, parrots name their chicks, and mice show empathy – to list just a few.

With knowledge comes responsibility. We must change our behaviour towards animals. We may ask diplomatically: *Should we deliberately poison sentient animals?* and *Is it right to inflict pain, suffering and death on them?* But is there really any doubt that such practices are uncivilised and unethical? Even if animal experiments were reliable (they are not), there are effective alternatives, including cell and tissue cultures, computer models and human clinical studies.

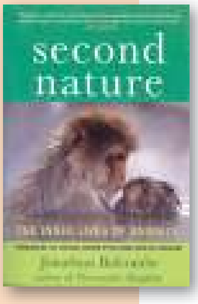
As a scientist, I value science for providing evidence. Science and common sense show that animals feel pain (and pleasure) in essentially the same way that we do. Animals also experience diverse emotions, from easily recognised joy or terror, to subtler equally intense feelings like depression and optimism. It follows, I believe, that animals merit the same sort of respect and concern that we give to our fellow humans.

I'm proud to be associated with this edition of SAFE's groundbreaking series *Animals & Us*. This teaching resource encourages critical thinking by challenging traditional, human-centred views about animals' place in science. It shows that scientific discovery need not – indeed, ought not – be at the animals' expense, and that the best science is ethically responsible. This is the future of science.



JONATHAN BALCOMBE

Jonathan Balcombe is an animal behaviour scientist who has written a number of books and scientific papers on animal behaviour, humane education and animal research. Jonathan's most recent book is *The Exultant Ark: A Pictorial Tour of Animal Pleasure*. This book is a striking pictorial celebration of the full range of animal experience. Prior to that Jonathan's critically acclaimed *Second Nature: The Inner Lives of Animals* questioned the prevailing scientific orthodoxy that humans alone possess the ability to reason. Raised in New Zealand, Jonathan now lives in the US and works as an independent consultant. He has blogged for *First Science* and also *New Scientist* and is a past winner of the *Ethical Men* series. While working as a Senior Research Scientist for PCRM, Jonathan wrote an online column entitled *Beyond Animal Research*. He also wrote a book questioning animal dissection in high schools entitled *The Use of Animals in Higher Education: Problems, Alternatives & Recommendations*.



Jonathan Balcombe's website: www.jonathanbalcombe.com

ABOUT SAFE AND ANIMALS & US

SAFE – the voice for all animals

Founded in 1932, SAFE (Save Animals From Exploitation) is a leading and unique voice for animals in New Zealand. SAFE is New Zealand's largest and most respected animal rights organisation and is regularly contacted for advice and comment on animal issues.

With over 16,000 members and supporters, a small dedicated staff, and a team of volunteers working around the country, SAFE undertakes high-profile campaigns, public stalls, displays, demonstrations, meetings, education visits, research, and promotional and publicity events to foster a more informed and compassionate understanding of human-animal relations in contemporary Aotearoa New Zealand.

SAFE's vision is of a society in which all animals are understood and respected in such a way that they are no longer exploited, abused or made to suffer. Our purpose is to achieve this vision through educating and advocating to:

- change attitudes
- create awareness
- foster compassion
- challenge cruel and exploitative practices.

SAFE has a long history of advocating for animals. Some of our more recognised achievements include:

- **Battery hen farming exposé:** In 1993 SAFE drew national attention to the plight of animals in factory farms, appearing on *60 Minutes* and exposing the conditions on New Zealand battery hen farms.
- **Circus animals relocated:** In 2000 SAFE successfully negotiated the relocation of circus chimpanzees Buddy and Sonny to Chimfunshi animal sanctuary in Africa.
- **Pig farming cruelty revealed:** In 2009 SAFE, with the support of Mike King, appeared on the *Sunday* show, and shocked the nation with a graphic exposé of the cruelty inherent in factory pig farming. The impact of this campaign on the New Zealand public directly contributed to the government's decision to ban sow crates in New Zealand from 2016.

These campaigns have not only changed public attitudes and behaviours regarding how we as a society view and treat animals, they have more significantly resulted in tangible improvements in the lives of the animals themselves. SAFE brings hope for a future where animals are no longer mistreated, abused or disregarded.

Animals & Us

Animals & Us is an education initiative created by SAFE in 2006. One of the key areas of SAFE's work is education, and SAFE endeavours to provide schools, teachers and students with relevant and factual information on the human-animal relationship.

VISION

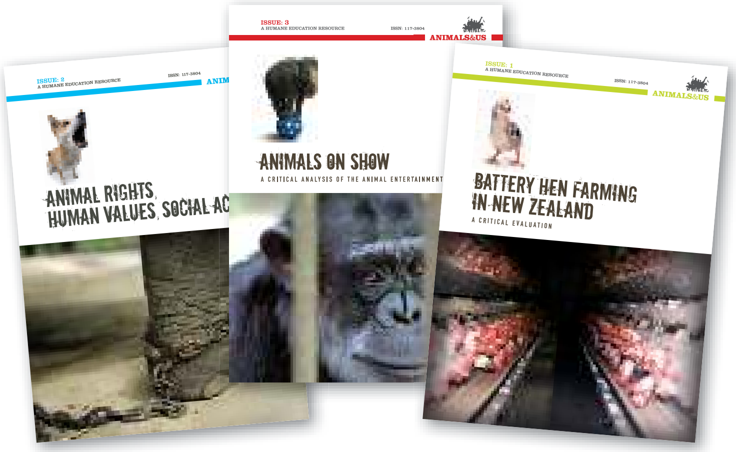
That *Animals & Us* will advance knowledge and critical thinking about the relationship between human and non-human animals while fostering attitudes and values of compassion, respect and empathy.

MISSION STATEMENT

Animals & Us is a SAFE education initiative that:

- provides professional resources specifically designed for the New Zealand education framework
- advances knowledge and critical thinking about the social, economic, political, environmental and scientific relationship between human and non-human animals.

The quality of the *Animals & Us* programme is guaranteed by SAFE's ability to draw upon the knowledge of the most experienced animal advocates, and to combine this with the expertise of researchers, academics and teachers working in the area of human-animal studies.



Four *Animals & Us* textbooks have been published since 2007:

Issue 1: Battery Hen Farming in New Zealand
A Critical Evaluation

Issue 2: Animal Rights, Human Values, Social Action

Issue 3: Animals on Show
A Critical Analysis of the Animal Entertainment Industry

Issue 4: Animals in Science
Ethical Arguments and Alternatives to Animal Experiments

ACKNOWLEDGEMENTS

Animals in Science is the fourth issue in the SAFE *Animals & Us* series. *Animals in Science* provides opportunities to reflect on the ethical implications of animal experiments and poses questions as to whether or not animal experimentation is a valid science. There are also opportunities to study animals in a non-invasive way. This issue has taken significantly more time to produce than the previous issues. Earthquakes and organisational changes have caused significant disruption. During this time of upheaval *Animals in Science* has been worked on quietly in fits and starts. It wouldn't have been possible without the help of a wide range of volunteers and professionals.

This issue required considerable research before writing could commence and we would like to thank Christopher Berg who co-authored the units of study, created the ethograms and also went into the field to help film dogs at play for the DVD. Francesca Suggate helped research and write the bibliography, online resources and glossary, which saved many hours. Once the writing had commenced the need for an editor became evident. Karen Petersen offered her assistance and helped shape and ease *Animals in Science* into a reasonable size and structure. Elizabeth Welsh also helped with the editing of some of the lesson plans and texts in the early stages. Vicki Andrews proofread the document, which is no small feat.

We are delighted to be able to include a foreword in this issue by Jonathan Balcombe. Jonathan is a best-selling author and one of the world's leading experts in animal behaviour. He also recommended we include the lesson on sentience in the textbook. Top ethologists Marc Bekoff and Judy Diamond provided a wide range of texts for the lesson on play behaviour and we are incredibly grateful for their knowledge and inspiration.

Academic, author and veterinarian Andrew Knight took time out of his busy schedule to film an interview on the ethics of animal experimentation which features on the *Animals in Science* DVD. Andrew also wrote the introduction to the textbook.

Each issue of *Animals & Us* has an accompanying DVD. This DVD is edited and put together by our amazing and talented volunteers Debbie Matthews and Graeme Mulholland. Debbie and Graeme also edited the Andrew Knight interview. Thanks to SAFE Promotions Manager Amanda Sorrenson for doing the voice-over on the Andrew Knight interview, and SAFE Graphic Designer Michael Steele for the DVD artwork.

The cover design is the creation of Ali Teo and John O'Reilly, and the illustrations in the 'Bodies Apart' lesson are also by artistic Ali. The stunning graphic design is by Emily Fletcher of Rose Cottage Design.

Animals in Science addresses a topic that is controversial and often disturbing. Sourcing images of animal experimentation is not easy and we would like to thank Stephen Manson from the New Zealand Anti-Vivisection Society for his help in this area.

Production costs for the *Animals & Us* series are kept to a bare minimum and we would like to thank Jan Cameron for her support of *Animals & Us*.

We would especially like to thank Pub Charity, the Southern Trust, The Lion Foundation and the June Shearer Foundation for their support and grants towards this textbook.

Lastly, thanks to my workmates who have stood by with patience and understanding during the long production process.

Animals in Science is dedicated to the millions of animals used in experiments in New Zealand and around the world each year. These animals suffer and die in the name of science and progress. Their consent is not asked for. Their lives are sacrificed because we believe in a greater good that they are not privy to. This textbook offers an alternative to progress at any cost and a hope that future scientists will continue to seek the answers to perplexing questions and, through their actions and decisions, strive for responsible and ethical solutions.

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INTRODUCTION

Ethical Arguments and Alternatives to Animal Experiments

HANK MORGAN – Getty Images

ANIMALS IN SCIENCE

In 2010, an AgResearch scientist commented in the *New Zealand Herald* on animal deaths in scientific experiments, saying "he did not see the deaths as a 'big deal', and they were part of the learning process for scientists".[1]

Such comments highlight the thinking of some of those in the scientific community: animals are seen as expendable and their deaths merely as collateral damage sustained in the service of a higher cause.

Globally, teachers, students and scientists use animals in science – over 100 million animals each year – and every person who wants to do a scientific experiment on an animal is required to consider the following:

- The harm or distress that could be felt by the animal as a result of the experiment.
- Whether the design of the experiment will achieve the expected results.
- Whether the animal species is appropriate.
- Whether the number of animals is the minimum necessary to achieve meaningful results.
- Whether the health and welfare of the animals can be ensured before, during and after the experiment.
- Whether suitably qualified people will be undertaking the experiment.
- Whether the experiment will need to be duplicated.
- Whether the same animals will be used repeatedly in other experiments.[2]

These questions fail to address a larger moral question, however: Should we use animals in experiments at all? Is experimenting on animals to predict results ethically acceptable, particularly given inter-species differences? Should we not strive to seek valid results without harming other living beings?

DR ANDREW KNIGHT

European Veterinary Specialist in Welfare Science, Ethics and Law, and Fellow of the Oxford Centre for Animal Ethics.

Andrew's studies examining the contributions of animal experiments to human healthcare have attracted a series of awards at international scientific conferences and formed the basis of his doctorate.

Author of *The Costs and Benefits of Animal Experiments*.

Andrew Knight's website: www.AnimalConsultants.org

These are important questions, and the purpose of *Animals in Science* is to encourage students to think seriously about the use of animals in experiments, and whether this is scientifically and morally acceptable.

Animals in Science provides lessons and texts that will help students answer these important questions.

In **Unit 1, 'Rats Have No Gall Bladder'**, students will research animal experimentation as a socio-scientific issue – delving into the validity and ethics of animal experimentation.

In **Unit 2, 'Do Animals Play Fair?'**, students will investigate life processes – in particular, reciprocal play patterns and the behaviour of dogs and kea. This non-invasive investigation provides opportunities to study animals without harming them.

Unit 3, 'Bodies Apart', not only provides students with the opportunity to investigate life processes, but also offers meaningful learning experiences without the need to dissect animals.

Unit 4, 'Sentience is the Bedrock of Ethics', is a lesson in which students will be able to explore the behavioural, emotional and sensory world of animals while considering the ethical implications of using animals in science.

ANIMALS IN SCIENCE IN NEW ZEALAND

New Zealand prides itself on its clean, green, pure image. Most Kiwis are not aware that their environment and animals are not as protected as they would like to believe. The ultimate manipulation of animals – genetic engineering – is prevalent within New Zealand, and has been for years.

Take, for example, Daisy the cow – the name conjures up an idyllic rural scene: a cow peacefully grazing in a lush meadow, flicking flies with her tail and enjoying the sunshine.

In the real world Daisy is a genetic abnormality, a transgenic cow, born prematurely with a swollen abdomen and without a tail. She is in an AgResearch containment facility in Ruakura. Daisy is not her actual name. At AgResearch she is referred to as cow number 11014. Daisy is part of a series of experiments "to develop in containment genetically modified goats, sheep and cows", in order to produce milk with therapeutic value and to study "gene function, milk composition and disease resistance".[3]

Cow's milk allergy is one of the most common allergies in infants. Studies have shown that it is different to lactose intolerance. It is far more dangerous, and potentially life-threatening.[4]

As scientists we are taught to question, investigate and understand our world. Sometimes we want to push boundaries and play with the natural order of life. In evolutionary terms humans are not designed to consume the milk of other species of animals, and they are the only mammals to continue a regular diet of milk after infancy. Human breast milk does not contain the allergen beta-lactoglobulin (BLG), but cow's milk does. Daisy/11014 was genetically engineered so that her milk would not contain the allergen BLG.[5]

Cow's milk supports a 14 billion dollar industry in New Zealand.[6] Rather than employ existing technology, which has successfully removed BLG from cow's milk products, AgResearch has created transgenic cows like Daisy, leading to unnecessary animal suffering.[7]

It took 12 years of experiments and the suffering and death of hundreds of animals before 11014/Daisy was finally created.[8] In 2011 AgResearch was forced to change the transgenic trials because only 10% of the animals cloned using nuclear-transfer technology survived.[9]

Creating transgenic animals that produce 'human' milk is not only interfering with the natural order of life, it is also pushing scientific and ethical boundaries to the extreme. Daisy's missing tail is not just a 'scientific' anomaly, it is a warning of the most serious kind.

In other transgenic animal experiments AgResearch is trying to create cows that produce a human follicle-stimulating hormone to help women with low fertility. Dr Elvira Dommisse, who has worked in the field of genetic engineering, stated in 2011:[10]

"*I was not surprised at all as there is a history in the AgResearch research programme of transgenic animals of birth defects and abnormalities arising later in life. This is not unusual, this is fairly standard and almost to be expected … In the case of follicle-stimulating hormone, there are other, much safer ways of getting this follicle-stimulating hormone; we do not need to do this to animals in order to produce this hormone. The idea behind this GE animal project is to make vast amounts of money; it is not to benefit the human population because we can already do this. There are good fertility programmes* *in place for women – we do not need to be testing them on cows."*

The failed AgResearch transgenic experiments throw a disquieting spotlight on the validity and ethics of animal experimentation. It is important as scientists that we never lose sight of our respect for the lives we 'tinker' with when we investigate our world.

In the end, Daisy/11014 and her transgenic cousins suffered needlessly and at great cost.

Animals in Science aims to teach science students to respect animals and to consider how we can eliminate the harm we inflict on animals used in science. Science professionals such as I endorse the view that an ethical scientist does not forge ahead with hypotheses without considering the short- and long-term consequences of his or her actions. There are always gains to be made in science – but we should never fail to consider at what, or more importantly whose, cost. Every animal life has an inherent value and when we lose sight of this value we lose the key aspects of our humanity – empathy, tolerance, sensitivity, sympathy and compassion, all the characteristics that make great rational minds and brilliant scientists. Ethical scientists never assume that animal research is the only way to help humans, and consistently seek research that does not cause harm to animals.

ANIMALS IN SCIENCE AND THE NEW ZEALAND CURRICULUM

The young scientific minds of today have to come to terms with the legacy of the past and the conundrums of the present before they can start grappling with the challenges of the future. Animal experimentation is one of the more contentious scientific issues they will face.

The New Zealand Curriculum discusses "what science is about".[11] It explains how to carry out an investigation, the importance of developing scientific knowledge through communication and debate, and the need for logic, insight and respect for evidence.

Ethics is also an important consideration but this word is often surprisingly absent from the discussion. Animal experimentation is one of the few areas of science whereby scientific study can cause direct harm and even death to living beings.

In New Zealand, science students are required "to consider the social and ethical implications involved in making decisions about living things".[12]

Animals in Science is intended to assist science students in making informed decisions on this important aspect of learning about the living world.

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11 Ministry of Education. *Science in the New Zealand Curriculum*. p. 52. 1996

12 Ibid

Rabbits trapped in a laboratory.
Getty Images

A researcher prepares to anaesthetise a nude mouse to harvest tumour cells.
HANK MORGAN – Getty Images

Close-up of a guinea pig used in a scientific experiment in a toxicology laboratory.
Getty Images

Ham, the first chimpanzee in space.
Getty Images

SECTION 1

UNITS OF STUDY

Ethical Arguments and Alternatives to Animal Experiments

LESTER LEFKOWITZ - Getty Images


DAVID HISER – Getty Images

ANIMALS IN SCIENCE

Every year over 100 million animals are used in experiments globally. New Zealand's contribution to this figure is around 250,000 animals. Animal experimentation is a contentious issue that has sparked outrage and division between members of the public and scientists and even within the scientific fraternity itself. Justification for animal experiments generally hinges on the benefits to humans outweighing the costs to animals. This is easy to say when animals are paying the cost and not the humans.

Animals in Science invites students to consider the cost to animals and investigate the possibility of alternatives to animal experimentation.

The texts in this resource are intended to open a dialogue and spark debate about the legitimacy of animal experimentation. *The New Zealand Curriculum* describes science as "generating and testing ideas, gathering evidence … making observations … carrying out investigations … and debating with others".[1] *Animals in Science* presents a series of questions for science students to ask when considering animal testing. Questions are posed about the ethical objections regarding the sentience of animals and their ability to suffer. Are animal experiments valid scientifically, and can we extrapolate from mice to men? What alternatives are available, and is there enough effort being put into finding alternatives to animal experiments? Is it possible to study animals in a non-invasive way? These questions and many others are posed in the units of study provided in *Animals in Science*.

1 *The New Zealand Curriculum*. p. 28.

"generating and testing ideas, gathering evidence … making observations … carrying out investigations … and debating with others"

***Rats Have No Gall Bladder:* The validity and ethics of animal experimentation** (Year 13)

In this unit students will research and write about a contemporary and controversial socio-scientific issue – animal experimentation. They will discuss the implications for animals and explore the various opinions about animal experimentation. This unit provides an opportunity for students to think critically about a much debated, contentious issue.

***Do Animals Play Fair?:* A non-invasive behavioural study** (Year 12)

In this unit students will conduct a study of cognitive ethology (the study of cognitive processes). Students will investigate the importance and relevance of play behaviour in dogs and native parrots. The task will involve the collection, interpretation and processing of data. This unit provides a unique opportunity for students to observe behaviour in the field, practically in their own backyards.

***Bodies Apart:* A non-invasive comparative anatomy study** (Years 9-10)

In this unit students will investigate, describe and compare the circulatory and respiratory systems of mammals, amphibians and birds. This unit provides an opportunity to examine anatomical structures and differences without harm to human or non-human animals.

***Sentience is the Bedrock of Ethics:* A study of sentience in non-human animals** (Year 11)

In this unit students will investigate the scientific evidence of sentience in non-human animals. Using a set text, *Second Nature* by Jonathan Balcombe, students will gather, process and interpret information and then produce a report of their findings. Secondary resources can be used to support evidence and back up arguments.

BIOLOGY UNIT OF STUDY 1

■ YEAR 13 ■ NCEA AS91602 ■ LEVEL 3.2 ■ CREDITS 3 ■ DURATION 3-4 weeks

Supports internal assessment for Achievement Standard 91602
Integrate biological knowledge to develop an informed response to a socio-scientific issue

Rats Have No Gall Bladder

The validity and ethics of animal experimentation

TEACHER GUIDELINES

The following guidelines are supplied to enable teachers to carry out valid and consistent assessment using this internal assessment resource. Teachers need to be very familiar with the outcome being assessed by Achievement Standard 91602. The achievement criteria and explanatory notes contain information, definitions and requirements that are crucial when interpreting the standard and assessing students against it.

CONTEXT/SETTING

This task requires students to research and integrate biological knowledge to develop a reasoned informed position on **the validity and ethics of animal experimentation** and **alternatives to animal experimentation**. They need to present a personal position, propose action(s) at a personal and/or societal level and explain why they chose this position and action(s). Students are asked to analyse and evaluate relevant biological knowledge related to the issue to justify this position and action(s). Students can collect primary and secondary data, information and opinions. A range of material covering the basic biological knowledge, implications and different opinions relating to the issue is required.

NOTE: *Animals in Science* provides a range of materials and opinions that **oppose** animal experimentation. Students will need to do research outside this textbook for materials and opinions that are in favour of animal experimentation.

This issue is a contemporary one with direct relevance to New Zealand and/or the Pacific region (over 250,000 animals are used in experiments in New Zealand each year). It is expected that students begin with a broad issue such as toxicology, behavioural studies, genetic engineering or biomedical tests, and refine it into one with direct relevance to the New Zealand/Pacific region.

CONDITIONS

Students must work individually through the task, which should take approximately **three to four weeks**, both in and out of class. Select a time frame that suits you and your students to ensure they have enough time to complete the assessment.

If this work is to be completed out of school then teachers can employ their school's strategies to ensure authenticity. These may include conferencing at milestones, random checking of phrases using internet search engines, handing in copies of the research information highlighted to show ideas and signed authenticity guarantees from students.

At Level 3, the investigation is carried out with guidance. While the whole process is student driven, teachers provide support throughout. For example, the teacher can provide additional resource material and/or suggest sites for further research or possible new directions. Students are required to sift and evaluate any material in order to select and integrate the most relevant information.

All processed material used in the development of the student's response (e.g. in a research logbook or portfolio) is to be submitted and may be used as evidence of authenticity, processing, integration and evaluation.

RESOURCE REQUIREMENTS

Students will need access to a range of information sources. Some of these can be found in this *Animals & Us* textbook and could be supplemented with secondary information (i.e. science and biology magazines, science and biology internet sites, news sites, etc). Access to computers may be required.

ADDITIONAL INFORMATION

Students will be expected to integrate material from different sources (often within a paragraph), rewritten in the student's own words. Paragraphs should flow in a logical manner rather than jumping from one topic to another. Referencing the presentation or selecting and organising information in their research logbook may demonstrate integration.

Good referencing practice, using accepted protocols, is expected at this level. To make a judgement about the authenticity and integration of student work, the teacher may use references or a reference list as evidence. As there is no specific requirement for referencing this will not preclude the achievement of the standard. However, if no references are given then an alternative means of authentication must be submitted by the student.

Assessment may involve the development of a report, an article for a newspaper, a speech or a presentation to an appropriate audience, or other appropriate response. It is important that students are not precluded from showing evidence of excellence by electing to use a specific approach or format that potentially limits them. So if the informed response was a letter to the editor or a PowerPoint presentation, for example, the processed and integrated supporting material must form part of the evidence collected towards the standard.

Conditions of assessment related to this Achievement Standard can be found at: www.tki.org.nz/e/community/ncea/conditions-assessment.php

FOCUS FOR RESEARCH

Alternatives: What are the alternatives to animal experimentation (e.g. epidemiology, clinical studies, *in vitro*, autopsies, studies of genetics, diagnostic imaging, post-marketing drug surveillance)?

Validity: Are animal experiments a valid way to predict effects in humans (can results from one species be applied to another species – e.g. rat to mouse or mouse to human)?

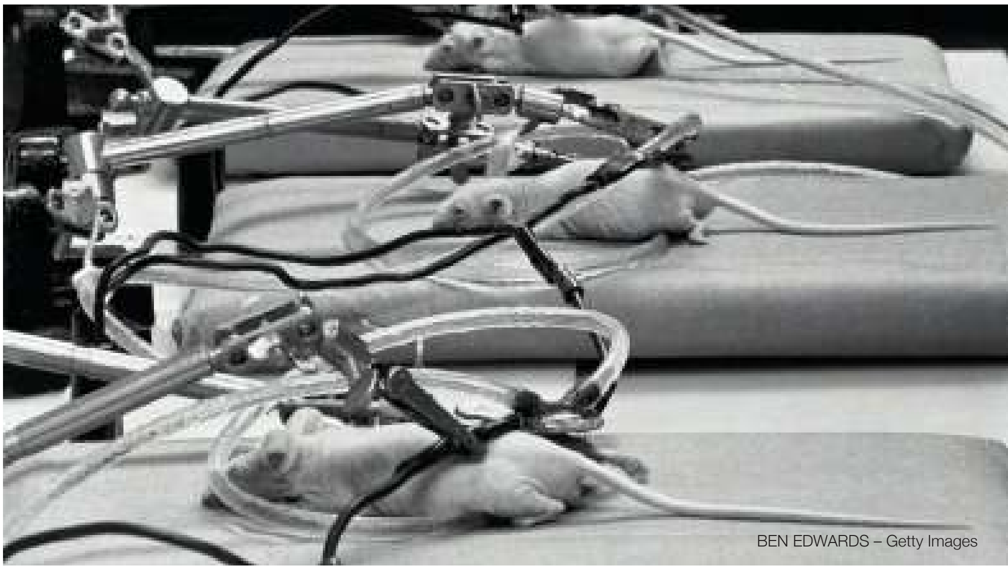
Suffering: To what degree do animals suffer physically and psychologically in experiments (e.g. discuss the use of anaesthesia and analgesics)?

Ethics: What are the ethical arguments for and against the use of non-human animals in experiments?

BACKGROUND INFORMATION

There are four **main purposes** for animal experimentation:

1. **Basic biological research** – e.g. manipulation of animals for educational/academic purposes.
2. **Commercial research** – e.g. manipulation of animals for pharmaceutical companies and corporations, to create new drugs and increase the productivity or efficiency of animals.
3. **Medical research** – e.g. manipulation of animals in order to find cures for diseases or medical conditions.
4. **Veterinary and animal husbandry research** – e.g. manipulation of animals for veterinary and agricultural purposes.



BEN EDWARDS – Getty Images

Internal assessment Achievement Standard 91602 Level 3.2 © NZQA. Adapted by *Animals & Us* with permission.

The main **types of experiments** conducted on animals include:

1. **Toxicology** (manipulation of animals to test household products and/or cosmetics, drugs and medications) – e.g. LD50, Draize test, skin irritancy, carcinogenicity, neurotoxicity, pyrogenicity, reproductive and developmental toxicity.

   Potential **research** topics:

   - The use of LD50 tests in animal experiments.
   - The use of the Draize test in animal experiments.
   - The use of skin irritancy tests in animal experiments.
   - The use of carcinogenicity tests in animal experiments.

2. **Behavioural studies** (manipulation of animals for psychological purposes) – e.g. causing animals to be addicted to drugs, exposing animals to stressors such as electric shocks to assess reactions.

   Potential **research** topics:

   - The use of electric shocks in behavioural studies.
   - The study of animals in artificial environments.
   - The effect of isolation on social animals.
   - The use of addiction tests in animal experiments.
   - The use of sleep deprivation tests in animal experiments.
   - The use of dietary manipulation in animal experiments.
   - The removal of animals from the wild for animal experimentation.

3. **Genetic engineering of animals** (manipulation of animals for the purpose of creating genetic hybrids or variants) – e.g. transgenics, cloning, xenotransplantation.

   Potential **research** topics:

   - The use of transgenics in animal experiments.
   - The use of xenotransplantation in animal experiments.
   - The use of cloning in animal experiments.

4. **Biomedical tests** (manipulation of animals to improve human health, e.g. to find cures for cancer, Aids, heart disease, blindness, deafness, paralysis) – e.g. infecting animals with diseases, disabling animals to mimic impairment, surgeries on animals.

   Potential **research** topics:

   - Infectious diseases in animal experimentation.
   - Cancer research in animal experimentation.
   - Disability research in animal experimentation.
   - The use of invasive procedures in animal experimentation (surgery, transfusions, drawing blood).

NOTE: Students may be unable to access published examples of current animal experiments. Many scientists, however, publish abstracts of their findings on the following website:

US National Library of Medicine, www.ncbi.nlm.nih.gov/pubmed

These abstracts in themselves give little evidence of the impact on animals and are not in lay terms. Full texts are available in some cases but most come at a cost.

Doctors carry out a haemorrhagic shock experiment on white rats in a laboratory.

CHINA PHOTOS – Getty Images

Achievement Criteria AS91602 (Biology 3.2): Integrate biological knowledge to develop an informed response to a socio-scientific issue.		
ACHIEVEMENT	ACHIEVEMENT WITH MERIT	ACHIEVEMENT WITH EXCELLENCE
Integrate biological knowledge to develop an informed response to a socio-scientific issue.	Integrate biological knowledge to develop a **reasoned** informed response to a socio-scientific issue.	Integrate biological knowledge to develop a **comprehensive** informed response to a socio-scientific issue.
Evidence/Judgements for Achievement	Evidence/Judgements for Merit	Evidence/Judgements for Excellence
The student integrates relevant biological knowledge to develop an informed response on the issue of the ethics and validity of using animals in experiments by describing: • the biological concepts and processes relating to the issue *For example:* *A reasonable and rational balance should be sought between upholding the interests of people and those of laboratory animals.* • one biological and one social implication (economic, ethical, cultural or environmental) of the issue. *For example:* *Almost all animals used in animal experiments are higher vertebrates and possess the neuroanatomical mechanisms and psychological capacities necessary to experience pain, fear and psychological distress.* *Animal-based toxicology appears to be "frozen in time, using and accepting the same old animal models again and again, often without stringent examination of their validity".*	The student integrates relevant biological knowledge to develop a **reasoned** informed response on the issue of the ethics and validity of using animals in experiments by describing: • the biological concepts and processes relating to the issue • one biological and one social implication (economic, ethical, cultural or environmental) of the issue • two different opinions or viewpoints about the issue (one for and one against) • a personal position and one proposed personal/societal action. The personal position and proposed personal/societal action are explained by giving reasons, with supporting evidence, on why these have been chosen. *For example:* *I oppose the use of animals in experiments as an ethical and valid way to predict results in humans as described by …* *The physiological differences between species, and even between genders, renders experiment results meaningless.* *… explains that stress in laboratory animals has also been studied intensively, with results showing that cardiovascular parameters, serum concentrations and hormones in laboratory animals are significantly distorted.* *I will write to NAEAC (National Animal Ethics Advisory Committee) to ask how New Zealand has meaningfully committed to the three 'R's and what alternatives have been developed to replace …*	The student integrates relevant biological knowledge to develop a **comprehensive** informed response on the issue of the ethics and validity of using animals in experiments by describing: • the biological concepts and processes relating to the issue • one biological and one social implication (economic, ethical, cultural or environmental) of the issue • two different opinions or viewpoints about the issue (one for and one against) • a personal position and one proposed personal/societal action. The personal position and proposed personal/societal action are explained by giving reasons, with supporting evidence, on why these have been chosen. An analysis and evaluation of the biological knowledge related to the issue is used to justify a personal position and proposed personal/societal action by one of: • comparing the significance of the biological and/or social implications • considering the likely effectiveness of the proposed personal/societal action • commenting on the sources of biological knowledge used by considering ideas such as validity (date/currency, peer review status, scientific acceptance) or bias (attitudes, values, beliefs). *For example:* *There are several viable alternatives to … as described in … At this stage it is unknown if New Zealand is utilising these alternatives. In its annual report NAEAC states … in regard to alternatives to animal experiments. The likelihood of gaining access to specific experiments carried out in New Zealand is very low, as these details are not made public. Since a large proportion of animal experimentation is commercially based the chances of corporations making changes towards alternatives without either some kind of internal change in philosophy or external pressure is quite small.*

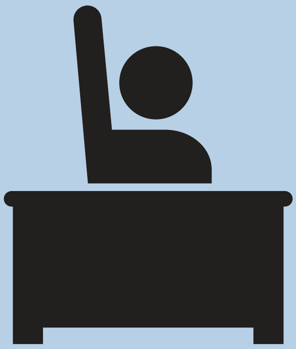
BIOLOGY UNIT OF STUDY 1

■ YEAR 13 ■ NCEA AS91602 ■ LEVEL 3.2 ■ CREDITS 3 ■ DURATION 3-4 weeks

Supports internal assessment for Achievement Standard 91602
Integrate biological knowledge to develop an informed response to a socio-scientific issue

Rats Have No Gall Bladder

The validity and ethics of animal experimentation



STUDENT GUIDELINES

This assessment activity requires you to integrate biological knowledge to prepare a report in response to the socio-scientific issue of the **validity and ethics of animal experimentation**. In your report you will present a personal position and propose action(s) at a personal and/or societal level.

INTRODUCTION

Animal experimentation is a subject that has been vigorously debated in society since the mid-1800s due to the pain and suffering experienced by animals, and questions over ethics and the significance of many of the experiments. Despite its long history this issue remains as contentious as ever. Today, new technologies and developments in genetic engineering and biomedicine demand the use of increasing numbers of animals. Experiments where human and non-human animal genes are combined are not only controversial, they create complex ethical dilemmas. Increasing numbers of scientists are beginning to question whether the results from experiments on animals are relevant or safe for humans.

In this resource, the focus will be on the socio-scientific debate surrounding animal experimentation.

CONDITIONS

You will be assessed on the comprehensiveness of your response and on the extent to which you justify your response by analysing and evaluating relevant biological knowledge.

You will work independently and have four weeks to complete the assessment. Your teacher may provide you with extra resource material and/or suggest relevant information sites or possible new directions for your research.

TEACHER NOTE: Select a time frame that suits you and your students, ensuring they have enough time to complete the assessment. Specify milestone points to monitor progress and a due date.

You will need to hand in your research notes and a reference list to show the sources of your information.

TEACHER NOTE: Define a particular format for your students to collate their research notes and reference list in (e.g. a research logbook or portfolio).

NOTE: This *Animals & Us* textbook contains information that argues against animal experimentation. In order to seek differing opinions, you will need to widen your research beyond the materials provided in this textbook.

A rat whose DNA has been genetically modified so that its skin is covered in wrinkles. It is used to test anti-ageing cosmetics.

Photo taken from: COLORS no. 19/1997

BACKGROUND INFORMATION

This unit looks at the socio-scientific topic of animal experimentation with particular emphasis on the ethics and validity of animal experimentation. The main **types of experiments** conducted on animals include:

TOXICOLOGY

NOTE: Due to public pressure, technological advancements and ethical concerns the LD50 and Draize tests are falling out of use.

Manipulation of animals to test household products and/or cosmetics, drugs and medications – e.g. LD50, Draize test, skin irritancy, carcinogenicity, neurotoxicity, pyrogenicity, reproductive and developmental toxicity. **Potential research topics include:**

- use of the LD50 test in animal experiments
- use of the Draize test in animal experiments
- use of skin irritancy tests in animal experiments
- use of carcinogenicity tests in animal experiments.

BEHAVIOURAL STUDIES

Manipulation of animals for psychological purposes – e.g. causing animals to be addicted to drugs, exposing animals to stressors such as electric shocks to assess reactions. **Potential research topics include:**

- use of electric shocks in behavioural studies
- study of animals in artificial environments
- effect of isolation on social animals
- use of addiction tests in animal experiments
- use of sleep deprivation tests in animal experiments
- use of dietary manipulation in animal experiments
- removal of animals from the wild for animal experimentation.

GENETIC ENGINEERING

Manipulation of animals for the purpose of creating genetic hybrids or variants – e.g. transgenics, cloning, xenotransplantation. **Potential research topics include:**

- use of transgenics in animal experiments
- use of xenotransplantation in animal experiments
- use of cloning in animal experiments.

BIOMEDICAL TESTS

Manipulation of animals to improve human health, e.g. to find cures for cancer, Aids, heart disease, blindness, deafness, paralysis – e.g. infecting animals with diseases, disabling animals to mimic impairment, surgeries on animals. **Potential research topics include:**

- infectious diseases in animal experimentation
- cancer research in animal experimentation
- disability research in animal experimentation
- use of invasive procedures in animal experimentation (surgery, transfusions, drawing blood).

NOTE: If you wish to choose your own topic please present this to your teacher for approval.

MARTIN ROGERS – Getty Images

Rabbit subjected to skin irritancy test for a cosmetic in the laboratories of the Mennen Company.

PETA

BACKGROUND INFORMATION

Be sure to include information on the following areas in your report.

ETHICS

Are ethics overshadowed by scientific demands for advancement, in the case of animal experimentation?

What are the ethical objections to animal experimentation (consider speciesism, principle of equality, status, moral capacities, intellect, ability to communicate, sentience)?

What are animal ethics committees, and how do animal ethics committees make their decisions about animal experimentation? Are they effective?

Would you allow your companion animal to be experimented on? Why/why not?

VALIDITY

What criteria do you think would justify animal experimentation (e.g. only if it saves human lives or to increase production)?

How valid do you think animal experiments are? Do the anatomical, physiological and genetic differences between human and non-human animals affect the validity of the results of animal experiments (i.e. can we extrapolate test results from mice to men)?

ALTERNATIVES

In your opinion, is enough effort being put into finding alternatives to animal experimentation?

Why aren't alternatives used more often?

What role do the government and business sectors play in preventing alternatives from being used?

PAIN AND SUFFERING

How much pain and suffering is involved in animal experimentation? Is this pain necessary to the results of the experiment? Can it be justified?

NOTE: It will help your research process if you pose a set of questions on each of the key areas for consideration: ethics, validity, alternatives, and pain and suffering.

EXTENDED WRITTEN TEXTS

Books (non-fiction)

- Greek, Jean Swingle and Greek, C. Ray (2000). *Sacred Cows and Golden Geese: The Human Cost of Experiments on Animals.* pp. 133-139 (validity), pp. 140-151 (alternatives)
- Knight, A. (2011). *The Costs and Benefits of Animal Experiments.* pp.158-171
- Regan, Tom (1994). 'Ill-gotten gains'. *The Great Ape Project*. pp. 120-125

SHORT WRITTEN TEXTS

Journal

- Phillips, M.T. (1993). 'Savages, Drunks, and Lab Animals: The Researcher's Perception of Pain'. *Society & Animals* Vol. 1:1, p. 194

Newspapers

- Chug, Kiran (2011). 'Animal death toll ends cloning trials'. *The Dominion Post.* p. 209
- Gibson, Eloise (2010). 'GM Mutant cows die in trial'. *New Zealand Herald.* p. 211
- NZPA (2003). 'Animal testing body seeks rigid record keeping'. *New Zealand Herald.* p. 213
- Woulfe, Catherine (2008). 'Headless chickens put to the test'. *Sunday Star Times.* p. 214

Magazines

- Bone, Alistair (2002). 'Pain Factor: How much do animals suffer in this country in the name of science?' *Listener.* p. 205
- Graham-Rowe, D. (2009). 'Could lab rats be replaced by a lung on a chip?' *New Scientist* Vol. 202: 2712. p. 209
- Lyon, Z.M. (2007). 'Human skin to replace animal tests'. *New Scientist* Vol. 195: 2614. p. 210

Statistics

- Graphs and notes. p. 215

ONLINE RESOURCES

Books

- Amey, Catherine (2008). *Clean, Green, and Cruelty Free? The True Story of Animals in New Zealand.* Rebel Press, Auckland. www.nzchas.canterbury.ac.nz/Clean, green cruelty free April 2008.pdf

Journal Article

- Knight, Andrew (2007). *Systematic reviews of animal experiments demonstrate poor human clinical and toxicological utility.* Altern Lab Admin. altweb.jhsph.edu/wc6/paper125.pdf

Reports

- Anderegg, C., Archibald, K., Bailey, J., Cohen, M.J., Kaufman, S.R., & Pippin, J.J. (2006). *A Critical Look at Animal Experimentation.* Medical Research Modernization Committee. www.safermedicines.org/resources/index.shtml
- Bourke, D. & Eden, M. (2003). *Lifting the veil of secrecy on live animal experiments.* Alliance Against Vivisection. www.animalsandus.org.nz/animals_in_science.html
- Animal Welfare Directorate. *Animal use statistics.* Ministry of Agriculture and Forestry www.biosecurity.govt.nz/regs/animal-welfare/pubs/animals-used-in-research (click on Animal Use Statistics – Guidance for Completing Statistical Returns, under the heading 'Animal Manipulation Statistics' at the bottom of the page)

Lecture

- Dr Ray Greek www.afma-curedisease.org/video.html

WEBSITE LINKS

- American Anti-Vivisection Society www.aavs.org
- Americans For Medical Advancement www.curedisease.com
- Andrew Knight, Bioethicist www.andrewknight.info/index.html
- Animal Aid www.animalaid.org.uk/
- BUAV The Campaign To End All Animal Experiments www.buav.org
- Center for Alternatives to Animal Testing (CAAT) caat.jhsph.edu/
- Centre for Animals and Social Justice www.casj.org.uk/
- GE-Free NZ www.gefree.org.nz/
- InterNICHE www.interniche.org/about.html
- Johns Hopkins University Bloomberg School of Public Health: Alternatives to Animal Testing altweb.jhsph.edu/
- SAFE Inc www.safe.org.nz/safeshopper.org.nz/
- Soil and Health Association/Organic NZ www.organicnz.org/
- The Green Party www.greens.org.nz/ge
- The Tom Regan Animal Rights Archive www.lib.ncsu.edu/animalrights/
- Uncaged www.uncaged.co.uk/

VISUAL AND ORAL TEXTS

Documentaries

- Safer Medicines Trust *Animals in Science* DVD
- Wasted Lives *Animals in Science* DVD

Undercover footage

- BUAV TV: The Ugly Truth (animal testing at Wickham Labs) *Animals in Science* DVD
- BUAV TV: Primate Testing www.youtube.com/watch?v=Sgkgwfahfiw&feature=related

INTRODUCTORY BIBLIOGRAPHY

- Recommended reading. p. 222

NOTE: Page numbers refer to *Animals in Science*

TASK 1

Select a Research Topic

A socio-scientific issue is one on which people hold different opinions or viewpoints. The issue will have both biological and social implications. Social implications may be economic, ethical, cultural or environmental.

After examining the suggested readings provided, choose a research topic on which to base your report.

Follow the steps described in Tasks 1-3 to produce a report (including references) on the validity and ethics of animal experimentation. Your final position could be presented during a debate to Year 13 students who do not study biology or delivered at a public meeting called to discuss this issue. Keep a logbook documenting your research. Include references.

TASK 2

Conduct your Research

Research the issue of the validity and ethics of animal experimentation with a particular focus on your chosen research topic.

Select and organise relevant biological knowledge that can be used to develop an informed response to this issue.

Keep a record of your research in a logbook. Include a reference list. Your research logbook must be handed in with your completed presentation, as it is used to assess how you have processed and integrated the biological knowledge you have gathered during your research.

A sample research log is provided on pages 19-20.

Check out the suggested reading on page 16, online resources on pages 226-231 and introductory bibliography on pages 222-225.

Tips to refine and define your research topic

Write a short summary that:

- briefly states the research topic you have chosen
- states why the research topic is a socio-scientific issue
- identifies some initial key research questions
- lists some suitable resources that could be used.

Tips for researching and collecting information

Sources could include books, newspaper articles, journal articles, TV programmes, videos, websites, interviews, etc.

Filter out the:

- scientific, biological, social, economic, ethical and environmental viewpoints that relate to your research topic
- background of your research topic – e.g. how it emerged as a socio-scientific issue
- range of differing opinions relating to the research topic.

Tips for processing your information

Processing will involve:

- sorting out and summarising relevant information and evidence
- listing key points and relevant arguments from your information and evidence.

After processing your information, you may realise that it is incomplete, and that you need to carry out further research.

Organise your research

Collate your notes and copies of research material into a clearfile folder or portfolio.

Highlight and tag key ideas

Go through the research material and use colour highlighters, stickies and/or annotations to draw attention to the key points. This will help you to quickly access the main ideas from your research material when you come to write your report.

Produce a reference list

Create a reference list that includes all the sources of information you are likely to use in your speech or presentation.

TASK 3

Create your Report, Speech or Presentation

Using your research as a basis, create your report, speech or presentation.

Presentation

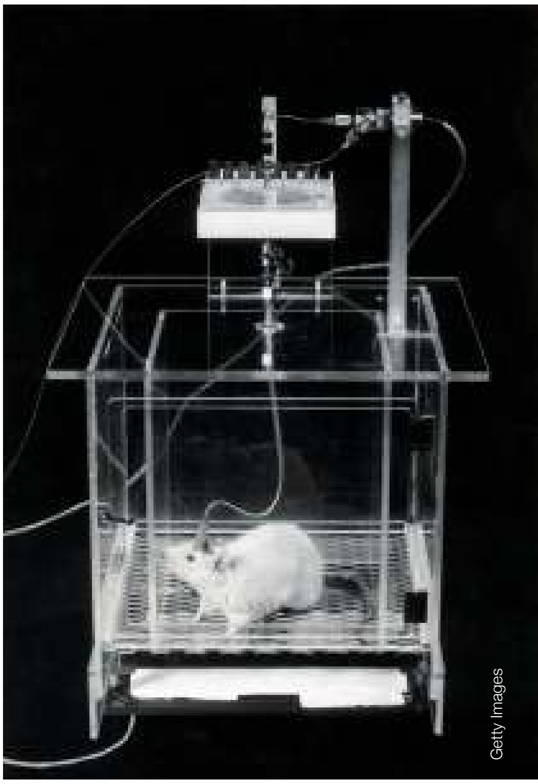
Choose a format for your presentation from the list below. Make sure that the format you use allows you to complete a comprehensive, informed response:

- written report
- speech
- PowerPoint presentation (including supporting information)
- seminar
- video.

In your report, speech or presentation:

1. Outline relevant biological knowledge such as:
   (a) biological concepts and processes on the ethics and validity of animal experiments (e.g. the suffering of animals during animal experiments)
   (b) biological implications (e.g. the effects of animal experiments on the human population) and social implications (e.g. the ethical debate in regard to animal experimentation)
   (c) different opinions or viewpoints that people have about animal experimentation (consider how bias may influence these opinions on both sides of the argument).
2. Use the biological knowledge you have gathered to present your personal position and proposed action(s) by yourself and/or society on the use of animal experiments in New Zealand.
3. Give reasons (with supporting evidence) to explain why you chose this position and proposed action(s).
4. Analyse and evaluate the biological knowledge related to the issue to justify your position and proposed action(s) by:
   (a) comparing the significance of the biological and social implications of the issue
   (b) considering the likely effectiveness of your and/or society's proposed action(s)
   (c) commenting on your sources and information by considering ideas such as:
      - validity (date/currency, peer review status, scientific acceptance)
      - bias (attitudes, values, beliefs) – i.e. weighing up how science ideas are used by different groups.

Hand in your written report, speech or presentation along with your research logbook.



Getty Images

Internal assessment Achievement Standard 91602 Level 3.2 © NZQA. Adapted by *Animals & Us* with permission.

Research Topic: Use of LD50 animal experiments

Student Name: ____________

QUESTIONS → SOURCES ↓	Why are some people ethically opposed to using animals in research such as LD50 experiments?	What happens to rodents used in LD50 experiments?	Are the LD50 experiments always able to be extrapolated to humans?	What are the alternatives to using rodents in LD50 experiments?
Animal Liberation by Peter Singer	*"We have seen that experimenters reveal a bias in favor of their own species whenever they carry out experiments on nonhumans for purposes that they would not think justified them in using human beings, even brain-damaged ones. This principle gives us a guide toward an answer to our question. Since a speciesist bias, like a racist bias, is unjustifiable, an experiment cannot be justifiable unless the experiment is so important that the use of a brain-damaged human would also be justifiable."* p. 85	*"The most widely known acute toxicity test is the LD50. LD50 stands for 'lethal dose 50 percent': the amount of the substance that will kill half of the animals in the study. To find that dose level, sample groups of animals are poisoned. Normally, before the point at which half of them die is reached, the animals are all very ill and in obvious distress. In the case of fairly harmless substances it is still considered good procedure to find the concentration that will make half the animals die; consequently enormous quantities have to be force-fed to the animals, and death may be caused merely by the large volume or high concentration given to the animals."* pp 53-54	*"Toxicologists have known for a long time that extrapolation from one species to another is a highly risky venture. The most notorious drug to have caused unexpected harm to humans is thalidomide – which was extensively tested on animals before it was released. Even after thalidomide was suspected of causing deformities in humans, laboratory tests on pregnant dogs, cats, rats, monkeys, hamsters, and chickens all failed to produce deformities … As well as exposing people to harm, testing on animals may lead us to miss out on valuable products that are dangerous to animals but not to human beings. Insulin can produce deformities in infant rabbits and mice, but not in humans. Morphine, which is calming to human beings, causes mice to go into drug frenzies. And as another toxicologist has said: 'If penicillin had been judged by its toxicity on guinea pigs, it might never have been used on man.'"* p. 57	
Sacred Cows and Golden Geese by Jean Swingle Greek and C. Ray Greek	*"Those who say we test on animals to avoid testing on people are wrong. Once animal studies are complete, all new medications are evaluated on humans. The first people to take a new substance are being experimented on as surely as if they were guinea pigs locked in a laboratory.* *Open up a rat, a dog, a pig, and a human, and you will find much the same terrain but with differences. These visible differences have an impact when it comes to assimilating drugs. Consider the most commonly used species in toxicology research, the rat. Rats have no gall bladder. They excrete bile very effectively. Many drugs are excreted via bile so this affects the half-life of the drug. Drugs bind to rat plasma much less efficiently."* p. 59		*"Rats always breathe through the nose. Because some chemicals are absorbed in the nose, some are filtered. So rats get a different mix of substances entering their systems. Also they are nocturnal. Their gut flora are in a different location. Their skin has different absorptive properties than that of humans. Any one of these discrepancies will alter drug metabolism. And these are only differences on a gross level."* p. 59	*"We would conduct experiments on human cells and human tissues, examine and document humans at autopsy, tally and analyze the results of human epidemiology studies, more carefully observe humans in the clinical setting and spread the word among humans on preventative measures. It is human health that is at risk and human wellness that is our objective. Is it not reasonable to observe the species that needs curing directly?* *Everyone agrees that epidemiology makes sense. Same with autopsy. Few intelligent people argue that a clinical condition documented in an actual human never happened. Genetic, in vitro, and high tech developments may be inscrutable to the average person. But few question whether it is prudent to study the composition of the very cells and genes that are inflicting or skirting human disease."* pp. 99-100

QUESTIONS → SOURCES ↓	Why are some people ethically opposed to using animals in research such as LD50 experiments?	What happens to rodents used in LD50 experiments?	Are the LD50 experiments always able to be extrapolated to humans?	What are the alternatives to using rodents in LD50 experiments?
The Costs and Benefits of Animal Experiments **By Andrew Knight**	*"It is the opinion of various philosophers (e.g. Singer 1990, Busche 2008) that a reasonable and rational balance should be sought between upholding the interests of people and those of laboratory animals. This requires balanced consideration of the interests of both groups: primarily, the human interests in obtaining benefits such as new clinical interventions and the identification of toxins, and the interests of animals in avoiding harms such as involuntary confinement, social disruption, various forms of suffering, and death."* p. 180		*"… animal experimentation is unreliably – and frequently poorly – predictive of human outcomes, and consumes enormous financial resources and human expertise, which are then unavailable to other research fields. Those potentially affected include patients, consumers, and scientists. The moral implications are profound when consumers suffer serious toxic reactions to products assessed as safe in animal studies (Chapter 5) …"* pp. 185-186	*"During pharmaceutical development or toxicity assessment, qualities such as absorption, distribution, in vivo concentrations in various body compartments, organ systems affected, toxicity, efficacy, clearance, and metabolic fate can be predicted to varying degrees though physico-chemical evaluation, chemical grouping with interpolation or extrapolation of properties, and computerised modelling, including the use of structure-activity relationships and expert systems.* *A variety of tissue cultures are available, including immortalised cell lines, embryonic and adult stem cells, and organotypic cultures. In vitro assays using bacterial, yeasts, protozoal, mammalian, or human cell cultures can predict a wide range of toxic and other endpoints."* p. 184
'A Critical Look at Animal Experimentation' Medical Research Modernization Committee. pp. 1-22. www.mrmcmed.org		*"The lethal dose 50 (LD50) test – which determines how much of a drug, chemical or household product is needed to kill 50% of a group of test animals – requires 60 to 100 animals (usually rats and mice), most of whom endure great suffering."* p. 6	*"Because of difficulties extrapolating the results to humans, the [LD50] test is highly unreliable. Also, since such variables as an animal's age, sex, weight and strain can have a substantial effect on the results, laboratories often obtain widely disparate data with the same test substances."* p. 6	*"In vitro tests have been validated to replace the LD50 test, which was deleted from the test guidelines of the Organisation for Economic Cooperation and Development (OECD) in 2002."* pp. 6-7

NOTE: This example focuses on an experiment that has fallen out of use. When selecting a topic ensure your research is based on current experiments.

BIOLOGY UNIT OF STUDY 2

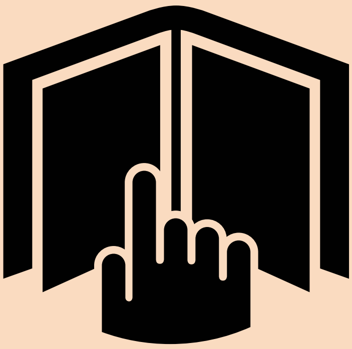
■ YEAR 12 ■ NCEA AS91153 ■ LEVEL 2.1 ■ DURATION 2-3 weeks

Supports internal assessment for Achievement Standard 91153
Carry out a practical investigation in a biology context, with supervision

A LESSON IN COGNITIVE ETHOLOGY

Do Animals Play Fair?

A non-invasive behavioural study



TEACHER GUIDELINES

The following guidelines are supplied to enable teachers to carry out valid and consistent assessment using this internal assessment resource. These teacher guidelines do not need to be submitted for moderation.

CONTEXT/SETTING

Students are expected to carry out an **investigation of life processes**, in this instance cognitive ethology (the broad biological study of cognitive processes). Well-known cognitive ethologists include Dr Jane Goodall (chimpanzees) and Dian Fossey (gorillas). This investigation will look at **reciprocal play patterns and behaviours** in dogs, kea or kaka. The investigation will discuss how reciprocal play processes illustrate a survival advantage. There is an extension exercise on how this survival advantage can lead to moral development in animals.

Students will need to have had considerable practice at developing investigations. In regard to developing their investigation and collecting data they will need to know how to plan, carry out, process and interpret data. In regard to writing their report they will need to know how to develop a conclusion, discuss biological concepts and processes relating to the investigation (i.e. what the investigation showed about the concept or process), and evaluate the investigation.

This investigation involves the assessment of a pattern or relationship (EN 5).

SUPERVISION: Parts 1, 2 and 3 all provide opportunities for the teacher and student to discuss and clarify the student's ideas about the investigation (EN 6). Supervision can be written or verbal, and can occur at checkpoints or milestones when the work in progress is handed in or it could occur through general discussion with the class and with individuals.

It is expected that students will work through the complete investigation process and will have the opportunity to make changes to their initial method as they carry out the investigation (EN 4).

CONDITIONS

This is a practical activity that will be carried out both in the field and in the laboratory. Students will need **approximately two hours** to plan, trial and develop a method for their investigation. Students will need **approximately three hours** to collect primary data and a further **two to three hours** to process the data and write a report (although this will depend on the type of animal studied and location of the investigation).

This assessment activity is to be carried out in three parts that lead to the production of an investigative report.

The specific conditions (equipment and materials required) are stated on the student instruction sheet.

RESOURCE REQUIREMENTS

Equipment and materials required:

- Video camera
- Videotape
- Tripod
- Movie software (Movie Maker for PC or iMovie for Mac)
- Cell phone (with video)
- Computer
- Access to animals (dogs, kea, kaka) at play (dog park, animal shelter, ski field, national park, etc).

ADDITIONAL INFORMATION

Health and safety procedures and compliance with the Animal Welfare Act 1999 must be adhered to (EN 2).

During the teaching and learning of the investigation procedures related to Year 12 Biology, examples of Achieved, Achieved with Merit and Achieved with Excellence reports should be gathered and annotated to highlight evidence that meets the standard. The annotations should be developed though consultation with other Year 12 biology teachers and the reports kept for future reference.

To gain merit and excellence, students need to **discuss and evaluate** the investigation. In the discussion they need to show understanding and recognition of key play-soliciting and anti-social behaviours. They need to show understanding by discussing how and why these behaviours occur and how they ensured that the method they used was **valid and reliable** – i.e. how sources of errors were minimised and limitations overcome, how bias (the lack of objectivity when carrying out the investigation) was removed and how they know they gathered sufficient data (EN 9).

THE INVESTIGATION

PART ONE
Develop a Plan/Method

The student is provided with a *Planning Sheet* (p. 29) and will work independently or in pairs to complete this.

The student should be given the opportunity to conduct trials to develop their method, and to establish the sample selection for pattern seeking. A record of this trialling needs to be outlined on the *Planning Sheet* or in the final report.

The student uses the *Planning Sheet* and trial results to write a detailed, step-by-step method. The *Planning Sheet* (or other check sheets) may be used to self-evaluate whether the method is workable.

PART TWO
Collect and Record Data

The student follows their written method as they proceed to collect their own data. The method may be modified, but these modifications must be recorded in their final report and indicated to the assessor. The student must process the data collected in a form that shows a pattern or trend or the absence of either. This may be achieved by averaging, using a table or using a graph.

PART THREE
Present a Report

The student, working independently, presents the report of the investigation following the directions/format given in the student instructions.

GUIDE TO NON-INVASIVE ANIMAL STUDIES

This behavioural study unit looks at animal play in both domestic and wild animals. The beauty of this particular unit of study is that all we need to do is observe the animals in as unobtrusive a manner as possible. In fact, the more 'invisible' we are, the more likely the animals will relax and behave in a natural manner. Domestic dogs are familiar with the presence of humans and as a consequence are usually natural, comfortable and at ease playing around us.

The purpose of including this lesson on animal behaviour is to illustrate that it is possible to investigate, study and, as a consequence, learn about animals in a non-invasive way. Wild kea and kaka might be a little more shy and difficult to get close to (although kea are famous for their cheeky antics!). To learn more about the importance of minimising or even eliminating human intrusions when studying animal behaviour, see the extracts from Marc Bekoff's book *The Emotional Lives of Animals* on pages 103-119 of *Animals in Science*.

<table>
<tr><td colspan="3">Achievement Criteria
AS91153 (Biology 2.1): Carry out a practical investigation in a biology context, with supervision.</td></tr>
<tr><td>ACHIEVEMENT</td><td>ACHIEVEMENT WITH MERIT</td><td>ACHIEVEMENT WITH EXCELLENCE</td></tr>
<tr>
<td>Carry out a practical investigation in a biology context, with supervision.

The report shows the development and carrying out of an investigation.</td>
<td>Carry out an in-depth practical investigation in a biology context, with supervision.

The report shows the development and carrying out of a quality investigation.</td>
<td>Carry out a comprehensive practical investigation in a biology context, with supervision.

The report shows the development, carrying out and evaluation of a quality investigation.</td>
</tr>
<tr>
<td>The report includes:

Purpose of the investigation (explicit) describing how reciprocal play processes illustrate a survival advantage.
A method that includes a description of the range of data to be collected for each animal, how samples and sample size will be decided and how other variables will be measured.
Collecting, recording and processing of data relevant to the purpose:

construction of an ethogram
data processed in a way that allows a trend or pattern to be determined.

Reporting on the findings

Conclusion reached based on the processed data in relation to the purpose of the investigation.

</td>
<td>The report includes:

Purpose of the investigation (explicit) describing how reciprocal play processes illustrate a survival advantage.
A method that includes a description and explanation of a valid range of data to be collected for each animal, how samples and sample size will be decided and how other variables will be measured.
Collecting, recording and processing of data to enable a trend or pattern to be determined:

construction of an ethogram
data processed in a way that allows a trend or pattern to be determined and interpreted
accurate calculation of results in a table, graph or calculation of averages.

Reporting on the findings

Valid conclusion reached based on the processed data in relation to the purpose of the investigation.
Discussion uses knowledge of play processes and behaviours to explain the trend or pattern in the results.
</td>
<td>As for Achievement with Merit.

Evalution of the investigation by justification of the conclusion in terms of the method used by considering EITHER the reliability of the data OR the validity of method. For example, sufficient data, appropriate range of IV, appropriate processing using ethograms and graphs, minimisation or removal of sources of errors, limitations, bias.

</td>
</tr>
</table>

BIOLOGY UNIT OF STUDY 2

■ YEAR 12 ■ NCEA AS91153 ■ LEVEL 2.1 ■ DURATION 2-3 weeks

Supports internal assessment for Achievement Standard 91153
Carry out a practical investigation in a biology context, with supervision

A LESSON IN COGNITIVE ETHOLOGY

Do Animals Play Fair?

A non-invasive behavioural study

STUDENT INSTRUCTIONS

In this assessment you will carry out an investigation of life processes, in this instance cognitive ethology (the broad biological study of cognitive processes). Famous cognitive ethologists include Dr Jane Goodall (chimpanzees) and Dian Fossey (gorillas). This investigation will look at reciprocal play patterns and behaviours in dogs, kea or kaka. The investigation will discuss how reciprocal play processes illustrate a survival advantage. There is an extension exercise on how this survival advantage can lead to moral development in animals.

You will develop a method; collect, process and interpret information; and present a report on play behaviour in animals.

The assessment has three parts plus an optional extension exercise:

PART ONE: Develop a Plan/Method
PART TWO: Collect and Record Data
PART THREE: Present a Report
EXTENSION EXERCISE (optional)

PART ONE

Develop a Plan/Method

Use the information in this section (Part One: Develop a Plan/Method) to help you fill in the planning sheet provided (see page 29).

Before you start planning, take a look at some of the suggested reading texts on page 33. Reading through these extracts will assist the planning of your investigation.

1. Purpose of investigation – Do animals play fair?

You are to develop and carry out an investigation into life processes that explains how and why reciprocal play behaviour is a valuable survival adaptation. As an extension exercise you may also consider how this type of play behaviour leads to moral decision making and development in animals.

In this investigation you will explore play behaviour in dogs, kea or kaka. You will learn how to collect and analyse behavioural data from animals engaged in play.

1. (a) Preparation of investigation question (purpose of investigation)

Some examples of testable questions that you could research include, but are not limited to:

- Which behaviours are used most consistently to solicit play?
- Do animals that engage in high rates of offensive play behaviour (e.g. chasing, forcing partner down) initiate play with more or less frequency than those that play without (or with fewer) offensive behaviours?
- Do animals show a preference in their play partner?
- Is there a temporal pattern underlying any of the play behaviours? For example, do 'play bows' in dogs always occur at the beginning of play interactions or are they distributed throughout the play bout?

- What proportion of bites are immediately followed by a 'play bow' in dogs?
- Do kea primarily 'play' in groups or in pairs?
- Does play attract others?
- What proportion of play bouts leads to episodes of play fighting in kea?
- Does the variety of the displayed play repertoire increase significantly with bout length (e.g. the longer the play bout, the greater the variety of play behaviours)?
- What proportion of play interactions in kea begins with a hopping approach or head cock?

Use different combinations of the following contrasting features to form your question for the investigation: male/female, larger/smaller, younger/older. For example:

- Do females or males self-handicap more regularly?
- Do females initiate play more regularly with larger or smaller animals?
- Do younger animals show higher rates of aggressive behaviour in comparison with older animals?
- Do smaller dogs solicit play more frequently than larger dogs?

There are many more potential questions that you could investigate. Have a look at the suggested reading if you are stuck for ideas.

It is usual scientific practice to make initial observations before forming hypotheses. From the observations you will develop tentative answers to questions (hypotheses), which will enable you to make predictions. Testing your predictions gathers results that either support or oppose your hypothesis. Testing predictions also gathers new observations that can be developed into new hypotheses for future research.

2. Data collection for pattern seeking

Pattern seeking involves observing and recording natural events, or carrying out experiments where the variables can't easily be controlled.

In pattern seeking, it is important to note and record variables. The investigator needs to try to identify patterns that result from these variables.

Once a pattern has been observed this may lead to other investigations in an effort to try to explain why a particular pattern occurs, and to a classifying and identifying system.

Source: www.tki.org.nz/r/science/science_is/teaching_science/types_investigation_e.php

2. (a) What/who are you going to observe?

The next stage of the investigation involves deciding what **type of animal** you intend to investigate:

- DOGS
- KEA
- KAKA.

2. (b) How/where will the observations occur?

Record the location where you intend to film your chosen animals playing.

Some suggestions include, but are not limited to:

- Dog park (dogs)
- Dog shelter (dogs)
- Boarding kennel (dogs)
- Beach (dogs)
- Your home/farm (dogs)
- Arthur's Pass (kea)
- Ski field car park (kea)
- Wildlife sanctuaries (Zealandia, Pukaha Mt Bruce, Little Barrier Island, Kapiti Island) (kaka)
- Some national parks (kea, kaka).

Also record if you will use different locations or make return visits to the same location over the course of your investigation.

2. (c) How many observations will you need to take to get reliable data?

A play bout that only lasts for a couple of minutes contains a surprising amount of information when viewed frame by frame. Aim to record as many play bouts as practical within the time constraints.

NOTE: If you spend more than three hours filming and fail to get any usable footage, you can resort to using the footage on the DVD provided with this resource.

3. Other factors that could influence the investigation

A range of factors can influence play behaviour. For instance, some ethologists suggest that play happens more often at certain times of the day. You can control this factor by scheduling your filming for the same time each day. Another factor that you need to take into account is the mitigating factor of human presence. Some subject animals may behave differently in the presence of people or become fixated on people. On occasion, animals react to subtle cues given by people. One author controlled this variable by blindfolding the humans, but this may be inappropriate for your investigation. For your study you can control human influence by politely asking people to ignore the animals you are filming.

4. How will you ensure that your results are reliable?

When more than one person is analysing the film footage, it is a good idea to test observer agreement. Watching the same footage without the other observer(s) present and filling in the results sheet achieves this. Comparing the two results following the observation will generate observer agreement.

5. Extraneous notes from your trials

Be sure to make a note of any extraneous results from your trials to include in your report.

Extraneous results are those unexpected or unrelated results that have occurred but fall outside the scope of your investigation.

NOTE: Extraneous results are only worth mentioning if they in some way interfered with your investigation.

6. Method

Develop a method to investigate reciprocal play behaviour in dogs, kea or kaka.

Your method should state:

- the purpose of your investigation (an explicit testable question, prediction or hypothesis, or an aim) in relation to reciprocal play behaviour
- the range of data to be collected (which animals, and specific information about the individual animals – i.e. species, sex, age, size, etc)
- how the data will be collected for each animal (or play bout)
- how animals will be chosen and the number of play bouts decided upon
- how other variables and factors that could have a significant impact on the investigation will be measured or observed (i.e. interference from people or other factors)
- the equipment needed
- how the results will be checked to see if they are accurate, valid and reliable.

You may have to trial aspects of this initial method to ensure that it is workable.

Write up a step-by-step method that someone else could follow. Check that your method includes all the information listed in the bullet points above and that it provides data or information relevant to your hypothesis.

This investigation will require you to record instances of play on video and analyse the footage frame by frame. Have a look at Bekoff, *Play Signals as Punctuation* and Diamond and Bond, *Kea, Bird of Paradox* and *Social Play in Kaka* in the suggested reading on page 33 for examples of methods using the filming of play behaviour.

You will need to construct an ethogram before you start analysing the film footage. An ethogram is a list of behaviours with corresponding descriptions. Examples of ethograms for dogs and kea are given below (on pages 31-32) for you to model your own ethogram on.

It is also useful to construct a results table for simplified collection and analysis of film footage data. An example of a results table is also given (on page 30).

DO ANIMALS PLAY FAIR? – PLANNING SHEET

Student name:

1. Purpose of investigation (this may be an aim or a testable question, prediction or hypothesis)

2. Pattern seeking

(a) What/who are you going to observe?

(b) How/where will the observations occur?

(c) How many observations will you need to take to get reliable data?

3. Other factors that could influence the investigation that you intend to take into account.

Describe how this will be done.

4. How will you ensure that your results are reliable?

5. Extraneous notes from your trials

6. Method (this may become your final method that you will use for your report)

7. Changes made to method

Now use the information on your planning sheet to write a detailed step-by-step method that you intend to carry out over the course of your investigation.

PART TWO

Collect and Record Data

1. Carry out your investigation, recording any changes that you make to your initial method developed in Part One.

2. Record data and observations relevant to your investigation in an appropriate way.

- Construct an ethogram using the data gathered on the animal you have chosen to investigate. Examples of ethograms are provided (on pages 31-32).

3. Process your data to produce results that can be compared directly with each other – i.e. to enable a trend or pattern (or absence) to be determined.

- Follow your method to collect data and record the results in a table or another appropriate way. A sample results table can be found below.

4. Graph the processed data in a way that allows you to **interpret the trend** in the data.

- This will usually involve some calculations (e.g. averages) and/or a graph. Look at the table below for an example of how to do this.
- Remember to record any changes to your method as you go. Changes or modifications will often enhance your scientific method and results.
- Record any action or alteration that you carried out to make sure that your method was valid and produced reliable, accurate results (this information could be used in your evaluation).

Sample Results Table

Results Table for Kea Behaviour Experiment

	Behaviour																										
Time	BA	HC	WF	FP	HA	HP	JP	BL	MO	MJ	SS	RO	TS	CH	TW	HU	AP	WI	CR	JF	JC	SD	WH	AL	FL	VO	WH
0.02		X																									
0.03			X																								
0.04	X																										
0.12						X																					
0.13								X																		X	
0.25							X																				
0.26						X																					
0.35		X																									
0.36										X																X	
0.39		X																									
0.42							X																				
0.45										X																	
0.51											X																
0.53		X																								X	
0.56								X																			
1.05												X															
1.06										X																	
1.08							X																				
1.11							X																				
1.15				X																						X	
1.17		X																									
1.23										X																	
1.24																	X										
1.25																X										X	
1.26																			X								
1.27																				X							
1.29																					X						
1.31																											
1.32																											
1.33																											
Total	1	4	1	1	0	2	4	2	0	4	1	1	0	0	0	1	1	0	1	1	1	0	0	0	0	5	0

ETHOGRAMS

ETHOGRAM FOR DOGS

Behaviour	Code	Description
Bow	B	Crouching on forelegs and elevating hind legs
Exaggerated approach	EA	Approaching in a 'loose bouncy' gait at a speed greater than observed during normal walking; the shoulders and head are frequently moved from side to side
Approach/withdrawal	A/W	Approaching then withdrawing
General movements	GM	Includes movements of the head and eyes, such as head tossing and eye rolling, and also body movements such as shoulder swaying
Face pawing	FP	Extension of one of the forelimbs towards the face of the other animal
Leap-Leap	LL	Two high-amplitude leaps in which the forelimbs are lifted off the ground and hit the ground simultaneously
Barking	Bk	Barking directed at the play partner
Chin rest	CR	Resting chin on play partner
Face lick	FL	Licking directed at the face
Inguinal response	IR	Remaining passive during groin contact and genital investigation by play partner
Standing over	SO	One individual places their forepaws on the shoulder or back of another animal and incompletely or fully extends the forelegs
Rolling over	RO	Rolling over on the back and exposing abdomen
General-body bite	GB	Biting directed at the body
Leap	L	One leap in which both the forelimbs are lifted off the ground and hit the ground simultaneously
Tail wag	TW	Wagging tail
Approach	A	Dog moves nearer to play partner
Tail-wag approach	TWA	Wagging tail while approaching play partner
Head shake	HSh	Shaking head from side to side
Hip slam	HS	Shoving hips into the body of the play partner
Scruff-bite intension	SBI	Incomplete biting directed at the back of the neck
Scruff bite	SB	Biting directed at the back of the neck
Face-bite intension	FBI	Incomplete biting attempt directed at the face
Face bite	FB	Biting directed at the face
Mouthing	M	Chewing or gentle biting without closing the mouth tightly
Stalking	ST	One animal slowly circles their play partner and then slowly, stealthily approaches
Chasing	CH	One animal pursuing the other with the apparent intent to catch
Face bump	FBp	Charging and pushing face into play partner

ETHOGRAM FOR KEA

Behaviour	Code	Description
Bite attempt	BA	Using the bill to grab some part of another individual
Head cock	HC	Turning head on one side while looking at or approaching another in play
Wing flap	WF	The wings are opened and flapped as in flight several times, the legs are stretched and the body is held almost vertical
Foot push	FP	Using the feet to push play partner
Hang	HA	Hanging upside down from a branch using feet or bill
Hop	HP	Moving to or from another bird along the ground using both feet simultaneously in short bouncy movements
Jump	JP	One bird jumping; includes jumping over the play partner, and sometimes in the air next to the play partner
Bill lock	BL	Locking, pulling, pushing, wrestling and twisting using bills
Manipulate object	MO	Bird picks up small object such as pieces of paper or small rock
Mutual jumping	MJ	Both birds jumping
Standing on stomach	SS	One bird jumps on the stomach of a bird in a supine position
Roll over	RO	Bird rolls its entire body over and lies on its back and waves its feet in the air
Toss	TS	Bird holds an object in its bill and then jerks its head vertically, releasing the object in the air, sometimes in the direction of the play partner
Chase	CH	One bird pursuing another
Tug-of-war	TW	Bird trying to grasp an object with its bill that is already being held by play partner and both tugging to claim object
Hunch	HU	Posture in which the head is directed downwards and the body is crouched; feathers are fluffed and the tail is fanned out

KEA INFORMATION

How to recognise a juvenile kea

Juvenile kea have bright yellow eyelids, cere and beak. Their crown feathers have a yellowish tinge to them. Fledglings typically acquire their adult plumage at around 18 months of age, although it can take up to four years for juvenile kea to lose the yellow around their eyes.

How to differentiate between males and females

The only visible distinction between the sexes is their beak, with the male kea possessing a larger, longer, curving upper beak. Males, who average around 48cm in length, are also slightly larger in general than females and on average 5% heavier, with bill length and curvature about 14% more than their female counterparts. However, a light male can weigh less than a heavy female.

Females have a distinctly shorter and less curved bill.

Source: www.avianweb.com/keas.html

PART THREE

Present a Report

Write a well-organised report on your investigation that includes:

- The **purpose** of the investigation (e.g. explicit aim, testable question or hypothesis) in relation to the concept or process you investigated).
- The **final step-by-step method** used in the investigation.
- **Recorded measurements** (including units) and observations.
- All **data processed** in a way that allows you to determine a trend or pattern (or absence) relevant to the purpose. This will include tables and graphs if appropriate.
- A **conclusion** analysing your processed data in terms of the purpose of your investigation.
- A **discussion** of the biological concept or process in relation to the results of your investigation.
- An **evaluation** of your investigation. This involves a justification of the conclusion in terms of the method that you used by considering the reliability of the data or the validity of the method (i.e. how sources of error, limitations or bias were minimised or overcome).

SUGGESTED READING

NOTE: Page numbers refer to *Animals in Science*

Kea and Kaka

- *Kea, Bird of Paradox: The Evolution and Behaviour of a New Zealand Parrot.* 1999. J. Diamond and A. Bond. (pp. 126-132)
  This extract discusses a study of kea play behaviour and covers the methods, procedures and types of kea play.
- 'Social Play in Kaka (*Nestor meridionalis*) with Comparisons to Kea (*Nestor notabilis*)'. *Behaviour.* 2004. J. Diamond and A. Bond. (pp. 183-186)
  A results table comparing percentages of play bouts and play actions in both kea and kaka.
- 'Social Play in Kakapo (*Strigops habrotilus*) with Comparisons to Kea (*Nestor notabilis*) and Kaka (*Nestor meridionalis*)'. *Behaviour*. 2006. J. Diamond, D. Eason, C. Reid and A. Bond. (pp. 187-190)
  A table with a comparative ethogram that describes and compares play behaviour in kea, kaka and kakapo.

NOTE: See *Animals in Science* DVD for examples of play behaviour in dogs and kea.

Dogs

- 'Mammalian Play: Training for the Unexpected'. *The Quarterly Review of Biology*. June 2001. M. Spinka, C. Newberry and M. Bekoff. (pp. 191-193)
  This article extract looks at the adaptive value of play, explains 'self-handicapping' and discusses the 'excitement' of play for the animals involved.
- 'Play Signals as Punctuation: The Structure of Social Play in Canids'. *Behaviour.* 1995. M. Bekoff. (pp. 172-178)
  This article extract looks at and explains what play signals are and how to interpret them. It also discusses the structure of play sequences and the methods ethologist Marc Bekoff used to study play in canids.
- 'Social Play and Play-soliciting by Infant Canids'. *American Zoologist*. 1974. M. Bekoff. (pp. 179-182)
  This extract gives definitions of specific canine play actions with photographic illustrations.

EXTENSION EXERCISE

This extension exercise enables you to look further into the *moral* significance of play behaviour. In this exercise you will question whether fairness, trust, honesty, forgiveness, empathy and virtue play a part in play behaviour.

Today's leading ethologists (those who study the science of animal behaviour) are turning their attention to the emotional lives of animals – how they live and how they play. Most of us have witnessed, or even participated with, animals at play at some time or other. In the following passage Marc Bekoff explains how studying animal play helps us understand animal morality:

"… when animals play there are rules of engagement that must be followed, and when these break down, play suffers. Animal play appears to rely on the universal human value of the Golden Rule – do unto others as you would have them do unto you. Following this requires empathy (feeling another's feelings) and implies reciprocity (getting paid back for favors assuming that others follow the same rule). Further, in the social arena, animals who don't play well don't seem to do as well as those who do play. Darwin might very well have been right when he speculated that more sympathetic individuals have more reproductive success – they survive better."

Bekoff, Marc. *The Emotional Lives of Animals: A Leading Scientist Explores Animal Joy, Sorrow, and Empathy – and Why They Matter*. 2007. p. 87 (p. 103 of *Animals In Science*).

Jonathan Balcombe explains that: *"Play is a good indicator of well-being. It occurs when other needs, such as food, shelter and safety, are sufficiently met, and when unpleasant feelings like fear, anxiety and pain are minimal or absent. Otherwise the animal's efforts would be directed at meeting these needs or relieving these feelings, at the expense of play."*

Balcombe, Jonathan. *Pleasurable Kingdom: Animals and the Nature of Feeling Good*. 2006. p. 68.

TASK 1

Choose one of the following moral questions and consider how it relates to your findings. Write **200 words** on the question of whether or not moral behaviour was evident in your investigation into animal play behaviour.

MORAL QUESTIONS (these need to tie in with the investigative questions)

Fairness, trust, honesty and cooperation

- How do animals react to unfair play?
- How do animals negotiate agreements to play (as opposed to mating or fighting)?
- How do animals display honesty and trust during play? Was trust ever violated, and if so were there any penalties or 'costs' for being dishonest?
- In what ways does play teach animals the agreed notions of right and wrong behaviour?
- Did your investigation reveal any evidence that the animals under observation were working to a set of 'rules' apparent to all involved?

Rough play

- Were individuals who played too roughly or aggressively avoided? For instance, did individuals that showed high rates of aggressive behaviour have trouble engaging others in play, did they have shorter bout lengths or were they involved in fewer play interactions?

Apology and forgiveness

- In what ways do animals experience and communicate 'good' and 'bad' behaviour when playing together?
- Were there any behaviours that indicated what could constitute an 'apology'?

Vulnerability and concern for others (self-handicapping, role-reversing)

- How did animals manage differences in size, age and dominance during play? Did this lead to self-handicapping (inhibiting one's strength, dominance, etc) such as role-reversing?

Read the following texts to help with your conclusions:

- 'Wild justice and fair play: cooperation, forgiveness and morality in animals'. *Biology and Philosophy* 19. 2004. M. Bekoff. p. 227

  This article extract discusses the evolution of social morality and how it relates to non-human animals using social play as an example of how cooperation and fair behaviour are negotiated.
- *The Emotional Lives of Animals: A Leading Scientist Explores Animal Joy, Sorrow, and Empathy – and Why They Matter.* 2007. M. Bekoff. p.103

  This book extract defines fairness during play and discusses the idea of morality in animals. It also looks at the emotional response to play and explains the role of the play bow, role-reversing and self-handicapping.

NOTE: Page numbers refer to *Animals in Science*

SCIENCE UNIT OF STUDY 3

■ YEARS 9-10 ■ DURATION 1-2 weeks

Level of Achievement 5

MAKING SENSE OF THE LIVING WORLD

Bodies Apart

A non-invasive comparative anatomy study

TEACHER GUIDELINES

At Level 5, science students will begin to investigate and interpret life processes, ecology and evolution using models, scientific symbols and conventions. Students should at this level be able to evaluate the suitability of their investigative methods and communicate using a wide range of science vocabulary. By gathering relevant scientific information students will draw evidence-based conclusions in order to develop an understanding of socio-scientific issues and, particular to this science strand, life processes, ecology and evolution.

LIFE PROCESSES

- Identify the key structural features and functions involved in the life processes of plants and animals.
- Describe the organisation of life at cellular level.

ECOLOGY

- Investigate the interdependence of living things (including humans) in an ecosystem.

EVOLUTION

- Describe the basic processes by which genetic information is passed from one generation to the next.

LEARNING EXPERIENCES

Possible learning experiences for this topic include:

- comparing the organs of human and non-human animals to make observations on physical differences and collect data on variation
- debating the topic 'conscientious objection – ethical objections to animal experiments and dissection in the classroom' to help clarify ideas and feelings about a current scientific issue.

CONTEXT/SETTING

The practice of dissecting animals in the classroom is a controversial topic with more and more people developing negative attitudes towards it. Millions of animals are killed and dissected in classrooms every year, and many students protest at this gross waste of lives and conscientiously object to undertaking dissection.

In the past, this objection may have led to students losing course credits or losing their enthusiasm for biology altogether. However, with the advent of new technology, there are increasing opportunities for students to learn about animal physiology without any bloodshed.

This lesson focuses on learning about animal physiology without dissecting animals. It provides students with resources to learn about comparative physiology and also an example of how students can learn biological processes through non-invasive experimentation. The aim is to provide students with the same (or better) level of understanding that they would get from dissecting animals. Changing attitudes in the classroom is also a key point covered, with an entire section devoted to conscientious objection. Any student who undertakes this lesson should be able to justify why they object to vivisection.

CONDITIONS

This is a research activity that will be carried out in the laboratory. Students will need **approximately four to six hours** to plan, research and write up their investigation.

RESOURCE REQUIREMENTS

Equipment and materials required:

- *Animals & Us* Issue 4: *Animals in Science*
- Computer
- Library or internet access.

SCIENCE UNIT OF STUDY 3

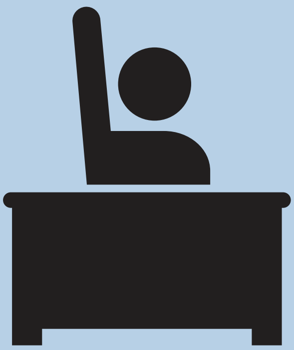
YEARS 9-10 ■ DURATION 1-2 weeks

Level of Achievement 5

MAKING SENSE OF THE LIVING WORLD

Bodies Apart

A non-invasive comparative anatomy study



STUDENT INSTRUCTIONS

In this unit of study you will investigate and describe two key structural anatomical features and functions in human and non-human animals: the **circulatory system** and the **respiratory system**. You will also learn the reasons behind **conscientious objection** to animal dissection.

Two comparative anatomy examples are provided in this lesson, circulation and breathing.

Circulation

When investigating the circulatory system you will compare an amphibian heart with a human heart.

Breathing

When investigating the respiratory system you will compare avian breathing with human breathing.

On completing this investigation you should be able to:

- explain processes that occur during circulation and respiration in frogs, birds and humans
- describe the necessity of life functions in frogs, birds and humans
- understand the differences in circulation and respiration between frogs, birds and humans
- demonstrate how differences in circulation and respiration between frogs, birds and humans affect the behaviour of each species
- record personal data relating to circulation and respiration and compare with that of others
- identify specific anatomical features relating to circulation and respiration in frogs, birds and humans
- compare anatomical structures involved in respiration and circulation in frogs, birds and humans
- discuss the reasons for conscientious objection to animal dissection.

There are **four sections** in this unit.

SECTION ONE
Comparative anatomy

In section one you will learn about the circulatory and respiratory systems in frogs, humans and birds.

1. You will identify the key structures of the human and amphibian hearts and the human and avian respiratory systems.

2. You will describe the differences between the circulatory and respiratory systems of humans, frogs and birds.

SECTION TWO
Multi-choice quiz

Section two will test your knowledge and understanding of the human, avian and amphibian circulatory and respiratory systems in a multi-choice quiz.

SECTION THREE
Experiments

In section three you will do some experiments where you record your own heartbeat and rate of respiration. You will compare your results with the results of others in the class and with other species of animals.

SECTION FOUR
Conscientious objection

Section four explains the concept of conscientious objection and the range of humane alternatives to the use of animals in education.

SECTION ONE

The Circulatory and Respiratory Systems in Human and Non-human Animals

CIRCULATION IN FROGS

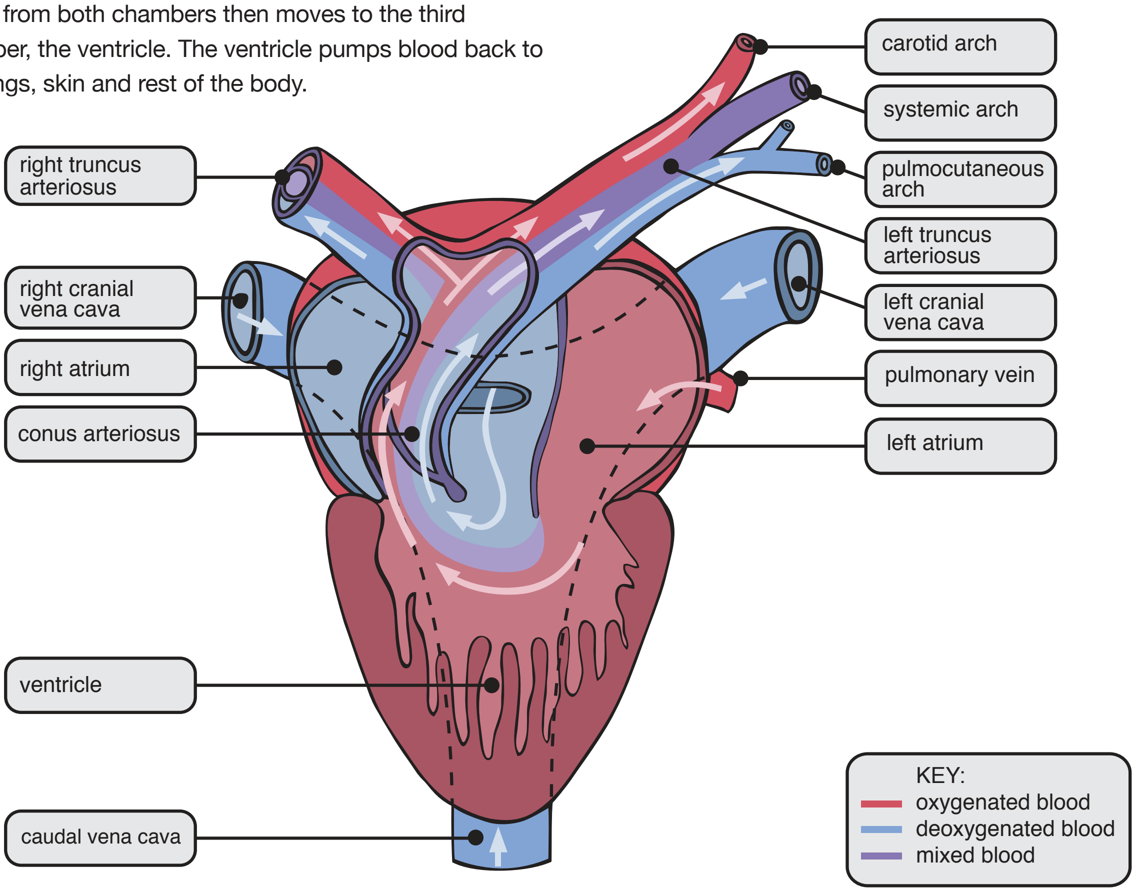
Frog Heart

Frogs have a three-chambered heart. These three chambers are called the right atrium, left atrium and ventricle. The right atrium receives deoxygenated blood from the body. The left atrium receives oxygenated blood from the lungs and skin (a frog's skin is unique in its ability to 'breathe' and participate in gas exchange).

Blood from both chambers then moves to the third chamber, the ventricle. The ventricle pumps blood back to the lungs, skin and rest of the body.

In the ventricle the oxygenated blood (from the lungs and skin) is partially mixed with deoxygenated blood (from the organs). Therefore, the blood that leaves the ventricle for the organs is not saturated with oxygen (as it is in the human circulatory system).

This system works well for a cold-blooded animal.



KEY STRUCTURES OF THE FROG HEART

LEFT ATRIUM
receives **oxygenated** blood from the lungs and skin.

RIGHT ATRIUM
receives **deoxygenated** blood from the body.

VENTRICLE
pumps the blood into the body.

CONUS ARTERIOSUS
carries blood from the ventricle.

LEFT TRUNCUS ARTERIOSUS
carries blood to the left side of the body.

RIGHT TRUNCUS ARTERIOSUS
carries blood to the right side of the body.

PULMOCUTANEOUS ARCH
carries **deoxygenated** blood from the ventricle to the skin and lungs.

PULMONARY VEIN
carries **oxygenated** blood from the lungs to the left atrium.

CAROTID ARCH
carries **oxygenated** blood to the mouth, pharynx and brain.

SYSTEMIC ARCH
carries **oxygenated** blood to the neck, back of the head and forelimbs.

RIGHT CRANIAL VENA CAVA
returns **deoxygenated** blood from the head and right forelimb.

LEFT CRANIAL VENA CAVA
returns **deoxygenated** blood from the head and left forelimb.

CAUDAL VENA CAVA
returns **deoxygenated** blood from the posterior body.

SECTION ONE

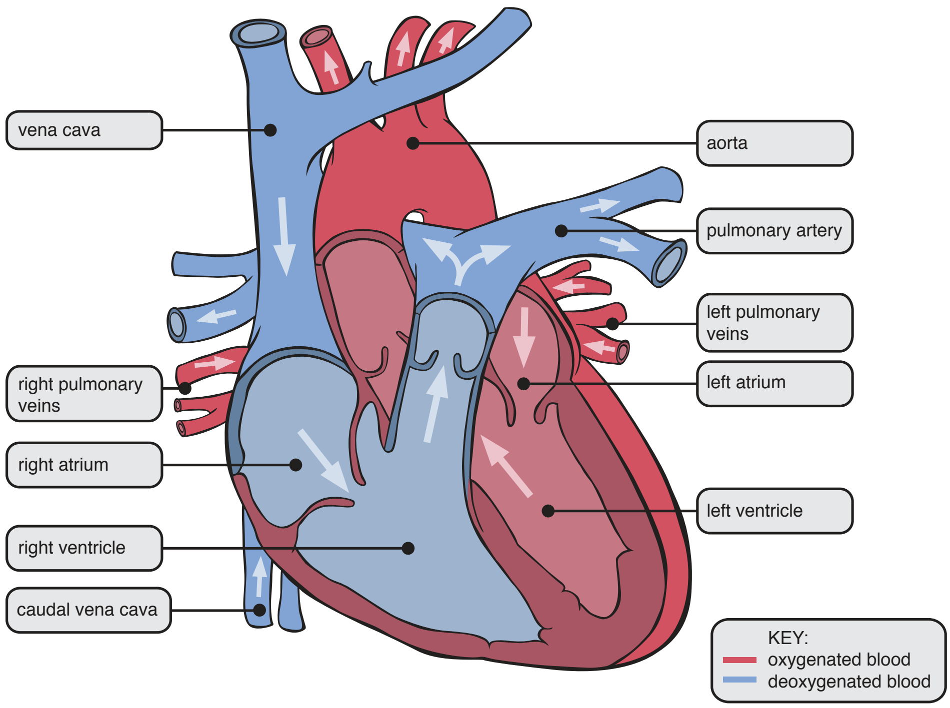
The Circulatory and Respiratory Systems in Human and Non-human Animals

CIRCULATION IN HUMANS

Human Heart

Humans have a four-chambered heart. The four chambers are called the right atrium, left atrium, left ventricle and right ventricle. The left atrium receives oxygenated blood via the pulmonary veins from the lungs. Blood from the left atrium then flows into the left ventricle where it is sealed in by the left atrioventricular valve. The left ventricle contracts, pumping the blood into the aorta where it is fed into the body.

The right atrium receives deoxygenated blood from the body via the vena cava. This blood then passes into the right ventricle where it is sealed in by the right atrioventricular valve. When the right ventricle contracts, blood is passed into the pulmonary artery and then into the lungs where the deoxygenated blood is cleared of its carbon dioxide and reoxygenated.



Arteries

- **Arteries** carry blood away from the heart. Due to the fact that the blood is being pumped by the **ventricle** at high pressure, **arteries** need to be thicker than **veins** and **capillaries**.

Veins

- **Veins** are more elastic tubes than arteries and carry deoxygenated blood from the body tissues back to the heart.

NOTE: In frogs there are two types of veins:

- **Systemic veins** which carry **deoxygenated** blood away from the body.
- **Pulmonary veins** which carry **oxygenated** blood from the lungs.

Valves

Valves allow blood to flow in one direction to prevent the backflow of blood.

- **Atrioventricular valves** are found between the ventricle and atrium. These valves open and close when the heart contracts. The valves stop blood from flowing back into the atriums.
- **Semilunar valves** are found between the ventricles and the aorta and pulmonary artery. These valves prevent blood from flowing back into the ventricles.

KEY STRUCTURES OF THE HUMAN HEART

LEFT ATRIUM
receives **oxygenated** blood from the lungs.

RIGHT ATRIUM
receives **deoxygenated** blood from the body.

LEFT VENTRICLE
pumps **oxygenated** blood into the body.

RIGHT VENTRICLE
pumps **deoxygenated** blood into the lungs.

VENA CAVA
carries **deoxygenated** blood from the body to the heart.

AORTA
carries **oxygenated** blood to all parts of the body.

LEFT AND RIGHT PULMONARY VEINS
carry **oxygenated** blood from the lungs to the heart.

PULMONARY ARTERY
carries **deoxygenated** blood from the heart to the lungs.

CAUDAL VENA CAVA
carries **deoxygenated** blood from the body to the heart.

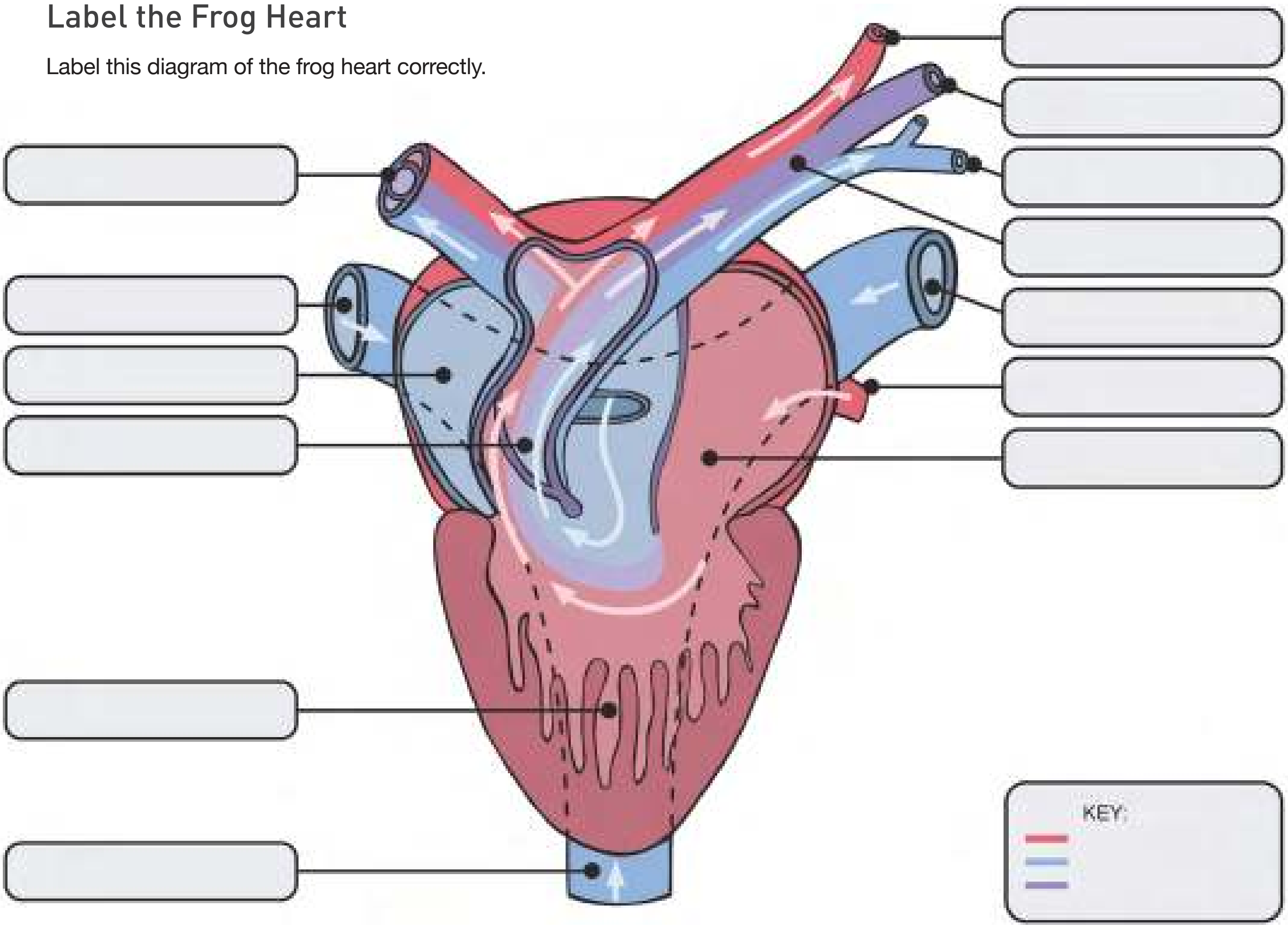
SECTION ONE

The Circulatory and Respiratory Systems in Human and Non-human Animals

TASK 1

Label the Frog Heart

Label this diagram of the frog heart correctly.



Labels

LEFT ATRIUM	LEFT TRUNCUS ARTERIOSUS	CAROTID ARCH
RIGHT ATRIUM	RIGHT TRUNCUS ARTERIOSUS	SYSTEMIC ARCH
VENTRICLE	PULMOCUTANEOUS ARCH	RIGHT CRANIAL VENA CAVA
CONUS ARTERIOSUS	PULMONARY VEIN	LEFT CRANIAL VENA CAVA
CAUDAL VENA CAVA		

Answer on page 57

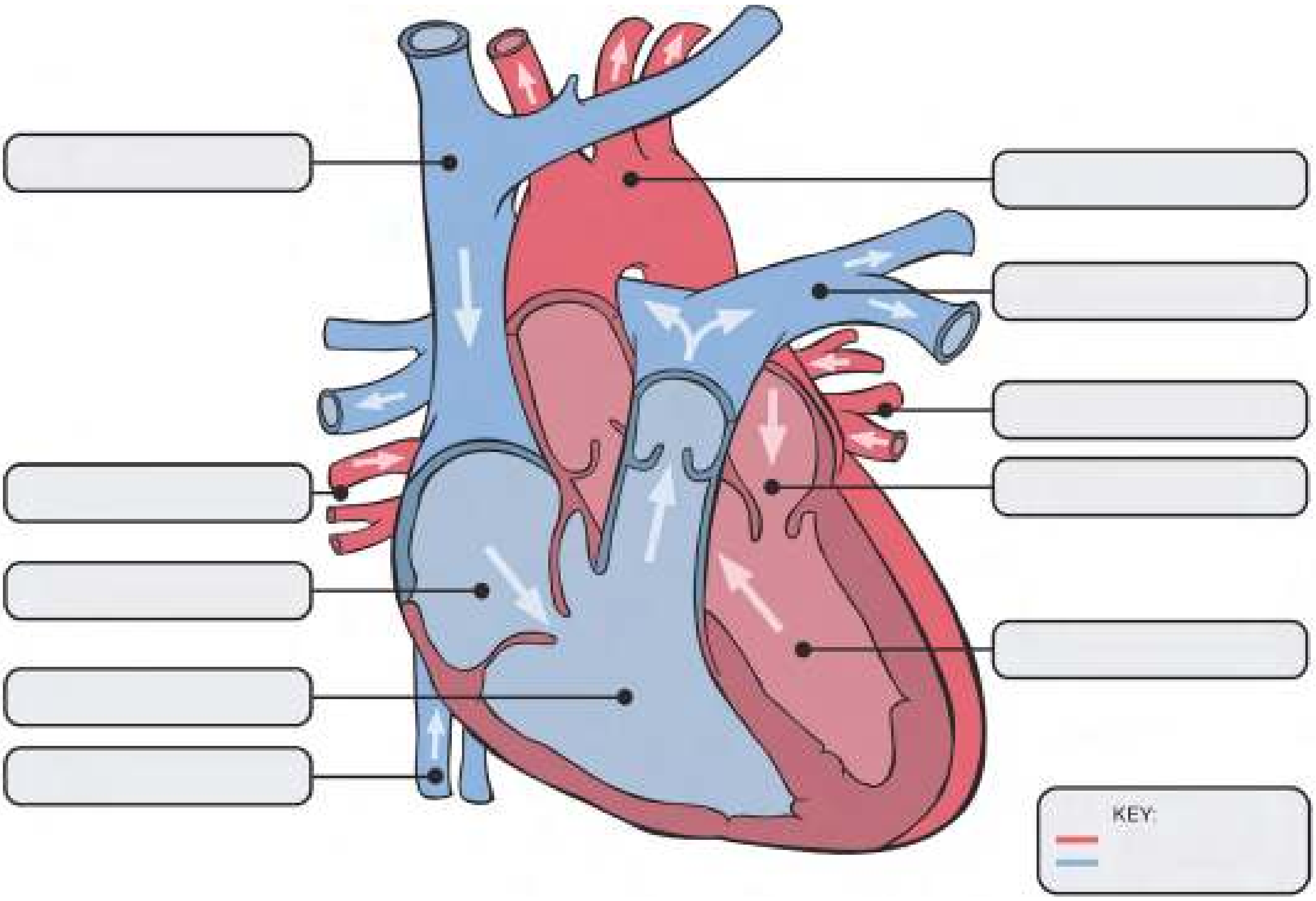
SECTION ONE

The Circulatory and Respiratory Systems in Human and Non-human Animals

TASK 2

Label the Human Heart

Label this diagram of the human heart correctly.



Labels

LEFT ATRIUM	VENA CAVA	RIGHT VENTRICLE
AORTA	LEFT PULMONARY VEINS	PULMONARY ARTERY
RIGHT ATRIUM	RIGHT PULMONARY VEINS	
LEFT VENTRICLE	CAUDAL VENA CAVA	

Answer on page 57

SECTION ONE

The Circulatory and Respiratory Systems in Human and Non-human Animals

TASK 3

Write a Paragraph

Write a paragraph on how the circulatory system of frogs is different to that of humans.

INTERACTIVE LINKS

The following interactive links help to explain the circulatory systems of humans and frogs.

Label the [human] heart

www.sciencelearn.org.nz/Contexts/See-through-Body/Sci-Media/Animations-and-Interactives/Label-the-heart

Human heart animation

www.argosymedical.com/Circulatory/samples/animations/Heart/index.html [no sound]

Frog and human circulatory system (*Animals in Science* DVD)

www.youtube.com/watch?v=oPDjt5_G2V8

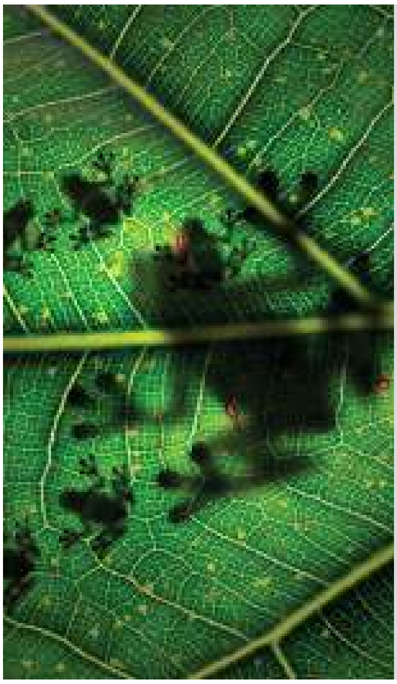
SUGGESTED READING

Electronic Texts

WEBSITES

Save the Frogs
www.savethefrogs.com

Digital Frog International
www.digitalfrog.com



NON-INVASIVE ANIMAL STUDY

Millions of vertebrate animals (most commonly rats and frogs) are bred and killed around the world for the purpose of classroom dissection in biology lessons.

These animals are not recorded in the National Animal Ethics Advisory Committee (NAEAC) animal use statistics because they are already dead when the experiment is conducted (which for statistical purposes prohibits them from being included).

For many students the prospect of an animal being killed and dissected in the classroom is emotionally distressing and ethically fraught.

Animal dissection is an invasive procedure. The animals are killed so that they can later be cut open and have their organs removed and studied.

The learning outcome is not unique for each student – the animals are all killed for the same purpose, the sole reason being that each student will have a personal practical 'hands-on' learning experience.

This unit of study is designed to provide a learning experience that is non-invasive to animals.

SECTION ONE

The Circulatory and Respiratory Systems in Human and Non-human Animals

RESPIRATION IN BIRDS

Avian Breath

Birds need to inhale and exhale twice in order to take a normal breath. In a sense their breath is cyclical. Birds have lungs that are serviced through a system of air sacs. The two main sets of air sacs are the anterior thoracic air sacs and the posterior thoracic air sacs. Gas exchange occurs only in the lungs (not in the air sacs). The series of air sacs and double inhalation/exhalation system ensure birds' lungs have a constant supply of fresh air available. The air sacs act like bellows to ventilate the lungs. This enables birds to survive at altitudes that would require humans to have an oxygen tank.

Breath 1

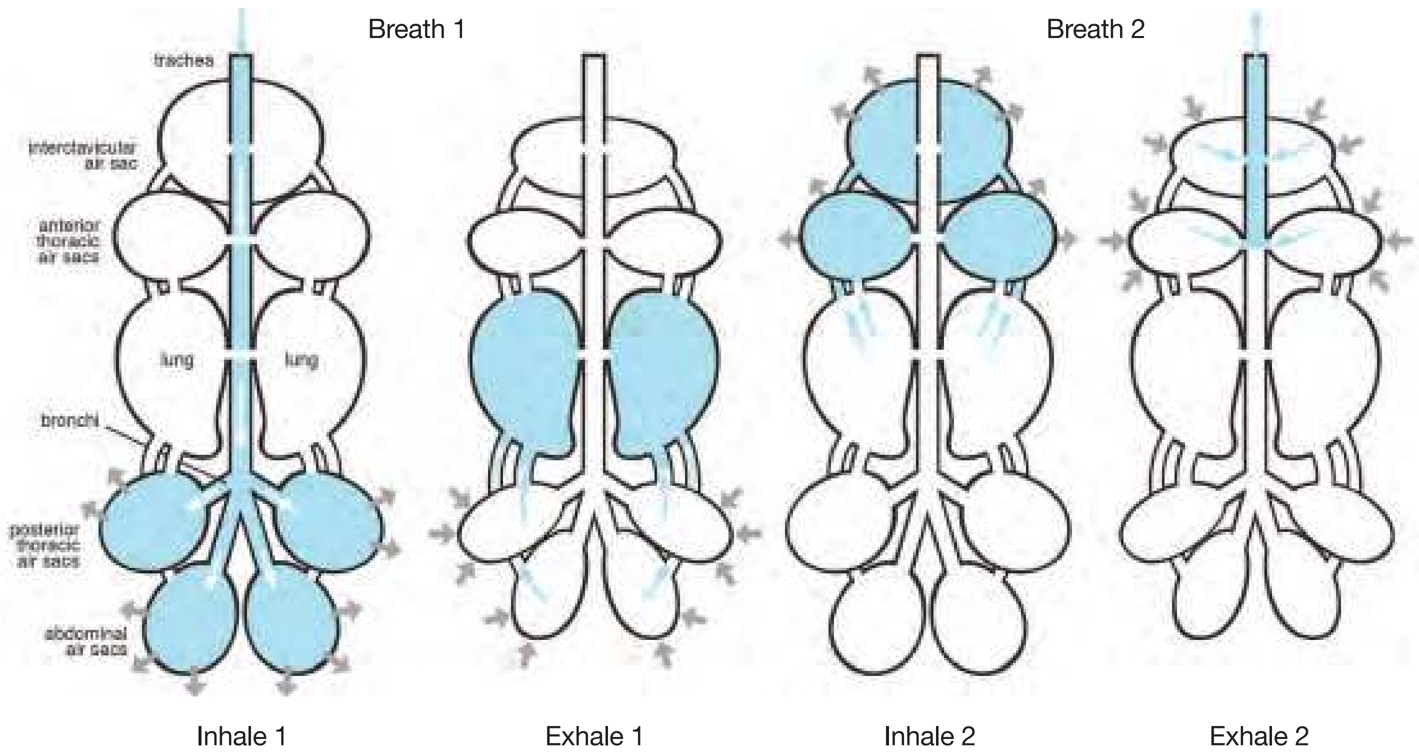
During the first **inhalation** the air sacs expand and fresh air is drawn into the posterior thoracic air sacs. At the same time any air in the lungs is drawn into the anterior thoracic air sacs.

During the first **exhalation** the air sacs compress and this process pushes fresh air out of the posterior thoracic air sacs into the lungs. Any air in the anterior thoracic air sacs is pushed out through the trachea.

Breath 2

During the second **inhalation** the posterior and anterior thoracic air sacs expand. Air moves from the lungs into the anterior thoracic air sacs via the interclavicular air sacs.

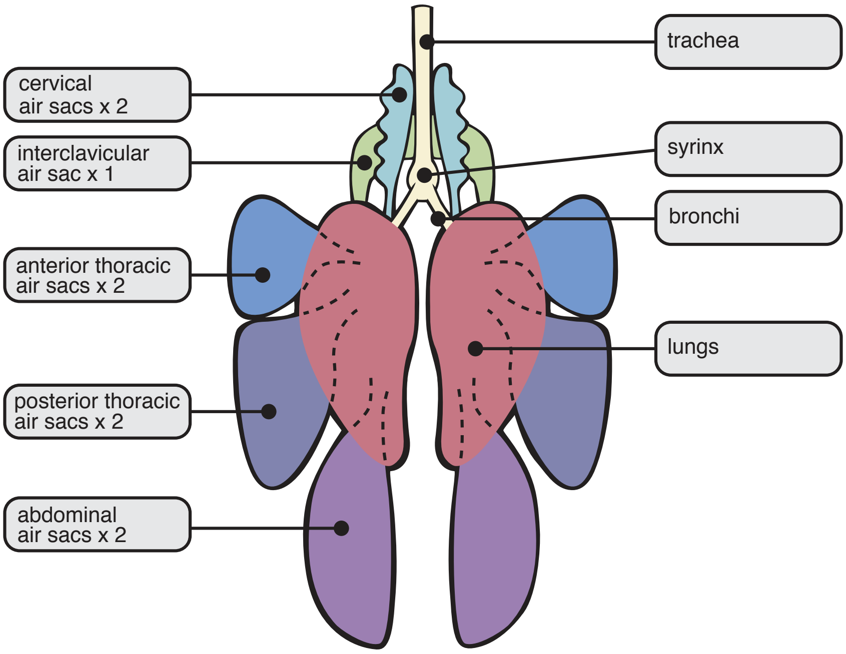
During the second **exhalation** the posterior and anterior thoracic air sacs compress. Air leaves the anterior thoracic air sacs via cervical air sacs into the trachea.



SECTION ONE

The Circulatory and Respiratory Systems in Human and Non-human Animals

RESPIRATION IN BIRDS



Key Structures for Avian Respiration

Trachea

Fresh air moves through the trachea to the syrinx. The trachea then divides in order to take air to the posterior thoracic air sacs (via the abdominal air sacs).

Anterior air sacs (cervical, interclavicular and anterior thoracic)

Cervical air sacs

Air is transferred into the cervical air sacs and moves out and back into the trachea.

Interclavicular air sac

Air moves from the lungs into the interclavicular air sac.

Anterior thoracic air sacs

Air moves from the lungs into the anterior air sacs via the interclavicular air sacs.

Posterior air sacs (abdominal, posterior thoracic)

Posterior thoracic air sacs

Air travels into the posterior air sacs on the first inhalation. On the first exhalation fresh air is pushed from the posterior air sac into the lungs.

Abdominal air sacs

Fresh air moves into the abdominal air sacs from the trachea and from there to the posterior air sacs.

Lungs

Fresh air is fed into the lungs via the posterior air sacs. Deoxygenated air is drawn out of the lungs by the anterior air sacs.

The lungs in birds do not inflate and deflate as they do in mammals. They remain still while the air sacs (which do inflate and deflate) feed fresh air into and draw deoxygenated air out of the lungs).

Syrinx

Lower larynx or voice box, located at the point just before the trachea divides in two.

Bronchi

Air passages that come off the trachea. On the second exhalation air passes from the anterior air sacs back into the bronchi and out of the bird's system.

Diaphragm

In mammals the diaphragm is a dome-shaped muscle that separates the thorax from the abdomen. The contraction and retraction of the diaphragm enables the lungs to inflate and deflate. Paralysis of the diaphragm is serious as without the diaphragm the lungs are unable to receive or expel air.

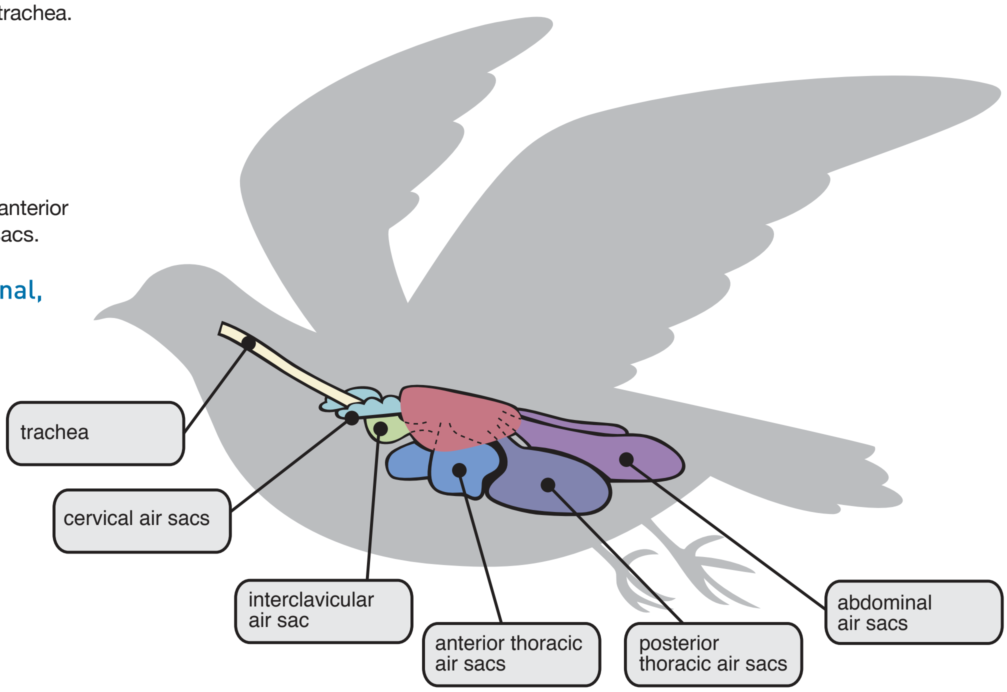
Birds do not have a diaphragm. Muscles in the sternum and chest cavity in combination with the air sacs allow air to flow through the lungs. Therefore, it is important when restraining a bird not to hold its body so tightly that its chest is unable to expand and contract, as this can lead to suffocation.

Parabronchi

Birds do not have alveoli, instead they have parabronchi. Parabronchi are tiny passages that the air flows through on its way to air capillaries where oxygen and carbon dioxide are exchanged with blood capillaries by diffusion.

Nares

These are the bird's equivalent of nostrils and are found on the upper beak. Birds have two nares just as we have two nostrils.



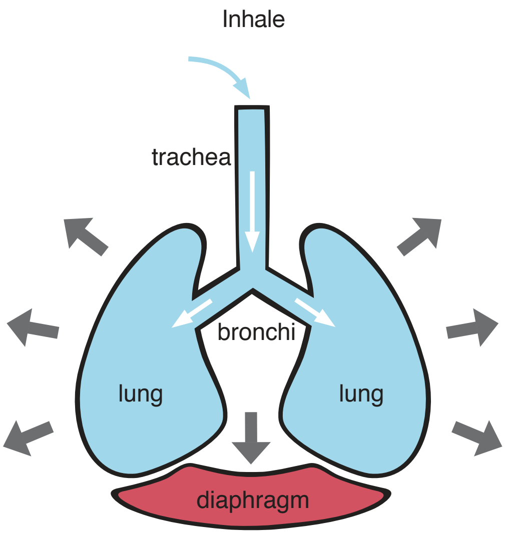
SECTION ONE

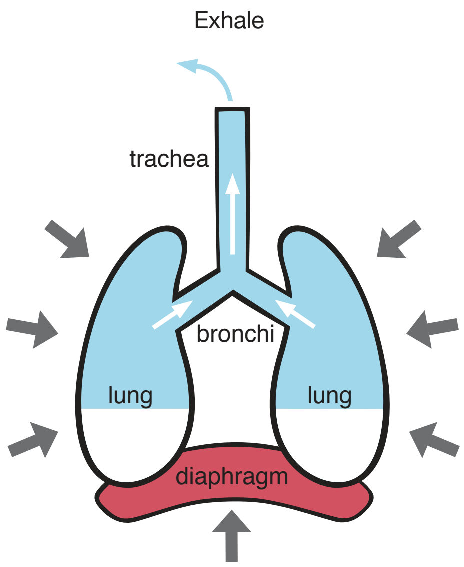
The Circulatory and Respiratory Systems in Human and Non-human Animals

RESPIRATION IN HUMANS

Mammalian Breath

Humans and other mammals breathe through the nose and mouth. Air is carried to and from the lungs via the trachea. On its way to the lungs air is moistened, warmed and filtered in the nasal passage. The diaphragm is a vital part of the breathing process. On each inhalation the diaphragm contracts, allowing the chest cavity to expand and the lungs to fill with air. On each exhalation the diaphragm relaxes and pushes upwards into the chest cavity, causing it to tighten and air to be pushed out of the lungs.





Key Structures for Human Respiration

Nostrils

External openings to the nasal cavity that admit air to the body.

Trachea

Air travels to and from the lungs via the trachea (also called the windpipe). The trachea extends from the larynx (voice box) to the bronchial tubes.

Bronchi

Bronchial tubes transfer air from the trachea to the lungs and specifically to the alveoli (air sacs).

Diaphragm

During an inhalation the diaphragm contracts and moves downwards. The lungs inflate with air and expand into the extra space created in the chest cavity. During an exhalation the diaphragm relaxes and moves upwards, contracting the chest cavity and forcing air out of the lungs into the trachea and out via the nose and mouth.

Lungs

These are the organs that allow oxygen from the air to pass into the bloodstream. They also enable carbon dioxide to be removed from the bloodstream.

Larynx

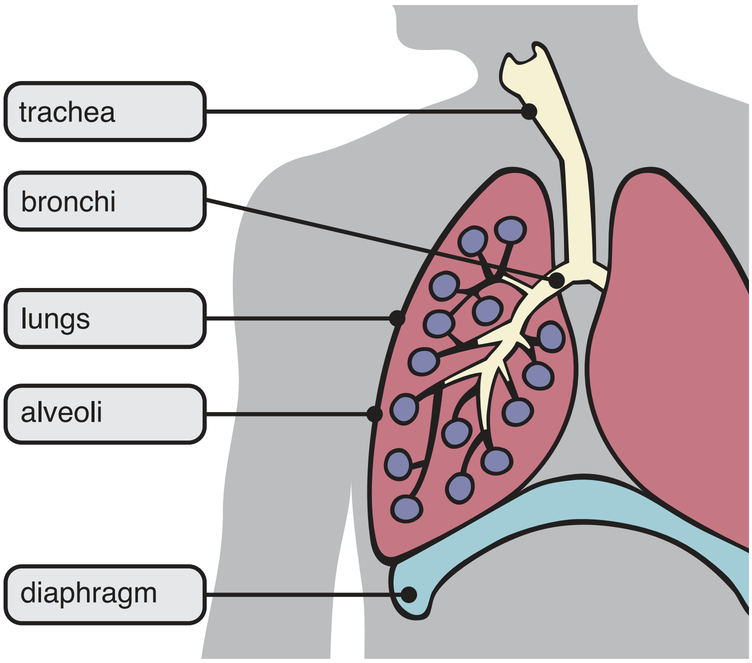
Also known as the voice box, located at the top of the trachea.

Intercostal muscles

The muscles situated between the ribs.

Alveoli

The tiny air sacs at the end of the bronchial tubes that exchange carbon dioxide and oxygen with the red blood cells.



SECTION ONE

The Circulatory and Respiratory Systems in Human and Non-human Animals

TASK 4

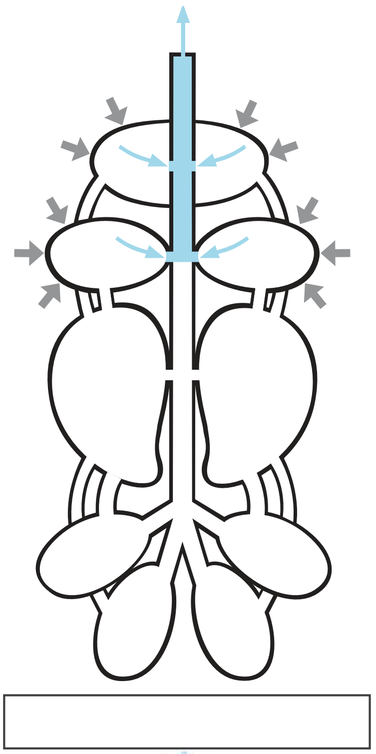
Label the Bird Respiratory System

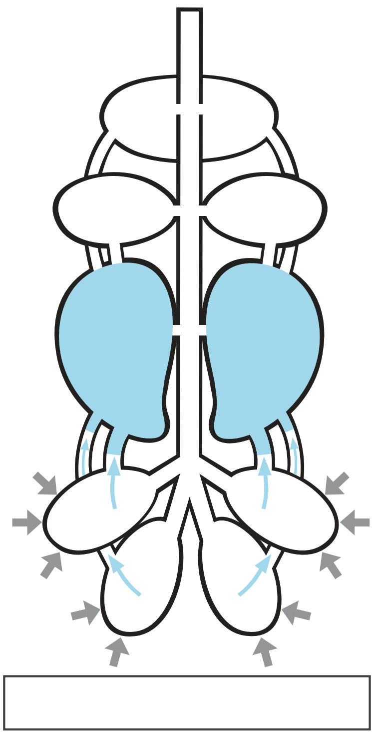
1. Label the following diagrams and place them in the correct order.

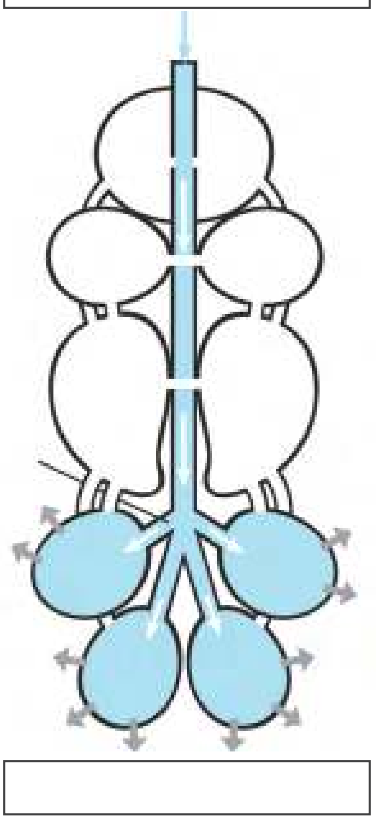
Labels – breath order

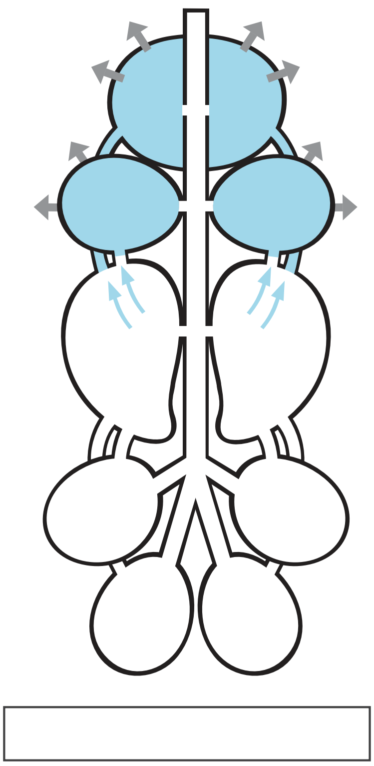
INHALE 1
EXHALE 1
INHALE 2
EXHALE 2

Answer on page 58









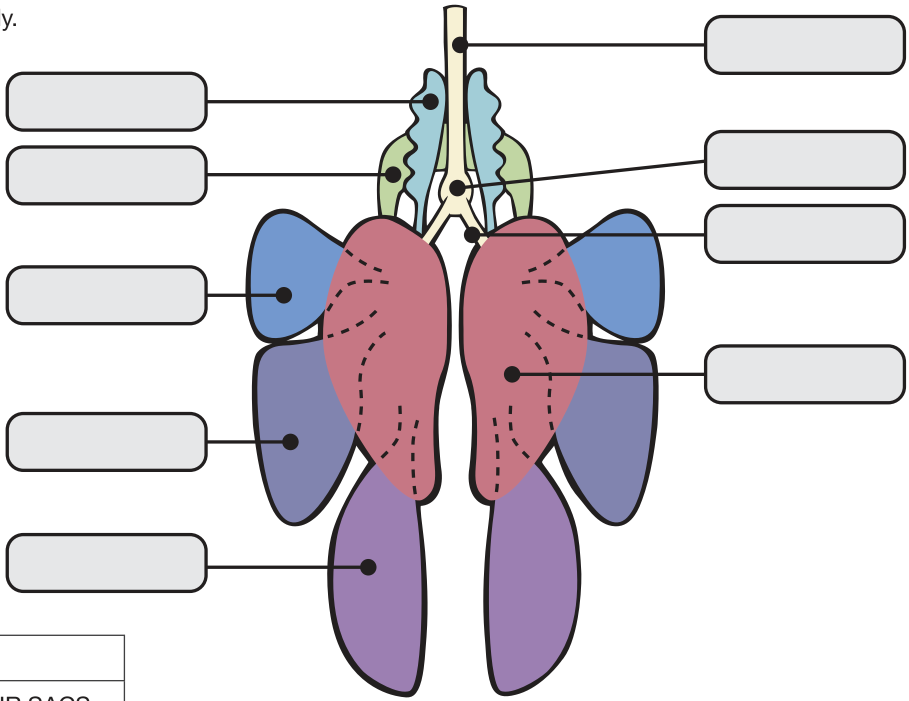
SECTION ONE

The Circulatory and Respiratory Systems in Human and Non-human Animals

TASK 4

Label the Bird Respiratory System

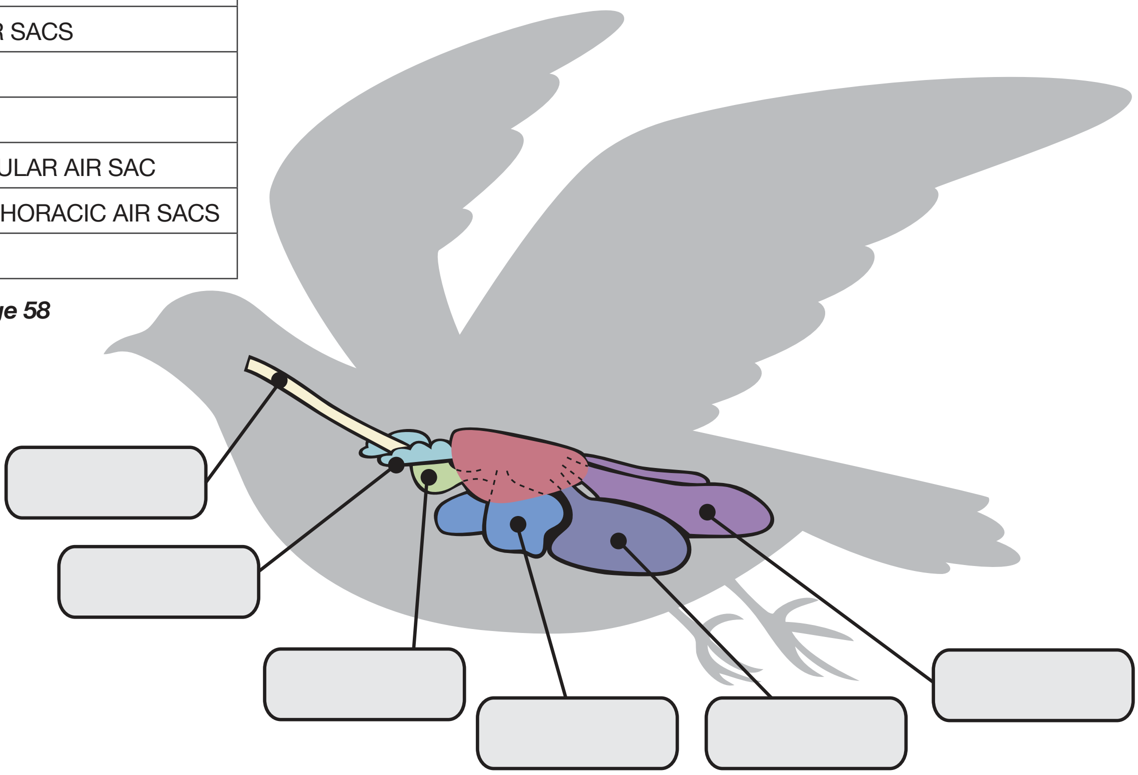
2. Label this diagram of the avian respiratory system correctly.



Labels

TRACHEA
ANTERIOR THORACIC AIR SACS
ABDOMINAL AIR SACS
CERVICAL AIR SACS
LUNGS
BRONCHI
INTERCLAVICULAR AIR SAC
POSTERIOR THORACIC AIR SACS
SYRINX

Answer on page 58



SECTION ONE

The Circulatory and Respiratory Systems in Human and Non-human Animals

TASK 5

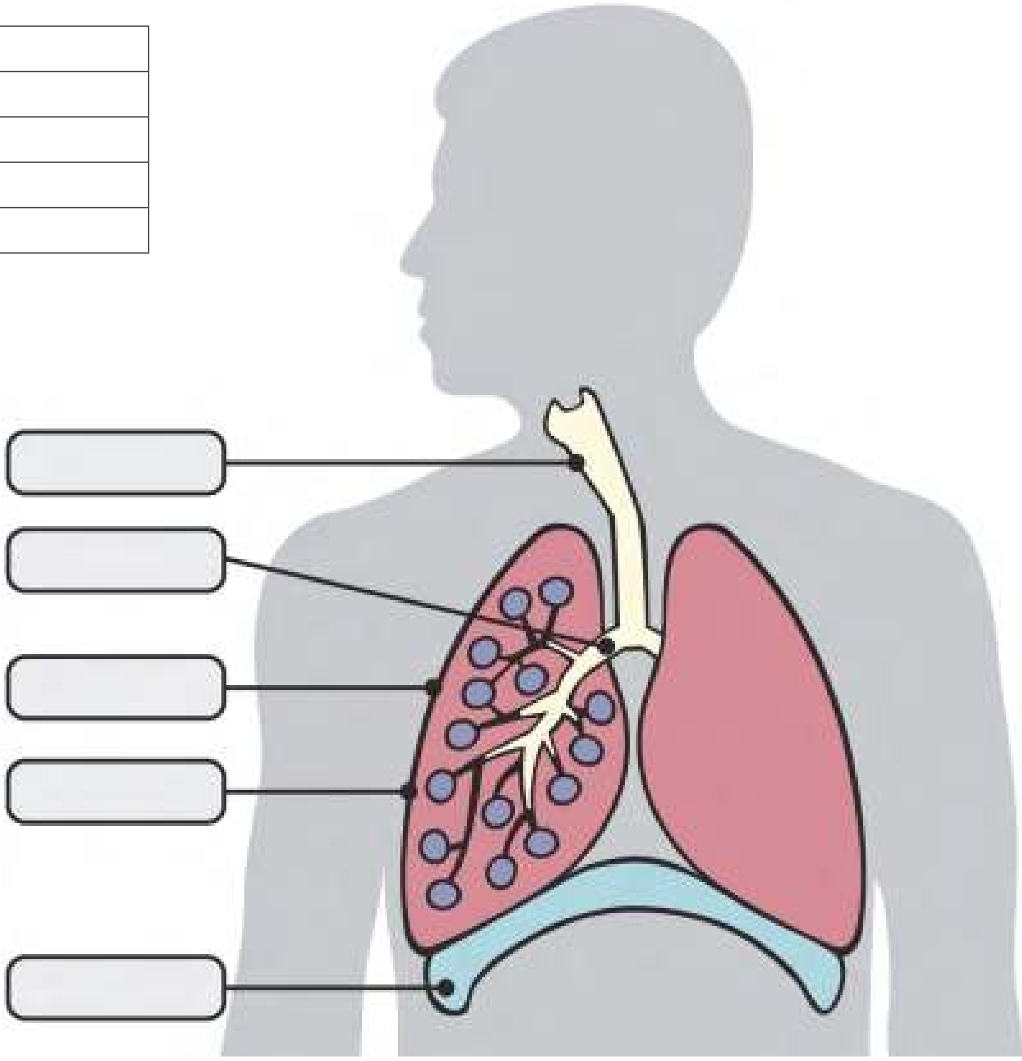
Label the Human Respiratory System

Label this diagram of the human respiratory system correctly.

Labels

TRACHEA
BRONCHI
LUNGS
ALVEOLI
DIAPHRAGM

Answer on page 58



SECTION ONE

The Circulatory and Respiratory Systems in Human and Non-human Animals

TASK 6

Write a Paragraph

Write a paragraph on how the circulatory system of birds is different to that of humans.

INTERACTIVE LINKS

The following interactive links help to explain the respiratory systems of humans and birds.

Human respiratory system
bcs.whfreeman.com/thelifewire/content/chp48/4802002.html

Lung (human respiratory system)
media.wwnorton.com/college/biology/animations/ch22a03.swf

Airflow in birds (bird respiratory system)
bcs.whfreeman.com/thelifewire/content/chp48/4801s.swf

Human lungs (how the lungs work)
www.nhlbi.nih.gov/health/health-topics/topics/hlw/system.html

Avian respiration
people.eku.edu/ritchisong/birdrespiration.html
www.paulnoll.com/Oregon/Birds/Avian-Respiratory.html

SECTION TWO

Multiple Choice Questions

CIRCULATION

1. Which blood vessels carry blood into the right atrium in frogs?

a. Right and left truncus arteriosus.

b. Carotid, systemic and pulmocutaneous arches.

c. Right and left cranial vena cava and caudal vena cava.

2. What is the primary function of arteries in the human body?

a. To bring deoxygenated blood into the lungs from the rest of the body.

b. To carry oxygenated blood from the heart to the rest of the body.

c. To bring deoxygenated blood from the body to the heart's right atrium.

3. Which one of the following carries deoxygenated blood from the heart to the lungs in humans?

a. Pulmonary artery.

b. Venule.

c. Pulmonary vein.

4. What are the upper chambers of the heart called?

a. Ventricle.

b. Atrium.

c. Arteriole.

5. What other organ (apart from the lungs) participates in gas exchange in frogs?

a. Heart.

b. Liver.

c. Skin.

6. Human hearts have four chambers. How many chambers do frog hearts have?

a. Three.

b. Four.

c. Two.

7. In which type of heart is there a mixing of oxygenated and deoxygenated blood?

a. Bird.

b. Mammal.

c. Frog.

8. The pulmonary vein carries oxygenated blood from the lungs to where in humans?

a. Right atrium.

b. Left atrium.

c. Left ventricle.

9. Deoxygenated blood enters the heart through which of the following in humans?

a. Left ventricle.

b. Vena cava.

c. Aorta.

10. What is the conus arteriosus?

a. The artery that carries blood from the ventricle to the body of the frog.

b. A large blood vessel that carries blood from the lungs to the left atrium of the frog heart.

c. The largest artery in the human body.

11. Blood enters the left atrium of the frog heart through which blood vessel?

a. Pulmocutaneous arch.

b. Pulmonary vein.

c. Caudal vena cava.

Answers on page 59

SECTION TWO

Multiple Choice Questions

RESPIRATION

12. After passing through the lungs blood is:

- **a.** Deoxygenated.
- **b.** Metabolised.
- **c.** Oxygenated.

13. What is the function of air sacs in birds?

- **a.** To allow air to flow unidirectionally (in one direction) through a bird's respiratory system.
- **b.** To play a direct role in gas exchange.
- **c.** They are the sound-producing organs in birds.

14. Which feature of the mammalian respiratory system is not found in birds?

- **a.** Alveoli.
- **b.** Diaphragm.
- **c.** Both of the above.

15. Which of the following statements is false?

- **a.** The respiratory system of birds is more efficient than that of mammals.
- **b.** Bird lungs do not expand or contract like the lungs of mammals.
- **c.** Respiration in birds requires only one respiratory cycle – the same as mammals.

16. How many inhalations and exhalations do birds have to make in order to take a 'full' breath?

- **a.** One inhalation and one exhalation.
- **b.** Two inhalations and two exhalations.
- **c.** Two inhalations and one exhalation.

17. How many air sacs do birds have?

- **a.** Nine.
- **b.** Seven.
- **c.** Three.

18. Which air sacs push fresh air into the lungs?

- **a.** Abdominal air sacs.
- **b.** Posterior thoracic air sacs.
- **c.** Anterior thoracic air sacs.

19. Which of the following statements is true for bird respiration?

- **a.** The air sacs expand during inhalation.
- **b.** The air sacs compress during inhalation.
- **c.** The air sacs do not move during inhalation.

20. Which are the 'posterior' air sacs?

- **a.** Interclavicular air sac.
- **b.** Cervical and anterior thoracic air sacs.
- **c.** Abdominal and posterior thoracic air sacs.

21. At which point are the lungs in birds empty of fresh air?

- **a.** During the first exhalation.
- **b.** During the second exhalation.
- **c.** Never.

22. In mammals what does the diaphragm do with each inhalation?

- **a.** Relaxes and moves upwards.
- **b.** Contracts and moves upwards.
- **c.** Contracts and moves downwards.

Answers on page 59

SECTION THREE

Experiments

HEART EXPERIMENT

How many times will your heart beat in your lifetime?

OBJECTIVE

Students will make measurements to determine their pulse rate before and after different events. Students will explore how heart rate is affected by exercise and other activities. They will be able to determine how the heart rate changes after exercise and other activities, and how many times their heart is likely to beat in their lifetime. Conclusions will be able to be reached on how heart rate affects longevity in human and non-human animals.

MATERIALS NEEDED

- A digital watch or clock with a second hand
- Calculator

PROCEDURE

Part One

1. Locate a pulse point on your body. Good places to find your pulse include your wrist and neck. To find the pulse on your wrist place the first two fingers of your right hand along the outer edge of your left wrist just below where your wrist and thumb meet. You should find the pulse between your wrist bone and tendon. Make sure your left wrist is facing palm-side up. Press down with your fingers until you feel your pulse but don't press too hard because you will not be able to feel the pulsation. The pulse in your neck is located beneath the jawbone. If you have difficulty finding your pulse ask for a friend to help or get the teacher to demonstrate how to find it. Do not use your thumb to find your pulse because its strong pulse may interfere with finding the site of pulsation.

2. Count the number of times your pulse beats in 15 seconds. Multiply this number by four. This is the number of times your heart beats in one minute. This is your 'at rest' heart rate. Enter this number on the heart rate table on page 52.

3. Do some aerobic activity to increase your heart rate. Do either physical exercise such as press-ups or other physical activity such as running. Do this for one minute.

4. Record your heart rate immediately after the activity. Do this in the same way you measured your 'at rest' rate. Enter this number on the table on page 52. This is your 'active rate'.

5. Once your pulse has returned to its resting rate, do something that will **elicit a strong emotional response** from you such as watching a video of animals being dissected or experimented on. Record your pulse rate immediately after the event. Enter this number on the table on page 52 as 'emotional rate'.

6. After **calculating the heart rate** for each activity, show this on a graph.

7. Compare the heart rates of students in the class. Also show this on a graph.

8. Determine the average heart rate of students. The average rate can be found by adding up all the heart rates of students and dividing the total by the number of students.

9. Extrapolate the number of times your heart beats per hour, per day, per year, over your lifetime (assuming you live to age 80). Enter this data on the table on page 52.

SECTION THREE

Experiments

HEARTH RATE TABLE

Heart Rate:____(insert your name)

	At Rest	Active Rate	Emotional Rate
Beats in 15 seconds			
Beats per minute			

Extrapolation

	At Rest	Active Rate	Emotional Rate
Beats per hour			
Beats per day			
Beats per year			
Beats in your lifetime (80 years)			

SECTION THREE

Experiments

Part Two

1. Compare the heart rates of the various mammalian animals listed in the table below. Is there a relationship between the size of the animal and its heart rate? You may enter your data under the 'human' animal category if you wish.

2. Is there a relationship between heart rate and lifespan?

Animal	Average Heart Rate (beats per minute)	Average Weight (grams)	Average Lifespan (years)	Lifetime Heart-beats (billions)
Cat	150	2,000	15	1.18
Monkey	192	5,000	15	1.51
Horse	44	1,200,000	40	0.93
Chicken	275	1,500	15	2.17
Cow	65	800,000	22	0.75
Pig	70	150,000	25	0.92
Elephant	30	5,000,000	70	1.10
Rabbit	205	1,000	9	0.97
Hamster	450	60	3	0.71
Dog	90	5,000	15	0.71
Giraffe	65	900,000	20	0.68
Human				
Large whale	20	120,000,000	80	0.84
Mouse	700	20	2	0.74

SECTION THREE

Experiments

WEBLINKS

Part Three

The online lessons below will help you build your knowledge of the circulatory and respiratory systems.

CIRCULATION LESSONS

Pulse of life

Students can measure their pulse rate and explore how heart rate is affected by various activities.

www.smm.org/heart/lessons/lesson1.htm

Keeps on pumpin'

Students can measure and calculate heart rates per minute and for other units of time. They will determine the amount of blood pumped by their heart during various intervals of time.

www.smm.org/heart/lessons/lesson2.htm

Under pressure

Students can investigate the implications of blood pressure.

www.smm.org/heart/lessons/lesson3.htm

Sounds of the heart

Students will investigate the sounds of the heart, construct a stethoscope and investigate the workings of valves.

www.smm.org/heart/lessons/lesson4.htm

Lub dub (valves)

Students can investigate the source of the sounds of the heart.

www.smm.org/heart/lessons/lesson5.htm

The heart as a pump

Students can explore the working of the heart by making comparisons with the actions of a pump.

www.smm.org/heart/lessons/lesson5a.htm

Go with the flow

Students can name and locate the major areas and structures of the heart and trace the pathway of the blood through the heart, lungs and body.

www.smm.org/heart/lessons/lesson6.htm

RESPIRATION LESSONS

Catch your breath

Students can measure lung capacity and explore factors that affect the amount of air the lungs can hold.

www.smm.org/heart/lessons/lesson9.htm

Ins and outs of respiration

Students can determine their respiratory rate and explore the factors that affect breathing rate.

www.smm.org/heart/lessons/lesson8.htm

Lung model

Students can discover the function of various parts of the body's respiratory system.

www.smm.org/heart/lessons/lesson7.htm

O2CO2 skit

Students can act out the flow of blood in the circulatory system.

www.smm.org/heart/lessons/lesson10.htm

SECTION FOUR

Conscientious Objection

Conscientious objection allows all students the chance to enjoy and express their enthusiasm for biology, whatever their ethical beliefs. It permits students to choose study methods that do not contradict their beliefs, such as the harming or killing of animals. This *Animals & Us* educational resource allows all students access to a high-quality education by offering alternatives to dissection.

The right to 'conscience' or conscientious objection is a right decreed by the United Nations General Assembly in article 18 of the Universal Declaration of Human Rights. This states that everyone has the right to freedom of thought and conscience. This right includes freedom to change beliefs, and freedom – either alone or in a community with others and in public or private – to manifest this belief in teaching and observance.

The concept of conscientious objection is becoming a more salient issue for students worldwide.

This section outlines some of the reasons why this is taking place, as well as the humane alternatives that are available to conscientious objectors of dissection.

REASONS FOR USE OF HUMANE ALTERNATIVES

There are numerous reasons to choose a humane alternative to animal dissection. These include:

Ethical Considerations

- Animal suffering (animals used for dissection may suffer in the process of being captured, transported and ultimately killed).
- Inhumane killing practices.

Respect for Student Beliefs

- Students cannot and should not be forced or coerced into doing dissection if they are opposed to it.

Teaching Efficacy

- Studies comparing animal dissection to non-animal alternatives have demonstrated the superior or equivalent efficacy of alternative methods at all levels of education.[1-6]

Psychological Impacts of Harmful Animal Use

- Desensitisation to suffering and killing.
- Diminished capacity for compassion and ethical decision making.
- Negative underlying message about the intrinsic value of animals' lives.
- Development of a utilitarian view that animals are here merely for our use.
- Risk of losing interest in science.
- Risk of psychological trauma.

Economic Advantages

- Alternatives are substantially less expensive (no need for transport, housing, feeding, veterinary care, anaesthesia, euthanasia).

Adverse Environmental Impacts

- Millions of vertebrate animals are dissected yearly in US high schools alone.[7]
- Collection for educational uses has been cited as contributing to frog declines in the US[8] and Canada.[9]
- The threatened spiny dogfish shark *Squalus acanthias* remains a popular species for school dissections despite its tenuous ecological status.[10]

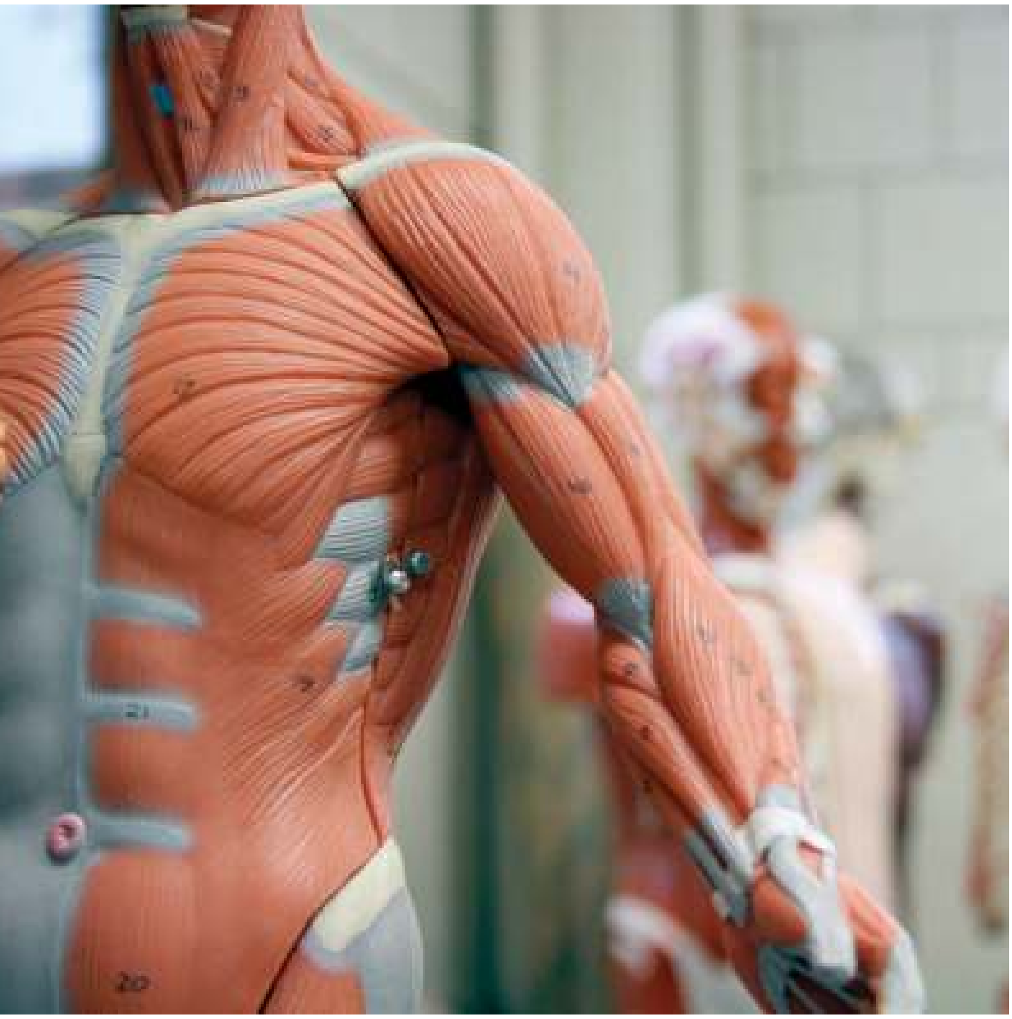
SECTION FOUR

Conscientious Objection

HUMANE ALTERNATIVES TO HARMFUL ANIMAL USE IN EDUCATION

For those who are opposed to the killing and dissection of animals for educational purposes there are a wide range of alternatives available. These include:

- computer simulations
- models
- videos
- plasticised specimens (a deceased animal's tissue is chemically replaced by plastic, allowing preservation of minute detail in gross anatomical features and producing a durable model for repeated use)
- non-invasive self-experimentation
- surgical simulators
- ethically sourced cadaver surgery (for medical students)
- supervised clinical experience
- animal shelter sterilisation programmes (for veterinary students).



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1. Balcombe, J. Accessed 16 August 1999. *Comparative studies of dissection and other uses of animals in education.* Online via www.hsus.org, Animals in Research, Animals in Education.
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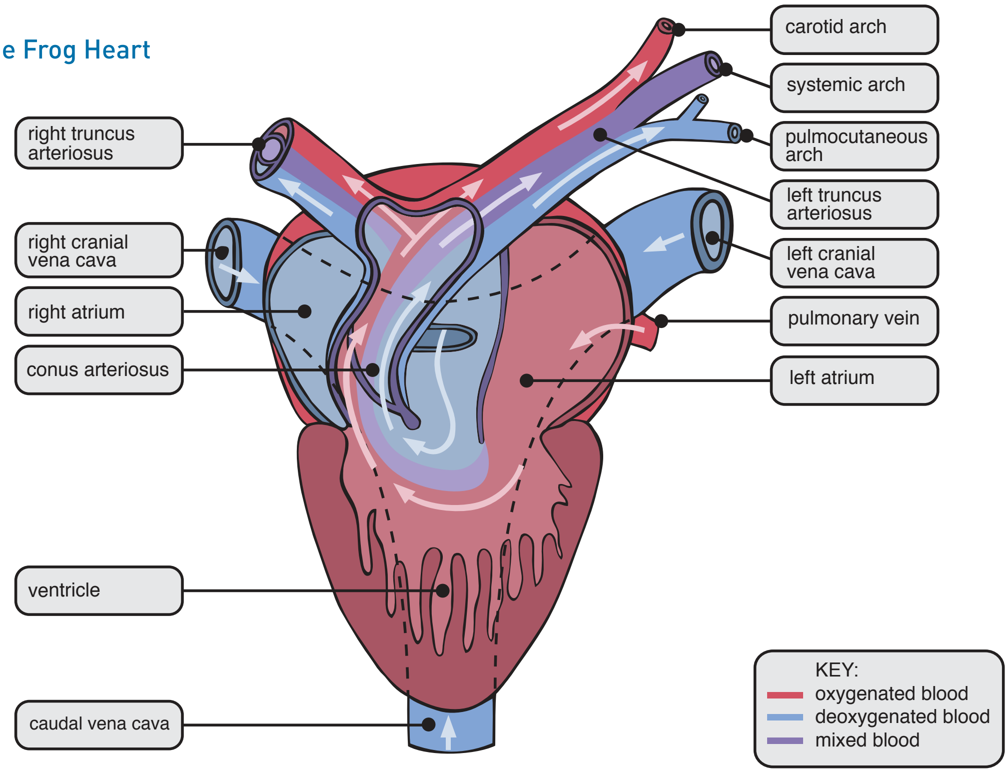
3. Kinzie, M.B., Strauss, R. & Foss, J. 1993. 'The effects of an interactive dissection simulation on the performance and achievement of high school biology students'. *Journal of Research in Science Teaching* 30(8): 989-1000.
4. Lieb, M.J. 1985. *Dissection: A valuable motivational tool or a trauma to the high school student?* Unpublished Thesis, Master of Education, National College of Education, Evanston, Illinois.
5. McCollum, T.L. 1987. *The effect of animal dissections on student acquisition of knowledge of and attitudes toward the animals dissected.* Unpublished Doctoral Dissertation, University of Cincinnati.
6. Strauss, R.T. & Kinzie, M.B. 1994. 'Student achievement and attitudes in a pilot study comparing an interactive videodisc simulation to conventional dissection'. *The American Biology Teacher* 56(7): 398-402.
7. HSUS. Questions and answers about dissection. www.humanesociety.org/issues/dissection/qa/questions_answers.html. Retrieved 22 June 2012.
8. Vogt, R.C. 1981. *Natural history of amphibians and reptiles in Wisconsin.* Milwaukee, Wis.: Milwaukee Public Museum.
9. Kingsmill, S. 1990. 'Bullfrog blues: Where have all the bullfrogs gone?' *Seasons* 30(2): 16-19, 36.
10. Balcombe, J. 2000. *The use of animals in higher education.* The Humane Society Press, Washington.

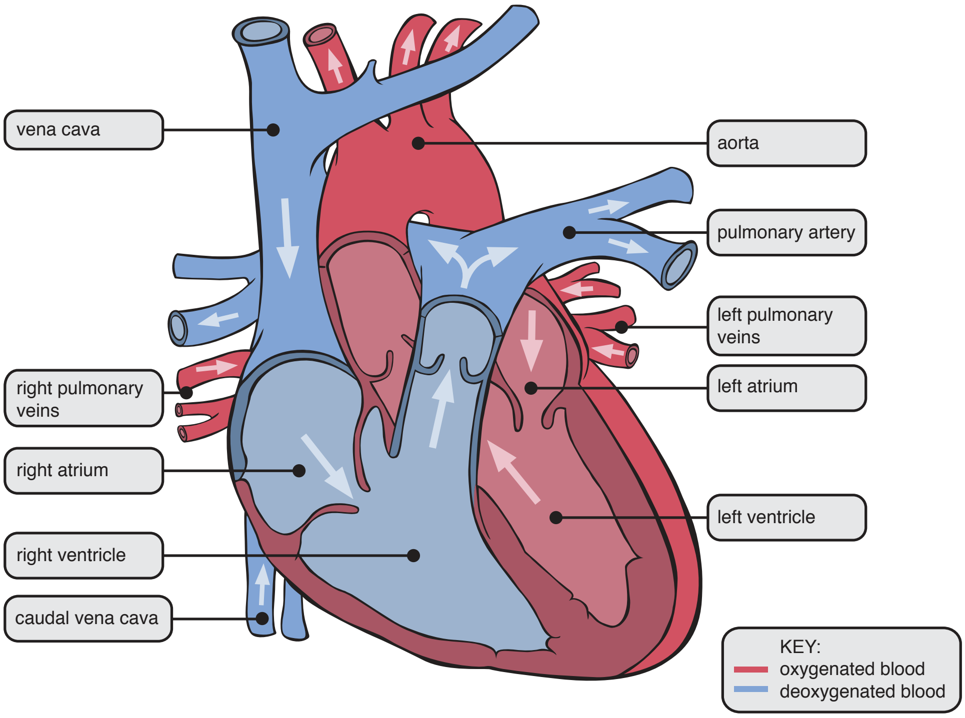
TASK 1
Label the Frog Heart

Page 39



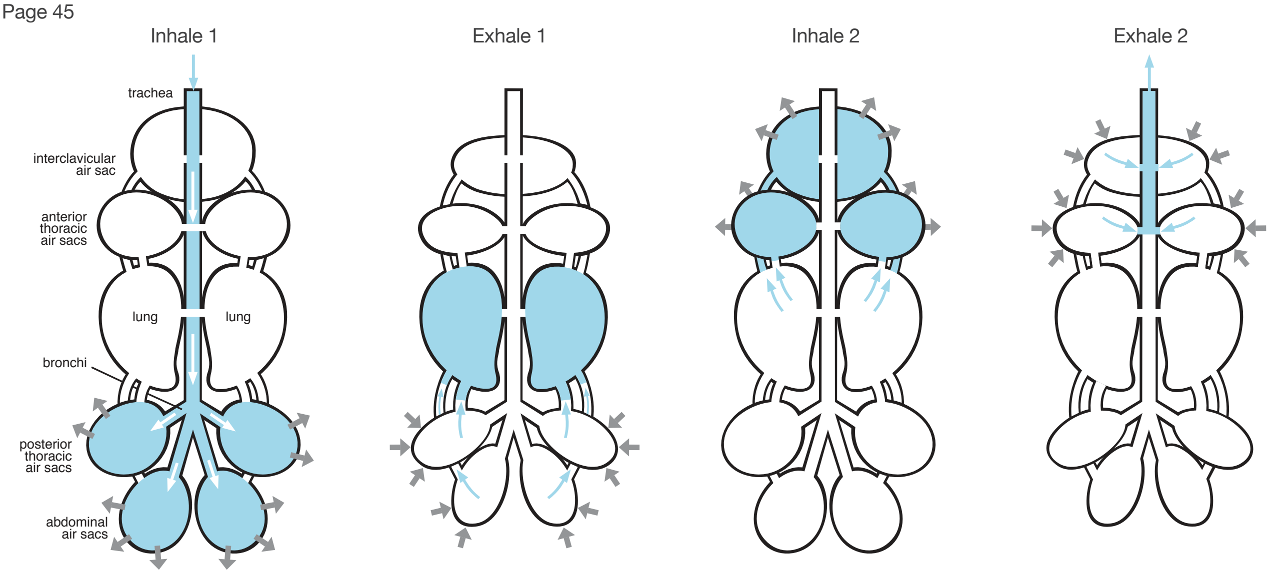
TASK 2
Label the Human Heart

Page 40



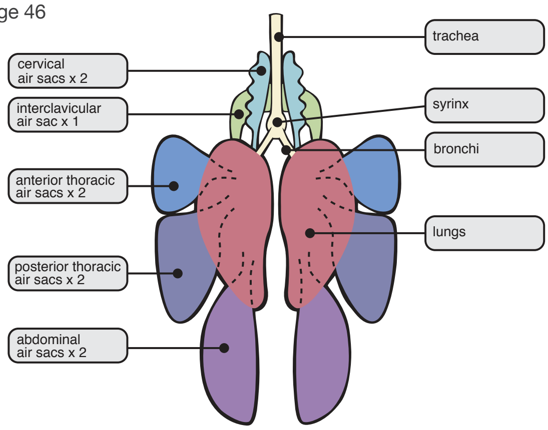
TASK 4
Label the Bird Respiratory System

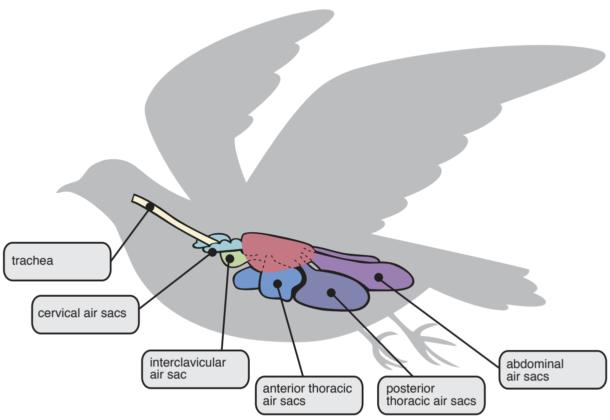
Page 45



TASK 4
Label the Bird Respiratory System

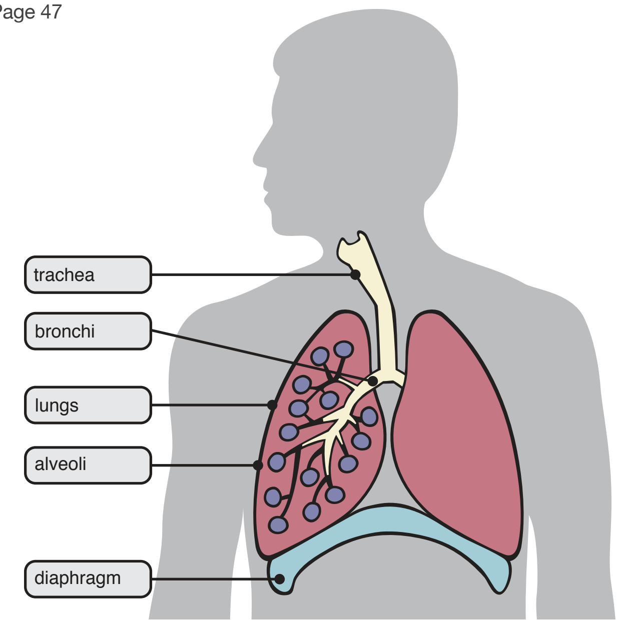
Page 46





TASK 5
Label the Human Respiratory System

Page 47



Multiple Choice

1. c

2. b

3. a

4. b

5. c

6. a

7. c

8. b

9. b

10. a

11. b

12. c

13. a

14. c

15. c

16. b

17. a

18. b

19. a

20. c

21. c

22. c

BIOLOGY UNIT OF STUDY 4

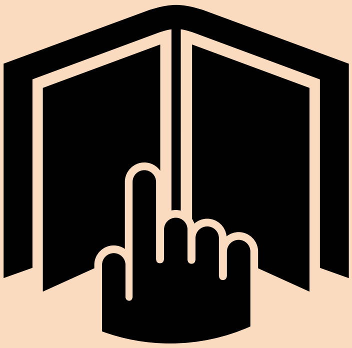
■ YEAR 11 ■ NCEA AS90926 ■ LEVEL 1.2 ■ DURATION 2-3 weeks

Supports internal assessment for Achievement Standard 90926
Report on a biological issue

A LESSON IN ETHICS AND NON-HUMAN AWARENESS

Sentience is the Bedrock of Ethics

A study of sentience in non-human animals



TEACHER GUIDELINES

The following guidelines are supplied to enable teachers to carry out valid and consistent assessment using this internal assessment resource.

CONTEXT/SETTING

This activity requires students to collect and process data and/or information to report on a biological issue. An issue is one on which people hold different opinions or viewpoints. The issue that this research assignment will explore is **sentience in non-human animals**.

Sentience in non-human animals has been and continues to be contested and debated extensively in the scientific community. New discoveries regarding sentience in non-human animals are made on a regular basis. This is an important topic for science students to consider because of the ethical implications involved in the use of animals in science and in experiments.

Science students are required "to consider the social and ethical implications involved in making responsible decisions about living things" (*Science in the New Zealand Curriculum* p. 52). Learning about sentience in non-human animals will help students when making ethical and responsible decisions about the use of animals in science.

The study of ethology has in recent years changed the cultural and scientific perceptions and treatment of non-human animals and continues to do so. Great Apes are not used in experiments in the Netherlands, New Zealand, the United Kingdom, Sweden, Germany and Austria, largely due to new knowledge and understanding of sentience in these animals.

This assignment will include the processing of information and the linking of the processed information to a use of science. At Level 1, teacher direction sets the scope of the research by:

- choosing the topic to research
- providing templates on which the students base their reports indicating the presentation of the information and links required.

In order to report comprehensively students must:

- refine a suitable question or purpose
- identify multiple links between the biological ideas that are related to the question or purpose
- collect and process primary or secondary data and/or information from a range of sources
- evaluate sources of information/ data in respect to the question or purpose
- identify at least two different points of view supported by evidence
- take and justify a position with a recommendation for action
- present findings in a report.

A choice of topics is provided for this research assignment. These topics will help students explore the behavioural, emotional and sensory worlds of non-human animals. Students will be asked to consider animal intelligence, pain perception, awareness, communication, sociability and morals.

Research topics students can choose from include:

- evidence of **intelligence** in non-human animals
- evidence that non-human animals experience **emotions and physical sensations**
- evidence that non-human animals are **aware** of their surroundings
- evidence that non-human animals **communicate** their needs
- evidence that non-human animals are **sociable** with others
- evidence that non-human animals are **virtuous**.

This assessment is an open-book research assignment.

The assignment consists of two parts that lead to the production of a report.

Part 1 involves processing information. This information can be researched or provided.

Part 2 involves interpretations of the information and reporting the research results. The report will follow the provided format or template.

CONDITIONS

Students will need sufficient time to carry out the research, processing and reporting required for this activity. As a guide it is expected that the research component could be completed in **three to four hours** with a further **one to three hours** required to complete the report. Students will need sufficient access to both computers and the internet either at school or at home.

This time could be allocated in a single fortnight or could be spread over a longer interval such as a school term to allow for research and processing of a range of source material. Teachers need to keep in mind the credit value of this standard when determining the time for this assessment.

All work is likely to be undertaken individually and appropriate measures should be taken to ensure authenticity. This could involve collecting all student notes with the final report; requiring authentication of any work undertaken at home and/or collecting work undertaken in class at the end of each lesson and returning it to students as required.

Teachers need to keep in mind the credit value of this standard when determining the time for this assessment.

ADDITIONAL INFORMATION

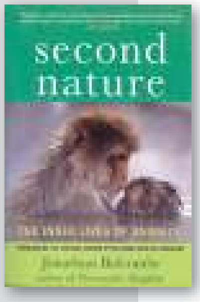
The following prior teaching is required:

- **Issues** – What makes a biology topic and issue (i.e. when people hold different opinions or viewpoints about it)?
- **Refining a question** – Taking a general question or purpose about an issue and refining it to make it suitable to guide research.
- **Making multiple links involving biological ideas** – Describing and explaining the biological ideas related to the question or purpose and identifying multiple links between the different ideas and the question.
- **Processing data/information** – Selecting biological ideas relevant to the issue from a range of sources and organising the ideas for reporting. A range is likely to involve at least three sources, and the sources can be the same type (e.g. all from the internet).
- **Evaluating sources** – Identifying sources that provide biological ideas relevant to the question and checking the sources for accuracy, being up to date and/or bias; providing reasons why a particular source was/was not used.
- **Using evidence to support different points of view** – Selecting at least two different points of view and then selecting biological ideas that support why a person, group or organisation holds each of these points of view.
- **Justifying a position** – Stating their own opinion with reference to specific information they have researched.
- **Giving a recommendation for action** – Saying what they believe should be done about the issue and why.
- **Presenting findings** – Structuring a comprehensive report to clearly present findings.
- **Recording sources** – Writing a list of sources in a way that can be accessed by others.

RESOURCE REQUIREMENTS

Students need to access a range of information sources. These may include biology magazines, internet sites, Alpha resources and other Royal Society resources. Use of primary sources (e.g. through interviews) is acceptable. Information is required on the biological ideas and processes related to the issue and on the different points of view held by people. Students also require access to computers and the internet for their research and reporting.

Key resource



Second Nature: The Inner Lives of Animals by Jonathan Balcombe. Palgrave Macmillan, 2010. pp. 71-99.

Secondary resources

Frozen Planet. BBC Natural History Unit. 2011.

The Life Collection: David Attenborough. BBC Natural History Unit, 2005.

The Blue Planet. BBC Natural History Unit, 2005.

Meerkat Manor. Oxford Scientific Films, 2005-2008.

Generic Assessment Schedule: Sci/1/2

AS90926 (Biology 1.2): Examples of evidence, relevant to the specific context being assessed, will need to be inserted in the spaces indicated before this schedule can be used.

EVIDENCE	JUDGEMENT FOR ACHIEVEMENT	JUDGEMENT FOR ACHIEVEMENT WITH MERIT	JUDGEMENT FOR ACHIEVEMENT WITH EXCELLENCE
The complete report.	Report on a biological issue. Report includes:	Report in depth on a biological issue.	Report comprehensively on a biological issue.
	• **Evidence of processed** information relating to the question on "sentience in non-human animals"	• As for Achievement.	• As for Achievement.
	• **Description** of a use related to the science knowledge.	• **Explanation** of a use related to the science knowledge. [insert examples]	• **Discussion** of a use related to the science knowledge. [insert examples]
	• The report is mostly in the student's own words.	• As for Achievement.	• As for Achievement.
	• A list of **three** reference sources, given in a way that would enable another person to find the information.	• As for Achievement.	• As for Achievement.

BIOLOGY UNIT OF STUDY 4

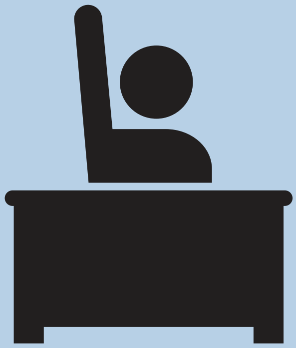
■ YEAR 11 ■ NCEA AS90926 ■ LEVEL 1.2 ■ DURATION 2-3 weeks

Supports internal assessment for Achievement Standard 90926
Report on a biological issue

A LESSON IN ETHICS AND NON-HUMAN AWARENESS

Sentience is the Bedrock of Ethics

A study of sentience in non-human animals



STUDENT GUIDELINES

This activity requires you to report on a biological issue. An issue is something on which people hold different opinions and viewpoints. There are a number of issues that impact on New Zealanders. In this activity you will be researching an issue related to sentience or awareness in non-human animals.

Sentience in non-human animals has been and continues to be contested and debated in the scientific community.

In recent years ethologists (scientists who study animal behaviour) such as Jonathan Balcombe have started to explore sentience and the emotional lives of non-human animals. Dr Balcombe believes that "animal behavior is one of the clearest windows into animals' inner lives. The way animals behave helps to demonstrate their sentience, and I like to say that sentience is the bedrock of ethics": www.guardian.co.uk/technology/2010/apr/25/jonathan-balcombe-animal-feelings

Peter Singer, a Professor in Ethics and Philosophy, explains the animal researcher's dilemma in his book *Animal Liberation – Second Edition*: "the researcher's central dilemma exists in an especially acute form in psychology: either the animal is not like us, in which case there is no reason for performing the experiment; or else the animal is like us, in which case we ought not to perform on an animal an experiment that would be considered outrageous if performed on one of us" (p. 52).

Ethologists such as Dame Jane Goodall have changed the way we view primates. New Zealand was one of the first countries in the world whose Animal Welfare Act prohibited the use of Great Apes in animal experiments (currently Great Apes cannot be experimented on in the Netherlands, New Zealand, the United Kingdom, Sweden, Germany and Austria), the reason being that chimpanzees, bonobos, gorillas and orangutans have been proven to be cognitively so similar to humans that using them as test subjects is considered unethical. This decision was without doubt influenced by the work conducted by ethologists such as Dame Jane Goodall and Dian Fossey.

In this study you will use Jonathan Balcombe's book *Second Nature: The Inner Lives of Animals* as a primary text to explore sentience in non-human animals.

In *Second Nature* Dr Balcombe explains the term 'umwelt', a term coined in 1905 by the German ethologist Jakob von Uexküll. "The idea is that variations in brains, sensory equipment, and lifestyles of different kinds of animals likely result in their having different mental and perceptual experiences. Dogs, for example, see mainly black and white, but their acute sense of smell allows them to discern a kaleidoscope of information. Just watch dogs on their walks: they spend a lot of time with their nose against the ground, sniffing up clues as to who or what has been there before." (*Second Nature* p. 18.)

In this activity you will be required to individually develop and refine a suitable research question or purpose based on the issue of sentience in non-human animals.

In order to answer your research question and present your findings in a comprehensive report you are required to complete the following three tasks:

TASK 1 Develop and refine a research question

TASK 2 Collect and process information

TASK 3 Report your results

TASK 1

Develop and Refine a Research Question

1. Develop possible questions suitable for research, relating to the issue of sentience in non-human animals.

The research topics or areas you can choose from include:

- evidence of intelligence in non-human animals
- evidence that non-human animals experience emotions and physical sensations
- evidence that non-human animals are aware of their surroundings
- evidence that non-human animals communicate their needs
- evidence that non-human animals are sociable with others
- evidence that non-human animals are virtuous.

2. Select and refine **one** question or purpose on which to base your research. This must relate to the biology of sentience. It will help you focus your research.

Use the references (derived from *Second Nature*) in Tables 1-2 to help you refine your question and choose an area of animal sentience to focus on.

3. Submit your research question or purpose to your teacher before beginning your research.
This is to be completed before:

(date)

NOTE: All work is to be completed at school OR you may do some research at home, but if you do you must get an adult to verify it is your own work. You will be required to hand in all your research notes, showing evidence of processing, with your final report. Processing information could involve listing, sorting, collating, highlighting, using stickies or summarising relevant scientific information.

TASK 2

Collect and Process Information

You will have **three to four hours** to collect and process your information.

1. Use a range of at least **three** sources to collect information related to your question or purpose. The information must include biological ideas about sentience in non-human animals. Also collect and process information on the differing viewpoints that people, groups and/or organisations have expressed about this issue.

2. Make sure you collect enough information to allow you to **take a position** on the issue. You will be expected to justify your position using information taken from your sources. You must also make a recommendation for further action and give reasons for your recommendation.

3. Evaluate the information in each source as you find it. Questions you could ask include:

- Is the information it contains useful?
- Does it contain accurate biological information?
- Is the information up to date (look for the date it was developed or last updated)?
- Is the information fact or opinion?

4. Record all sources you collect information from in a way that allows another person to find the same source. Also note any sources you do not use and explain why they were unsuitable.

Possible sources you may choose to use are:

Key resource

Second Nature: The Inner Lives of Animals by Jonathan Balcombe, Palgrave Macmillan, 2010.

Secondary resources

Frozen Planet. BBC Natural History Unit, 2011.

The Life Collection: David Attenborough. BBC Natural History Unit, 2005.

The Blue Planet. BBC Natural History Unit, 2005.

Meerkat Manor. Oxford Scientific Films, 2005-2008.

ANIMAL EXPERIENCE EVIDENCE CHART

The creation of an animal experience evidence chart will assist you with the collection and processing of information.

If your research question focuses on a specific animal experience or type of coexistence you can create an animal experience evidence chart as shown on page 66.

Reminder: The experiences and coexistences you can choose from are:

- Experience/Sensitivity
- Experience/Intelligence
- Experience/Emotions
- Experience/Awareness
- Coexistence/Communication
- Coexistence/Sociability
- Coexistence/Virtue.

ANIMAL EXPERIENCE EVIDENCE CHART

Animal species	Experience/Coexistence	Evidence
Grey squirrel	Deception	*"Grey squirrels practice food-burying deception. Close observations have found that these rodents will – in addition to burying nuts – dig and cover empty holes. Not surprisingly, this 'deceptive caching' occurred more often in the proximity of other squirrels, and it was found to be effective in reducing the likelihood of theft by 'surrogate cache pilferers', the humans studying them … Once a squirrel has been purloined, s/he is more likely to engage in deceptive caching, as well as to bury nuts in places harder to reach …" Second Nature* pp. 74-75
Adelie penguin	Deception	www.youtube.com/watch?v=LbTZg5TGM1c BBC film crew captures Adelie penguins stealing stones from each other's nests and getting caught in the act on the documentary series *Frozen Planet*.
Monkey	Deception	*"Researchers at Yale University presented twenty-seven wild and free-ranging monkeys with two visually identical containers of food; one rattled when handled, and the other was silent. If a human sitting nearby faced the apparatus, the monkeys showed no preference from either container. But when the human's gaze was averted, the monkeys showed a strong preference for the silent container. Thus, the monkeys attempt to obtain food silently only in conditions in which silence is relevant to obtaining the food without risk of detection by a bystander." Second Nature* p. 72

EXAMPLE OF ANIMAL EXPERIENCE EVIDENCE CHART

RESEARCH QUESTION: Is there evidence that non-human animals are **aware** of themselves and others?

Examples of awareness include deception, alliances, planning, problem solving, tool use, humour, imitation, discrimination, gaze following, attention, anticipation, wariness, vigilance, theory of mind and metacognition.

Place your animal species in the first column, the experience or coexistence you are focusing on in the second column, and the evidence of the experience or coexistence in the third column.

TASK 3

Report Your Results

You will have______________________________[insert time] to present your findings.

Write a comprehensive report on sentience in non-human animals in which you:

- State your research question or purpose, which must be suitable for research and refined from the issue above.
- Identify the biology relating to the question or purpose by making multiple links between relevant biological issues.
- Identify **two** different points of view on the issue of sentience in non-human animals supported by evidence (i.e. giving reasons why the people, groups and/or organisations hold these viewpoints).
- State your own position on the issue. Use information from your sources to justify why you hold that position, and make a recommendation with reasons for action in the future.
- Evaluate at least **three** sources of information you have used related to your question or purpose (i.e. explaining why they were suitable (or not) to collect information from). For example:
  - Is the information it contains useful?
  - Does it contain accurate biological information?
  - Is the information up to date (look for the date it was developed or last updated)?
  - Is the information fact or opinion?
  - Is the source biased to one particular point of view?
- Record the sources you used in a way that allows them to be found by another person. All processed material used in the development of the student's response (e.g. in a research logbook or portfolio) is to be submitted and may be used as evidence of authenticity, processing, integration and evaluation.

NOTES ON TABLES 1-2

Tables 1-2 are based on the key resource *Second Nature* by Jonathan Balcombe.

These tables refer to pages in *Second Nature* where you can find evidence to support your research question. Some extracts from *Second Nature* have been reproduced in this issue of *Animals & Us*.

The categories outlined in these tables can also be applied to, and used as a guide for, other resources and materials.

Animals in Science has been written in order to provide teachers and students with a set of materials that argue against animal experiments. The key resource *Second Nature* contains some examples of animal sentience where the animals involved are used in experiments. The following is a disclaimer from author Jonathan Balcombe regarding this issue.

Disclaimer:

Please note that some of the experiments cited in this section caused varying amounts of avoidable harm to the animal subjects. The inclusion of these studies is intended to demonstrate the animals' sentience only, and is not meant as an endorsement of such methods.

Jonathan Balcombe

TABLE 1
Range of Experiences

Source: *Second Nature*	EXPERIENCE Sensitivity (pp. 74-80)	EXPERIENCE Intelligence (pp. 81-83)	EXPERIENCE Emotions (pp. 84-88)	EXPERIENCE Awareness (pp. 89-91)
	Navigation	Memory	Emotional fever	Alliances
	Perceptions	Delayed gratification	Gratitude	Deception
	Hearing	Teaching	Grief	Planning
	Flexible behaviour	Planning	Stress	Problem-solving
	Play	Awareness	Attention	Tool use
	Flight	Predator inspection	Interest in others	Humour
	Individual recognition	Protection of others	Persecution	Awareness
	Mother-pup reunions	Sentience	Post-traumatic stress disorder	Imitation
	Predation	Perceptions	Regret	Audience effects
	Activity levels	Learning	Abnormal behaviour	Discrimination
	Touch	Problem-solving	Emotions	Gaze-following
	Magnetic perception		Optimism and pessimism	Theory of mind
	Homing			Attention
	Eavesdropping			Metacognition
	Learning			Self-awareness
	Senses			Anticipation
	Need for control			Success
	Call signatures			Wariness
	Ultrasound			Vigilance
	Communication			
	Memory			

NOTE: Page numbers refer to *Animals in Science*

TABLE 2
Types of Coexistence

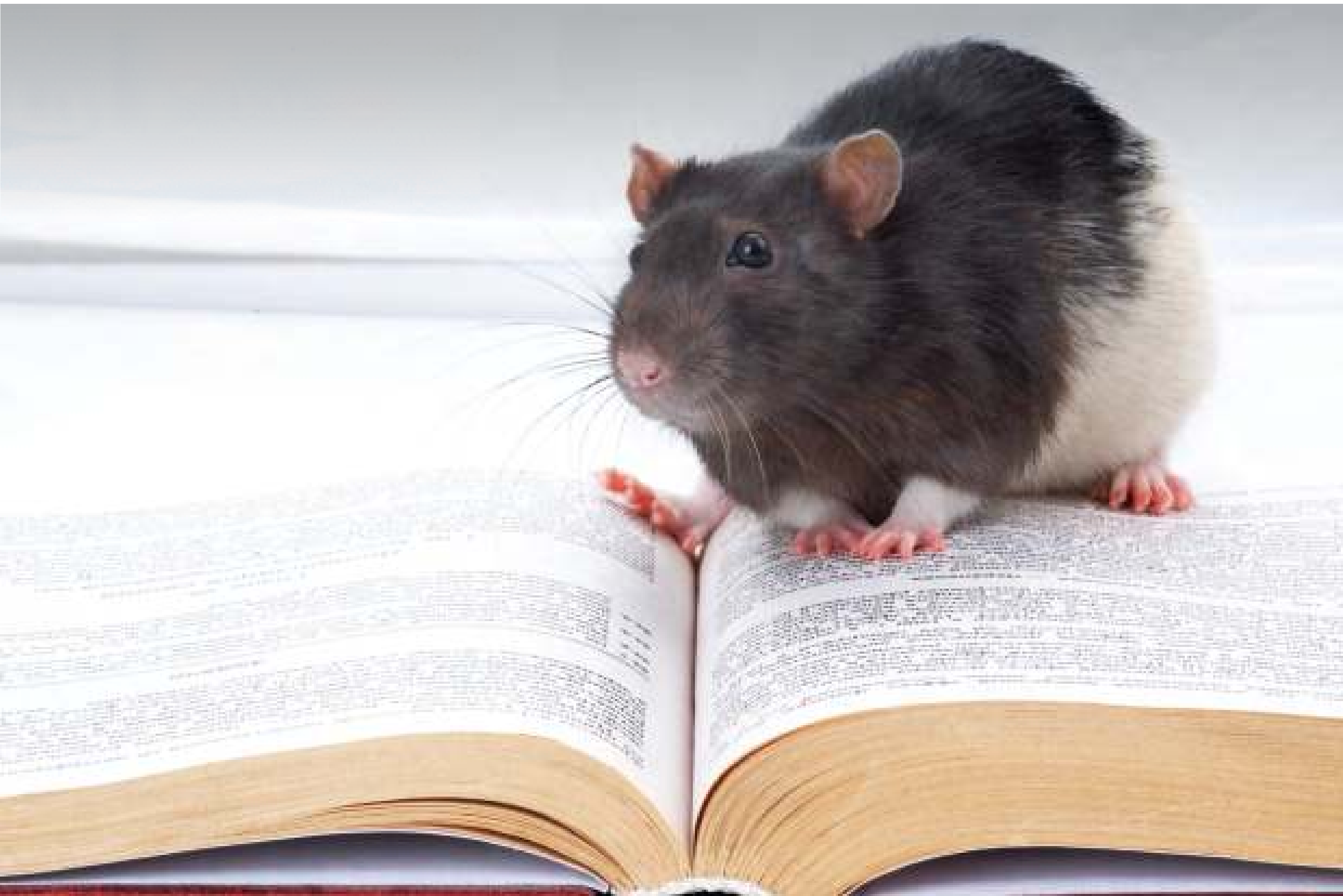
Source: *Second Nature*	COEXISTENCE Communicating (pp. 92-96)	COEXISTENCE Sociability (pp. 97-100)	COEXISTENCE Virtue (p. 102)
	Communication	Sharing	Altruism
	Language	Collaboration	Courage
	Dialects	Midwifery	Consolation
	Vocabulary	Solidarity	Emotional awareness
	Communication with vertebrate	As mutualists	Empathy
	Calling by	Cheating	Communal nursing
	Sign language	Cleaner-client fish relations	Democracy
	Gestures	Role of pleasure	Peacemaking
	Semaphoring	Image-scoring	Reconciliation
	Triangulation	Punishment	Restraint
	Ventriloquy	Cognition	Sense of fairness
	Individual labelling by	Cooperation	Concern for others
	Recognition of others	Social, success of	Deference
	Symbolic communication	Sociability	Self-handicapping
	Alarm calls	Virtue	Pain
	Referential calls	Cooperative hunting	Conflict resolution
	Individual recognition	Communal nursing	Fairness
	Echolocation control	Reconciliation	Mirror neurons
	Ultrasound	Babysitting	Virtue
	Perceptiveness		Sympathy
	Problem-solving		
	Theory of mind		
	Awareness		
	Expectations		

NOTE: Page numbers refer to *Animals in Science*

SECTION 2

RESOURCES

Texts for Units of Study



LIST OF TEXTS
Science/Biology
Extended Written Texts

NON-FICTION (extracts from)

74 ***Second Nature: The Inner Lives of Animals.*** Balcombe, Jonathan. 2010.

103 ***The Emotional Lives of Animals: A Leading Scientist Explores Animal Joy, Sorrow, and Empathy – and Why They Matter***. Bekoff, Marc. 2007.

120 ***Ill-gotten Gains.*** Regan, Tom. **The Great Ape Project.** Cavalieri, Paola and Singer, Peter (eds). 1994.

126 ***Kea, Bird of Paradox: The Evolution and Behaviour of a New Zealand Parrot.*** Diamond, Judy and Bond, Alan. 1999.

133 ***Sacred Cows and Golden Geese: The Human Cost of Experiments on Animals.*** Greek, Jean Swingle and Greek, C. Ray. 2000.

158 ***The Costs and Benefits of Animal Experiments.*** Knight, Andrew. 2011.

Short Written Texts

JOURNALS

172 **Behaviour.** Bekoff, M. 'Play Signals as Punctuation: The Structure of Social Play in Canids'. 1995.

179 **American Zoologist.** Bekoff, M. 'Social Play and Play-soliciting by Infant Canids'. 1974.

183 **Behaviour.** Diamond, Judy and Bond, Alan. 'Social Play in Kaka (*Nestor meridionalis*) with Comparisons to Kea (*Nestor notabilis*)'. 2004.

187 **Behaviour.** Diamond, Judy and Bond, Alan. 'Social Play in Kakapo (*Strigops habrotilus*) with Comparisons to Kea *(Nestor notabilis)* and Kaka (*Nestor meridionalis*)'. 2006.

191 **The Quarterly Review of Biology.** Spinka, M., Newberry, R.C. and Bekoff, M. 'Mammalian Play: Training for the Unexpected'. 2001.

194 **Society & Animals.** Phillips, M.T. 'Savages, Drunks, and Lab Animals: The Researcher's Perception of Pain'. 1993.

MAGAZINES

203 **Listener.** Bone, Alistair. 'Pain Factor: How much do animals suffer in this country in the name of science?' 2002.

204 **Resurgence.** Creamer, Jan. 'Vivisection: "The blackest of all crimes"'. 2012.

207 **New Scientist.** Graham-Rowe, D. 'Could lab rats be replaced by a lung on a chip?'. 2009.

208 **New Scientist.** Lyon, Zeeya Merali. 'Human skin to replace animal tests'. 2007.

NEWSPAPERS

209 **The Dominion Post.** 'Animal death toll ends cloning trials'. Chug, Kiran. 2011.

210 **New Zealand Herald.** 'Animal experiments jump 21pc says ethics group'. Collins, Simon. 2004.

211 **New Zealand Herald.** 'GM Mutant cows die in trial'. Gibson, Eloise. 2010.

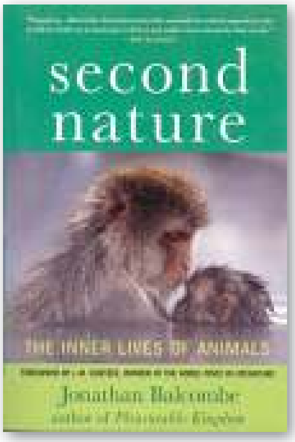
213 **New Zealand Herald.** 'Animal testing body seeks rigid record keeping'. NZPA. 2003.

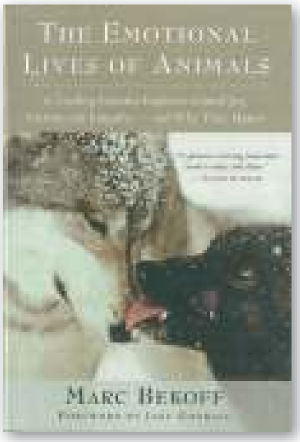
214 **Sunday Star Times.** 'Headless chickens put to the test'. Woulfe, Catherine. 2008.

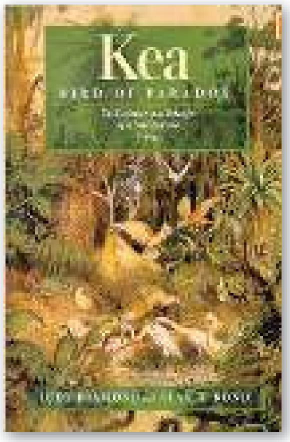
STATISTICS

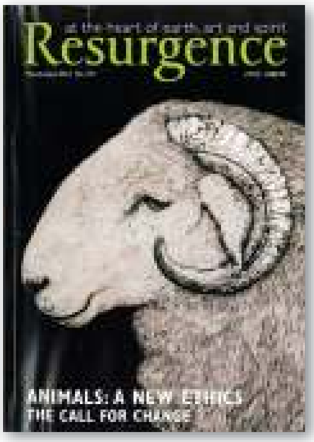
215 **Ministry of Agriculture and Forestry.** NAEAC (National Animal Ethics Advisory Committee). Annual Reports 1998-2011.

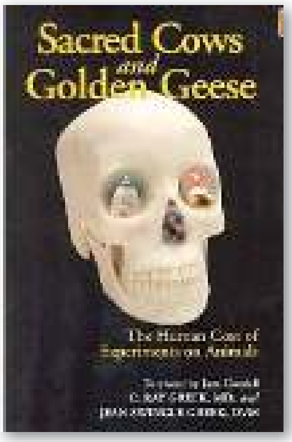
SCIENCE/BIOLOGY TEXTS











J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 15-25.
Extract from Chapter two: Tuning in: Animal sensitivity.

Sentience Expanded

How does a human's sentience—our capacity to feel pain and pleasure—stack up against a nonhuman's? An important problem with questions like this is that we cannot know for certain, because another's feelings, whether simple or complex, are private. We can, however, divine a great deal from the anatomy, physiology, and behavior of other animals, and by using our own experiences as a guide. Insofar as we are more intelligent than, say, a sea lion or a bat, we may be capable of richer experiences and feelings in the mental-emotional domain. I can anticipate getting together with friends, journeying to a new country, or delighting in a clever joke, whereas the sea lion, presumably, is not privy to at least some of these sorts of mental pleasures. But to the same degree, the sea lion is perhaps comparatively free from the mental anguish my own rational mind is capable of producing. In his best-selling book *The Power of Now*, the spiritual teacher Eckhart Tolle seeks to guide us out of the angst and unhappiness we bring on ourselves by our preoccupations with unalterable past and unpredictable future events.[1] On this reasoning, there is no clear basis for the assumption that a more intelligent life is inherently better (or worse) lived. Quality of life does not align smoothly with intelligence.

Furthermore, a less intelligent animal may experience life no less richly than a human, in the sensory realms. This is not a new idea. The British clergyman Humphry Primatt (1735–1776), an early writer on animal welfare, knew the tenuousness of linking suffering to intellect: "Superiority of rank or station exempts no creature from the sensibility of pain, nor does inferiority render the feelings thereof the less exquisite."[2] More recently, the biologist John Webster, author of *Animal Welfare: Limping towards Eden*, has expressed a similar sentiment, if somewhat more bluntly: "People have assumed intelligence is linked to the ability to suffer, and that because animals have smaller brains they suffer less than humans. That is a pathetic piece of logic."[3]

Because animals evolve greater sensitivities in realms relevant to their survival, and because different niches present diverse sensory challenges to organisms, it follows that humans have not cornered the evolutionary market on sensory perceptions. Elephants communicate in infrasound, bats in ultrasound, and some fishes with electricity. Many organisms far exceed us in olfactory and other chemical sensitivity. Others have more advanced organs for detecting subtle changes in water or air movements. In the emotional domain, it is far from clear that a monkey's or a rabbit's fear is felt less acutely than our own fear, or that feelings of affection, and subsequent grief at their loss, are duller between two parrots who mate for life than such feelings between two humans.

SCIENCE/BIOLOGY TEXTS

EXTENDED WRITTEN TEXTS (NON-FICTION)

J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 15-25.
Extract from Chapter two: Tuning in: Animal sensitivity.

As far as is known from physiological studies, the perception of noxious stimuli and their conduction to parts of the brain that register pain are fairly identical processes among the different mammals that have been so examined.[4] The benefit of measuring pain perception at the brain level is that it is not vulnerable to confounding factors such as stoicism, which may make an animal appear to be less in pain that she or he actually is. Age, genetics, sex, and prior experiences are other factors that may influence the perception of pain. In a paper published in 2008, University of Massachusetts veterinarian Jerald Silverman concluded that "with regard to experiencing pain, there are no unequivocally 'higher' or 'lower' sentient species among the mammals."[5]

Because many animals have more acute senses then we do, they may feel certain things more intensely than we do. What proof have we that a needle prick is less painful to a mouse than to a man? Recognizing a painful sensation and trying to escape from it should not be any less compelling an evolutionary imperative for a rodent than for a primate. The propagation of mouse genes—which pain evolved to assist by helping mice avoid situations that threaten to destroy them and their genes—is no less worthy a project for a morally indifferent nature than is the propagation of human genes. In some situations, it is possible that a human's knowing the reasons for pain—such as a necessary medical procedure—may lessen (or intensify) the experience of the pain.

British ethologist Donald Broom believes fishes may in some cases suffer more than we do, for they may lack ways that we have for dealing with pain. For instance, humans can be told (or we can tell ourselves) that a pain will not last for long, whereas fishes presumably are unable to do so.[6] For American ethologist Marc Bekoff, suffering may be greater in an animal with no rich cognitive life with which to remember past events or anticipate the future.[7] In *The Unheeded Cry: Animal Consciousness, Animal Pain, and Science*, American bioethicist Bernard Rollin suggests that animals with a reduced concept of time may not look forward to or anticipate the cessation of pain. "If they are in pain, their whole universe is pain; there is no horizon; they are their pain."[8]

It is well documented that the adrenal response to stress in humans is not nearly as dramatic as in animals. One possible explanation for this is that humans are very adept at finding ways to cope with stress. Our various psychological defenses and coping devices "damp down" the stress response.[9] When I reviewed published articles on animals' responses to unpleasant or painful routines in laboratory settings, I learned that their stress responses are pronounced and lasting. In response to being stuck with a needle, having blood drawn, or being force-fed, rats, mice, rabbits, monkeys, and various birds all show dramatic increases in typical stress markers. Blood levels of the "stress hormone" corticosterone soar to as much as five-times normal, and it can take up to 90 minutes before they return to baseline levels. Heart rates and blood pressure also rise.[10] There are also so-called witnessing effects: Animals who are in the same room as other animals being mistreated or killed also show stress reactions.[11]

J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 15-25.
Extract from Chapter two: Tuning in: Animal sensitivity.

Sensitivity to pain has been better studied in farmed animals than most other animals. Physiological and behavioral responses to such routine practices as castration, hot-iron branding, tail removal, horn-bud cauterizing, and beak-searing—all of which are performed without anesthesia—indicate that pain is intense and lasting.[12] Though "prey" animals such as sheep, cattle, goats, and pigs may have evolved stoicism to avoid being singled out as weak or vulnerable by a lurking predator, changes in body posture and movements (e.g., shaking, twitching, alternating lifting of hind legs), and raised blood stress hormone levels indicate that their pain is real.

Time Perception

Have you ever wondered if other animals experience time at a different rate than us? The perception of time by animals with different life spans and activity rates was another part of the umwelt concept conceived by von Uexküll. Popular folklore assigns seven dog years to every one of ours, but this seems likely to be more a product of dogs' shorter life span than their actual *experience* of time. Yet, the speed of some animal responses reveals a finer perception of time than we can achieve. Knifefish communicate with electrical discharges of up to a thousand pulses per second. A nightingale sings each note of his elaborate song in just one-tenth of a second; humans can only appreciate its complex nuances if they record it at high speed and slow it down.[19] Mated pairs of Amazon splash tetras make synchronized leaps from the water to deposit and fertilize their eggs on overhanging leaves. So closely timed are these leaps that the two fish appear as one.[20]

I have timed the quick movements of a brown creeper shimmying up the trunks of trees and vines, turning her head and probing the crevices with her beak. Each movement occurred at a rate of approximately three to four per second. If this tiny bird is using her brain consciously with each movement—as seems likely, given that she is foraging and must detect and respond to specific cues in her surroundings to do so successfully, all the while remaining vigilant for the occasional lurking hawk—then her perceptual speed must function faster than ours.

Bats have been shown in experiments to be able to make time discriminations in their perception of echoes down to 10 billionths of a second.[21] Some people are incredulous at this, but we may expect animals to be exceedingly good at perceiving stimuli that are highly important to their survival. Being able to make precise time discriminations in three-dimensional space in the dark can mean the difference between a hit and a miss for a little brown bat (*Myotis lucifugus*) pursuing a midge.

SCIENCE/BIOLOGY TEXTS

EXTENDED WRITTEN TEXTS (NON-FICTION)

J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 15-25.
Extract from Chapter two: Tuning in: Animal sensitivity.

Flocking birds and schooling fish are renowned for the coordination of their movements. To our eyes at least, it appears that the entire flock or school changes direction at one instant, as if there were some internal knowledge of the decision-making of all others. Some naturalists had ascribed this coordinated behavior to a form of telepathy, but analysis of slow-motion filmed sequences shows that these creatures' sensory systems are operating on a much finer time scale, so that it only appears to us that they all change direction instantaneously when in fact there are minuscule delays.

Many birds sing antiphonally. In some species of wren, up to eight birds intercalate individual calls into a unified, seamless whole that has stunning acoustic beauty and coordination. Plain-tailed wrens (*Thryothorus euophrys*) of South America sing in synchronized choruses, each bird using a repertoire of about 20 phrases, each carefully matched to the other birds' calls. Songs can last two minutes, during which individuals drop in and out.[22] This speaks to the birds' remarkable temporal and pitch perceptions. Human encroachment may be forcing the wrens and other birds to ramp up their signals. Dutch researchers recorded the calls of great tits in ten major European cities, including London, Paris, Amsterdam, and Prague, and found that city-dwelling birds sing shorter, faster, and higher songs than the slower melodies of their country cousins.[23] It's thought to be an adaptation to counter background noise and make it easier to find a mate amid the urban din. Umwelts evolve.

Beyond Our Senses

To get by in their ecological niches, many animals have evolved perceptual abilities that exceed our own. Wildebeests have the uncanny ability to detect the presence of rainfall thirty miles away. Using this ability, wildebeests move to greener pastures, rather than waiting for the rain to come to them by chance. How they do this is not certain, but researchers studying them in Kenya have speculated that they may use a combination of sight, smell, and sound.[24]

Because seed predators hinder a tree's reproductive output, many trees have evolved a swamp-and-starve strategy, producing relatively little seed in most years, then a sudden glut before the seed-eaters can recover. Squirrels, however, are somehow able to predict a "mast" year when a spruce tree produces a bumper crop of cones. In such years, mother squirrels interrupt the weaning of their first litter of pups and conceive a second one. They do this ahead of the impending food glut, and it isn't known quite how they anticipate the bumper crop; perhaps they are able to see a difference in the buds that will form cones, or perhaps they can detect a chemical change.[25] Either way it allows squirrels to hear the dinner bell before it has even been rung. Mangabey monkeys have been shown to rely on their memory of recent patterns of temperature and solar radiation to decide whether or not to travel to a particular patch of fruit.[26] Biologists working on Panama's Barro Colorado Island claim that if you want to be sure a storm is nigh, just listen for the howls of howler monkeys. They never get it wrong.[27]

SCIENCE/BIOLOGY TEXTS

EXTENDED WRITTEN TEXTS (NON-FICTION)

J. Balcombe, *Second Nature: The Inner Lives of Animals.* (Palgrave Macmillan, New York, 2010), pp. 15-25.
Extract from Chapter two: Tuning in: Animal sensitivity.

Estuarine crocodiles have superb long-distance homing abilities. This was not known until scientists decided to affix tracking devices to three adults caught near popular Australian beaches and rivers before shipping them to more remote areas. For instance, when one large crocodile was flown by helicopter to the east coast 400 km (250 miles) away, he was back home within three weeks.[28] One scientist couldn't resist likening them to boomerangs, except that boomerangs don't think or act on their own.

While there is probably a physical explanation for these phenomena, they illustrate certain types of perception that far exceed the capabilities of humans. Perhaps these animals have sophisticated ways of predicting future patterns based on past events combined with a rich mental representation of their physical environments.

Because we don't think or see like them, and because we are not intimately versed in another species' postures, vocalizations, smells, and personalities, we miss a lot of what's going on. Fortunately, technological advances are expanding our observational niche. It was only when the play of babbler birds was studied on slow-motion video that subtle exchanges between individuals were noticed: eye contact and special postures during play, for example.[29] Similarly, Marc Bekoff only discovered the role of eye contact and stances in the play of dogs when he examined video frame by frame.[30]

Research from the University of Sheffield and the Massachusetts Institute of Technology has shown strong parallels between rats' use of whiskers and humans' use of fingertips to explore their surroundings. High-speed video recordings of the movements of the animals' whiskers and their associated muscles reveal that rats adjust their whisker movements, "whisking" them back and forth many times each second, using information from each contact to decide how best to position the whiskers for the next one. Smooth surfaces are explored with periodic waves of motion, while rough surfaces are treated with large, irregular, high-speed brushes. These movements are actively controlled by the rats, just as we guide the movements of our fingertips as we explore the feel of shapes and textures.[31]

Walruses also have supremely tactile whiskers. Recent studies show that walruses and manatees control their thick vibrissae by a network of muscles arranged like the struts of the Eiffel Tower. Each whisker can be telescoped out and moved in a coordinated fashion, allowing the animal to detect the size, shape, texture, and taste of small objects hidden beneath mud and sand.[32] Colleen Reichmuth of the University of California at Santa Cruz reports that "if you drop a little piece of fish on the whiskers away from the mouth they can walk it along the whiskers, across the muzzle and into the mouth."[33]

J. Balcombe, *Second Nature: The Inner Lives of Animals.* (Palgrave Macmillan, New York, 2010), pp. 15-25.
Extract from Chapter two: Tuning in: Animal sensitivity.

Mouse Fidelity

Cute and popular in animated films, reviled as "pests" and abused as laboratory subjects, house mice pay royally for cohabiting with *Homo sapiens*. Yet cohabit they do. The temptations are just too great, and they have enough guile to thrive. Rodents, in particular mice and rats, are also commonly demeaned as "lower mammals," even though molecular studies suggest that rodents (and rabbits) are more closely related to monkeys than are dogs.[34]

Most humans around the world have had contact with mice. Extraordinarily resourceful and successful at living commensally with us, the house mouse in particular has made a good living by entering human habitations and living off the tailings left by their lumbering, distant mammalian cousins. Small and with a straightforward "design," the mouse ranks, on first glance, as a cheap compact sedan among some of the Cadillacs and Bentleys of the mammalian class. Yet, on closer inspection, the mouse is an astonishing marvel. House mice are acutely attuned to their surroundings. They are highly sensitive to sound, smell, taste, and touch. Their vision, while relatively poor in brighter light, is keenly adapted to the low-light conditions they encounter in their nocturnal wild ways.[35]

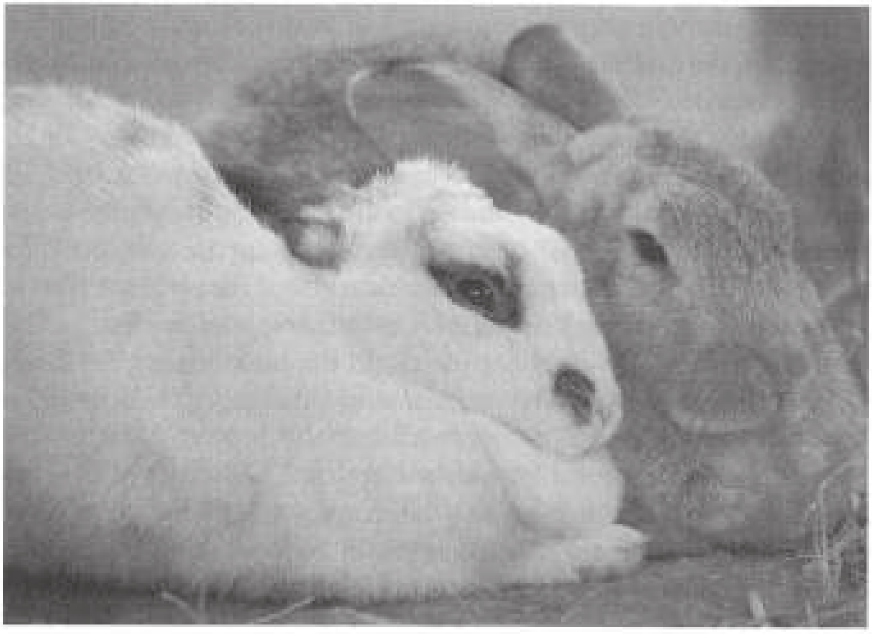
Their sensory worlds are quite different from ours. If we left a trail of urine wherever we went, we'd not be very popular, but for a mouse, it's a normal social courtesy. A mouse's urine is like a signature. It contains chemical information that communicates an individual's sex and social status.[36] Mouse pee also allows other mice to discern genetic relatedness, a process which may have evolved to avoid inbreeding.[37] There is even evidence that female mice can discriminate the degree of parasite infestation in males based on the smell of their urine, and that this may in turn influence females' mating proclivities.[38] It is not clear whether mice are conscious of the discriminations they make. At the very least, though, these abilities indicate that a mouse's sensory system operates with fidelity comparable to a human's.

J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 15-25.
Extract from Chapter two: Tuning in: Animal sensitivity.

Clever Bunnies

Rabbits are often dismissed as simpletons with little up top (except for those prominent ears). Rabbit rescuer Andrea Bratt-Frick is often surprised by the alertness of her rabbits. Preferring to have the rabbits' living quarters tidy before their dinnertime, Andrea began training some of them to put a toy in their hay box before giving them their evening salad. Within a week they were getting pretty good at it. The following week, as she began making salads in the kitchen, Amanda started hearing noises in the rabbit cages. She looked out the window and all the rabbits were putting toys in their boxes before she even gave them the command. She figures either they heard or smelled the kitchen preparations, or they had seen what she was doing through the window.

Bratt-Frick is one of a growing number of people who clicker-train domesticated rabbits to negotiate obstacle courses. The training technique uses the same positive reinforcement approach that is so effective with dogs. When a rabbit performs a desired behavior, she is immediately given a small food treat accompanied by the sound of a handheld



Rabbits are intelligent and keenly perceptive. (Photo by Connie Pugh.)

mechanical clicker. The bunnies soon learn to associate the click with the reward and will perform on cue from the clicker. The result is that we have rabbits behaving much like dogs, hopping up and down ramps and leaping over obstacles in a prescribed course.

J. Balcombe, *Second Nature: The Inner Lives of Animals.* (Palgrave Macmillan, New York, 2010), pp. 38-42.
Extract from Chapter three: Getting It: Intelligence.

Frick reports that her rabbits quickly learn new things, and that they sometimes invent novel solutions to problems. Whereas most of the rabbits clear the one- to two-foot-high tiered obstacles with graceful bounds calculated to just clear the top, one of Frick's videos shows a particularly fluffy rabbit named Muffy pausing in front of obstacles, removing a slat with her mouth, then hopping through the gap. Muffy performed the behavior spontaneously, but another rabbit named Mattie didn't. Observing Muffy's shortcut, he also began removing slats. To avoid having the trick spread through the bunny flock like a knock-knock joke through a playground, Frick had to train Muffy and Mattie separately for a while. Social learning in rabbits? You bet.

Misunderstood Fish

The common view that fishes are unfeeling robots with fins is becoming increasingly outdated in the face of emerging studies. Forty years ago, the idea of producing a book devoted to the mental and emotional qualities of fishes was unthinkable. Science wasn't ready to accept, let alone study, fishes in those contexts. Times have changed. In 2005, three fish biologists published an edited volume titled *Fish Cognition and Behavior*. Contributors included fish behavior experts from five continents. As biologist Tony Pitcher notes in his foreword, fishes have had over 60 million years to evolve brains that deal flexibly with diverse underwater environments.[16] Biologist Gordon Burghardt dedicates an entire chapter of his book *The Genesis of Animal Play* to evidence that fish engage in play behavior.

We have many prejudices about fish. To us, they are "lower animals," cold-blooded and machinelike. It's a shallow view considering the sheer diversity of this legion of vertebrates. There are at least 25,000 fish species worldwide, which accounts for more than all the other vertebrate groups (mammals, reptiles, birds, and amphibians) combined. Fish didn't stop evolving when the first lobe-finned member of their kind ventured onto land and established the terrestrial vertebrate lineages. Fishes encompass a diversity of perceptual, mental, emotional, and cultural phenomena.

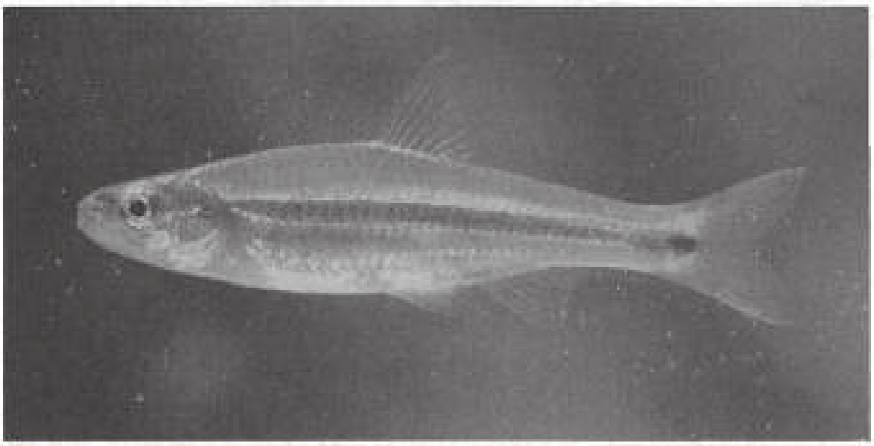
In their aquatic element, fishes are finely tuned to their surroundings. They have been shown in careful scientific studies to engage in precise discriminations, such as their preference for shoaling (grouping) with fish carrying fewer or no parasites than those with higher parasite loads. They also show social learning both within and between species, predator inspection behavior, and the ability to generalize from one live prey type to another. Even the smallest fishes show awareness of their surroundings. When individual three-spined sticklebacks were presented with two unfamiliar shoals of sticklebacks—one of fishes who were familiar with each other, and the other of mutual strangers—they preferred to swim with the shoal of familiars.[17] Human observers could detect no differences in the swimming behavior of familiar- and stranger-shoals, so it isn't known what the sticklebacks were cueing on. But it's a useful discrimination to make, for it turns out that familiar-shoals locate and consume food more efficiently than do stranger-shoals.[18]

SCIENCE/BIOLOGY TEXTS

EXTENDED WRITTEN TEXTS (NON-FICTION)

J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 38-42.
Extract from Chapter three: Getting It: Intelligence.

And in case you thought fishes have no sense of sound, they have been shown to discriminate and generalize between different genres of music. In a study that presented recordings of Bach's classical music and the blues of John Lee Hooker to three individual carp, all three subjects learned to distinguish between the two genres, and could generalize from the specific artists to multiple artists presented from each genre (twenty representing blues, nine for classical).[19] Finally, like mice,



Minnows are among several types of fish that show preferences for other familiar individuals. (Photo courtesy of Mike Howell.)

monkeys, and other mammals discussed earlier, fishes also suffer stunted learning capacity when reared in unstimulating environments.

Fishes have a well-developed chemical sense. Water is an excellent medium for diffusing chemicals, and fishes use it both voluntarily and unwittingly. Like the urine signatures of mice, fishes can extract information from each other's chemical secretions. For example, female swordtails select well-fed males based on chemical cues.[20] Many fishes produce chemical cues in response to physical situations such as injury, or to fearful situations. Other fishes cue into this useful information. A fish may release an alarm chemical in the presence of a predator fish (or in response to the odor of one). Other fishes, detecting the chemical, may react appropriately, such as by taking cover or being more vigilant.

SCIENCE/BIOLOGY TEXTS

EXTENDED WRITTEN TEXTS (NON-FICTION)

J. Balcombe, *Second Nature: The Inner Lives of Animals.* (Palgrave Macmillan, New York, 2010), pp. 38-42.
Extract from Chapter three: Getting It: Intelligence.

Predator inspection involves one or more fishes leaving their shoal, approaching a potential predator, and assessing the likelihood that the predator will attack, before rejoining the shoal. It has been observed in many fish species, including guppies, sticklebacks, minnows, paradise fish, damselfish, bluegill sunfish, and mosquitofish.[21] Predator inspection begins with predator recognition, which in itself is not an innate skill—fishes must learn to recognize specific predatory species as dangerous, and one way they learn is by observing the alarm response (odors and behaviors) of other fishes of their own kind in the presence of a new predator. Because predator inspection is obviously risky, fishes tend not to do it alone. Sticklebacks usually inspect in pairs, and studies find that they prefer to team up with the same inspection partner. Further experiments have shown that a stickleback need observe just four predator inspections by other pairs of fish to be able to remember and favor the better (more cooperative) of the two partners. Guppies also preferred to associate with the better of two inspectors four hours after they had observed them in action. The ability to discriminate individuals within a shoal has now been scientifically demonstrated in several species of fishes.

Another example of monitoring behavior in fishes is known to occur in Siamese fighting fish and green swordtails. Males monitor aggressive interactions between neighboring males and use this information in deciding whether or not to fight another male. Predictably, they are more willing to fight males they have seen lose than to take on a prior winner.[22] Male Siamese fighting fish also alter their threat displays depending on who's watching; if a female is in the audience, he puts more sexuality into his movements by performing more tail-beats and spending more time with his gill-covers erect.[23]

As we learn more about fishes and their mental capacities and sentience, we are beginning to revise our previous dismissive attitude toward them. In Norway, where fishes have been excluded from that nation's Animal Welfare Act since 1974, a new act gives fishes a level of protection on par with other vertebrates (see the "New Days, New Ways" section of Chapter 11). As researchers at the Norwegian School of Veterinary Science point out, because individuals suffer and not species, the ramification of fishes' capacity to feel pain and to suffer are great, given the enormous numbers of fishes humans exploit and kill.[24]

SCIENCE/BIOLOGY TEXTS

EXTENDED WRITTEN TEXTS (NON-FICTION)

J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 50-57.
Extract from Chapter four: With feeling: Emotions.

Gratitude is a social emotion because it is felt, and usually expressed, toward another being. Primatologist Frans de Waal of Emory University describes a touching example of gratitude expressed by a chimpanzee. Roosje was an infant chimpanzee born in Holland's Arnhem Zoo to a deaf mother who couldn't properly care for him because she couldn't hear his cries for help or attention. Fearing for the little chimp's welfare, de Waal decided reluctantly to move Roosje to safety. Kuif, another chimp in the same colony, had lost more than one of her own infants and had suffered deep depression each time, marked by rocking, self-clutching, refusing food, and heart-wrenching screams. De Waal decided to train Kuif to bottle-feed Roosje through the bars of the chimps' compound. Kuif took well to this, and was eventually given Roosje to bottle-feed. Chimpanzees tend to disapprove of taking someone else's infant, and Kuif glanced between Roosje and de Waal, kissing each, as if asking permission. She was the most caring and protective mother that could have been hoped for. Up to that time, Kuif had had a rather neutral relationship with de Waal, but from that day onward she showered him with the utmost affection whenever he would show his face. Three decades later, Kuif's gratitude remained undiminished.[13]

When a female humpback whale became entangled in the ropes of crab traps near the Farallon Islands (aka the Farallones) off the coast of San Francisco in December 2005, several divers wielding knives dove into the water in a rescue attempt. Rope was wrapped at least four times around the humpback's tail, midriff, and the left front flippers, and there was a line in the whale's mouth—yet, the whale remained calm while the divers cut through the ropes. "When I was cutting the line going through the mouth, its eye was there winking at me, watching me," said James Moskito, one of the rescue divers. "It was an epic moment of my life." Once free, the whale didn't swim away but approached and nuzzled each diver.[14]

An outpouring of gratitude signals something profound. It shows that the animal values his or her life. It also suggests feelings of relief from pain and fear and the fulfillment of a fundamental desire for freedom.

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EXTENDED WRITTEN TEXTS (NON-FICTION)

J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 50-57.
Extract from Chapter four: With feeling: Emotions.

Taking an Interest

Have you ever been in a situation where there are throngs of people and just two dogs, and as soon as one dog spots the other her attention is riveted on the other canine? I'm always bemused by this because it indicates that from a dog's perspective, another dog is infinitely more interesting than a human. I suspect this tendency to favor one's own species is widespread for adaptive reasons, though there are bound to be common exceptions. Even a parasite, whose lifestyle hinges on gravitating toward a host species, nevertheless has to fraternize with other members of its kind to reproduce (though there are some parasitic worms that save themselves the bother by hitching up in a permanent state of copulation.)

Like dogs, elephants show greatest interest in others of their kind. Their fascination with bones occasionally extends to the bones of other species, but their closest attention appears to be directed toward the bones of other elephants. To test this hypothesis, Karen McComb and colleagues with the Amboseli Elephant Research Project in Kenya conducted experiments in which elephants were presented with ivory tusks and bones of elephants along with the remains of other animals and inanimate objects. Their findings indeed showed that elephants spend significantly greater time exploring elephant remains than inanimate objects or the remains of other large herbivores.[22]

Now that cognition and emotion are more readily ascribed by scientists to other animals, scientists are beginning to acknowledge the depths of feeling that may accompany these behaviors. Combining GPS tracking data, long-term association records of who spends time with whom, and direct observations, renowned elephant researcher Iain Douglas-Hamilton and colleagues describe elephants showing compassionate behavior toward others in distress. In Kenya's Samburu Reserve, Eleanor, the matriarch of a family unit called the First Ladies, became gravely ill and fell to the ground. Grace, the matriarch of another family called the Virtues, immediately went to her aid. Seeing Eleanor down, Grace ran over to her with tail raised and temporal glands streaming secretions, sniffed and touched Eleanor with her trunk and foot, then used her tusks to help lift Eleanor to her feet. Grace appeared stressed and continued to try to lift Eleanor with her tusks and foot after she collapsed again. During the next week following Eleanor's death, elephants from five family units visited her body. Douglas-Hamilton's team also documented general awareness and curiosity about death, and that these behaviors are directed both toward kin and toward nonrelated individuals. The study authors conclude that elephants show compassion toward one another and have an awareness and interest in death.[23] Might it be that elephants have a sense of their own mortality?

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J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 50-57.
Extract from Chapter four: With feeling: Emotions.

Experiencing Loss

The response of elephants to elephant bones might be just curiosity, though it also hints at feelings of sadness. It is fairly clear that elephants recognize the bones of their own kind; otherwise why would they spend more time inspecting them than the bones of, say, a hippo or a rhino?

There is also anecdotal evidence that elephants can feel regret. If animals can experience regret, then elephants would be a good candidate species because they are a long-lived, social species whose individuals remember the actions of others. A tragic incident at the Elephant Sanctuary in Hohenwald, Tennessee, suggests feelings of regret in Winkie, a forty-year-old elephant. In the summer of 2006, during a routine inspection by her two human caretakers, Winkie suddenly struck one of them, thirty-six-year-old Joanna Burke, across the chest and face with her trunk. Burke was sent flying to the ground by the blow, and Winkie stepped on her, killing her instantly.

Winkie was withdrawn for weeks following the incident. Perhaps she was mourning the loss of her caretaker. Winkie's life prior to her arrival at the Elephant Sanctuary in 2000 had been one of confinement in zoos. Her early history is uncertain, but like many captive elephants her age, she may have suffered the emotional trauma of witnessing her entire family being brought down by rifle bullets. Thousands of such "culling" operations have been carried out in parts of Africa as expanding populations (more often human than elephant) create conflict over diminishing habitats. In May 2008, South Africa announced that it was going to resume elephant culling operations, after a thirteen-year moratorium.[24]

Animal friendships are not confined to their own species, and we may expect that loss can be felt for other species, too. In November 2007, four members of the army of Zimbabwe, wearing camouflage uniforms and carrying automatic assault rifles, tied up three guards assigned to each of three black rhinoceroses, then opened fire on the animals, killing them. The three huge beasts—Amber, DJ, and Sprinter—were members of a small population lovingly reared and bred by the Travers family, who own the Imire Safari Ranch where the crime took place. Six weeks earlier the rhinos had been dehorned to make them less attractive to poachers, but the murderers still tried to hack out the few centimeters of new horn growth on one of the victims before being frightened off.

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J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 50-57.
Extract from Chapter four: With feeling: Emotions.

There were other victims of this senseless, violent crime. Seven-week-old calf Tatenda was left orphaned, and Amber was due to give birth to her calf the following week. To those mourning the loss must be included three elephants, Mundebvu, Makavusi, and Toto. These elephants often walked around with the three rhinos. They all knew each other and at night the elephants slept just outside the compound where the rhinos were kept for protection. They must have been very aware of the shots and screams of the rhinos, according to a Travers family member following the attack. Two days after the incident, the rhinos' three elephant companions were taken to their burial spot. According to witnesses, the elephants reacted very strongly to the site, passing sticks to each other with tears running down their faces. Mundebvu (herself pregnant), dug down over three feet into the earth, apparently trying to reach her fallen companion, all the while letting out screams and shrieks.[25]

Elephants have much to cry and be bitter about. Like so many of Africa's charismatic fauna (and that of all the other continents), populations have been reduced to fragments of their former scale. Ethologist and author Gareth Patterson took me for a walk through the forests near Knysna, South Africa, where he has been studying the relict elephant population that took shelter there and has survived despite prolonged persecution by European settlers and their subsequent elimination from most of South Africa. Human signs nailed to trees demarcating this as elephant territory are often damaged by the elephants, who seem to take exception to such human markings. Gareth showed me a large metal signpost weighing about 10 kg that had been torn down and gored. Ironically, the sign read: DANGER! HARVESTING IN PROGRESS.

In 2005, journalist Kathleen Stachowski witnessed the shooting of an adult male bison near Yellowstone National Park, Montana. The targeted animal—a descendant of the fortunate twenty-three Yellowstone refugees who escaped the massive bison genocide of the 1870s—sat calmly in the grass among three of his comrades. The first shot brought all four animals to their feet. It took two more shots before the victim fell down again, at which point the remaining three gathered around him. Stachowski records what followed:

> The carriage of their tails registered distress. One, in particular, seemed especially anguished; he pawed the motionless shoulder as if to rouse him. Getting no response, he nudged the body with his head then with the shank of his horn. Again and again he nudged and butted...[26]

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J. Balcombe, *Second Nature: The Inner Lives of Animals.* (Palgrave Macmillan, New York, 2010), pp. 50-57.
Extract from Chapter four: With feeling: Emotions.

An elephant's comment on deforestation—damaged logging sign from Knysna, South Africa. The hand holding sign at upper left indicates scale. (Photo by the author.)

It may not be an overstatement to say that a zebra stallion feels grief at the loss of his son. Biologist Cynthia Moss, who has studied African wildlife for over thirty years and has written several books on the animals' behavior, refers to the "extremely strong personal bonds" between them when an older stallion returned several times to his dead four-and-a-half-year-old son and repeatedly tried to rouse him. Later he left his family group and searched the herd, calling for six hours.[27]

SCIENCE/BIOLOGY TEXTS

EXTENDED WRITTEN TEXTS (NON-FICTION)

J. Balcombe, *Second Nature: The Inner Lives of Animals.* (Palgrave Macmillan, New York, 2010), pp. 71-75.
Extract from Chapter five: Knowing It: Awareness.

Deception

Deception is widespread in animals. Once thought to be merely instinct, recent studies show it to be flexible and calculating. Deceitful acts rapidly lose effectiveness if employed too often (recall Aesop's fable of the boy who cried wolf). Also, to be effective, deception hinges on others acting honestly most of the time. At the outset, let me distinguish forms of deception that don't require any sort of mentality from those that do. It doesn't require any awareness by red admiral butterflies to deceive would-be predators into thinking they are toxic by mimicking the appearance of foul-tasting monarch butterflies. On the other hand, when a gorilla feigns having his arm stuck in the bars of his cage, then quickly removes his arm and hugs the keeper who hurries over to help, we are seeing a form of deception that is premeditated, and cognitive.[23]

Some birds use a form of acoustic deception. Shrikes are medium-size birds that prey on large insects and other small animals such as mice and lizards. Shrikes often perch with mixed flocks of birds, and benefit by catching desirable insects flushed by the smaller birds' activities. Flock members benefit by the increased vigilance of other birds, and also by alarm calls given by alert shrikes in the presence of a predator, such as a hawk. Occasionally, a shrike will utter an alarm call when there is no predator about, particularly when one of the smaller birds has captured a desirable insect. The sudden danger signal may cause the frightened bird to drop the insect, which the shrike then snatches.[30]

There are many other examples of deceptive alarm calls. Great tits use them to scatter competing sparrows from a feeder; vervet monkeys fake them to help settle boundary disputes with neighboring vervet troops, causing them to flee. Lower-ranking spotted hyenas will give an alarm cry during a feeding frenzy, causing others to scatter and freeing up space at the carcass. Increasingly known for their ingenuity, hyenas have also used this ploy to spare another from bullying.[31] This is evidence that these signals are not merely a stereotypical stimulus-response action.

Vervet monkeys may also sometimes withhold making an alarm call even though the situation warrants one. When they presented predator stimuli to vervets in Amboseli National Park, Kenya, Dorothy Cheney and Robert Seyfarth found that adult females alarm-called significantly more often when with their offspring than with unrelated juveniles. Similarly, adult males alarm-called at higher rates in the presence of adult females than in the presence of other adult males—presumably because doing so earns them credit for being more vigilant and protective. This sort of deception may be particularly effective because it is hard to detect a cheater who withholds making a signal.[32]

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J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 71-75.
Extract from Chapter five: Knowing It: Awareness.

Scientists had thought the aerial alarm call given by roosters was just a reflex response to the appearance of a hawk flying overhead. But experiments in which computer-generated images of hawks are flown over have shown that the call is under voluntary control. A solitary rooster who sees the image remains silent even though he may take flight; but if a hen is present, he utters the aerial alarm call. Chris Evans, an ethologist at Macquarie University in Australia who specializes in animal communication and social behavior, describes this call as a "conspiratorial whisper," which helps to reduce the rooster's risk of being detected by the hawk while simultaneously warning the hen.[33] It turns out that alarm calls—and not food-solicitation calls—were the strongest predictor of mating success in roosters.

Deception can mean the difference between life or death. Playing dead is a form of deception reserved for such situations. Prey who have been attacked but not killed by a predator may feign death in a last-ditch attempt to make an escape. Studies show that death-feigning prey will open their eyes gradually every thirty seconds or so to survey the predator situation. If the pretender still sees two eyes—typical of most predators looking—then he slowly recloses his eyes. If the coast appears clear, the prey is more likely to make a dash for it. If you've ever pretended to be asleep in another's presence, perhaps you have opened your eyes a shade to see if you're being watched. The stakes are lower, but the ploy is the same.

A scene captured on film in the BBC's production *Big Cat Week* shows apparent death-feigning by a vulture. A lioness ambushed a kill surrounded by vultures, swatting one of the birds to the ground with two whacks. Lions aren't especially partial to vulture meat, and she took little interest after a preliminary sniff. Her cub arrived, further distracting her, and as the two began to amble off, the vulture suddenly sprang to life and flew off. Had the large bird continued to struggle, he likely would have come off worse.

When a herd of females comes onto the territory of a male impala (an elegant, mid-size African antelope), he will sometimes use an amusing form of deception to try to encourage them to stay—or rather, to not leave. Suddenly stiffening in an alarm posture, he focuses his gaze on some distant object as if he has just spotted some danger over in the adjoining territory. The ploy is to make the females reluctant to wander from the perceived relative safety of the male's territory. Biologist Cynthia Moss, who describes this behavior, is careful to use quotation marks around the word "pretend" so as not to assume that the male impala is necessarily aware of his ploy.[37]

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J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 71-75.
Extract from Chapter five: Knowing It: Awareness.

Gray squirrels practice food-burying deception. Close observations have found that these rodents will—in addition to burying nuts—dig and cover empty holes.[38] Not surprisingly, this "deceptive caching" occurred more often in the proximity of other squirrels, and it was found to be effective in reducing the likelihood of theft by "surrogate cache pilferers," the humans studying them. Crows, jays, and other squirrels are all known to "cache in" on another squirrel's buried larders. Once a squirrel has been purloined, s/he is more likely to engage in deceptive caching, as well as to bury nuts in places harder to reach, such as in trees, under bushes, or in mud.

In sum, animal deceptions involve flexibility, restraint, context sensitivity, and—because there is a cost to using it too often—rationing. Each of these features invokes an understanding of how to use it to deceive effectively.[39]

J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 84-90.
Extract from Chapter six: Communicating.

Semaphore—a system of communicating over long distances by holding the arms or two flags in certain positions—is not a very efficient mode of communication for us. But for the Panamanian golden frog semaphore is just the ticket. These frogs live near waterfalls, where the constant din renders vocal communication useless. So while the males of other frog species woo females with beeps, chirps, and booms, these frogs have, over the course of evolution, traded in acoustic for visual signaling. When they want to get someone else's attention, they flash pale patches of skin on their limbs or the webs between their toes.

Is it communication? To find out, Erik Lindquist and Thomas Hetherington of Ohio State University presented male frogs with mirrors. The frogs signaled significantly more at their own reflections than they did at a nonreflective control surface. Staged encounters between males further showed that semaphores were not directed randomly, but instead were aimed toward target individuals.[2]

It takes light to perceive a visual signal, so, not surprisingly, all of these frogs are diurnal. Except one, which uses semaphore on moonlit nights. Of course, different modes of communication are not mutually exclusive. Both males and females of a species of frog in Borneo have been found to use foot-flagging, arm-waving, vocal sac-pumping, and open-mouth displays.[3]

Some frogs are ventriloquists, and their pure tone calls are extremely hard to locate. I once spent ten minutes fruitlessly trying to find a calling spring peeper frog. I got within inches, but whenever I turned my head it seemed the frog was calling from somewhere else. Female barking tree frogs don't have to deal with ventriloquist males, but they are presented with another location problem, and they have a neat way of solving it. Like most frogs, females tend to favor larger males as mates. Larger males may be distinguished by having louder calls, but a smaller male who is closer may sound louder. Female barking tree frogs use triangulation to locate the more promising mate. By moving about and listening for changes in the angle from which the sounds are coming, the female can detect a faster change in the direction of the smaller frog's calls. Triangulation is a more complex calculation than monitoring how the sound degrades or working out how fast calls get louder as the female approaches its source. "They're smarter than I realized," says Christopher Murphy, the behavioral ecologist who conducted the study.[4]

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J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 84-90.
Extract from Chapter six: Communicating.

Recent research has detected elephants using a special acoustic technique to track others. Their feet are beautifully adapted for communicating and listening infrasonically, that is, at frequencies below human hearing. Preliminary studies reveal a high density of pressure-sensitive nerve endings at the front of the footpad and around the edges. This enables them to remain in contact with each other for weeks at a time even though they may be separated by miles of savannah. It may also act as an early-warning system for earthquakes, explaining why elephants and virtually all other large animals had already moved to higher ground when rising water from the giant tsunami pounded Asian coastlines on December 26, 2004.

Because we have virtually no close contact with whales, the vast extent of their communications with other whales remains a mystery to us. The high conductivity of water means that a whale's calls might be heard by another whale hundreds of miles away. Wops, thwops, grumbles, and squeaks are among the thirty-four different types of call so far identified in a study of humpback whale communication. Researchers monitoring humpbacks migrating along Australia's east coast recorded 660 sounds from sixty-one different groups of whales. A male's "purr" seems to indicate his amorous intentions toward a female, while high-pitched cries and screams were associated with disagreements between males jostling to escort females. The "wop" call appears to be a mother-calf contact call.[5]

Whales also show signs of acoustic culture, including a variety of dialects found in orcas and sperm whales.[6] Dialects are cultural because they are learned and not genetically coded. These dialects are characterized by different rhythms in the clicks the whales make: "Acoustic clans" is a term used to describe the clusters of dialects found among the estimated total population of 360,000 sperm whales worldwide. Other marine animals also draw information from these dialects. Unfortunately, trying to interpret whale communication is a bit like trying to interpret ancient cave paintings. We are so vastly separated from these creatures that we may, so far, only scrape the surface of what is actually being communicated.

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J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 84-90.
Extract from Chapter six: Communicating.

Fish are not quiet. They produce sounds by grating jaws, clicking spines, slapping fins, and vibrating their swim bladders—air-filled sacs that control buoyancy.[7] In 2003, Ben Wilson and his colleagues at the Bamfield Marine Sciences Centre in British Columbia discovered the source of loud raspberry sounds among schools of herring: the fish were forcing a stream of bubbles from their anal region. The source of the bubbles is probably the swim bladder rather than digestive gas from the gut.[8] Members of the family of fishes that includes herrings and sardines have excellent hearing, aided by a gas-filled sac near the inner ear, which acts to amplify sound pressure. It is unclear for what purpose the herring use the "fast repetitive tick" sound (the acronym, appropriately, is FRT)—neither exposure to a fearful stimulus (shark extract) nor hunger elicited the FRTs in captive herring shoals. The leading theory is that the sounds allow the herring to locate one another and maintain contact in the darkness. Because the FRT frequencies are higher than the hearing of most predatory fishes, they can stick together without revealing their position to the enemy.[9]

There is a sobering footnote to the underwater communication systems of the whales and the herrings. Marine animal sound communication is threatened by human-caused noise pollution. Engine noise from shipping, seismic guns used for oil surveys, and naval testing exercises all interfere with the ability for these animals to hear each other.

In 1999, researchers from Macquarie University in Sydney, Australia, reported that domestic chickens used a variety of clucks, thirty different calls in all, as signals to refer to specific objects or situations in their surroundings. When, for instance, a rooster makes a distinctive "tck tck tck" call, it brings a nearby hen running to take the morsel from the gallant rooster's beak, or to search for it in the grass. When the Macquarie team broadcast a recording of the food call, hens who had recently been allowed to peck clean a floor scattered with corn kernels looked down for only a third as long as did hens who hadn't been fed (and who therefore didn't know whether or not there was any food present). This demonstrates that the call is not an automatic trigger for some reflex to search the ground; the birds respond flexibly according to their state of knowledge.[14]

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EXTENDED WRITTEN TEXTS (NON-FICTION)

J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 84-90.
Extract from Chapter six: Communicating.

This nice study is more a measure of our past reluctance to acknowledge animals' savvy awareness than it is a measure of birds' intellect. It is only because our science has recently begun to allow the once heretical notion that animals think that studies like this are being done. The chickens were demonstrating what they were doing all along and it only took someone to take notice and verify.

Teresa Cummings notices. With her husband, Terry runs Poplar Spring Animal Sanctuary in Maryland, a haven for abused and neglected farm animals. One day, as Terry and I were cleaning out one of the chicken sheds, a rooster let out a screech and a group of chooks happily scratching in the grass outside suddenly made a mad dash into their shed. As I dumbly looked at them, Terry was gazing upward at a hawk gliding past overhead. Unlike me, she'd seen this response before, and knew what caused it. A recent study documents at least two aerial predator calls in the domesticated chicken: one for large, and less dangerous, predatory birds, and one for smaller, stealthier enemies.[15]

If you think a chicken's alarm call is useful only for chickens, think again. The rabbits at Poplar Spring have also learned to dart for cover whenever they hear the hens' air-raid siren in the adjacent barn. There is abundant evidence that animals respond to the alarm signals of others. They do so because sounding the alarm is risky to the individual but it helps relatives survive. It is also a good deed that others may remember, and they may return the favor. Animals know they should take alarms seriously, and heeding these signals may be the difference between life and death.

Birds smaller than chickens have been found to have intricate alarm systems as well. "We really were surprised at just how sophisticated the alarm call system is and how sophisticated the judgment of predation risk was," said Christopher Templeton, who, as a doctoral student conducted a study of the alarm calls of chickadees, tiny songbirds that weigh less than half an ounce. Chickadees produce distinctive "seet" calls to warn of larger aerial predators, such as the great horned owls. Smaller, more agile predators, such as sharp-shinned hawks, present a greater threat; they elicit the characteristic chick-a-dee-dee-dee call. The number of "dees" a chickadee affixes to the end of her call (up to fifteen) provides specific information about the type of predator, and may also call in other birds to mob the predator. A predator who's been spotted first poses little immediate danger to these agile songsters, and mobbing tends to encourage the predators to leave.[16]

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J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 84-90.
Extract from Chapter six: Communicating.

The call discrimination abilities of these small birds reveal a finely honed perception of slight differences in sounds. It's an ability at which humans excel because we must regularly discriminate very similar words, and there are many anecdotes that testify to a similar skill in birds. When Chris Chester had some corn for B, an orphaned house sparrow he had reared from a chick, he would call out "corn." Even if he was in mid-flight, B would veer back and land on Chris's shoulder to be fed. Chester tried similar words, "born, torn, morn, horn, worn," using the same intonation, none of which had any effect on B.[17] Similarly, Len Howard, a musicologist who lived for a decade among wild birds in England, observed on many occasions that great tits understand the command to "get off the bed." If she used the same intonation to reprimand them with an irrelevant command, such as "poke the fire," they wouldn't fly off.[18] Another great tit named Twist took to delivering a gentle peck to Howard's nose when she said "kiss"; Twist never did this without being asked, and he never kissed in response to other words. The bird was employing the same skills she used for distinguishing the calls of other birds, only this time in a domestic setting.

Befitting their social nature, prairie dogs have developed a sophisticated system of predator detection. Their alarm calls convey specific information about an approaching foe, including species, size, shape, and even color. When hawks or humans come into view, prairie dogs run to their burrow entrances and dive inside; if the enemy is a coyote, they watch vigilantly from the burrow entrance, or if it's a dog, they may just stand erect and watch from where they are foraging. If presented with only recordings of an alarm call in the absence of any actual predator, the rodents respond in kind, demonstrating that they understand the meanings of these different calls. The alarm calls of prairie dogs vary with geographic locale, so there are local dialects that dogs from other districts wouldn't understand.[19]

SCIENCE/BIOLOGY TEXTS

EXTENDED WRITTEN TEXTS (NON-FICTION)

J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 109-114.
Extract from Chapter seven: Getting along: Sociability.

Cleaners and Clients

The cooperative relationship between cleaner fishes and their clients is one of the most advanced mutualisms in nature. It involves cross-species cooperation where cleaner fishes groom other fishes—plucking parasites, algae, or other unwanted debris from the scales, mouths, and gills of their clients. The cleaner benefits by getting fed; the client by getting a spa treatment. The partners form relationships built on trust, developed and nurtured over the course of weeks or months. Clients will line up, waiting their turn to be serviced by their favorite cleaners. Business is brisk; a cleaner may have hundreds, even thousands, of interactions in a day, servicing a variety of fish species.[17]

This process requires that individual cleaners be able to recognize individual clients, and vice versa. Observational studies bear this out. In choice experiments where a cleaner could choose to swim near one of two clients, the cleaner spent significantly more time near familiar fish. Interestingly, client fish showed no such preference in these experimental trials, and the authors speculate that they need only remember the location of where the cleaner does business to achieve repeated interactions with the same individual.[18]

The best studied of the cleaner fishes is the cleaner wrasse, a small, slender reef fish with bright horizontal stripes. They occasionally cheat their clients by taking a quick nip at a fin. They distinguish between two different, overlapping client categories: predatory/nonpredatory, and resident/visiting clients.[19] Predatory clients are almost never cheated, and if a visitor is cheated he or she simply swims away. A resident, on the other hand, who has built up a relationship of trust with the cleaner, takes serious offense at the gaff, chasing the cleaner around.[20] This punishment makes cleaners more cooperative in future interactions. Cleaners also show extra consideration for clients in the early stages of their relationship. This includes applying extra tactile stimulation (gentle strokes of the client's dorsal fin with the cleaner's pelvic and pectoral fins—a fish massage).[21] Field observations indicate that prospective clients watch the performance of cleaners before deciding whether to permit a cleaner to inspect them, a behavior called "image scoring" or a "social prestige" rating.[22] Unsurprisingly, cleaners are more cooperative to a client if other eavesdropping clients are around.[23] That all this cognitive capacity resides in the brain of a fish just a few inches long should remind us that size is only one measure of intelligence, and a rather flimsy one at that.

SCIENCE/BIOLOGY TEXTS

EXTENDED WRITTEN TEXTS (NON-FICTION)

J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 109-114.
Extract from Chapter seven: Getting along: Sociability.

Sensory pleasure helps to sustain adaptive behaviors, and social interactions are no exception. The relationship between cleaner fish and their clients is mediated by good feelings. I doubt that client fish think "I need to get rid of these parasites. Let's swim over to that stripy fish so he can remove them from me. I'll be healthier and more likely to be reproductively successful." Instead, they probably think something like: "There's my cleaner buddy. It feels good when he gives me those massages. I'm getting in line."

Helping Raise Others

For many sexually reproducing species, cooperation is woven deeply into their biology; the successful production and rearing of offspring requires that they work together. The most extreme form of cooperative breeding occurs in the eusocial insects—bees, ants, wasps, and termites—in which sterile female workers help raise their queen's brood. Cooperative breeding also occurs in many mammals, including primates, bats, rodents, and social carnivores such as wolves, lions, foxes, and meerkats. At least nineteen species of cichlid fishes in Lake Tanganyika in Africa engage in some form of cooperative breeding. In one of the best studied of these, the Princess of Burundi cichlid, there are typically about five helpers of both sexes, who may or may not be genetic relatives of the breeding pair.[25] Helpers do the lion's share of guarding the nest, and defending and maintaining the family territory.

Studies of evening bats by Jerry Wilkinson found that about one in five nursings involved females feeding unrelated pups. Because such behavior doesn't fit a conventional, selfish view of animal nature, attempts are made to try to explain it from a selfish perspective. One theory is that mothers may be getting rid of excess milk to reduce their weight prior to a foraging flight. Such "milk dumping" may also reduce risk of infection and stimulate the production of more milk.[26] I find this idea rather unsatisfying by itself, and wonder if pleasant sensations associated with nursing and nurturing might also motivate such selfless behavior. In any event, communal nursing is another example of how evolution can favor generosity and kindness, not the opposite. Nursing of another's offspring is known from at least a hundred mammalian species.[27]

SCIENCE/BIOLOGY TEXTS

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J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 109-114.
Extract from Chapter seven: Getting along: Sociability.

Male manakins—small, brightly colored birds of the tropics of the Western Hemisphere—perform song-and-dance routines to try to induce females to mate with them. Even though only one male—the designated alpha—will do any of the mating in a given season, he is assisted by one or more beta birds who act as "backup singers/dancers." The duo or trio perform their routines in an elaborate, coordinated fashion. For instance, the birds may shimmy across a horizontal twig with such rapid and tiny steps that they appear to be on a conveyor belt, or they may hop over one another like balls being juggled. We find the effect of this team effort undoubtedly more impressive to behold than if a single male were performing. Female manakins apparently share that opinion, for there is evidence for higher reproductive success among team-supported alpha males.[33] Emily DuVal, who studies lance-tailed manakins in Panama, informs me that solo males (i.e., without backups) also sometimes breed successfully, which raises the intriguing question: Why be a beta (a backup) if you can go it alone? Strictly speaking, evolutionary theory would predict that betas ultimately have greater reproductive success than do solo birds. Further research may tell, but it is an intriguing cooperative mating system.

Female house mice breed cooperatively, with two or more mothers combining their pups into a single crèche, or group. They share a variety of brood-rearing duties, including nursing another mother's pups. This sharing is not predicted by a selfish, competition-focused evolutionary system, because the extra labor of looking after another's pups would cost the helping mother more expenditure of energy that she might otherwise devote to her own offspring. Communal nursing behavior is now known to be common for many rodent species.[34]

For the young mongoose, there is an even greater level of care. Childless adults follow a "feed the nearest pup" rule, provisioning, protecting, carrying, grooming, and playing with the most vulnerable pups in the band. Escorts consistently associate with the same pup, but since it is the opportunistic pup who maintains the relationship, they are not likely to be genetically related.[35]

Mongooses' once-obscure but now popular cousins, the meerkats, are highly social and cooperative, performing several functions including huddling together to conserve warmth during the cold desert nights, hunting collectively, defending their burrows, and taking turns standing sentry duty, sharing information through a repertoire of vocalizations.[36] Another task shared by these tight-knit groups is the feeding of young. Like mongooses, meerkats also follow a "feed the nearest pup" rule. Hungrier pups beg more and are more likely to be fed if they are nearby and the morsel is large, regardless of whose offspring they are.[37]

J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 109-114.
Extract from Chapter seven: Getting along: Sociability.

Democrats

Most human societies believe that decisions ought to be made democratically. We form committees, stage elections, and, in most cases, arrive at decisions either by negotiating until a compromise consensus is reached or by agreeing to a majority opinion. Until recently, decision-making in animal groups was thought to be autocratic—the leader decides, and all follow. Evidence has begun to accumulate that many animals also try to canvass a group's opinion to make democratic decisions. Recent studies by Tim Roper and Larissa Conradt from the University of Sussex find that when a group of animals makes a decision to move from one place to another—be it a flock of geese flying to another lake, or deer walking to another pasture—that decision is made only when a majority (typically about 60 percent) make intentions to move.[40] In the case of deer, an individual's "vote" is made by standing up. Among African buffalo, females make the decisions, and vote with the direction of their gaze.[41] Whooper swans use head movements. As we might expect of congregations of beings who are autonomous, not automatons, individuals in the group may have different interests and desires at a given moment, but they are willing to suppress those immediate wants for the greater benefit of staying with the group.

Democracy also occurs in social insects. From time to time, honeybees need to find new nest sites. How does a colony of twenty thousand bees make this decision? Although the hive has a matriarch in the queen, the plans for relocation are not autocratic but decidedly democratic. Bees fly out from the swarm to scout potentially good new nest sites, then return to recruit others who fly out to assess the site. The level of enthusiasm for prospect sites is conveyed in the intensity of the waggle dances performed by returning recruits. Every time a bee returns from a site, she makes about fifteen fewer runs than on her previous trip. So the number of recruits, and subsequent support for a site, can fade away if recruits disagree with a scout's assessment. A computer simulation of this "quorum sensing," starting with 150 runs and reducing by fifteen runs each time, ensures that the choices of error-prone bees are filtered out and that a favorable decision is efficiently reached.[42]

J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 109-114.
Extract from Chapter seven: Getting along: Sociability.

Good Deeds

In March 2008, a bottlenose dolphin named Moko at New Zealand's Mahia Beach rescued two pygmy sperm whales. The whales had become stranded in a narrow, shallow finger of seawater between a sandbar and the shore. Conservation Department officer Malcolm Smith had tried unsuccessfully to push the ten-foot mother whale and her five-foot calf back out to sea. When Moko arrived, Smith could hear the whales and dolphins making sounds, apparently to one another. Moko then led the whales about two hundred yards along a channel of water parallel to the shore, then she turned a right angle and escorted them out to sea.[43]

It seems likely that for every incident of this sort that is witnessed by humans, many more occur out of view. The article also reports that whales become stranded on Mahia Beach about thirty times a year, and that most incidents end with the whales being euthanized. This bit of information reveals much about our different attitudes toward nonhumans. Can you imagine reading that *Each year some thirty people get lost in Desert X and most end up having to be put down?*! Euthanasia is certainly better than being left to die a slow death, but surely human ingenuity and morals can do better than this. What about inventing an inflatable raft with a harness that can be slipped beneath a stranded whale, inflated, then used to pull the animal to safety? What is stopping us from intervening in a more systematic, determined fashion?

In the Tuli bushlands of Botswana where Gareth Patterson studied elephant populations, one of the elephants was maimed and her trunk was rendered useless by a poacher's snare. Gareth received reports from antipoaching guards that they had seen other elephants placing food into the mouth of their handicapped comrade, who was now surviving with just half a trunk. Gareth occasionally saw this elephant drinking, which she performed by reverting to the method of babies, who kneel down and suck water directly into their mouths.[44]

Cynthia Moss recounts the adoption of a one-week-old elephant calf by a family unit. The calf was orphaned when his mother was killed outside Uganda's Rwenzori National Park. Simon Trevor, a filmmaker, and Michael Woodford, a veterinarian, decided to introduce the calf to a family unit inside the park. When they released the calf near an elephant herd, the calf kept following the men. In desperation, they pushed the calf headfirst into a bush, causing the animal to trumpet. This drew the attention of the nearby herd, whose replies sent the calf in their direction. The first elephant the calf approached was unfortunately a large bull, who knocked him flying with a swat of his trunk. The second was a nursing cow, who gently drew him toward her with her trunk and allowed him to nurse. The team tracked the herd the following day, and the calf appeared to be an accepted member of the family unit. There is some evidence that allomothering (nonmaternal infant care) in elephants is more prevalent during hard times—when it is most needed.[45]

J. Balcombe, *Second Nature: The Inner Lives of Animals*. (Palgrave Macmillan, New York, 2010), pp. 135-138.
Extract from Chapter eight: Being nice: Virtue.

Animals are not rigidly fixed in their evolutionary roles. As sociable, engaged, considerate beings they show flexibility in their behavior. Giving, cooperating, and nurturing are basic elements in life. As babies, we are the recipients of the largesse of another, and as we grow into adults we reciprocate. Life is sustained through the generations by the goodness of others.

Rich Experience

The main elements of animal sentience and coexistence are their sensory, perceptual, emotional, and cognitive capacities, which together engender a rich world of experience. The presence of others enriches the experience further, and gives rise to emergent properties: communication, sociality, and virtue. It is a mistake to think that morality originated with *Homo sapiens*. Being nice was adaptive long before we stalked the earth, and virtuous nature is beginning to garner the scientific attention it deserves. Let me also emphasize that the reason why I think it is important for us to be conscious of other animals' own forms of intelligence, awareness, and virtues is not to liken them to us, but rather so that we might realize that they have lives worth living.

Part III takes the information from Parts I and II and applies it to our relationship with animals. In the next chapter I want to address a question that Part II has been leading up to: Is life worth living for animals? This is a deeply philosophical question. It is also accessible to science. Too often we encounter depictions of wild nature as harsh and cruel, with animals locked in an earnest struggle for survival. In a discussion that includes examples of the benignity and sustainability with which animals conduct their affairs, I want to show that life for animals is very much worth living. In Chapter 10 I put human nature under the microscope, arguing that it is hypocritical to portray animal life as uncivilized in light of our ongoing history of violent conflict and our institutionalized indifference toward animals. The final chapter is about the path that humankind can, and really must, choose if we want our grandchildren to inherit a better world. For too long, an attitude that might makes right has governed humankind's relationship to animals. It is time our hearts caught up with our knowledge. Grounded in science and driven by ethics, I argue for an emergent, less selfish worldview that grants animals the respect and consideration they are due.

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Extracts from Chapter Four: Wild Justice, Empathy, and Fair Play: Finding Honor among Beasts.

Those communities which included the greatest number of the most sympathetic members would flourish best and rear the greatest number of offspring.

— CHARLES DARWIN, *THE DESCENT OF MAN AND SELECTION IN RELATION TO SEX*

I've long been interested in play behavior. This might sound like a frivolous field of study — a number of my colleagues certainly told me so when I first started — but after years of examining videotapes of playing dogs, coyotes, and wolves and trying to understand why animals play the way they do, I have been led to ask a series of big and ultimately surprising questions: Do animals play fair? Do they negotiate agreements to play (as opposed to fighting or mating), and do those agreements require cooperating, forgiving, apologizing, and admitting when they're wrong, as well as trusting others? Are animals honest? If one breaks their agreement, do they consider that wrong? Are there consequences for doing something wrong? If animals demonstrate a dislike for getting the short end of the stick or being short-changed, does that indicate that animals have a sense of justice, of right and wrong, good and bad — does that mean, in other words, that animals are moral beings? And if animals can be shown to display a sense of justice along with a wide range of cognitive and emotional capacities, including empathy and reciprocity, does that make the differences between humans and all other animals a matter of degree rather than kind?

Finally, if all this is true, then is morality in fact an evolved trait? Does "being fair" mean being more fit — does being more virtuous improve an individual's reproductive fitness, while being less virtuous harm it? To put it anther way, do nice guys, gals, and their genes last longest? Do the nicest survive best?

These are indeed big, complicated, difficult questions, but mounting evidence points straight to the conclusion that there is "honor among beasts." While much of the research that's been aired widely deals with nonhuman primates, especially the work of Frans de Waal and his colleagues at Emory University in Atlanta, Georgia, there are also compelling data from studies on social carnivores that support the claim that moral behavior is more widespread among animals than previously thought. In *Primates and Philosophers: How Morality Evolved*, de Waal argues that human morality is on a continuum with animal sociality, though he isn't sure that animals are moral beings. However, he doesn't consider social play behavior.

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Based on my long-term detailed studies of play in social carnivores — including wolves, coyotes, red foxes, and domestic dogs — I believe we can make the stronger claim that some animals might be moral beings. Other ethologists (such as Nobel laureate Niko Tinbergen and the well-known field biologist George Schaller) certainly stress that we might learn more about the evolution of human behavior from studies of social carnivores than from studies of other primates because the social behavior and social organization of many carnivores resemble that of early hominids in a number of important ways (divisions of labor, food sharing, care of young, and intrasexual and intersexual dominance hierarchies). Given this, social carnivores may hold the key for unlocking the nuances of animal morality.

So how does play figure into discussions of morality? To begin with, when animals play there are rules of engagement that must be followed, and when these break down, play suffers. Animal play appears to rely on the universal human value of the Golden Rule — do unto others as you would have them do unto you. Following this requires empathy (feeling another's feelings) and implies reciprocity (getting paid back for favors assuming that others follow the same rule). Further, in the social arena, animals who don't play well don't seem to do as well as those who do play. Darwin might very well have been right when he speculated that more sympathetic individuals have more reproductive success — they survive better. By the end of this chapter, I propose that this means we should make another paradigm shift in how we understand animals and ourselves. "Survival of the fittest" has always been used to refer to the most successful *competitor*, but in fact *cooperation* may be of equal or more importance. It is likely that for any species individual survival requires both to some degree, while for social species (as opposed to asocial species) the balance may shift significantly, with the most cooperative individuals most often "winning" the evolutionary race.

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JEROME AND FERD:

Two Dogs at Play

A few years ago one of my students, Josh, called me and, with much excitement in his voice, told me the following story of watching his 120-pound malamute, Jerome, engaged in play:

> I saw the most amazing thing today at Mount Sanitas. Jerome wanted to play with a strange dog named Ferd who was about a quarter his size. Jerome bowed, barked, wagged his tail, rolled over on his back, leapt up, and bowed again, all to no avail. Ferd just stood there with surprising indifference. But about a minute later, while Jerome was sniffing a bush where a large mutt had just peed, Ferd strolled over and launched onto Jerome's neck, and bit him hard and was sort of hanging in midair, legs off the ground. I thought, this is it; Jerome will kill this little monster.
>
> And you know what? Jerome shrugged Ferd off like a fly on his back, turned around and bowed, and then took the little guy's head into his mouth and gently mouthed him. They then played for about half an hour, during which Jerome never ever was very assertive or unfair. He'd bite Ferd softly, roll over, paw at his friend's face, and swat him lightly. Then when things got rough, and Ferd backed off with his tail down and cocking his head from side to side — trying to figure out if he was a goner — Jerome would bow again and they'd play some more. Jerome seemed to know that he had to be nice and fair in order to play with his little buddy. Ferd knew what Jerome wanted, and Jerome knew what Ferd wanted, and they worked together to get it. Man, dogs are smart. I couldn't believe it.

Josh was a good student. He understood the "language" of animal play (which I describe further below), and so he was able to "read" this encounter and all of its internal communications. However, I'm willing to guess that anyone watching these two mismatched dogs would have been able to tell, after a few minutes, that they were playing and not fighting — just as we can tell at a distance whether two boys who are wrestling really mean to hurt each other or whether they are just kidding around. This is because, when animals play, they must *agree* to play. They must cooperate and behave fairly, and the language of cooperation is easy to recognize. Further, when cooperation and fairness break down, play not only stops, it becomes impossible. *Uncooperative play* is an oxymoron, and that is a large reason why play is such a clear window into the moral lives of animals.

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WHAT IS PLAY?

Most of my research on play has involved domestic dogs and their wild relatives, coyotes and wolves (that is, canids, or members of the dog family), so while I focus on the animals I know best in this chapter, there are ample examples from other animals that support my views on play and social morality. Young cats, chimpanzees, bears, and rats, to name only a few, love to play to exhaustion. Even as I'm writing this at six o'clock on a cool August morning, two red foxes are playing outside my office. They do this almost every day. One invites the other to play by bowing, the other responds, and then they wrestle, rear up on their hind legs and scream and box, chase one another, rest, and play some more. If one bites the other too hard, there's a brief pause during which they look at each other to make sure all is okay — that this is still play — and then resume romping. They're negotiating with each other to maintain the rules of fair play. So long as they keep negotiating, they feel comfortable playing very vigorously because they share a common goal and know that neither will try to beat up the other.

I think of play as being characterized by what I call the "Five S's of Play": its Spirit, Symmetry, Synchrony, Sacredness, and Soulfulness. The Spirit of play is laid bare for all to see as animals wildly run about, wrestle, and knock one another over. The Symmetry and Synchrony of play is reflected in the harmony of the mutual agreements to trust one another — individuals share intentions to cooperate with one another to prevent play from spilling over into fighting. This trust is Sacred. Finally, there's deepness to play, for animals become so completely immersed in it that I like to say they *are* the play. Play is thus a Soulful activity, an expression of the essence of an individual's being.

There's also incredible freedom and creativity in the flow of play. This is easy to see and amazing to watch. I refer to this as the "Six F's of Play": its Flexibility, Freedom, Friendship, Frolic, Fun, and Flow. As they run about, jump on one another, somersault, and bite one another, animals re-create a mind-boggling array of scenarios and social behaviors. It's difficult to believe that when animals are deep into play they can actually keep track of what they are doing, but they can. It's possible that animals are "practicing" and "rehearsing" important behaviors that will help them to survive. As animals play, it's not unusual to see known mating behaviors intermixed in highly variable kaleidoscopic sequences along with actions that are used during fighting, looking for prey, and avoiding becoming someone else's dinner. In no other activity but play do you see all of these attributes and behaviors occurring together.

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FUN, FUN, FUN:
Why Animals Play

Animals love to play because play is fun, and fun is its own very powerful reward. Dogs and other animals seek out play relentlessly, and it's very difficult to get them to stop; normal animals don't usually intentionally seek out activities they don't enjoy. The joy associated with play is so strong that it outweighs the possible risks, such as injury, depletion of energy and therefore compromised growth, and death by a perceptive predator. Young animals know how to play from the get-go, and when they don't, we take that as a sign there's possibly something wrong.

When animals play we can feel their deep joy. Play is contagious, and other animals feel the joy and glee as well. Research on mirror neurons (which I describe in chapter 5) supports the notion that individuals can feel the emotions of others, and this likely is the reason that an atmosphere of play spreads rapidly among animals in a group. In her book *On Talking Terms with Dogs*, Norwegian dog trainer Turgid Rugaas refers to play signals as "calming signals." Animals typically play only when they're relaxed, so the inherent joy and serenity in play often spreads to anyone who is watching.

Indeed, as we've already seen, animals and humans share many of the same emotions and same chemicals that play a role in the experience and expressions of emotions such as joy and pleasure. Recent research has also shown that when people are cooperating and being fair to one another, it feels good. Since play is dependent on cooperation and fairness, this may be another reason animals love to play. James Rilling and his colleagues have used functional Magnetic Resonance Imaging (fMRI) on humans to show that the brain's pleasure centers are strongly activated when people cooperate with one another. This important research shows that there's a strong neural basis for human cooperation: that it feels good to cooperate, that being nice in social interactions is rewarding. Also, researchers have identified a "trust center" in human brains called the caudate nucleus. Activity in the caudate nucleus is greatest when generosity is repaid with generosity. There's every reason to believe that the brains of animals share this trust center with us. In short, research is showing that we might actually be wired to be nice to one another.

If being nice feels good, then that's a good reason for being nice. It's also a good way for a pattern of behavior to evolve and to remain in an animal's arsenal.

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IT BEGINS WITH A BOW:

How Animals Play

We know that birds and many other species engage in social play, but as yet there are too few data from which to draw detailed conclusions about the nature of their play. But in my studies of dogs and other canids, I've learned that they use specific play signals to initiate and to maintain social play. Play is a voluntary activity, and it can't occur if individuals don't agree.

How do animals tell one another "I want to play with you"? Play frequently begins with a bow (which I describe in chapter 2), and bowing is repeated during play sequences so as to insure that play doesn't slip into something else, like fighting or mating. After each individual agrees to play, there are on-going, rapid, and subtle exchanges of information so that their cooperative agreement can be fine-tuned and negotiated on the run, so that the activity remains playful. It's important for players to express and to share their intentions to play.

As I've noted, when animals play they often use actions, such as predatory behavior, antipredatory behavior, and mating that are also carried out in other contexts. Because there's a chance that various behavior patterns that are performed during ongoing social play can be misinterpreted as being real aggression or mating, individuals use a bow to tell one another such messages as "I want to play," "This is still play no matter what I am going to do to you," and "This is still play regardless of what I just did to you."

In order to learn the dynamics of play, it's essential to pay attention to subtle details that can be lost or go unnoticed when, for instance, we are simply watching dogs in the park. Dogs and other animals keep close track of what's happening, so we need to also. My studies of play are based on careful observation and meticulous analyses of videotape. I watch tapes one frame at a time to see what the animals are doing and how they exchange information about their intentions and desires during play. This can be tedious work, and indeed, some of my students who were excited about studying dog play had second thoughts after seeing what it entailed.

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After many years of study, I've discovered that the "bow" isn't used randomly but with a purpose. For example, biting accompanied by rapid side-to-side shaking of the head is performed during serious aggressive and predatory encounters, and it can easily be misinterpreted if its meaning isn't modified by a bow. I was surprised to learn that bows are used not only right at the beginning of play to tell another dog "I want to play with you," but also right before biting, accompanied by rapid side-to-side head shaking, as if to say, "I'm going to bite you hard but it's still in play." Bows are also used right after vigorous biting, as if to say, "I'm sorry I just bit you so hard, but it was play." Bows serve as punctuation, an exclamation point, to call attention to what the dog wants.

Infant dogs and their wild relatives rapidly learn how to play fairly using play markers such as the bow, and their response to play bows seems to be innate. Pigs use play markers such as bouncy running and head twisting to communicate their intentions to play. Jessica Flack and her colleagues discovered that juvenile chimpanzees will increase the use of signals to prevent the termination of play by the mothers of their younger play partners. Researchers who study the activity always note that play is highly cooperative. I can't stress enough how important it is that play is carefully negotiated, that it is fine-tuned on the run so that the play mood is maintained. There are social rules that must be followed.

Across many different species there's little evidence that play signals are used to deceive others. Play signals are honest signals, and only very rarely are they used to hide aggressive intentions. Animals almost never say, "I want to play with you" and then, when the other animal is vulnerable, engage in a real attack. This is most likely because there are sanctions for lying. For example, I discovered that coyotes who bow and then attack are unlikely to be chosen as play partners, and they also have difficulty getting others to play. My field studies also have shown that this makes them more likely to leave their group, and this can lower their reproductive fitness.

It's simple: If a dog wants to play, he must ask first by bowing. If the other dog doesn't return the bow, she doesn't want to play, and the first dog must move on.

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Other Play Markers: Role-Reversing and Self-Handicapping

The bow isn't the only signal used during social play; two other important ones are role-reversing and self-handicapping. Role-reversing and self-handicapping reduce inequalities in size and dominance rank between players, and they promote the reciprocity and cooperation that's needed for play to occur.

Self-handicapping (or "play inhibition") happens when an individual performs a behavior pattern that might compromise her outside of play. For example, a coyote might decide not to bite her play partner as hard as she can, or she might not play as vigorously as she can. Inhibiting the intensity of a bite during play helps to maintain the play mood. I once picked up a twenty-two-day-old coyote only to have him bite through my thumb with his needle-sharp teeth. His bite drew blood and it really hurt. The fur of young coyotes is very thin, and as I found out, an intense bite results in much pain to the recipient, as evidenced by the high-pitched squeals (the coyotes', not mine!). An intense bite is a play-stopper. In adult wolves, a bite can generate as much as fifteen hundred pounds of pressure per square inch, so there's a good reason to inhibit its force. I once foolishly tried to show a captive adult male wolf, Lupey, where his food was by pointing toward it, and he immediately showed me that he knew where it was by clasping his mouth over my extended forearm and squeezing ever so gently. I wore Lupey's teeth marks for two weeks, but he didn't break skin; we may not have been "playing," but he inhibited his bite anyway. With domestic dogs, one of the great advantages of making sure puppies play with other puppies is that they learn bite inhibition and will most likely never harm another.

Red-necked wallabies, kangaroos of a kind, engage in self-handicapping as well. Biologist Duncan Watson and his colleagues found that these playful creatures adjust their play to the age of their partner. When a partner is younger, the older animal adopts a defensive, flat-footed posture, and pawing rather than sparring occurs. Also, the older player is more tolerant of its partner's tactics and takes the initiative in prolonging interactions.

Fairness and trust are important in the dynamics of playful interactions in rats as well. Psychologist Sergio Pellis discovered that sequences of rat play consist of individuals assessing and monitoring one another and then fine-tuning and changing their own behavior to maintain the play mood. When the rules of play are violated, when fairness breaks down, so does play.

M. Bekoff, *The Emotional Lives of Animals: A Leading Scientist Explores Animal Joy, Sorrow, and Empathy – and Why They Matter*. (New World Library, Novato, 2007), pp. 85-107.

Extracts from Chapter Four: Wild Justice, Empathy, and Fair Play: Finding Honor among Beasts.

Role-reversing happens when a dominant animal performs an action during play that wouldn't normally occur during real aggression. For example, a dominant wolf might never roll over on his back during fighting, but he will do so while playing. In some instances role-reversing and self-handicapping occur together — a dominant wolf might roll over while playing with a subordinate dog and at the same time inhibit the intensity of a bite. Self-handicapping and role-reversing, along with play invitation signals, serve to communicate an individual's intention to play, and they are important in maintaining fair play.

FAIR IS GOOD:
The Benefits of Play

Play isn't an idle waste of time. Play is essential for an individual's mental and physical well-being. Play is brain food because it provides important nourishment for brain growth; it actually helps to rewire the brain, increasing the connections between neurons in the cerebral cortex. Play also hones cognitive skills, including logical reasoning and behavioral flexibility — the ability to make appropriate choices in changing and unpredictable environments.

But some of the most important benefits of play are social — play helps the individual and the group to get along together. Social play relies on, and also teaches, trust, cooperation, niceness, fairness, forgiveness, and humility. Dogs and their relatives aren't alone in the tactics they use in play. Recent research on nonhuman primates has shown that punishment and apology play important roles in maintaining cooperation.

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Why do animals carefully use play signals? Why do they engage in self-handicapping and role-reversing? It's plausible to argue that during social play, immature individuals learn ground rules about what behavior patterns are acceptable to others — how hard they can bite, how roughly they can interact — and how to resolve conflicts in a situation that is safe, enjoyable, and nonthreatening. This is similar to the reasoning behind why human children are encouraged to play organized sports: it teaches them how to behave, how to cooperate and resolve conflicts in a setting where the stakes are not high. Through their behavior, animals show us that they place a premium on playing fairly and trusting others to do so. There are codes of social conduct that regulate actions that are and aren't permissible. What could be a better atmosphere in which to learn about the social skills underlying fairness and cooperation than during social play, where there are few penalties for transgressions? It's also possible that individuals might generalize codes of conduct learned while playing with specific individuals to other group members and to different situations, such as sharing food, defending resources, grooming, and giving care.

Play is not only fun. It's a useful behavior. And studies of play indicate that animals actively cultivate a sense of fairness and cooperation by playing. This becomes even clearer in instances where play breaks down.

GETTING A BAD REPUTATION:
The Costs of Breaking Trust

When animals are not having fun, animals won't play. Animals who don't play often can't interact with others because they don't know how to tell their friends what they want and they can't understand what their friends want. They're not socialized. They can't function as card-carrying members of their own species because they haven't learned how to communicate with others. The consequences of the inability to play well start small but possibly grow quite large.

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For instance, dogs don't tolerate noncooperative cheaters, who may be avoided or chased from play groups. When a dog's sense of fairness is violated, there are consequences. While studying dog play on a beach in San Diego, California, for her doctoral dissertation in cognitive science, Alexandra Horowitz observed a dog she called Up-ears enter into a play group and interrupt the play of two other dogs, Blackie and Roxy. Up-ears was chased out of the group, and when she returned, Blackie and Roxy stopped playing and looked off toward a distant sound. In a fooling behavior, Roxy began moving in the direction of the sound, and Up-ears ran off following their line of sight. Having gotten rid of Up-ears, Roxy and Blackie immediately began playing once again.

Of much more importance to biologists, however, is how differences in the performance of a given behavior, such as play, influence an individual's reproductive success. Do differences in play and variations in fair play affect an individual's reproductive fitness? If we want to know whether a sense of fairness or morality evolved because it's adaptive in its own right — because it improves an individual's, and thus a species', chance for survival — then we should be able to show that more "virtuous" individuals are more fit and have more offspring than less virtuous individuals (as Darwin indicated). If play and fairness are inextricably linked (as they seem to be), then is it true that individuals who play well do better reproductively than those who don't? It's almost impossible to directly link fair play with an individual's reproductive success or fitness, but it's also extremely difficult to show with great certainty that the performance of *most* behaviors is directly and causally coupled to reproductive success. However, my students and I have collected some intriguing data on captive and wild coyotes that indicate a relationship between play and fitness.

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Dogs, coyotes, and wolves are fast learners when it comes to fair play. There are serious sanctions when they breach the trust of their friends, and these penalties might indeed become public information if others see an individual cheating on his companions. Biologists call these penalties "costs," which means that an individual might suffer some decline in his or her reproductive fitness if they don't play by the expected rules of the game. Our fieldwork on coyotes has revealed one direct cost paid by animals who fail to engage in fair play or who don't play much at all. I found that coyote pups who don't play as much as others because they are avoided by others or because they themselves avoid others are less tightly bonded to other members of their group. These individuals are more likely to leave their group members and try to make it on their own. But life outside the group is much more risky than within it. In a seven-year study of coyotes living in Grand Teton National Park in Wyoming, we found that more than 55 percent of yearlings who drifted away from their social group died, whereas fewer than 20 percent of their stay-at-home peers did. Was it because of play? We're not sure, but information that we collected on captive coyotes suggested that the lack of play was a major factor in individuals spending more time alone, away from their littermates and other group members.

Though all the evidence is not in, it seems quite likely that breakdowns in social play negatively affect individuals, and by extension their social groups. In social species at least, natural selection seems to weed out cheaters, those who don't play by the accepted and negotiated rules. Conversely, animals, including humans, survive and thrive better when they play fair and learn the group's moral codes for behavior. It sure is starting to look like morality evolved because it's adaptive.

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THE "BIG QUESTION": Is Morality Inherited?

They [animals] have the ingredients we use for morality.

— FRANS DE WAAL, "HONOR AMONG BEASTS"

The idea that morality may have evolved over millions of years isn't new, nor is the notion that animals share many of these behaviors. Charles Darwin proposed that human moral sentiments were a product of the evolutionary process, and he speculated about moral sentiments in animals. But it wasn't until recently that scientists gave these questions serious and sustained attention. What is emerging now is a fascinating tapestry of research into the biology of morality. We're beginning to recognize the role of morality in the lives of other species and to piece together the neurophysiological roots of moral emotion and cognition — roots that we share with other species.

Darwin's view is that morality is a natural extension and outgrowth of social instincts. Early theories of kin selection and reciprocal altruism among animals have now blossomed into a much wider inquiry into the pro-social behavioral repertoire: fairness and equity, empathy, reputation, punishment and forgiveness. At the same time, neuroscience is exploring the ethical brain: as we've seen, it is becoming clear that many moral behaviors originate in emotional centers in the brain — a neural architecture that humans share with other animals.

All of this research is confirmed by our studies of animal play. There seems to be strong evolutionary selection for playing fairly because most if not all individuals benefit from adopting this behavioral strategy, which fosters group stability. Numerous mechanisms have evolved as a result: play invitation signals, variations in the sequencing of actions performed during play when compared to other contexts, self-handicapping, and role-reversing. All these behaviors have evolved to facilitate the initiation and maintenance of social play in numerous mammals — to keep others engaged — so that agreeing to play fairly and the resulting benefits of doing so can be readily achieved. The observation from the field that play is rarely unfair or uncooperative surely indicates that natural selection acts to weed out those individuals who don't play by the rules.

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This sort of egalitarianism in animals is thought to be a precondition for the evolution of social morality in humans. From where did it arise? Truth be told, we really do not know. Studies of the evolution of social morality are among the most exciting and challenging projects that we face. However, given the evidence so far, if one is a good Darwinian and believes in evolutionary continuity, it is premature to claim that *only* humans can be empathic and moral beings. At a minimum, this constitutes the safest, most cautious approach, even as research points ever more strongly toward a more "radical" notion about evolution.

ANOTHER PARADIGM SHIFT:

Survival Depends on Cooperation, Not Competition

I believe that at the most fundamental level our nature is compassionate, and that cooperation, not conflict, lies at the heart of the basic principles that govern our human existence.... By living a way of life that expresses our basic goodness, we fulfill our humanity and give our actions dignity, worth, and meaning.

— HIS HOLINESS THE DALAI LAMA,
UNDERSTANDING OUR FUNDAMENTAL NATURE

We believe that most donkeys, if given the chance, would fashion a world without violence. Like St. Francis of Assisi, they would remake the natural world into a proverbial garden of Eden, where the lion and the lamb lay side by side.... We wonder how much the innocence, vulnerability and gentleness of [those two] donkeys may have effected Tolstoy, the peace-loving giant of world literature.

— MICHAEL TOBIAS AND JANE MORRISON, *DONKEY*

Some might call the Dalai Lama an optimist, but there are increasing scientific data to support His Holiness. Indeed, the time has come to revise our notions about what "survival of the fittest" really means.

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So far, most of the research on cooperation has focused on humans. As it turns out, humans aren't as selfish and self-centered as we're sometimes made out to be. Ernst Fehr and his colleagues have discovered that when treated fairly, many people will voluntarily cooperate with one another and also punish those who don't cooperate. They call this "strong reciprocity," and they show that it can lead to "almost universal cooperation in circumstances in which purely self-interested behavior would cause a complete breakdown of cooperation." They note that people are willing to punish individuals who behave unfairly to a third person.

There's also evidence that humans have a natural tendency to be altruistic. Felix Warneken and Michael Tomasello discovered that infants as young as eighteen months of age will help people in need, such as when they're searching for a lost object. Young chimpanzees also will do this. What's very interesting about this study is that young children, while still in diapers and not very skilled in using language, will only help retrieve a lost object when they believe that a person needs the object to complete a task. For example, they would only retrieve a clothespin if it seemed to have been dropped unintentionally by the researcher, but not if it was clearly thrown on the ground deliberately. Children can understand through body language when something is needed or not, and they help only if there is a need.

Research with animals shows similar findings. Obviously, as we've seen throughout, when it comes to play, cooperation is required, and almost every piece of communication is aimed at maintaining that cooperation. But cooperation seems to predominate in a wide range of social situations. Primatologists Robert Sussman and Paul Garber report that for diurnal prosimians, such as lemurs, New World monkeys, and great apes, the vast majority of social interactions are affiliative rather than agonistic or divisive. Grooming and bouts of play predominate in the affiliative category. For the prosimians, an average of 93.2 percent of social interactions are affiliative, and the numbers for the New World monkeys and Old World monkeys are 86.1 and 84.8 percent, respectively. Unpublished data for gorillas show that 95.7 percent of their social interactions are affiliative.

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Clearly, if these numbers can be repeated among other species, competition does not drive animal behavior; cooperation and friendliness aren't simply sideshows to aggression and fighting. Indeed, it almost seems trite to write about cooperation in animals, because everyone knows that animals cooperate with one another and it's obvious why they do so: if the group works together, then each individual's chance for survival improves. However, much of evolutionary theory is based on competition among individuals rather than on cooperation, and for some people this has meant that cooperation must be a by-product of competition that is not directly selected for in evolution. In this view, animals only cooperate because if they were competitive all of the time it would be difficult to form and to maintain stable social groups. For example, it would be impossible to have a stable wolf pack in which all of the males were top wolf or alpha individuals who always competed with one another. Cooperative interactions have to back competitive encounters so that the group will be cohesive and stable over time.

This "survival of the fittest" mentality, which pervades so much thinking and theorizing, is increasingly not supported by current research as being the prime mover in evolution. For a long time, cooperation has been ignored because of this ideological bias, but the recent deluge of research papers and other essays on cooperation indicate that the tide is changing. In fact, the more we look for cooperation, the more we discover its presence. Animals certainly still compete, but cooperation is central in the evolution of social behavior, and this alone makes it key for survival. When animals cooperate, they're doing what comes naturally, and cooperation relies on established, well-maintained social standards of behavior — that is, moral codes. This is what should become the starting point for evolutionary theory and the basis for our discussions about the lives of animals.

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Some ecologists take this even further. They wonder if, when studying "ecological interactions" — that is, encounters among different species of animals and interactions between animals and trees and plants — it makes more sense to concentrate on positive ecological interactions rather than on competition and predation. These researchers have been called "renegade ecologists" by more mainstream scientists, and they argue that there is more to ecology and the evolution of communities than just competition and predation. They maintain that a process called "facilitation" readily works alongside competition and provides a balance to its mechanisms that is important in the evolution of community structure. However, it's one thing to say that cooperation within a group of individuals, for example a wolf pack or a troop of baboons, is beneficial — that all wolves benefit more by helping one another than by competing with one another — but is cooperation an essential component of an entire forest or ecosystem? It's an intriguing notion, one on which I'm sure His Holiness the Dalai Lama would like to see more research.

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Extracts from Chapter IV Ethics: Ill-gotten Gains.

Late in 1981, a reporter for a large metropolitan newspaper (we'll call her Karen to protect her interest in remaining anonymous) gained access to some previously classified government files. Using the Freedom of Information Act, Karen was investigating the federal government's funding of research into the short- and long-term effects of exposure to radioactive waste. It was with understandable surprise that, included in these files, she discovered the records of a series of experiments involving the induction and treatment of coronary thrombosis (heart attack). Conducted over a period of fifteen years by a renowned heart specialist (we'll call him Dr Ventricle) and financed with federal funds, the experiments in all likelihood would have remained unknown to anyone outside Dr Ventricle's sphere of power and influence had not Karen chanced upon them.

Karen's surprise soon gave way to shock and disbelief. In case after case she read how Ventricle and his associates took otherwise healthy individuals, with no previous record of heart disease, and intentionally caused their heart to fail. The methods used to occasion the 'attack' were a veritable shopping list of experimental techniques, from massive doses of stimulants (adrenaline was a favourite) to electrical damage of the coronary artery, which, in its weakened state, yielded the desired thrombosis. Members of Ventricle's team then set to work testing the efficacy of various drugs developed in the hope that they would help the heart withstand a second 'attack'. Dosages varied, and there were the usual control groups. Administering certain drugs to 'patients' proved more efficacious in some cases than did administering no medication or smaller amounts of the same drugs in other cases. The research came to an abrupt end in the autumn of 1981, but not because the project was judged unpromising or because someone raised a hue and cry about the ethics involved. Like so much else in the world at that time, Ventricle's project was a casualty of austere economic times. There simply wasn't enough federal money available to renew the grant application.

One would have to forsake all the instincts of a reporter to let the story end there. Karen persevered and, under false pretences, secured an interview with Ventricle. When she revealed that she had gained access to the file, knew in detail the largely fruitless research conducted over fifteen years, and was incensed about his work, Ventricle was dumbfounded. But not because Karen had unearthed the file. And not even because it was filed where it was (a 'clerical error', he assured her). What surprised Ventricle was that anyone would think there was a serious ethical question to be raised about what he had done. Karen's notes of their conversation include the following:

> *Ventricle:* But I don't understand what you're getting at. Surely you know that heart disease is the leading cause of death. How can there be any ethical question about developing drugs which *literally* promise to be lifesaving?
>
> *Karen:* Some people might agree that the goal – to save life – is a good, a noble end, and still question the means used to achieve it. Your 'patients', after all, had no previous history of heart disease. *They* were healthy before you got your hands on them.
>
> *Ventricle:* But medical progress simply isn't possible if we wait for people to get sick and then see what works. There are too many variables, too much beyond our control and comprehension, if we try to do our medical research in a clinical setting. The history of medicine shows how hopeless that approach is.

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Karen: And I read, too, that upon completion of the experiment, assuming that the 'patient' didn't die in the process – it says that those who survived were 'sacrificed'. You mean killed?

Ventricle: Yes, that's right. But always painlessly, always painlessly. And the body went immediately to the lab, where further tests were done. Nothing was wasted.

Karen: And it didn't bother you – I mean, you didn't ever ask yourself whether what you were doing was wrong? I mean . . .

Ventricle: [interrupting]: My dear young lady, you make it seem as if I'm some kind of moral monster. I work for the benefit of humanity, and I have achieved some small success, I hope you will agree. Those who raise cries of wrongdoing about what I've done are well intentioned but misguided. After all, I use animals in my research – chimpanzees, to be more precise – not human beings.

The Point

The story about Karen and Dr Ventricle is just that – a story, a small piece of fiction. There is no real Dr Ventricle, no real Karen, and so on. But there *is* widespread use of animals in scientific research, including research like our imaginary Dr Ventricle's. So the story, while its details are imaginary – while it is, let it be clear, a literary device, not a factual account – is a story with a point. Most people reading it would be morally outraged if there actually were a Dr Ventricle who did coronary research of the sort described on otherwise healthy human beings. Considerably fewer would raise a morally quizzical eyebrow when informed of such research done on nonhuman animals, chimpanzees, or whatever. The story has a point, or so I hope, because, catching us off guard, it brings this difference home to us, gives it life in our experience, and, in doing so, reveals something about ourselves, something about our own constellation of values. If we think what Ventricle did would be wrong if done to human beings but all right if done to chimpanzees, then we must believe that there are different moral standards that apply to how we may treat the two – human beings and chimpanzees. But to acknowledge this difference, if acknowledge it we do, is only the beginning, not the end, of our moral thinking. We can meet the challenge to think well from the moral point of view only if we are able to cite a *morally relevant difference* between humans and chimpanzees, one that illuminates in a clear, coherent, and rationally defensible way why it would be wrong to use humans, but not chimpanzees, in research like Dr Ventricle's.

An obvious difference is that chimpanzees and humans belong to different species. A difference certainly; but a morally relevant one?

Let us test this idea by imagining that Steven Spielberg's E.T. and some of E.T.'s friends show up on Earth. Whatever else we may want to say of them, we do not want to say that they are members of our species, the species *Homo sapiens.* Now, if a difference in species is a morally relevant difference, we should be willing to say that it is *not* wrong to kill or otherwise harm E.T. and the other members of his biological species in sport hunting, for example, even though it *is* wrong to do this to members of our species for this reason. But no double standards are allowed. If *their* belonging to a different species makes it all right for us to kill or harm them, then *our* belonging to a different species from the one to which they belong will cancel the wrongness of their killing or harming us. 'Sorry, chum,' E.T.'s compatriots say, before taking aim at us or prior to inducing *our* heart attacks, 'but you just don't belong to the right species.'

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As for us, we cannot lodge a whine or a moral objection if species membership, besides being a biological difference, is a morally relevant one. Before we give our assent to this idea, therefore, we ought to consider whether, were we to come face to face with another powerful species of extraterrestrials, we would think it reasonable to try to move them by the force of moral argument and persuasion. If we do, we will reject the view that species differences, like other biological differences (e.g. race or sex), constitute a morally relevant difference of the kind we seek. But we will also need to remind ourselves that no double standards are allowed: though chimpanzees and humans do differ in terms of the species to which each belongs, that difference by itself is not a morally relevant one. Ventricle could not, that is, defend his use of chimpanzees rather than humans in his research on the grounds that these animals belong to a different species from our own.

The Soul

Many people evidently believe that theological differences separate humans from other animals. God, they say, has given us immortal souls. Our earthly life is not our only life. Beyond the grave there is eternal life – for some, heaven, for others, hell. Other animals, alas, have no soul, in this view, and therefore have no life after death either. That, it might be claimed, is the morally relevant difference between them and us, and that is why, so it might be inferred, it would be wrong to use humans in Ventricle's research but not wrong to use chimpanzees.

Only three points will be urged against this position here. First, the theology just sketched *(very* crudely) is not the only one competing for our informed assent, and some of the others (most notably, religions from the East and those of many Native American peoples) do ascribe soul and an afterlife to animals.

Second, even assuming that humans have souls, while other animals lack them, there is no obvious logical connection between these 'facts' and the judgement that it would be wrong to do some things to humans that it would not be wrong to do to chimpanzees. Having (or not having) a soul obviously makes a difference concerning the chances that one's soul will live on. If chimpanzees lack souls, their chances are nil. But why does that make it quite all right to use them *in this life* in Ventricle's research?

The Right to Consent

'Human beings can give or withhold their informed consent; animals cannot. That's the morally relevant difference.' This argument is certainly mistaken on one count, and possibly mistaken on another. Concerning the latter point first, evidence steadily increases regarding the intellectual abilities of the great apes.

Questions about the ability of chimpanzees to give informed consent aside, however, it should be obvious that this is not the morally relevant difference we are seeking. Suppose that, in addition to using chimpanzees, Ventricle also used some humans, but only mentally incompetent ones – those who, though they have discernable preferences, are too young or too old, too enfeebled or too confused, to give or withhold their informed consent. If the ability to give or withhold informed consent were the morally relevant difference we seek, we should be willing to say that it would not be wrong for Ventricle to do his coronary research on these humans, though it would be wrong for him to do it on competent humans – those humans, in other words, who can give or withhold their informed consent.

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But though one's willingness to consent to have someone do something to oneself may be, and frequently is, a good reason to absolve the other person of moral responsibility, one's inability to give or withhold informed consent is on a totally different moral footing. When Walter Reed's colleagues gave their informed consent to take part in the yellow fever experiments, those who exposed them to the potentially fatal bite of the fever parasite carried by mosquitoes were absolved of any moral responsibility for the risks the volunteers chose to run, and those who chose to run these risks, let us agree, acted above and beyond the normal call of duty – acted, as philosophers say, supererogatorily. Because they did more than duty strictly requires, in the hope and with the intention of benefiting others, these pioneers deserve our esteem and applause.

The case of human incompetents is radically different. Since these humans (e.g. young children and people with mental handicaps) lack the requisite mental abilities to have duties in the first place, it is absurd to think of them as capable of acting supererogatorily; they cannot act 'beyond the call' of duty, when, as is true in their case, they cannot understand that 'call' to begin with. But though they cannot volunteer, in the way mentally competent humans can, they can be forced or coerced to do something against their will or contrary to their known preferences. Sometimes, no doubt, coercive intervention in their life is above moral reproach – indeed, is morally required, as when, for example, we force a young child to undergo a spinal tap to check for meningitis. But the range of cases in which we are morally permitted or obliged to use force or coercion on human incompetents in order to accomplish certain ends is not large by any means. Primarily it includes cases in which we act with the intention, and because we are motivated, *to forward the interests of that individual human being.*

What is true in the case of human incompetents (those humans, once again, who, though they have known preferences, cannot give or withhold their informed consent) is true of chimpanzees (and other animals like them in the relevant respects, assuming, as we are, that chimpanzees cannot give or withhold their informed consent). Just as in the case of these humans, so also in the case of these animals, we are morally permitted and sometimes required to act in ways that coercively put them at risk of serious harm, against their known preferences, as when, for example, they are subjected to painful exploratory surgery. But the range of cases in which we are justified in using force or coercion on them is morally circumscribed. Primarily it is to promote *their* individual interests, as we perceive what is in their interests. It is *not* to promote the collective interests of *others,* including those of human beings.

The Value of the Individual

Philosophically, there is a way to insure that our gains will not be ill-gotten. This requires that we view individuals as having a distinctive kind of value – *inherent value,* to give it a name; others have called it by other names, including the *worth* or *dignity* of the individual. This kind of value is not the same as the positive value we attach to being happy or having various skills. An unhappy person has no less inherent value (no less worth or dignity) than a happy one. Moreover, the individual's inherent value does not depend on how useful others find him or her or how well he or she is liked.

To view the value of individuals in this way is not an empty abstration. To the question 'What difference does it make whether we view individuals as having equal inherent value?' our response must be, 'It makes all the moral dfference in the world!' Morally, we are *always* required to treat those who have inherent value in ways that display proper respect for their distinctive kind of value, and though we cannot on this occasion either articulate or defend the full range of obligations tied to this fundamental duty, we can note that we fail to show proper respect for those who have such value whenever we treat them as if they were mere receptacles of value or as if their value were dependent on, or reducible to, their possible utility relative to the interests of others. In particular, therefore, Ventricle would fail to act as duty requires – would, in other words, do what is morally wrong – if he conducted his coronary research on competent human beings, without their informed consent, on the grounds that this research just might lead to the development of drugs or surgical techniques that would benefit others.

SCIENCE/BIOLOGY TEXTS

EXTENDED WRITTEN TEXTS (NON-FICTION)

T. Regan, in *The Great Ape Project: Equality Beyond Humanity*, P. Cavalieri, P. Singer (eds). (Fourth Estate, London, 1993), pp. 194-205.

Extracts from Chapter IV Ethics: Ill-gotten Gains.

Who Has Inherent Value?

If inherent value could nonarbitrarily be limited to competent humans, then we would have to look elsewhere to resolve the ethical issues involved in using other individuals (for example, chimpanzees) in medical research. But inherent value can only be limited to competent human beings by having recourse to one arbitrary manoeuvre or another. Once we recognise that morality simply will not tolerate double standards, then we cannot, except arbitrarily, withhold ascribing inherent value, to an equal degree, to incompetent humans and other animals such as chimpanzees. All have this value, in short, and all have it equally.

Hurting and Harming

The prohibition against research like Ventricle's, when conducted on animals such as chimpanzees, cannot be avoided by the use of anaesthetics or other palliatives used to eliminate or reduce suffering. Other things being equal, to cause an animal to suffer is to harm that animal – is, that is, to diminish that individual animal's welfare.

Viewed against the background of these ideas, an untimely death is seen to be the ultimate harm for both humans and animals such as chimpanzees, and it is the ultimate harm for both because it is their ultimate deprivation or loss – their loss of life itself. Let the means used to kill chimpanzees be as 'humane' (a cruel word, this) as you like. That will not erase the harm that an untimely death is for these animals. True, the use of anaesthetics and other 'humane' steps lessens the wrong done to these animals, when they are 'sacrificed' in Ventricle-type research. But a lesser wrong is not a right.

The Criterion of Inherent Value

It remains to be asked, before concluding, what underlies the possession of inherent value. Some are tempted by the idea that life itself is inherently valuable. This view would authorise attributing inherent value to chimpanzees, for example, and so might find favour with some people who oppose using these animals as means to our ends. But this view would also authorise attributing inherent value to anything and everything that is alive, including, for example, crabgrass, lice, bacteria and cancer cells. It is exceedingly unclear, to put the point as mildly as possible, either that we have a duty to treat these things with respect or that any clear sense can be given to the idea that we do.

More plausible by far is the view that those individuals who have inherent value are *the subjects of a life* – are, that is, the experiencing subjects of a life that fares well or ill for them over time, those who have *an individual experiential welfare,* logically independent of their utility relative to the interests or welfare of others. Competent humans are subjects of a life in this sense. But so, too, are those incompetent humans who have concerned us. Indeed, so too are many other animals: cats and dogs, hogs and sheep, dolphins and wolves, horses and cattle – and, most obviously, chimpanzees and the other nonhuman great apes. Where one draws the line between those animals who are, and those who are not, subjects of a life is certain to be controversial. Still, there is abundant reason to believe that the members of mammalian species of animals do have a psychophysical identity over time, do have an experiential life, do have an individual welfare.

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If, then, those who meet this criterion have inherent value, and have it equally, chimpanzees and other animals who are subjects of a life, not just human beings, have this value *and* have neither more nor less of it than we do. Moreover, if, as has been argued, having inherent value morally bars others from treating those who have it as mere resources for others, then any and all medical research like Ventricle's, done on these animals in the name of possibly benefiting others, stands morally condemned.

Conclusion

Such a conclusion is probably at odds with the judgement that most people would make about this issue. If we had good reason to assume that the truth always lies with what most people think, then we could look approvingly on Ventricle-like research done on animals like chimpanzees in the name of benefits for others. But we have no good reason to believe that the truth is to be measured plausibly by majority opinion, and what we know of the history of prejudice and bigotry speaks powerfully, if painfully, against this view. Only the cumulative force of informed, fair, rigorous argument can decide where the truth lies, or most likely lies, when we examine a controversial moral question.

SCIENCE/BIOLOGY TEXTS

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J. Diamond, **A. Bond**, *Kea, Bird of Paradox: The Evolution and Behaviour of a New Zealand Parrot.* (The Regents of the Univ. of California, 1999), pp. 69-75.

Extracts from Chapter Three: Hanging Out with the Gang.

PLAYTIME

At the study site keas play at all times of the day and evening. Many kea displays are fairly subtle, but their play behavior is so intense and distinctive that it is impossible to overlook. Episodes of play typically persist for only a few minutes, but we occasionally saw bouts that lasted up to an hour. Keas play with many different kinds of objects and engage in elaborate social play, either in pairs or in groups of five or more. The prevalence and intensity of their play is unique among birds, as can be recognized from the variety of studies that have been conducted on kea play in captivity. And although various bird species, particularly parrots and ravens, are known to play, there are few detailed descriptions of the dynamics of avian play in the field.[31] This book provides the first detailed account of play among keas in the wild.

For young keas play is often a rough-and-tumble affair. They stand face-to-face and jump repeatedly, flapping their wings wildly. They push each other with their feet and wrestle with their bills, twisting their heads from side to side. One bird will roll on its back and the other will immediately leap on top, the two birds kicking and locking bills. Sometimes one kea will grasp the partner by the throat and drag him or her across the ground. Keas also chase each other, both on foot and in flight; play bouts that begin on the ground will often continue unabated in the trees.

Arboreal play is spectacular, with the participants jumping on each other and hanging upside-down, often by one foot, while biting the playmate. A hanging bird appears to invite being jumped on and having its feet bitten, which forces it to let go and drop to a lower layer in the tree, where the game begins anew. Throughout this exhausting activity the play partners vocalize continuously, producing a remarkably diverse array of squeals, shrieks, and gurgles that are otherwise rarely heard.

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Several characteristic play behaviors are sometimes seen in other contexts but appear to carry special meanings for play interactions.[32] For example, two playing keas often make repeated short, vertical jumps while furiously flapping their wings. Observers have likened this behavior to dancing, because the birds face each other and occasionally appear to jump in unison. Outside the play context, jumping and flapping may occur in the course of a fight as a component of wing-hitting, a strictly aggressive behavior similar in intensity to a serious bite. In this case, however, the action is seldom immediately repeated, and it is generally performed by only one bird at a time. When it occurs in play, the action is extraordinarily facilitative, appearing to reinforce and sustain the play activity.

Another typical play behavior is rolling over on the back while waving the feet in the air. Keas do this repeatedly during long play sessions, usually squealing at the same time. The other bird often runs over and leaps on the stomach of the displaying individual. Like jumping and flapping, rolling over is reminiscent of more serious kea behavior. In the midst of a full-scale battle, a kea will sometimes roll over on its back to fend off an attacker by kicking.[33] In play, however, keas usually roll over when the play partner is some distance away, encouraging the partner, it seems, not merely to approach but to take a flying leap at the bird's exposed belly. We thus believe that rolling over may serve as an invitation, a means of inducing a partner to begin or to continue a bout of social play.

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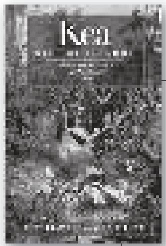

A pair of fledgling male keas jump and flap during an episode of tussle play. (Illustration by Mark Marcuson)

Another kea behavior that appears to carry a special significance in play is tossing a stone, stick, or other small object vertically in the air. It recalls excavation movements, where objects are thrown laterally to expose concealed food resources. Here, however, the object goes straight up and, as if to accelerate its ascent, the bird will often make a short hop to accompany the toss. Females may perform the action repeatedly over the course of a play interaction and continue to toss objects even after their partner, invariably a male, has moved away. We suspect that tossing serves as a female's invitation to courtship play, analogous to the manipulation of objects by crows and magpies during their precopulatory displays.[34]

Play signals like jumping and flapping, rolling, and tossing modify the significance of other behavior patterns and reassure the partner of the essential playfulness of the interaction. Play in keas thus seems to be fully analogous to play in mammals, particularly primates and canids, that also show play signals.[35] A play face in primates or a play bow in canids appears to change the meaning of subsequent actions, letting the participants know that this is all in fun. Similarly, the play signals of keas may allow more characteristically aggressive behavior patterns, such as kicking and biting, to be considered as playful rather than threatening and to be readily understood by both partners.

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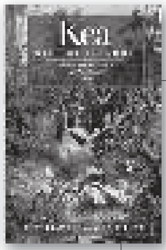

During tussle play between a pair of juvenile male keas, one bird rolls on his back with his feet in the air, and the other jumps on his stomach. (Illustration by Mark Marcuson)

TUSSLE PLAY AND TOSS PLAY

Keas display two distinctive types of play. The first, tussle play, is essentially rough-and-tumble play. It comprises five primary behavior patterns: jumping and flapping, rolling over, biting, locking bills, and pushing with the feet. The last two are parts of a wrestling maneuver, in which one participant grasps the other's bill and twists it back and forth, often while pushing him or her in the stomach with one foot. Other, more characteristically aggressive, actions are often incorporated in this type of play, including gaping and feinting with the bill, biting the feet, and occasionally even taking the partner by the neck and dragging him or her around.

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A striking feature of tussle play is that while any single bird's actions within the play sequence have no apparent pattern, the relationship between the partners looks almost choreographed. Each individual shows a strong tendency to echo what the other has just done. The amount of such facilitation within tussle play sequences is unusual when compared to other types of social interaction in keas. In some sequences almost two-thirds of the successive behavioral exchanges include components that are facilitated.[36]

The distribution of tussle play by age and sex follows complex rules. Tussling occurs primarily between fledglings *of either sex*, between fledgling and juvenile males, and between subadult or adult females interacting with fledgling or juvenile males. Juvenile females rarely play with other individuals of either sex. Tussle play is even less frequent among subadult males, although they occasionally interact in this fashion with juvenile males. Adult males rarely engage in tussle play, and when they do, it is mainly with mature females.[37]

The second type of play, toss play, appears to function in courtship or maintenance of a pair bond. Its chief actions are tossing, jumping and flapping, locking bills, and pushing with the feet. Somewhat less intense than tussle play, toss play seldom includes rolling over or biting. It is performed most frequently by adult and subadult females to solicit interaction with mature males. Although the males occasionally join in, the tossing action itself is mainly performed by females.[38]

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PLAY CONFLICTS

Like other aspects of kea social life, play is occasionally enmeshed in motivational conflicts. A forty-five-minute episode we observed among three male keas—an adult, a juvenile, and a fledgling—illustrates these discordant interactions. The adult kea was feeding the fledgling, when the juvenile approached them and drew the fledgling away into a long play session that involved biting, interlocking bills, mutual jumping and flapping, and rolling over. The adult repeatedly approached the playing youngsters, trying to regurgitate to its offspring. Sometimes the juvenile would stop playing and chase after the approaching adult, who would dodge him and run off. At other times the adult managed briefly to feed the fledgling, although the juvenile continued to interfere. In one case, the fledgling was lying on his back and the juvenile stood on top of him, gripping him around the throat, while the adult shoved food into the fledgling's mouth. The adult never showed aggression to either the fledgling or the juvenile, but he always evaded the juvenile's approaches. Twice he tried to drag the fledgling away from the juvenile by pulling on the former's neck, but the juvenile simply followed the pair and continued his play attempts.

Two aspects of this odd interaction are noteworthy. First, the adult actively sought out the fledgling to feed him. The fledgling made no obvious effort either to solicit or to avoid being fed. Second, the juvenile repeatedly used play to interfere with the feeding, besides trying to approach the adult directly and to pry open the fledgling's bill. The juvenile's behavior suggests that he was attempting to obtain the food for himself.

Such conflicts between the motivations of adults and offspring may be common, much as when human parents try to get their children to stop playing and come to dinner. On another occasion we watched two juvenile males engaged in a ten-minute play sequence involving bill-wrestling. An adult female followed them around like a referee, at times biting the feathers of one or the other of the participants, but always staying within a few centimeters of the tussling pair. Perhaps she was attempting to break up the interaction or perhaps she just wanted to join in.

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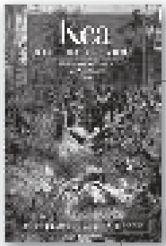

We have also seen several instances in which the mutual agreement for play may have been lacking. A typical case involved two juvenile males, one of whom repeatedly attempted to engage the other in tussle play. In response, however, the other juvenile would only crouch and solicit allopreening. The resulting behavioral sequence was quite confusing. At first the initiating juvenile would quietly nibble at the nape feathers of the soliciting bird. Then abruptly he would hop, flap his wings, and jump over his passive partner. Finally he jumped on the back of the solicitor, who then rolled over on his back. When the playful juvenile then jumped onto his stomach, the soliciting bird turned back over and, resuming a crouched position, nuzzled up to his partner. The initiating bird preened him for several seconds, hopped again, and then gave him a fierce bite. At this point the second juvenile ran away.

In addition to communicating readiness to play, play signals may inform others of the strength of an individual's interest in play, allowing play partners to negotiate the subsequent course of the interaction.[39] It seems likely, from our observations of kea play, that these negotiations may often be indeterminate. Certainly the pair of juveniles in our last example did not seem able to come to a consensus. The case of the juvenile that used play to interfere with an adult's attempts to feed a younger bird goes further: it suggests that play may, on occasion, participate in a confusing jumble of motivations and may even be used for ulterior, manipulative purposes. In this regard play mirrors the depth and complexity of other aspects of the kea's social life.

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J.S. Greek, **R.C. Greek**, *Sacred Cows and Golden Geese: The Human Cost of Experiments on Animals*. (Continuum, 2000), pp. 59-76.

Extracts from Chapter Four: The "Pathetic Illusion" of Animal-Modelled Drugs.

Open up a rat, a dog, a pig, and a human, and you will find much the same terrain but with differences. These visible differences have an impact when it comes to assimilating drugs. Consider the most commonly used species in toxicology research, the rat. Rats have no gall bladder. They excrete bile very effectively. Many drugs are excreted via bile so this affects the half-life of the drug. Drugs bind to rat plasma much less efficiently. Rats always breathe through the nose. Because some chemicals are absorbed in the nose, some are filtered. So rats get a different mix of substances entering their systems. Also they are nocturnal. Their gut flora are in a different location. Their skin has different absorptive properties than that of humans. Any one of these discrepancies will alter drug metabolism. And these are only differences on a gross level.

Smaller differences, being largely chemical, are more difficult to observe. Therein lies a greater dilemma. Medications do not act on the macro-organism—the large, visible level of, say, keeping organs in the right arrangement or bones in the right place. Medications act on the microscopic level. They interrupt and/or initiate chemical reactions, altering molecular activities that are far too small for the human eye to observe. Indeed, medications' actions are not apparent, even with high-tech instrumentation, until they occur.

The discrepancies between diverse mammals are largely microscopic. Imponderably intricate, they are born of millions of years of speciation, adaptation, and mutation. The more modern science reveals about genes, cell function, ion channels, proteins, and so on, the more apparent is the complex gulf between species. And the more ludicrous the existing requirement for animal testing becomes.

The other, even more obvious, problem with the animal model is that animals cannot communicate about their well-being. They cannot say, "I have a stomachache" or "my head hurts," or even "I ache all over." Hence, until animals manifest grand scale malaise in a lab, observations are all guesswork. Or as experts in toxicity write,

> The only universal model for a human—that is, one which would best predict what would happen at a given endpoint across the full range of chemical structures, concentrations, etc.—is other humans.[3]

Is it possible that we are not only receiving inaccurate data about the side effects of medications, but also not receiving access to certain drugs that do not produce those side effects that animal models claim? Are we missing good medications because of animal testing? Logic suggests that the answer to these questions is *yes*.

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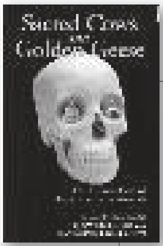

As it is now, animal testing for medications has created and continues to create catastrophe. Animal experiments fail to predict the lethal side effects of many drugs and also prevent good medications from reaching the marketplace. These two outcomes are called "false negatives" and "false positives," as we will explain. The critical word here is false. Animal models for human medicine are false.

Different chemicals have diverse effects on different species. Therefore, the belief that "simply doing enough animal testing will predict all human toxicity" is, as Dr. Louis Lasagna of the University of Rochester so eloquently put it, a "pathetic illusion."[14]

When compounds demonstrate therapeutic effect on an animal, therapeutic effect without ill side effect, they proceed to human clinical trials. There, very often—our research shows anywhere from 52 to 100 percent of the time—they fail, frequently by wounding or killing people. Animal testing has made it look as if given compounds will not injure humans, but they do, as the many examples later in this chapter indicate. Test results such as these are called "false negatives," an important term in the trial process. Thalidomide is a perfect example of a "false negative."

The second catastrophic impact of animal testing is this: compounds that show evidence of therapeutic effect in the human arena are tested on animals. When they bring on injurious side effects in animals, they are withheld from development for humans. More people stay ill. More people die. When it later turns out that humans do not experience the side effects as animals did and also that they actually benefit from the medication, then the animal modeled test results are called "false positives"—a second significant drawback to the animal testing protocol.

In this chapter we show many examples in both categories. These examples only begin to reflect the scope of the historic failure of testing potential human remedies on non-humans.

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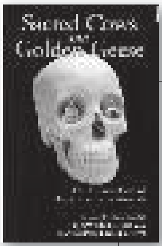

Delusions of Harm

"Normally, animal experiments not only fail to contribute to the safety of medications, but they even have the opposite effect." So stated Dr. Kurt Fickentscher of the Pharmacological Institute of the University of Bonn, Germany, in *Diagnosen*, March 1980. Here is another scientist emphasizing that animal tests not only fail to predict the bad effects. When they falsely predict side effects, it keeps good medications off the market. Koppanyi and Avery stated of many medications that are used to save lives today, "Had these drugs first been tested in animal experiments for their safety, some of them might never have reached clinical trial."[73] The truth is that all medications in use today can be found to cause a serious side effect in some animal. *Given that, if medications were withheld based on a negative side effect in animals, we would have no medications today.*

Pharmaceutical companies are very wary of releasing drugs that have extremely negative effects on their test animals for legal reasons. Therefore, they keep some of these compounds off the market. Again, as explained earlier, when an animal experiment predicts side effects that do not occur in humans, it is called a "false positive." It is the false positives that prevent potentially therapeutic medications from reaching afflicted humans who really need them.

For an idea of just how helpful these medications might be, we have only to weigh the personal benefit of several common painkillers—drugs that demonstrate false positives in animals but have outstanding therapeutic value in the human setting.

Look in your own medicine cabinet. When you get a headache, would you reach for a pain medication of which a single dose causes renal failure and death in cats? Perhaps. That medication is acetaminophen most commonly marketed as Tylenol. Leery now of Tylenol, you might prefer aspirin. Today, twenty-nine billion aspirin per year are sold in the United States and twice that number are sold worldwide. Aspirin is not only used for pain relief and fever reduction but for the prevention of strokes, heart attacks, and other illnesses. Aspirin causes birth defects in mice and rats and results in such extensive blood abnormalities in cats that they can only take twenty percent of the human dosage every third day.[74] How about ibuprofen, which most people know as Advil or Motrin? Ibuprofen causes kidney failure in dogs, even at very low doses.

When clinical success suggests itself for humans, researchers labor long and hard to find an animal whose response to the drug is favorable. Some animal, somewhere, will eventually produce the kind of results they are after. Some researchers even use fish! Once they know what kind of effect they are after, the cat (for example) is out of the bag.

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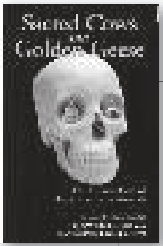

Frequently, drugs used abroad have such overwhelming evidence of effectiveness and safety for human use that the FDA eventually approves them for use in this country. Sometimes the FDA requires abbreviated animal testing. Other times it demands the entire protocol, but releases the manufacturer from certain requirements. Prozac is a good example of this.

We found many other examples of valuable medications of which Americans were initially deprived because the mandate for animal testing prevents their development and distribution here.

- Depo-Provera, the contraceptive, was barred from release in the U.S. in 1973 because it caused cancer in dogs and baboons.[75]

  Elsewhere in the world, women used it and found it safe. Not until 1993 did the FDA release the drug to the American public.
- Digitalis, a plant used by herbalists for centuries to treat heart disorders, was discovered without animal use. It is described later in this chapter. However, clinical trials of the drug were delayed when it caused high blood pressure in animals. Digoxin, an analogue of digitalis, was much later released and has saved countless lives. How many more could it have saved had it been released sooner?[76–79]
- Streptomycin, a popular antibiotic, is teratogenic in rats, causing limb malformations in offspring.

Just as corticosteroids have indications in humans that are not present in animals, the converse is also true. Animal experiments suggested that these drugs would help septic shock, a severe bacterial infection of the blood.[92,93] Unfortunately, humans reacted differently, leading scientists to conclude that corticosteroids were "... ineffective for the prevention or treatment of shock associated with sepsis ... [and] may make secondary infection worse."[94] Others agreed stating that "... extrapolation of data from experimental models to the clinical setting may be dangerous and misleading."[95]

The final analysis showed clearly that this treatment increased the death rate in cases of septic shock.[96] This variation from animals to humans should not be particularly startling. It happens all the time. The dose required to achieve therapeutic effects from corticosteroids in the cat is double that of the dog. The type and incidence of side effects also differs dramatically between these two seemingly similar species. Chronic steroid use damages the canine liver and causes diabetes in cats. In humans it causes adrenal suppression and osteoporosis. Though dogs also suffer adrenal suppression and osteoporosis from steroid use, they are less susceptible.

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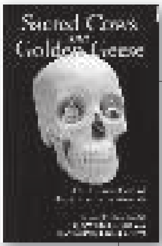


- Penicillin was delayed by animal testing and almost derailed altogether. Alexander Fleming saw penicillin kill bacteria in petri dishes in 1929 and tested it on rabbits. It did not work. We now know that rabbits excrete penicillin in their urine; it is eliminated before it can be effective. Based on rabbit work, Fleming put the drug aside, believing it to be useless as a systemic medication.[97] He later had a very sick patient and since he had nothing else to try, administered the penicillin. The rest is history. Interestingly H. W. Florey, co-winner of the Nobel Prize for penicillin administered penicillin to a sick cat at the same time Fleming was giving it to his sick human. Florey's cat died.[98] Fleming attributed the discovery to serendipity, saying, "Penicillin happened . . . It came out of the blue."[99]

  Fleming might have thrown his penicillin away entirely if he had tried it first on guinea pigs or Syrian hamsters instead of rabbits. It kills them.[100] In addition, penicillin is teratogenic in rats, causing limb malformations in offspring.[101] Fleming stated, "How fortunate we didn't have these animal tests in the 1940s, for penicillin would probably never been granted a license, and possibly the whole field of antibiotics might never have been realized."[102]

  Macfarlane, another early penicillin researcher, also credited serendipity in penicillin's discovery referring to "a series of chance events of almost unbelievable improbability."[103] And:

  > Mice were used in the initial toxicity tests because of their small size, but what a *lucky chance* it was, for in this respect man is like the mouse and not the guinea-pig. If we had used guinea-pigs exclusively we should have said that penicillin was toxic, and we probably should not have proceeded to try and overcome the difficulties of producing the substance for trial in man.[104] (Emphasis added.)

  What if mice had not worked either? It was Fleming's application to a human patient that proved the drug's effectiveness.

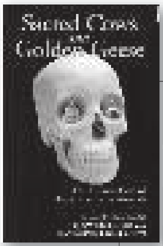
  Interestingly the other individuals awarded the Nobel Prize for penicillin, along with Florey and Fleming, Dr. E. B. Chain, stated this about testing medications on animals,

  > No animal experiment with a medicament, even if it is carried out on several animal species including primates under all conceivable conditions, can give any guarantee that the medicament tested in this way will behave the same in humans.[105]

- Prilosec (Omeprazole), a gastrointestinal medication, was almost canceled because of an effect in animals that did not occur in humans. The drug was delayed for years. Presently, millions now prefer it to the traditional H2 blockers like cimetidine.[106]

J.S. Greek, **R.C. Greek**, *Sacred Cows and Golden Geese: The Human Cost of Experiments on Animals*. (Continuum, 2000), pp. 59-76.

Extracts from Chapter Four: The "Pathetic Illusion" of Animal-Modelled Drugs.



- Isoniazid is a commonly used medication for tuberculosis. It causes cancer in animals. Here is what one researcher said about isoniazid:

  Presently, we recognize the ability of the effective antituberculosis drug, isoniazid, to induce lung adenocarcinomas [cancer] in a wide variety of mice that are susceptible to this tumor . . . Despite the fact that this drug has been effectively and extensively used since 1953, a period of 24 years, I know of no convincing evidence of its carcinogenic effect in man . . . Unfortunately, we know of no sure way to differentiate accurately between those drugs and other chemicals which induce cancer in both animals and man and those which although effective in animals, are ineffective in man.[107]

- Furosemide, commonly called Lasix, is another example of an important medication almost lost to the public due to animal studies. It is a diuretic, used to treat high blood pressure and heart disease. Mice, rats and hamsters suffer liver damage from this widely used drug, but people do not. The drug is metabolized differently in each species.[108,109,110]
- Fluoride, which causes cancer in rats, was initially withheld from dental use. A dentist made the discovery that fluoride may decrease the risk of dental decay. Observing patients who had mottled teeth from living in areas with a large concentration of fluoride in the water, he noticed that they had fewer cavities.[111]

For development and distribution of these drugs in the U.S., pharmaceutical companies overcame the animal model mandate only through perseverance. What of the potentially thousands of curative substances that do not overcome this hurdle? Is it possible that we are not only not getting accurate data from animals on the side effects of medications (false negatives) but also are not having access to certain drugs because of inaccurate predictions of side effects (false positives)? Are we missing good medications because of animal testing? Apparently so.

Dr. C. Dollery has this to say about missing good medications because of animal tests:

> For the great majority of disease entities, the animal models either do not exist or are really very poor. The chance is of overlooking useful drugs because they do not give a response to the animal models commonly used.[115]

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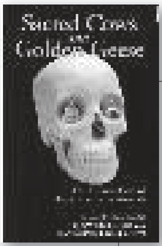

All medications in use today can cause a serious side effect in some animal. As we have already explained, if researchers persevere, inculcating enough species with high enough dosages, illness will eventually result in one or more species. Hence, if we truly withheld any medication from the public based on its negative impact on non-humans, we would have no medications today. This fact alone destroys all justification for continuing animal testing.

The more we learn in regard to the physiological differences between humans and other animals, the more strained support for animal experimentation becomes. What use are animal tests if scientists' chances of predicting safety are no better than fifty percent? The troubled impact of the animal model on drugs covered in this chapter, albeit incomplete, is tragic enough to merit overhaul of drug development procedures.

The National Cancer Institute and other prestigious institutions have issued statements stating that they no longer *rely* on animal tests. They do not believe animal tests are protective, and they admit there are cases of safe medications being withheld because of animal-derived data.

However, despite these institutions and despite billions and billions of dollars in flawed, misleading, inconclusive science and who knows how many hundreds of thousands of human lives lost, the animal testing mandate persists. Intelligent scientists and reputable publications continue to support it. In the February 1997 issue of *Scientific American*, in their article defending animal experimentation, authors Jack H. Botting and Adrian Morrison nonsensically state, "In truth, there are no basic differences between the physiology of laboratory animals and humans."

Current estimates place the cost of developing, testing, and marketing each new drug at between 150 and 349 million dollars, the latter figure according to a 1993 report by the Congressional Office of Technology Assessment.[116] The drug companies pass the costs along to the patients and our insurance companies. Drugs are so outrageously expensive in the United States that the elderly and poor cannot afford them. In view of these staggering costs, measures should be taken to insure that only cost-effective and accurate tests are conducted. Not until the Congress and the FDA changes the way medications are evaluated prior to releasing the drug will tragedies stop and valuable therapies, previously withheld, reach the needy expeditiously.

More extensive preclinical testing on human tissue, more extensive clinical trials, and mandatory postmarketing drug surveillance would offer the general public much safer medications. These changes are long overdue and absolutely vital!

The only truly accurate knowledge about the positive and negative effects of medications on humans is acquired through *in vitro* testing, computer modeling, epidemiology, clinical observation, and autopsy of humans. Today's technology makes observations of compounds on human systems more and more easy. Nonetheless, animal testing persists.

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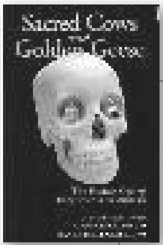

> The future of biology is really going to be [human] systems analysis.
>
> —Dr. Leroy Hood, University of Washington

Say we open the cages and let loose the lab animals. Then what? If we do not experiment on animals, on whom? How will we derive our discoveries, our cures?

Animal experimenters would have us believe that scientific innovation would come to a great, grinding halt if animals were let out of the lab, or as the Foundation for Biomedical Research publication *Animal Research Fact vs. Myth* puts it: "There are no alternatives to animal research [for human disease]."

As scientists, we find this insulting and ridiculous. Yes, if we abandoned the animal experimentation protocol, many researchers would have to scramble to learn other, more predictive methodologies; and certainly there would be major adjustments in publishing and drug approval. However, there are compelling reasons to believe that scientific innovation would get a big boost if medical research were devoid of animal models. Other, more rewarding techniques would gather strength under augmented effort, and maybe we would then find cures for today's most challenging illnesses.

There is an even more ludicrous scare tactic perpetrated by animal experimenters and their lobbyists. That is the claim that if there were no animal experiments we would have to experiment on humans. Human experiments, yes, but not on caged humans, nor prisoners, nor the mentally disabled, nor lab humans, nor any unwilling experimental humans. We would conduct experiments on human cells and human tissues, examine and document humans at autopsy, tally and analyze the results of human epidemiology studies, more carefully observe humans in the clinical setting and spread the word among humans on preventative measures. It is human health that is at risk and human wellness that is our objective. Is it not reasonable to observe the species that needs curing directly?

Everyone agrees that epidemiology makes sense. Same with autopsy. Few intelligent people argue that a clinical condition documented in an actual human never happened. Genetic, *in vitro*, and high tech developments may be inscrutable to the average person. But few question whether it is prudent to study the composition of the very cells and genes that are inflicting or skirting human disease.

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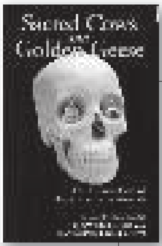

These modalities are the research techniques that we should be funding now. Ancient techniques—autopsy, clinical observation, and epidemiology—have worked well in the past; now they are far more sophisticated and accurate. Others are new and incredible, the more so when compared to the atavism of animal-modeled experiments. To date, these alternative methodologies are not anywhere near as well known as animal experimentation. Part of the reason people believe that stopping animal experimentation would put the brakes on medical development is because alternative protocols are not peddled by huge corporations, which have both the money and the incentive to sway public sentiment. Companies with science that works do not need to pay lobbyists and publicists to pave their futures. There is no need to be defensive about effective methodologies. Success speaks for itself.

But success does not yet speak loudly enough. Animal experimentation lobbyist and publicist efforts fall on susceptible ears. Everyone wants to be healthy, but few people can keep abreast of medicine's growing reservoir of complexities. Even many physicians do not have the expertise in comparative biochemistry to make sense of extrapolations from animals to humans. And certainly, lay people are entirely in the dark: justifiably misinformed, since their information comes from slick advertising and reporting of press releases churned out by the animal experimentation industry itself. When they hear that furry little creatures are saving their own lives and those of their children, they do not dare risk disbelieving it.

The animal experimentation lobby is the largest medical research lobby there is. It bathes scientifically illiterate congresspeople and reporters with a steady flow of persuasive half-truths and poignant stories to buoy support for this duplicitous form of science. And while it bathes, taxpayers misspend, consumers misspend, and lives are jeopardized by falsely modeled therapies.

Human-modeled protocols decrease human suffering and increase our medical knowledge base. We define and exemplify each of these following. Subsequent chapters have many more examples. Any one of these modalities described does far more for humankind than animal experimentation, and together they can revolutionize medical research.

Clinical Studies of Patients

The most obvious bellwethers for information about human disease are diseased humans. Careful observations and analyses of patients have always been an important index of medical research. Countless discoveries have occurred at the bedside—the successful treatment of childhood leukemia and thyroid disease, our present level of HIV and AIDS therapy, and the discovery of a number of heart drugs among them.

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Clinical observation could be encouraged. Without remuneration, physicians are disinclined to cooperate in studies that could have broad usefulness nationwide. If doctors were compensated, they would eagerly incorporate patients into studies. The information would be far more relevant and valuable than animal studies.

Researchers already rely on healthy human volunteers for studying new treatments and medicines, and strict guidelines control this type of research. Traditionally, volunteers receive tiny, harmless amounts of test drugs. Researchers carefully increase the dosage in the next person, while monitoring effects on breathing, heart rate, blood, urine, and various body functions. In addition to dosages, these tests also indicate how specific drugs are metabolized in the human body, information that cannot be reliably garnered from animal studies since animals metabolize differently than humans.

Called clinical pharmacology, this process is the only way to find out whether a drug will be safe and effective in people, and in what dosage. Studies like this repeat a lot of what drug companies do in animals. However, whereas the animal model tells only about the animal in question, clinical pharmacology produces data that is actually applicable to humans. More often than not, this data is entirely discrepant from that indicated in animal experiments.

In Vitro Research

As other chapters exemplify, *in vitro* research (or *test tube research* as it is also known) has revolutionized medical research, illuminating pathways to discoveries of great importance. Even the federal government acknowledges: "There is virtually no field of biomedical research that has not been affected by *in vitro* technology."[1]

In vitro means, literally, "in glass." *In vitro* research occurs in a flask or another controlled environment, rather than within a living organism or in a natural setting, which would be *in vivo*. To understand illness and therapies better, scientists observe the given culture, and observe the effects of other chemicals on it. When a chemical causes cells to mutate *in vitro*, or if it kills rapidly dividing cells, then it may cause disease in humans. When it interrupts the action of a disease-causing agent, or the disease itself, it may be curative.

For over a hundred years, scientists have refined methods for sustaining somatic cells (cells that make up our bodies, not germ cells). As a result, human cells and tissues, removed during surgery, biopsies or postmortems, can be grown outside the body in the "test tube." The cells are carefully cultured inside special flasks or dishes, bathed in a nutrient fluid. The fluid is a complex mixture of all the substances essential for the cells' continued survival and contains nutrients, enzymes, hormones and growth factors.

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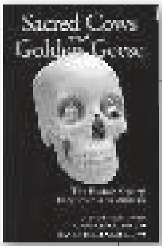

Cell and tissue preservation technology is now so advanced that many different types of cells can be kept alive almost indefinitely. Cell culture is an exciting and rapidly developing field of research that holds enormous potential for improving the quality of medical research. By culturing complex mixtures and layers of cells scientists can create more realistic models of parts of the body, such as skin and capillary vessels. This increases our insight into how they work.

Just as promising as it is controversial is stem-cell research. Stem cells are "master cells" that can grow into virtually any of the body's cell types. Originally harvested from early stage human embryos, it may now be possible for stem cells to be lab-grown. Researchers anticipate that they will be able to grow new cells to replace diseased or damaged cells in patients suffering from Alzheimer's, diabetes, Parkinson's, and other illnesses.

In 1985, the National Academy of Science emphasized the advantages of human studies over animal studies, saying, "Major recent advances in our knowledge of the immune system made possible by cell culture techniques would have been virtually impossible to achieve in intact vertebrates."[2]

Research on human body matter is much more reliable than animal studies since the cells or tissue that are diseased are the same as that you are studying. For instance, let us say you are studying human metastatic cancer. There is no shortage of human cancer tissue. Human tissue, rather than being thrown away after surgery, is now harvested for just such a purpose.[3] No one need observe an animal tumor since human tumor tissue is so abundant.

The leading animal experimentation handbook says that cytotoxicity studies such as the total cellular protein assay and the neutral red uptake assay, the Lowry method, evaluation of cell adhesion, cell proliferation, morphology, membrane damage uptake of radioactive precursors, microcinematography analysis can all be performed *in vitro*.[4] Why then use a rat?

Most illnesses do their work at a microscopic level. Hence, human proteins, ion channels, cells, and cell components such as genes obviously make ideal test beds for determining ways to interrupt the course of human diseases. Even in its early years, *in vitro* science allowed the discovery of antibiotics penicillin and streptomycin, and an understanding of blood types. Human cell and tissue culture observation, in the form of *in vitro* research, has refined the processes of vaccine production, toxicity testing, and selecting new drugs. It is leading to a better understanding of illnesses such as cancer, Parkinson's disease, multiple sclerosis, diabetes, heart disease, viral infections like AIDS, and many more.

On a gross level, surgeons use the human placenta to train to repair tiny vessels and nerves, such as in re-implant procedures. The human placenta can also be used to study reactions to medications and metabolism. Scientists can watch the effects of antibiotics and other medications on cells from specific organs, or on the organs themselves.[5,6,7]

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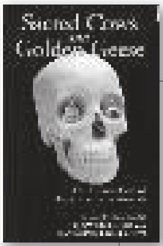

The human placenta has enormous potential for studying metabolic processes without recourse to animal experimentation. Its greatest advantage lies in eliminating the necessity for extrapolating results from animal experiments and trying to interpret them in terms of the human situation.[8]

Scientists have pointed out,

> Whenever human material becomes available for research in satisfactory condition and without danger to the patient, it should be preferred to any animal living material.[9]

State-of-the-art *in vitro* technology continues to streamline the medical research process. This demands precise tooling and miniaturization. Further advances in technology have led to the development of extremely sensitive and sophisticated equipment to monitor the cultures and detect minute cellular changes.

To contain human micro-matter, tiny screening plates, now not much bigger than a pager, hold several thousand miniature wells. Scientists can fill them with different cells, then subject these to potential therapies. Fluorescent assay technology then delivers accurate information about the compounds' efficacy fast, as many as 100,000 compounds per day, per screening plate. Moreover, conducting experiments the size of motes economizes what are frequently valuable and limited supplies of human organs, cells, and tissue.

Only the convention for animal testing prevents *in vitro* tests from being used more often. Toxicologist Bjorn Ekwall elucidated,

> We should not imitate cell test systems [because] that is an old toxicology; in fact simple cell line tests are much more revealing than people think, but it's difficult to sell the idea because it could be a threat, and the animal testing monopoly would be destroyed.[10]

Drug companies are branching into designing drugs that act specifically along signal transduction pathways. Signal transduction pathways are the "highways" on which many different internal stimuli travel to the cells. Since almost all known diseases make these signals dysfunction, drugs that controvert the dysfunction should inhibit disease. Scientists subject human cells to chosen chemicals *in vitro* and watch ensuing expression. They then record precise data that is far more likely to correlate to that of human clinical trials than data garnered from animals. (More about this in Chapter 7, Real Origins of Medications.)

Many scientists recognize and criticize the limited use of human tissue.[11] Some now state, "Direct extrapolation from animals to humans is frequently invalid . . . recently much interest has focused on use of human autopsy or biopsy tissue as a means of overcoming these limitations."[12]

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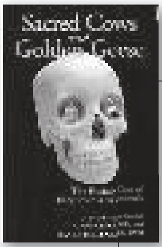

Autopsies

Autopsies have led to many of the great medical breakthroughs described in this book. They are an essential source of knowledge. If you want to know what caused a failure, investigate the failed entity. Drs. R. B. Hill and R. E. Anderson wrote,

> Virtually the whole field of modern medical knowledge was created through study of autopsies, aided and supported by physiology, physical diagnosis, and microbiology . . . It was above all autopsy study that ushered in the modern era.[13]

Research in diabetes, hepatitis, appendicitis, rheumatic fever, typhoid fever, ulcerative colitis, congenital heart disease, hyperparathyroidism, and many other illnesses has been enriched by autopsies.[14] Autopsies elucidated the mechanisms of shaken baby syndrome, sudden infant death syndrome, and head injuries suffered during car accidents.[15,16,17]

Autopsies also indicate aspects of illness missed in diagnoses. Studies of patients who present for autopsy, performed since 1970, indicate that physicians misdiagnosed approximately ten percent.[18] One study demonstrated that in 64 percent of 2,537 cases, findings at autopsy proved that an undiagnosed disease was present at death. Undiagnosed findings either caused the patients' demise or were an important factor in the patients' health.[19]

In former days, every patient was autopsied, and that is how discoveries were made. Unfortunately, autopsies are not now done with the frequency that they once were. The rate of autopsies has dropped to less than one-quarter of what it was in the 1950s, because no one will pay for them. Once a patient has died, only rarely is anyone on hand willing to go out of pocket to find out why. Pathologists do not routinely perform autopsies unless insurance companies reimburse them, which they usually do not. The NIH funds few research projects that utilize autopsies, therefore few universities perform them. Yet, if just one out of every five patients were autopsied, an immense amount of valuable information would be retrieved. And there were be more organs for research on specific parts of the body. Again, why not divert funds to autopsies from animal experiments?

The infrequency of human autopsy, as contrasted with the bottomless reservoir of experimental zoology, caused Dr. Robert Anderson, a pathologist at the University of New Mexico, to state, "We know more about the causes of death in old mice than we do about the causes of death in old people."

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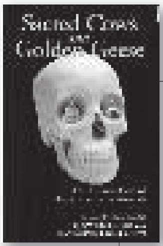

We do not have to kill humans to generate bodies for autopsies. Humans die, and it is not unreasonable, as some European countries have now realized, to use their bodies in order to ease suffering in subsequent patients.

An expert in medication development stated,

> No laboratory animal will ever be a completely satisfactory substitute for the human system and the time will come when we shall stop wasting the enormously valuable enzymes and organelles of the dead and instead put these to use to understand the living human being better.[20]

Epidemiology

Epidemiology is another highly rewarding area of medical research. Gathering and analyzing data regarding the incidence and prevalence of specific diseases among populations presents very valuable information about why and how the illness occurs. Scientists use this data as a point of departure for examining which genes confer either to disease or immunity. They can also draw conclusions about environmental or lifestyle factors that influence susceptible people positively or negatively. These insights suggest preventative measures that can mitigate the frequency of illness.

Epidemiology today is greatly facilitated by computer-accessible medical records that track thousands of patients at multiple institutions. Though now vastly more sophisticated, epidemiology is not a new field. Accumulated data about patients brought an end to the practice of blood-letting centuries ago.[21] In 1747, James Lind noticed that sailors came down with scurvy during long voyages. This epidemiological observation resulted in preventative action. The Royal Navy began to take limes and other citrus fruits on voyages; thus sailors were referred to as "limeys."[22]

Epidemiology uncovered innumerable occupation-induced diseases. One of the first to discover the association between industrial chemicals and disease was Alice Hamilton. Though hindered by gender bias at the turn of the century, Hamilton persisted. Her first observations revealed that lead was harmful. She went on to diagnose phosphorous poisoning in munitions workers, silicosis in sandblasters, mercury poisoning in felt workers, and carbon monoxide poisoning in steel workers. Hamilton's clinical observations and subsequent epidemiological studies laid the groundwork for many reforms in industrial health.[23] For example, wearing protective masks to filter out the silica particles now prevents silicosis.[24]

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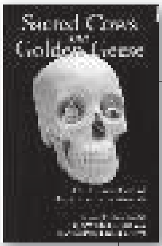

Building-related illnesses such as Legionnaires' disease, Pontiac fever, flu- and cold-like illnesses such as irritation of the upper airway, headache and difficulty focusing on the tasks at hand, allergic reactions, and immune system problems have all been discovered through epidemiology.[25] Causes include exposure to cigarette smoke, viruses, building materials, fungi, mites, and many other negative influences.

Epidemiological studies discovered the link between folic acid deficiency and spina bifida. They also showed the cause/effect relationship between smoking and cancer, heart disease and cholesterol, high blood pressure and stroke, high blood pressure and heart disease, repetitive motion and carpal tunnel syndrome, smoking and heart disease, coal dust and black lung disease, cotton dust and byssinosis, dietary fat and cancers of the colon and prostate, laundry and dry cleaning industries and cancers, and so on. Through epidemiology we learned how AIDS is transmitted.[26,27] The examples go on and on, as this book's later data indicate. As long ago as 1980, the U.S. Congress Office of Technological Assessment Report stated that epidemiological studies were more reliable than animal studies.[28]

Epidemiology gives us the opportunity to prevent disease but issues little profit to industry. This is probably why there is not a multimillion dollar political action committee called Americans for Epidemiology.

When computers simulate parts of the human body as mathematical equations, it is called *mathematical modeling*. Although this process requires the enormous simplification of various body systems, it is producing some surprisingly accurate results. For example, an American computer model of 10,000 brain cells produced signals similar to those given out by a real brain. In another example, scientists use a model of a "slice" of brain to investigate how people think and remember, as well as to shed light on disorders such as epilepsy. A computer model analyzing the body's response to cancer at the National Cancer Institute in Maryland was able to show that the immune system could both fight cancer and stimulate it. Researcher Dr. DeLisi said, "It comes up with things you might otherwise miss."

Breast cancer is another area illuminated by mathematical models. We describe others elsewhere. Mathematical modeling pointed out differences between breast tumors that looked identical under the microscope. This provided clinicians the basis for different therapies for what had, at first glance, appeared to be the same tumor.[29,30]

Using computer graphics, programs can create the three-dimensional structure of molecules on screen. By studying the shape, structure, and active sites of molecules known to be medically useful, scientists can then attempt to design similar or improved structures. Already some drugs, such as the high blood pressure medication, Captopril, have been designed this way.

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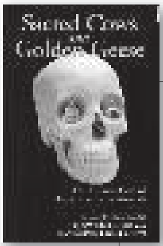

Similarly, chemical structures known to be toxic can be analyzed to predict toxicity of new substances without resorting to animal tests. One program called COMPACT, at Surrey University predicts chemical toxicity based on likely interaction with body enzymes. The system has already been tested on more than one hundred chemicals and so far has an accuracy of 82 percent. That is far greater than the average accuracy of animal testing. COMPACT could have predicted the toxicity of Opren, an anti-rheumatic, anti-arthritis drug withdrawn after causing liver damage.

The Electric Cell Substrate Impedance Sensing (ECIS) device uses electricity to study complex cell behavior. This non-invasive technique for testing cell cultures follows a cell's behavior at quarter-second intervals. Imagine continuing the animal testing convention in an epoch when this kind of observation is possible. Some call the people who work in these computer-driven biotech industries "robochemists."

Medical students now use interactive computer models that mimic various body systems to learn physiology. Students can prescribe drugs, monitor changes in heart rate, blood pressure, urine output, and so forth, and investigate the effects of altering certain variables. This software saves staff time, money, and space compared with animal experiments.

Instead of repeating previously conducted experiments, students, scientists, and physicians can access comprehensive medical databases to glean information, then devote valuable time and dollars to fresh explorations.

Genetic Research

Genetic research, such as the technologies created in the government-funded Human Genome Project and parallel pursuits funded by private enterprise, are changing the face of medicine. They have produced high-throughput DNA sequencing, gene mapping, and bioinformatics—fancy words for discovering what genes do. Scientists hope to identify the hundreds of thousands of genes that make up the genetic map by 2010.

The genetic variability that is so apparent in such features as height, skin and hair color, as well as temperament, extends to our health. Different genes alter susceptibility to disease, drug metabolism, and drug response. In other words, genes not only determine how we look, they also govern whether we will contract certain diseases, and how we will react to therapies. We do not yet understand even a small percentage of the total gene map and the Human Genome Project and private efforts will not answer all these questions. It may be a century before we know what all genes do and how they cooperate. But it goes without saying that the more research dollars devoted to this effort, the more expediently useful knowledge will reveal itself.

J.S. Greek, **R.C. Greek**, *Sacred Cows and Golden Geese: The Human Cost of Experiments on Animals*. (Continuum, 2000), pp. 99-111.
Extracts from Chapter Six: Alternatives.

By inserting new or different genes into existing DNA strands, scientists can already correct or alter some genetic traits. They use a restriction enzyme as a sort of genetic scissors to cut a gene from a donor organism. Then they insert it into a viral DNA or plasmid (segment of DNA independent of chromosomes) that will carry it into the host cell. Scientists now use this recombinant DNA technology, as it is called, for the questionable purpose of attempting to create human diseases and human characteristics in lab animals. Instead we should be funding research that will allow the information to be used to cure human disease. It has the potential to correct birth defects and cancer susceptibility, *in utero*.

This research has already yielded insulin from humans instead of animals, decreasing the side effects of animal-derived insulin. (Many patients were unable to tolerate insulin injections or developed allergies to cow or pig proteins, after years of injecting it.) Vaccines, enzymes, antibody fragments, and growth hormones have also come from recombinant-DNA research. Using recombinant DNA in combination with microorganic hosts such as bacteria, instead of animal tissue, decreases the risk of side effects and cross-species contamination as has occurred with SV40 and the TSEs, the most notable being bovine spongiform encephalopathy or Mad Cow disease. It also allows a more pure medication, vaccine, or other product to be marketed.

Gene insertion or DNA insertion could replace the altered gene thus preventing the child from ever experiencing the birth defect. We could prevent the diseases affecting twenty million children.

Pharmacogenetics determines how genetic factors sway response to drugs. Pharmacogenomics is applied pharmacogenetics, a "gene-to-drug" strategy. It predicts a person's response to a given drug before exposure to the drug. Though still in development, pharmacogenomics will be able to customize therapies to meet explicit genetic criteria, as described in more detail later.

John Bellenson of Pangea Systems Inc., says this about technology's contribution to studies of the human genome:

> Robotics, automated sequencing, and data compilation software have enabled the sequencing of thousands of genes and gene fragments . . . Making sense of this information, and understanding how these DNA sequences and sequence fragments correlate to specific genes and molecular targets has required the development of new analytic and visualization tools and the ability to think about biology in new ways.[31]

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Extracts from Chapter Six: Alternatives.

"New ways," as he describes them, are essentially more sensible ways. Watching the basic components of our human systems to see how they respond to medications and our environment makes sense. The old way—working exhaustively to give animals diseases that only vaguely resemble human diseases then trying to cure them—does not.

Dr. David Valle of Johns Hopkins University emphasized that the informational biology that is emerging from human systems analysis is synonymous with transferring the focus on treatment to a focus on prevention. "There's no question that if you can find a way to prevent disease onset, you're way ahead of the game."[152]

Diagnostic Imaging

Why should researchers plumb animals when state-of-the-art diagnostic imaging technology lets physicians peer into afflicted and non-inflicted patients without invasive dangers or discomforts? The most commonly used scanning tests are ultrasound, positron electron tomography (PET), computed tomography or computer-aided tomography (CT or CAT), and magnetic resonance imaging (MRI). A new imaging technique called the Fly-Through uses software to assemble slices of CAT or MRI imagery into a 3-D image of a patient's interior. Physicians can use this to simulate the operation before touching the patient.

Postmarketing Drug Surveillance

After drugs make it through clinical trials and are approved, pharmaceutical companies release them to the public. Postmarketing drug surveillance (PMDS) is the reporting of any side effect of a medication after its release. Since no surveillance systems are presently required, and only infrequently do doctors volunteer to report side effects, it is impossible to keep comprehensive data on any given drug's potential for negative reactions. Moreover, there is often confusion as to what caused a side effect. Without reporting systems and methods of analyzing input, the key postmarketing drug surveillance component is almost nonexistent.

Nevertheless, were PMDS in place, it could prevent many disasters. Thalidomide might have affected a few children, but not 10,000. The methodology would also increase the odds of finding new uses for old drugs. As you will read, many of the medications used today were intended for other illnesses. Only serendipity allowed us to discover their real potential.

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Extracts from Chapter Six: Alternatives.

Scientists have this to say regarding post marketing drug surveillance:

> Another objective of PMDS is to discover beneficial drug effects (anticipated or unanticipated) after a drug has been marketed. Although it is not possible to systematize serendipitous discoveries, it is desirable to approach the discovery of new indications for drugs more systematically. For example, careful follow-up of published reports of new effects of marketed drugs . . . or the monitoring of trends in medical events (e.g., cardiovascular deaths) in our population may provide useful clues about unanticipated beneficial effects of drugs. This objective is by no means a trivial one, as many additional benefits of drugs have been discovered after the drugs have been approved for marketing. Such discovery is not only beneficial for populations having a disease treatable by the new use of the approved drug, but also represents an improvement in safety and economy in drug development, since many new uses may reduce the cost of development and simultaneously prevent unnecessary exposure of subjects to potentially toxic and/or ineffective experimental drugs.[33]

The sheer bulk of these viable alternatives knocks the legs out from under the animal experimentation community's position, yet government, research institutions, and corporations continue to insist that animals are necessary to "validate" human findings. You will read throughout this book how ludicrous the insistence is. Scientists have gone on record supporting the fact that laboratory tests on animals ". . . cannot provide reliable risk assessment." and that, ". . . for the great majority of disease entities, the animal models either do not exist or are really very poor."[34,35]

Many of the causes of disease in humans cannot even be reproduced in animals. Even if animals could model the actual diseases exactly, which they cannot, the influence of human genetics, emotions, and lifestyle is essentially irreproducible.

In conclusion, it is becoming increasingly difficult to marginalize these outstanding alternative modalities, given their overwhelming superiority. Plus, scientists who recognize the inefficacy of extrapolating animal data to humans, as well as the efforts of biotech firms that wish to replace animals with their superior technologies, are making some inroads into change. As Stephen Sullivan, chairman of the board of biotechnology company Xenometrix, Inc., said,

> I'm going to guess it could be ten or twenty years, but eventually, gene expression and protein expression testing will probably replace animal testing . . . It's going to be an evolutionary process, not a revolutionary process.[36]

Many people and conventions thwart a rapid conversion of animal studies to these sophisticated alternatives. But it will happen. Why wait in the dark ages when the *Star Trek* sick bay is at hand?

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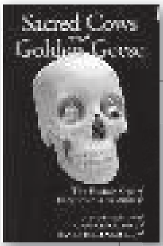
Extracts from Chapter Seven: Real Origins of New Medications.



And How to Test Their Safety

> Animal tests conducted to establish the effect of medicaments for humans are nonsense.
>
> —Dr. Herdegg, animal experimenter presenting at Conference on Laboratory Animals, Hanover, Germany, as quoted in *1,000 Doctors against Vivisection*[1]

The alternatives to animal experimentation are elegant. They are forward thinking. They save lives. But the public is still mired in the atavistic mindset that medicine will not progress without cages full of furry quadrupeds. They keep asking, "Where will medications come from if we do not test them on animals?" The truth is that new medications do not spring from lab rat to bottle.

Lab animals are only an unnecessary intermediary step between the design phase and clinical trials. Before the animal-testing stage, other factors suggest a given substance's usefulness and deploy scientists to verify their hypothesis. Great new medications are not hiding in mouse urine or chimp spit. There are four tried and true methods for finding fresh drugs:

- Discover new substances from nature.
- Uncover a different curative value in an existing medication.
- Modify the chemical structure of a similar medication.
- Design a new medication from scratch based on what you want the medication to do.

Once researchers have theorized about a substance's usefulness and tested it in test tubes, they administer it to animals to see whether or not it works on them. They obtain plenty of feedback about its effectiveness in the species tested, and if it is positive we will find out about it in the media. Nevertheless, just because it cures mice does not mean it will do the same for humans. As demonstrated in previous chapters, this animal testing often works at cross-purposes to discovery.

From prehistory forward, humans have gathered information about human cures only from trying them out on humans. Everything we know about drugs relates back to this data. The truth is, even now with the prevalence of the animal-model, real developments always arise from a human-modeled foundation.

J.S. Greek, **R.C. Greek**, *Sacred Cows and Golden Geese: The Human Cost of Experiments on Animals*. (Continuum, 2000), pp. 112-117.

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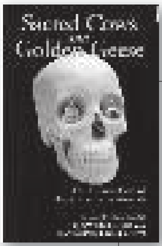

Natural Legacy

Prior to the 1900s, all medications resulted from astute observation and skillful application. Though certainly pharmaceutical development has accelerated enormously since the mid-nineteenth century—a pill for every ill—many, indeed most therapies have their foundation in curative ingredients passed from generation to generation throughout time. To say otherwise is deceptive. Of these, the following are but a few examples:

- Curare, a substance the Incas used to paralyze their prey, is now used to relax muscles during surgery. The drug is extracted from the wourali root.
- Vincristine, an anticancer drug is derived from the rose periwinkle plant. It is a frequently used chemotherapeutic.
- Yohimbine, a medication used to reduce high blood pressure in humans came from the bark of the African Rubacae tree.[2] (Yohimbine is used for the opposite purpose in dogs, in which it increases blood pressure following certain types of anesthesia.)
- Digoxin is also a botanical extract, from the foxglove plant, digitalis. William Withering, an English physician interested in botany, heard of this folk-remedy for "dropsy" from his patients. Unlike many physicians, he listened. He found foxglove in 1775, extracted digitalis from the plant, and gave it to patients suffering from the condition. It worked. Today "dropsy" is known to be a symptom of heart failure, and is treated with the modern version of digitalis, digoxin. Doctors also prescribe the medication for irregular heartbeats. In 1905, Dr. James Mackenzie gave the drug to patients suffering from rapid heart rates. It improved their condition and has been used ever since. This was discovered clinically as well.[3,4]
- Morphine is a potent painkiller extracted from poppy flowers.
- Quinine, a medication to treat malaria comes from cinchona bark. Serendipitously, a famous physician discovered that quinidine, also derived from cinchona bark, could treat irregular heartbeats.[5] In 1914, a patient of the now legendary Dr. K. F. Wenkebach was diagnosed with atrial fibrillation, which then had no treatment. The patient told the great doctor that he would just take care of it himself. The next day the patient returned, apparently cured. Wenkebach reportedly locked the door and told the patient that neither of them was leaving until the patient had explained how this miracle occurred. The patient was a businessman whose travel required him to take quinine for malaria protection. He had noticed that this sometimes helped his atrial fibrillation. Wenkebach took this information and published it. He noticed that quinine did, in fact, work, but not all the time. He, and others, therefore studied quinine, quinidine, and cinchonine and compared their ability to inhibit atrial fibrillation. Quinidine was the most effective and is still used today.[6,7]

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Extracts from Chapter Seven: Real Origins of New Medications.

- Artemether, a new antimalarial medication, was derived from the Chinese shrub wormwood plant. Physicians use artemether to treat cerebral malaria and forms of malaria that are resistant to more commonly used medications for malaria such as quinine.[8,9]
- Atanine, a drug derived from the plant Evodia rutaecarpa, kills the parasite responsible for schistosomiasis, a debilitating disease.[10]
- Aspirin was first prescribed by Hippocrates, around 400 B.C.E., in the form of willow bark. In 1853, a German scientist refined the active ingredient from willow bark. Bayer began commercially producing aspirin on August 10, 1897, making it the first mass-produced drug. The most commonly used medication in the world, it owes nothing to animal experimentation.

Weighing the whole of modern pharmaceutical progress, it is impossible to disagree with the following assessment by Dr. Anthony Dayan of Wellcome Research Laboratories:

> The weakness and intellectual poverty of a nave trust in animal tests may be shown in several ways, e.g. the humiliatingly large number of medicines discovered only by serendipitous observation in man (ranging from diuretics to antidepressants), or by astute analysis of deliberate or accidental poisoning, the notorious examples of valuable medicines which have seemingly "unacceptable" toxicity in animals, e.g. griseofulvin producing tumors and furosemide causing hepatic necrosis in mice, the stimulant action of morphine in cats, and such instances of unpredicted toxicity in man, such as the production of pulmonary hypertension by Aminorex and SMON. The rapidly increasing interest in clinical pharmacology, and the drive to better means of measurements in man, also reflect the uncertainty of animal experimentation and realization that the study of man alone can ever prove entirely valid for other men.[11]

Modifying Chance Cures

Consider what actually raises scientists' awareness of a compound's therapeutic potential for a particular condition. Look back over the history of drug development. Trace the antecedents of drugs like protease inhibitors. They were developed by rearranging chemical structures already known to produce specific effects. You will find that each has, at its origins, one aspect, and one aspect alone that directed recognition of the drugs' applicability to specific purposes. That aspect is chance.[12–15]

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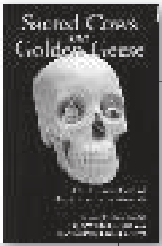

Some scientists take credit for discoveries which, in fact, were brought about by observing unexpected results. True, they had to notice the results and that demanded attentiveness, but the truth is they were just lucky. *Chance favors the prepared mind*. It is time that science and society stop crediting new drugs to animal experimentation and instead credit serendipity when appropriate.

We have already described what is possibly the most serendipitous occasion in medical history—the discovery of penicillin. Many other fortuitous discoveries, made without use of the animal model, or despite the use of the animal model, are described throughout this book. Examples are the use of nitrogen mustard, prednisone, and actinomycin D as cancer treatments, as noted in Chapter 8, Cancer, Our Modern-Day Plague.[16,17,18] Potassium bromide was introduced as an epilepsy treatment when in 1853 it prevented a young woman from having further seizures.[19] The bulk of curative compounds, accidentally discovered throughout history and acting as the foundation for present-day pharmaceutical development, is persuasive.

You have read how animal testing frequently attributes properties to compounds that ultimately prove incorrect when they reach the clinical trial phase. The effects that these compounds demonstrate during human testing sometimes suggest other uses. Or as one authority described,

> Perhaps a look into the past can give a glimpse of the future. In this regard, the potential of serendipity cannot be overlooked when evaluating treatment strategies. Throughout the history of medicine, there are examples of significant advances coming about as a result of careful clinical monitoring of a drug that was supposed to do something but had an effect in an unpredicted direction.[20]

Hence, humans now use the same drugs for entirely different purposes. Some are as follows:

- Catapres (Clonidine) is a drug originally intended to control headaches and sinus congestion. Allegedly, animal experiments suggested clonidine's effectiveness for these symptoms, though this does beg the question, how does one know when a rat no longer has a headache? It was tested and FDA-approved as a headache remedy. In point of fact, clonidine proved more useful as an anti-hypertensive agent, a use discovered clinically by physicians.[21,22] One unfortunate side effect of this drug is a withdrawal phenomenon. Patients must taper off the medication over a prolonged period of time, lest they suffer severe withdrawal symptoms. After the fact, scientists were unable to reproduce this withdrawal in rats, cats, or dogs.[23,24] Ironically, physicians discovered that clonidine aids humans in withdrawing from other drugs, a purpose for which it is now routinely administered.

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Extracts from Chapter Seven: Real Origins of New Medications.

- Another drug category, antidepressants, issued from clinical observation, not animal experimentation. Doctors administered iproniazid to tuberculosis patients to control secretions. The euphoria it caused suggested a new class of antidepressants. In 1983, N. Sitaram and E. S. Gershon noted iproniazid was effective in relieving depression in humans, and found that the drug induced hypothermia in mice. They conjectured that any other drug that could induce hypothermia in mice might also act as a human antidepressant. However, it turned out that this effect was unique to iproniazid. Iproniazid provided the basis for monoamine oxidase inhibitors. Another example of drugs conceived for other purposes are the tricyclic antidepressants originally developed as antipsychotics.[25,26]
- Antabuse developers designed the drug as an antiparasitic agent. They took it themselves, then had a cocktail and became violently nauseous. Antabuse is now used to discourage alcoholics from imbibing.[27]
- Non-steroidal anti-inflammatory drugs introduced as arthritis treatments are now used for dysmenorrhea, pain, and other orthopedic conditions.
- Selective serotonin-reuptake inhibitors such as floxetine (Prozac) and sertraline (Zoloft), first prescribed for depression, are now used for bulimia, anxiety, obsessive-compulsive disorder, alcoholism and other psychiatric conditions.
- Insulin has been found effective for lowering potassium as well as for treating diabetes.
- Calcium channel blockers, introduced for treating angina, now help patients with high blood pressure, headaches, coronary vasospasm, and dysrhythmias.
- Lidocaine is a commonly used medication for ventricular dysrhythmias. Its use was discovered accidentally during a heart catheterization.[28,29] Another medication used for irregular heartbeats is phenytoin. It was originally designed for use in epilepsy and is still used for that. However, during clinical trials it affected the irregular heartbeats of some patients.[30]
- Beta-blockers were originally used for irregular heartbeats, and still are, but during clinical use scientists noticed that the medication lowers blood pressure and relieves angina and headaches.[31]
- Grapefruit has an enzyme-suppressing ingredient that, should it be added to certain drugs, will reduce the needed dose. This was discovered accidentally by a doctor with a preference for grapefruit juice.[32]

These are but a few random examples. The point is this: Nature, experience, and human observation have always provided us with abundant direction. They continue to do so, and the directions benefit from all that modern biotechnology has to offer. This reservoir of indicators is more than sufficient, used in tandem with human-modeled assays, for drug development and testing. Any processes that employ nonhumans are senseless and dangerous.

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Extracts from Chapter Seven: Real Origins of New Medications.

As we have already pointed out in previous chapters, the inability to extrapolate data even between species of animals exaggerates this meaninglessness. A recent article in the *Journal of the Veterinary Medical Association* reinforced this with examples: the LD50 of digitoxin is 670 times greater in the rat than in the cat. The anticancer medication azauridine is tolerated by people but causes lethal bone marrow suppression in dogs. Serotonin raises blood pressure in dogs and people, but lowers it in cats. To examine other incongruities, how about diphenhydramine, marketed most commonly as Benadryl? Benadryl works well in humans and dogs, but at widely discrepant dosages. If humans take more than one-fourth the dose recommended for their Labrador retriever, they sleep for two days. The female mouse microsome metabolizes chloroform ten times slower than the male. Male mice are more susceptible to kidney damage from chloroform than are females.[40] Mice, rabbits, and horses cannot vomit, while dogs and cats can. As the journal author concluded, "It is unwise to extrapolate information concerning drugs from one species to another."[41] And this from the journal *Bio/Technology* in 1992: "One fundamental deficiency of animal tissue is that it contains *animal receptors*—a boon in the development of drugs for rats, cats, and dogs but of dubious value in human health care."[42] (Emphasis added.) Since animals cannot predict the reactions of other animals to a drug, it is not surprising that they fail to predict human reactions.

No matter how exhaustive the animal testing, problems can still develop. Fenclozic acid, a potential new anti-inflammatory drug, showed no side effects in mice, rats, dogs, rhesus monkeys, patas monkeys, rabbits, guinea pigs, ferrets, cats, pigs, cows, or horses. But the drug caused acute cholestatic jaundice, a type of liver failure, in humans.[43] Tragedies like these happen all the time.

Animal models for human reactions to medications simply do not exist. A renowned pharmacologist, Dr. B. B. Brodie, while accepting a prize for pharmacology, said this to a room full of scientists who make their living testing drugs for toxicity on animals, it is "a matter of pure luck that animal experiments lead to clinically useful drugs."[44] Relying on luck to prove efficacy is neither scientific nor safe.

Non-animal methods are not comprehensive, but they certainly offer more security than animal tests. And eliminating animal tests would free up funds for more comprehensive non-animal methods.

One important point glossed over by the animal-experimentation lobby is this: new medications must still go through clinical trials prior to being released to the public. This stage alone has the potential to predict adverse reactions accurately. Unfortunately, clinical trials are usually way too brief, both in scope and duration.

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A. Knight, *The Costs and Benefits of Animal Experiments*. (Palgrave Macmillan, 2011), pp. 179-193.
Extract from Chapter 12: The Costs and Benefits of Animal Experimentation.

12
The Costs and Benefits of Animal Experimentation

Unanswered questions about the precise psychological abilities of laboratory animals inevitably result in a degree of uncertainty about the nature and magnitude of the suffering likely to result from invasive procedures and protocols. It has been theorised that only those species with brain structures such as a cerebral cortex and thalamus and the capacity for synaptic feedback between the two have the capacity for sentience (Butler 2000). If true, this would include most vertebrates, with the possible exception of *chondrichthyes* (sharks and rays) and *cyclostomes* (lampreys and hagfish), but not invertebrates. Although many invertebrates display complex behaviour, there is little evidence of brain structures comparable to those believed to support consciousness in higher animals (Nicol 2010). Cephalopods, however, display electroencephalogram patterns (i.e. electrical activity or 'brainwaves') similar to those associated with differing wake–sleep states of consciousness in vertebrates (Edelman & Seth 2009), demonstrating their possible sentience, and also the limits of our understanding about what neuroanatomical mechanisms are necessary for sentience, and about which animals possess them, and to what degree.

Where such doubt exists, it seems reasonable to apply a precautionary principle – to assume until proven otherwise that suffering *may* occur, and to consider restrictions on procedures likely to cause such suffering. Similar precautionary principles are, after all, enshrined in fundamental social institutions, because they are considered to be rational, reasonable, and humane. The Western legal system, for example, generally assumes innocence until guilt is proven beyond reasonable doubt. Where such doubt remains, judicial punishment should be withheld.

Conversely, a precautionary principle could be applied in favour of human patients or consumers who may potentially benefit from animal experimentation: where healthcare advances or other human utility *may* result, perhaps such experiments should proceed until lack of benefit is proven beyond reasonable doubt.

A. Knight, *The Costs and Benefits of Animal Experiments*. (Palgrave Macmillan, 2011), pp. 179-193.

Extract from Chapter 12: The Costs and Benefits of Animal Experimentation.

These viewpoints represent diametrically opposite positions, consistent with ideologies that consider the interests of animals or people, respectively, to be overwhelmingly more important than the interests of the other group. These are but two of a diverse range of philosophical, cultural, and religious viewpoints on our moral duties towards animals and people that could be applied (Armstrong & Botzler 2003, Council of Europe 2006, Busche 2008).

It is the opinion of various philosophers (e.g. Singer 1990, Busche 2008) that a reasonable and rational balance should be sought between upholding the interests of people and those of laboratory animals. This requires balanced consideration of the interests of both groups: primarily, the human interests in obtaining benefits such as new clinical interventions and the identification of toxins, and the interests of animals in avoiding harms such as involuntary confinement, social disruption, various forms of suffering, and death. This *utilitarian* assessment aims to achieve the 'greatest good for the greatest number', and considers the interests of all those affected, whether human or other creatures likely to be capable of experiencing states as 'good' or as less desirable.

Such a utilitarian assessment forms the basis for most regulation governing scientific animal use. *Directive 2010/63/EU on the protection of animals used for scientific purposes*, which directs such animal use in all EU member states, asserts that it is essential, on both moral and scientific grounds, to ensure that the scientific or educational validity, usefulness, and relevance of each use of an animal are carefully assessed. It specifically requires that the likely harms to the animal should be balanced against the expected benefits of the project (EU 2010).

Fortunately, although uncertainties remain, sufficient evidence exists to draw some key conclusions about the likely costs to animals, and benefits to humans, of animal experimentation overall.

Animal costs

Numbers and species of animals used

Accurate estimation of global laboratory animal numbers is markedly impeded by the lack of published national statistics. Among those countries that do publish data, lack of standardisation hinders interpretation. Nevertheless, using a validated prediction model based on animal study publication rates, Taylor and colleagues (2008) were able to provide evidence-based estimates of national and global laboratory animal use (Chapter 2). Application of the most accurate statistical methods revealed that, worldwide in 2005, at least 126.9 million non-human vertebrates were subjected to fundamental or medically applied biomedical research, toxicity testing, or educational use; were killed for the provision of experimental tissues or as surplus to requirements; or were used to maintain established GM strains (Knight 2008a, Taylor *et al.* 2008). Although this total represents the most accurate recent, evidence-based estimate of global laboratory animal use, it remains highly conservative, due to several factors. It also excludes certain categories that raise ethical concerns, such as the use of advanced foetal developmental stages and of certain invertebrate species believed to possess significant capacity for suffering.

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On the basis of the latest EU reports (EC 2010a & 2010b; see also Chapter 3), the overwhelming majority of animals used are mice (around 59 per cent) and rats (around 18 per cent). Poikilotherms (fish, amphibians, and reptiles; 10 per cent) and birds (6 per cent) are the next-largest groups.

Clearly, almost all animals subjected to scientific procedures are higher vertebrates. These animals possess the neuroanatomical mechanisms and psychological capacities necessary to experience significant pain, fear, and psychological distress. Great apes in particular have advanced emotional, psychological, and social characteristics which enhance their potential for suffering in laboratory environments. To a lesser degree capacities for sentience may also exist in the small proportion of other animals, such as certain invertebrates, which are used.

Effects of stressors on welfare and scientific outcomes

A wide variety of stressors have the potential to cause significant stress, fear, and possibly distress in laboratory animals. These stressors may be associated with the capture of wild-sourced species such as primates to supply laboratories or breeding centres; with transportation, which may be prolonged for some animals; with laboratory housing and environments; and with both routine and invasive laboratory procedures (Chapter 4).

A large minority of all procedures are markedly invasive. These include procedures resulting in death (whether or not the animals were conscious), surgical procedures (excluding minor operative procedures), major physiological challenges, and the production of GM animals. On the basis of Canadian figures, the proportion of markedly invasive procedures has ranged between approximately 29 per cent and 44 per cent over the past decade, with a figure of 40 per cent recorded in 2008. The prevalence of such procedures may be increasing (CCAC 2009; see also Chapter 3).

A sizeable majority of all procedures utilise no anaesthetics of any kind. Canadian figures are not available, but in Britain procedures without anaesthesia have fluctuated between approximately 59 per cent and 69 per cent of recorded totals over the past two decades, with a figure of 67 per cent recorded in 2009 (Home Office 2010; see also Chapter 3).

To assess animal impacts further it would be helpful to know the frequency of analgesic use, the degree of correlation between markedly invasive procedures and anaesthetic or analgesic use, and the prevalence of environmental enrichment and socialisation opportunities. Unfortunately, such information is largely lacking.

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Extract from Chapter 12: The Costs and Benefits of Animal Experimentation.

Nevertheless, a large number of studies have demonstrated that the stress caused by laboratory housing and environments, and by routine laboratory procedures, may result in profound, statistically significant distortions in a range of physiological indices, including cardiovascular parameters and serum concentrations of glucose and various hormones. Behaviour may be markedly altered, and behavioural stereotypies and increased aggression may develop over time, as may alterations in certain neuroanatomical parameters and even cognitive capacities (Balcombe *et al.* 2004, Balcombe 2006, Baldwin & Bekoff 2007; see also Chapter 4). Some of these effects are also likely to be sequelae of other stressors such as invasive procedures and transportation.

Unsurprisingly, the chronic stress experienced by most laboratory animals may result in immunocompromisation, and subsequently increased susceptibility to a range of pathologies. As well as creating significant animal welfare and ethical problems, such stressors and their effects on laboratory animals may distort a wide range of experimental outcomes, such as those dependent on accurate determination of physiological, behavioural, or cognitive characteristics.

Human benefits

Human clinical and toxicological utility

In the EU, around 42 per cent of all procedures in 2008 were focused on the development, production, or safety evaluation of clinical interventions and other products, almost all of which were intended for human use (EC 2010a).

The historical and contemporary paradigm that animals are reasonably predictive of human outcomes provides the basis for such widespread use in toxicity testing and biomedical research aimed at combating human diseases. However, their use persists for historical and cultural reasons, rather than because it has been demonstrated to be scientifically valid.

In fact, most systematic reviews published in peer-reviewed scientific journals have demonstrated that animals are insufficiently predictive of human outcomes to provide substantial benefits during the development of human clinical interventions or the assessment of human toxicity. In only 2 of 20 such reviews located during a comprehensive survey (Knight 2007a & 2008b) did the authors conclude that animal models were either significantly useful in contributing to the development of clinical interventions or substantially consistent with clinical outcomes. Furthermore, one of these conclusions was contentious.

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A. Knight, *The Costs and Benefits of Animal Experiments*. (Palgrave Macmillan, 2011), pp. 179-193.
Extract from Chapter 12: The Costs and Benefits of Animal Experimentation.

Included were reviews examining the human clinical utility of invasive chimpanzee experiments, of highly cited animal experiments published in leading scientific journals, and of experiments approved by ethics committees at least partly on the basis of specific claims that these animal experiments were likely to lead to concrete advances in human healthcare. Seven additional reviews also failed to demonstrate reliable predictivity of human toxicities such as carcinogenicity and teratogenicity. Results in animal models were frequently equivocal or inconsistent with human outcomes (Chapters 5–6).

Those systematic reviews investigating the human clinical utility of chimpanzee experimentation or the toxicological utility of carcinogenicity bioassays are particularly significant, given that other animal models are even less likely to be generally predictive of human outcomes than chimpanzees, and other fields of toxicity testing are even less likely to provide public health benefits than carcinogenicity testing. By extrapolation, our current reliance on animal models of humans must be questioned in all fields of clinically oriented biomedical research and toxicity testing.

Causes of poor human utility

The likely causes of the poor human clinical and toxicological utility of animal models include inherent genotypic and phenotypic differences between human and non-human species, the distortion of experimental outcomes arising from stressful experimental environments and protocols, and the poor methodological quality of many animal experiments, which is apparent from numerous systematic reviews of experimental utility (Knight 2007a & 2008b). No reviews were identified in which a majority of animal studies were of good methodological quality.

Problems arising from stressors and poor methodological quality might theoretically be minimised, although fundamental changes to the practice of laboratory animal science would be required, given their widespread prevalence. However, limitations resulting from interspecies differences are likely to be technically and theoretically impossible to overcome.

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Non-animal alternatives

Much animal use in biomedical research and toxicity testing can be replaced by a broad range of non-animal methodologies, either individually or in combination (Chapter 8). Prior to commencing any biomedical research project or toxicological evaluation, researchers should collate and examine all relevant existing data to determine which, if any, remaining studies are necessary. Current commercially motivated restriction of access to important proprietary data has significant implications for the detection of toxicity in compounds under development, as well as for the wider development of clinical interventions, animal welfare, and resource allocation. New regulatory mechanisms are therefore necessary to enhance the sharing and assessment of such data. In other cases, information is publicly available, but its assessment is inadequate.

During pharmaceutical development or toxicity assessment, qualities such as absorption, distribution, *in vivo* concentrations in various body compartments, organ systems affected, toxicity, efficacy, clearance, and metabolic fate can be predicted to varying degrees through physicochemical evaluation, chemical grouping with interpolation or extrapolation of properties, and computerised modelling, including the use of structure–activity relationships and expert systems.

A variety of tissue cultures are available, including immortalised cell lines, embryonic and adult stem cells, and organotypic cultures. *In vitro* assays using bacterial, yeast, protozoal, mammalian, or human cell cultures can predict a wide range of toxic and other endpoints. To increase the spectrum of toxins detected, individual assays may be combined as test batteries. Human hepatocyte cultures and metabolic activation systems may allow identification of metabolic pathways and of metabolites produced, and assessment of organ–organ interactions. Toxicity onset, magnitude, and levels over time can be measured by analysis of biomarkers in the outflow of perfused cultures. Microarray technology will increasingly allow genetic expression profiling of toxins, increasing the speed of detection, well before more invasive endpoints.

Nevertheless, to predict the likely effects of test compounds most accurately, human studies will remain necessary. The safety for volunteers and predictivity for diverse patient populations of human clinical trials may be increased through measures such as microdosing, staggered dosing, larger study populations, and longer durations. Additional human-based studies could use surrogate tissues, advanced imaging modalities, and human epidemiological, sociological, and psychological investigations to shed light on illness aetiology and pathogenesis, and to facilitate the development of safe and effective clinical interventions.

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Weighing the costs and benefits

When considering costs and benefits overall, one cannot reasonably conclude that the benefits accruing to human patients or consumers, or to those motivated by scientific curiosity or profit, exceed the costs incurred by animals subjected to scientific procedures. On the contrary, the evidence indicates that actual human benefit is rarely – if ever – sufficient to justify such costs. The more speculative the human benefit becomes – as in the case of fundamental (rather than clinically applied) biological research, for example, which constitutes a major category of laboratory animal use – the more obvious the resultant disparity.

It is, in fact, only possible to conclude that such research is ethically justified if a profoundly unequal weighting is applied in which relatively minor or infrequent human benefits are considered more important than the significant adverse impacts commonly experienced by laboratory animals. However, this position is increasingly inconsistent with our growing understanding of the psychological and social characteristics of laboratory animals, including their ability to experience suffering and pleasure; of the impacts on laboratory animals resulting from laboratory environments and procedures; and of the moral obligations that stem from this knowledge. It also profoundly distorts the utilitarian cost/benefit analysis that fundamentally underpins most policy and regulation governing animal experimentation.

Even when animal interests are marginalised in such ways, it remains far from clear that animal experimentation is justifiable. The famous 'greatest happiness' definition of utilitarianism formulated by the noted utilitarian philosopher Mill (1971) asserted that one should always act so as to produce the greatest happiness for the greatest number of individuals. However, animal experimentation is unreliably – and frequently poorly – predictive of human outcomes, and consumes enormous financial resources and human expertise, which are then unavailable to other research fields. Those potentially affected include patients, consumers, and scientists. The moral implications are profound when consumers suffer serious toxic reactions to products assessed as safe in animal studies (Chapter 5), or if patients with serious conditions are denied effective clinical interventions partly because potentially more efficacious research fields are under-resourced.

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The costs of scientific animal use can be surprisingly wide-ranging, as illustrated by considering the case of veterinary students. Students are exposed to highly toxic chemicals used to preserve anatomy specimens between dissections, at levels that may exceed recommended safe limits. Their learning may be adversely affected by the stresses arising from the conflict created by simultaneous requirements to inflict grievous harm and to care for their animal subjects during laboratory classes. Finally, studies have demonstrated that senior veterinary students may suffer cognitive phenomena such as decreased awareness of animal sentience and inhibition of normal development of moral reasoning ability. They are also less likely to provide analgesia, and it appears likely that the animal welfare standards of veterinarians are adversely affected as a result (Chapter 11).

Such desensitisation-related phenomena are almost certainly adaptive coping mechanisms that enable previously caring students to withstand substantial psychological stress resulting from curricular requirements to harm and kill animals. The implications for laboratory animal scientists and technicians subjected to similar stresses of even greater frequency and magnitude, and the potential for adverse impacts on the welfare of animals in their care, are both obvious and disturbing.

The case for invasive animal research is further weakened by consideration of the potential offered by the diverse and growing array of non-animal or non-harmful research, testing, and educational methodologies. In the latter case the evidence is remarkably consistent: students using humane alternatives designed to impart knowledge or surgical skills virtually always achieve learning outcomes at least equivalent – and in some cases superior – to those achieved through traditional, harmful animal use.

Non-animal research and testing methodologies are not yet able to answer all potential questions about humans, particularly given current technological limitations. Yet the same criticism applies to animal models, which have a considerably more limited capacity for further development.

On the other hand, non-animal models can offer certain important advantages. Particularly when humans or human tissues are used, such methods may generate faster, cheaper results which are more reliably predictive for humans, and may yield greater insights into human biochemical processes. Such logistical considerations are increasingly important, given the unprecedented challenges posed by high-throughput US and EU toxicity testing programmes such as HPV and REACH respectively, as well as rising social pressures to find alternatives to laboratory animal use. These pressures are increasingly resulting in legislative or regulatory changes, such as the seventh amendment to the European *Cosmetics Directive 76/768/EEC*.

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The case of chimpanzees

Few research issues generate as much controversy as invasive chimpanzee experimentation. The unequalled phylogenetic proximity of chimpanzees to humans makes them potentially superior to all other laboratory species for use as human models in toxicity experiments and in pathological or therapeutic investigations it would be hazardous to conduct on humans. However, their use also raises greater animal welfare and bioethical concerns than the use of virtually any other laboratory species, because of their advanced emotional, psychological, and social characteristics. These characteristics markedly increase their ability to suffer when chimpanzees are born into unnatural captive environments, or captured from the wild (as many research chimpanzees once were), and then subjected to confinement, social disruption, and involuntary participation in potentially harmful biomedical research.

The justifications proposed for invasive chimpanzee experimentation rely on the important contributions advocates claim such research has made to the advancement of biomedical knowledge, and, in particular, to combating major human diseases. However, a recent large-scale citation analysis of the medical utility of chimpanzee experimentation indicated that the benefits are significantly less than is sometimes claimed. Half of the randomly selected published chimpanzee studies examined were not cited by any subsequent papers, apparently generating data of questionable value which made little obvious contribution to the advancement of biomedical knowledge. In addition, closer examination failed to identify any chimpanzee study that made an essential contribution, or, in a clear majority of cases, a significant contribution of any kind, to papers describing methods efficacious in combating human diseases (Knight 2007b & 2008c; see also Chapter 5). These conclusions have since been confirmed by additional studies examining the contribution of chimpanzee research to AIDS research and vaccine development (Bailey 2008), cancer research (Bailey 2009), and HCV research and vaccine development (Bailey 2010, Bettauer 2010).

The costs to chimpanzees enrolled in such experiments include involuntary confinement in laboratory settings, social disruption, and participation in potentially harmful research protocols. Recent studies have established beyond all reasonable doubt that the effects of laboratory confinement and procedures, especially long term, can be severe.

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Many captive great apes, including chimpanzees recently retired from US laboratories (Bradshaw *et al.* 2008), show gross behavioural abnormalities such as stereotypies, self-mutilation or other self-injurious behaviour, inappropriate aggression, fear, or withdrawal (Brüne *et al.* 2006, Bourgeois *et al.* 2007). It is increasingly acknowledged that such abnormal behaviours resemble symptoms associated with human psychiatric disorders such as depression, anxiety disorders, eating disorders, and post-traumatic stress disorder, and that pharmacological treatment modalities similar to those applied to human patients may be appropriate, and, indeed, morally compelled, for severely disturbed animal patients (Brüne *et al.* 2006, Bourgeois *et al.* 2007). Long-term therapeutic combination with positive reinforcement training, environmental enrichment, and social and environmental modification may be necessary in severe cases (Bourgeois *et al.* 2007).

Consideration of an analogous legal scenario is illuminating. Although these highly sentient creatures are innocent of causing any human grievance, including the serious diseases we attempt to induce in them, we sometimes subject chimpanzees to conditions that would cause widespread outrage if used to punish the most heinous of human criminals – for years on end, and, in some cases, for decades. Bradshaw and colleagues (2008) observed: 'The costs of laboratory-caused trauma are immeasurable in their life-long psychological impact on, and consequent suffering of, chimpanzees.' In contrast, human criminals are not normally punished until proven guilty beyond reasonable doubt. The application of such differing treatment standards to humans and chimpanzees reveals a lack of 'humanity' paradoxically less characteristic of chimpanzees, than of ourselves.

The logic of Bradshaw and colleagues' corollary is elementary, yet compelling: 'In human traumatology, the first step in treatment is to arrest its causes. This implies that prevention and treatment of chimpanzee psychopathology entails considering the factors and institutions that have brought chimpanzees to the point of irreversible distress: in simple terms, desisting from using apes as biomedical subjects in lieu of humans is compelled if trauma is not to be perpetuated.'

The remarkable biological characteristics of chimpanzees (which are rare in their own right) and their advanced emotional, psychological, and social characteristics (which have some similarities to those of humans) create a strong ethical basis for acknowledging the necessity of respecting at least the most basic and essential interests of chimpanzees, such as their interests in avoiding death, pain, suffering, and captivity (Cavalieri & Singer 1993, Morton 2000). When reasonable consideration is afforded to the interests of both humans and chimpanzees, it cannot be concluded that invasive chimpanzee experimentation is ethically justifiable.

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Implications

Ethical oversight

Almost all the chimpanzee experiments examined in Chapter 5 would have been approved by at least one institutional ethics committee obliged to permit only those experiments likely to result in substantial benefits, given the considerable animal welfare, bioethical, and financial costs inherent in chimpanzee experimentation. To varying degrees, similar costs are incurred when all higher vertebrates, and probably some invertebrates, are subjected to invasive experimentation.

Although the concept of ethical review is sound, these results demonstrate that its implementation is currently flawed. This flaw appears to have resulted from an over-reliance on the assumption that invasive experiments on chimpanzees and other laboratory animals were likely to be of substantial use in advancing biomedical knowledge. The approval of large numbers of such experiments despite their questionable merits clearly demonstrates a widespread failure of ethical oversight, adding significantly to previous concerns about the effectiveness of ethics committees in safeguarding laboratory animal subjects (Schuppli & Fraser 2005).

By approving these experiments on the basis of unfounded assumptions about their likely benefits, the ethics committees responsible failed in their duty to society, and to the animals they were charged with protecting.

Model validation

Despite substantial ongoing progress in the development of non-animal alternatives, compliance with the spirit of the 3Rs and, indeed, with the letter of some associated regulations remains poor in many sectors of government, academia, and industry. Continued reliance on animal models is understandable when they are truly required by regulators for the licensing of drugs and chemicals. The position of such regulators themselves appears less justifiable, however. Some apparently 'feel more comfortable' with animal data (O'Connor 1997), or even believe animal tests are inherently valid simply because they are conducted in animals (Balls 2004), despite a large and growing body of evidence to the contrary (Chapters 5–6). Animal-based toxicology, at least, appears to be 'frozen in time, using and accepting the same old animal models again and again, often without stringent examination of their validity' (Hartung 2008a; see also Leist *et al.* 2008b).

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It is clear that rather than relying on assumptions of human utility, we should subject animal experimental models to the same standards of scientific scrutiny currently required for non-animal alternatives prior to regulatory acceptance. Such scientific *validation* has traditionally involved the demonstration in multiple independent laboratories that the test in question is relevant to and reliable for its specified purpose (*practical validation*; Balls *et al.* 1995), such as the prediction of a certain *in vivo* outcome. However, it is not always scientifically necessary, or even logistically possible, to conduct multi-centre practical studies. Hence *weight-of-evidence validation*, also known as *validation by retrospective analysis* (ICCVAM 1997, OECD 2003), may be conducted by assessing existing data in a structured, systematic, and transparent manner – provided that data of sufficient quantity and quality are available (Balls & Combes 2006). Where practical validation studies do occur, they should adhere to best practice standards designed to ensure good methodological quality, including, for example, statistical justification of sample sizes, randomised allocation to test groups, and blinded treatment and assessment of results. Where feasible, inter-laboratory reproducibility should be demonstrated (Balls & Combes 2005).

Scientific validation should lead to a reasoned overall assessment that sufficient evidence exists to demonstrate that a model is, or is not, relevant to and reliable for the specified purpose, or that insufficient evidence exists to be reasonably certain either way. In some cases, an interim assessment may be made until further evidence becomes available (Balls & Combes 2006).

The European Centre for the Validation of Alternative Methods was created by the EC in 1991 to fulfil the requirements of European *Directive 86/609/EEC on the protection of animals used for experimental and other scientific purposes*. This Directive required the EC and its member states actively to support the development, validation, and acceptance of methods which could replace, refine, or reduce the use of laboratory animals (ECVAM 2010a). The US equivalent is the Interagency Coordinating Committee on the Validation of Alternative Methods, which has similar goals. Despite the high standards required for successful validation, between 1998 and 2010, 30 distinct tests or categories of test methods that could replace, reduce, or refine laboratory animal use were assessed and declared by ECVAM to be scientifically valid, of which 24 achieved regulatory acceptance (ECVAM 2010b).

Unlike non-animal models, animal models are generally assumed to be reasonably predictive of human outcomes in preclinical drug development, toxicity testing, and other fields of biomedical research without the need to undergo formal validation studies. Yet the 27 systematic reviews examined in Chapters 5–6 demonstrate the invalidity of assuming that animal models are reliably predictive of human outcomes, even when in use for long periods, without subjecting them to critical assessment.

A. Knight, *The Costs and Benefits of Animal Experiments*. (Palgrave Macmillan, 2011), pp. 179-193.
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Clearly, formal validation should be consistently applied to all proposed experimental models, regardless of their animal, non-animal, historical, contemporary, or possible future status. Model choices should also be based on mechanistic relevance to the hypothesis under investigation; on specificity, sensitivity, predictivity, durations, and other relevant scientific data; and on ethical, legal, and resource considerations. Such standards should be upheld regardless of historical or contemporary acceptance. Models not meeting these standards should be discarded, whether animal-based or otherwise.

Likely benefits of adherence to such standards would include greater selection of models truly predictive for human outcomes, increased safety of people exposed to chemicals that have passed toxicity tests, increased efficiency during the development of human pharmaceuticals and other therapeutic interventions, and decreased wastage of human and financial resources and animal lives.

Reduction and refinement

Where scientific animal use does continue, a range of strategies should be implemented to reduce animal numbers and minimise their suffering. Strategies to decrease animal numbers can be applied at the level of individual experiments (*intra-experimental reduction*). Improvements in experimental design and statistical analysis are key examples. Reduction strategies can also focus on implementing best practice policies at institutions where animal experiments occur (*supra-experimental reduction*). Improved education and training of staff, the inclusion of statisticians on animal ethics committees, and retrospective evaluation of experiments all fall into this category. More distantly related developments such as international harmonisation of testing requirements also have great potential to reduce animal numbers (*extra-experimental reduction*).

Refinement strategies aim to minimise animal suffering. They include appropriate use of analgesic and anaesthetic agents (which remain underutilised), non-invasive imaging modalities, telemetric devices, positive reinforcement techniques, and environmental enrichment and socialisation opportunities. In many cases simultaneous implementation of different 3Rs strategies can have synergistic effects, improving both animal welfare and scientific quality.

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Ethically justifiable research

Animal research ranges from field studies of free-living (wild) populations, through non-invasive behavioural or psychological studies of sanctuary or laboratory populations, to mildly harmful invasive experimentation, more harmful experimentation, and, finally, protocols resulting in major harm or death. According due respect to animal interests does not require the termination of all animal-based research. Bioethical concerns are minimised in non-invasive observational, behavioural, or psychological studies of free-living or sanctuary populations.

For animals with advanced psychological and social characteristics, such as chimpanzees, there are risks of boredom and associated pathology in sanctuary settings, unless these settings are highly enriched. Offering chimpanzees the choice to participate in behavioural or psychological studies may, in fact, constitute a valuable form of environmental enrichment (Matsuzawa *et al.* 2006). When participation remains truly voluntary – rather than coerced through conditional fulfilment of important needs such as food, water, or social contact with compatible conspecifics – bioethical concerns are minimised. Such studies are permissible under existing bans on great ape experimentation in countries such as Sweden, and are consistent with the US *Chimp Haven is Home Act* (2007), which prohibits further research on chimpanzees retired to federal sanctuaries, other than non-invasive behavioural studies (Participatory Politics & Sunlight Foundations 2008; see also 'Retirement of laboratory chimpanzees' in Chapter 13).

Limiting animal experimentation to non-invasive observational, behavioural, or psychological studies of free-living or sanctuary populations would inevitably restrict the range of scientific questions that could be investigated. It would, however, strike the correct ethical balance between satisfying the interests of animals and satisfying those of human beings.

M. Bekoff, 'Play Signals as Punctuation: The Structure of Social Play in Canids'. *Behaviour*. 132 5/6, 419-428 (1995).

PLAY SIGNALS AS PUNCTUATION: THE STRUCTURE OF SOCIAL PLAY IN CANIDS

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Summary

Actions called play signals have evolved in many species in which social play has been observed. Despite there being only few empirical demonstrations, it generally is accepted that play signals are important in the initiation ("I want to play") and maintenance ("I still want to play") of ongoing social play. In this study I consider whether a specific and highly stereotyped signal, the bow, is used to maintain social play in adult and infant domestic dogs, infant wolves, and infant coyotes.

To answer this question the temporal placement of bows relative to actions that are also used in other contexts (dominance or predatory encounters) such as biting accompanied by rapid side-to-side shaking of the head was analyzed to determine if bows performed during ongoing social play are used to communicate the message "I want to play despite what I am going to do or just did – I still want to play". The non-random occurrence of bows supports the hypothesis that bows are used to maintain social play in these canids when actions borrowed from other contexts, especially biting accompanied by rapid side-to-side shaking of the head, are likely to be misinterpreted.

Introduction

Why do many animals, especially mammals, who have been observed to engage in social play, use specific signals primarily in the context of play? Many people who study play have addressed this question (BEKOFF, 1975, 1977; BEKOFF & BYERS, 1981; FAGEN, 1981; LOEVEN, 1993; TOMASELLO et al.,1994), although there are few empirical demonstrations that what are called play signals actually might serve to initiate or to maintain ongoing social play (BEKOFF, 1975, 1977; BEKOFF & BYERS, 1981; FAGEN, 1981; TANNER & BYRNE, 1993). SIMONDS (1974) has suggested that in some primates there are two sets of play signals, one to initiate play and another to reinforce continually that the ongoing activity remains play. He also claimed that play signals are repeated whenever a clear statement of purpose (e.g. "this is still play") is necessary. Various actions appear to be important in the initiation of play in various canids (Fox, 1971; BEKOFF, 1975, 1977; LOEVEN, 1993) but their possible role in the maintenance of play has not been rigorously investigated. Here I reconsider the question of whether a specific action, the 'bow', is used to maintain social play in various canids: Is there a temporal pattern underlying when a bow is used, and does its position, relative to other behavior patterns, suggest that it might be used to punctuate play sequences (e.g. HAILMAN & DzELZKALNS, 1974; HAILMAN, 1977) such that it communicates to the recipient messages such as "I still want to play"?

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M. Bekoff, ‘Play Signals as Punctuation: The Structure of Social Play in Canids’. *Behaviour*. 132 5/6, 419-428 (1995).

To answer the question of whether play signals are repeated when a clear statement of purpose is necessary, I focused on a highly ritualized and stereotyped action, the bow, that is used almost exclusively in play. When performing the bow, an individual crouches on its forelimbs, remains standing on its hind legs, and may wag its tail and bark (BEKOFF, 1977). The bow is a stable posture from which the animal can move easily in many directions, allows the individual to stretch its muscles before and while engaging in play, and places the head of the bower below another animal in a non-threatening position. Previous data from a preliminary study of free-running adult domestic dogs (predominantly mixed breeds, Canis familiaris), infant domestic dogs (beagles, three to seven weeks of age), infant gray wolves (C. lupus), and infant coyotes (C. latrans) playing in controlled staged encounters (BEKOFF, 1974, 1977) indicated that bows were used to initiate play but were also performed randomly during social play; they did not occur regularly as every Nth action, they did not occur regularly every N seconds, and they were not used either immediately before or immediately after specific other actions; (see BEKOFF, 1976, Fig 4, p. 181 for further discussion). The present results from a larger data set suggest, to the contrary, that bows in some canids often are used immediately before and immediately after an action that can be misinterpreted and disrupt ongoing social play.

The present study is concerned with analyses of the structure of play sequences. The social play of canids (and of other mammals) contains actions, primarily bites, that are used in other contexts that do not contain bows (e.g. agonistic, predatory, or antipredatory). Previous work on infant eastern coyotes (C. latrans var.) indicated that bites directed to the tail, flank, legs, abdomen, or back lasted significantly a shorter time and were more stereotyped than similar bites performed during agonistic encounters (HILL & BEKOFF, 1977). However, bites accompanied by rapid side-to-side shaking of the head were not studied. Actions such as biting accompanied by rapid side-to-side shaking of the head are used in aggressive interactions and also during predation and could be misinterpreted when used in play. I asked the following questions: (1) What proportion of bites directed to the head, neck, or body of a play partner and accompanied by rapid side-to-side shaking of the head are immediately pre- ceded or followed by a bow? (2) What proportion of behavior patterns other than bites accompanied by rapid side-to-side shaking of the head are immediately preceded or followed by a bow? Actions considered here were mouthing or gentle biting during which the mouth is not closed tightly and rapid side-to-side shaking of the head is not performed, biting without rapid side-to-side shaking of the head, chin-resting, mounting from behind (as in sexual encounters), hip-slamming, standing-over assertively, incomplete standing-over, and vocalizing aggressively (for descriptions see BEKOFF, 1974; BEKOFF & HILL, 1977). (3) What percentage of bows in play sequences occur either before or after bites accompanied by rapid side-to-side shaking of the head? (4) What percentage of bows in play sequences occur either before or after behavior patterns other than bites accompanied by rapid side-to-side shaking of the head? I did not consider the situation in which the recipient of bites accompanied by rapid side-to-side shaking of the head performed a bow immediately before or immediately after its partner performed bite accompanied by rapid side-to-side shaking of the head or other action, because these rarely occurred. Thus, this study is concerned with an analysis of individual signaling and not an analysis of dyadic signaling sequences (M. PEREIRA, personal communication). I hypothesized that if bites accompanied by rapid side-to-side shaking of the head or other behavior pat terns could be or were misread by the recipient and could result in a fight, for example, then the animal who performed the actions that could be misinterpreted might have to communicate to its partner that this action was performed in the context of play and was not meant to be taken as an aggressive or predatory move. On this view, bows would not occur randomly in play sequences; the play atmosphere would be reinforced and maintained by performing bows immediately before or after actions that could be misinterpreted. To the best of my knowledge these ideas have not been analyzed empirically.

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SHORT WRITTEN TEXTS (JOURNALS)

M. Bekoff, ‘Play Signals as Punctuation: The Structure of Social Play in Canids’. *Behaviour*. 132 5/6, 419-428 (1995).

Methods

Films and written notes of 10 free-running owned adult domestic dogs, and four infant domestic dogs (beagles, three to seven weeks old), four infant gray wolves (three to seven weeks old), and four infant coyotes (three to seven weeks old) playing in controlled same-pair staged encounters were analyzed (BEKOFF, 1974, 1977). Infants were hand-reared from approximately 10 days of age and were all treated similarly. They were housed alone but could see one another between observation periods. Pairs were observed by me and the same co-observer (Suzanne KING) for 15 min per day (at the same time each day,

I h after feeding) from 21 to 50 days of age with a similarly reared littermate in a 1.5 m x 1.5 m four-walled arena, so observations were not independent. (Rearing conditions, as long as they allow for regular social interactions of the kind permitted here, do not seem to have any effect on the structure of play sequences in the young of these species; Fox, 1971). Thirty-five discrete actions were catalogued and coded. When films were used they were analyzed frame-by-frame. All play bouts that were used in the present study had been initiated with a bow (solicited bouts) to control for differences between bouts that begin with a bow and bouts that do not (unsolicited bouts). Solicited play encounters tend to be longer in duration, contain a greater number of individual acts or exchanges between the participants, and are less stereotyped than unsolicited play encounters (unpublished data). Data were pooled for all observation periods and analyzed using proportions tests (BRUNING & KINTZ, 1977, p. 222ff) which generates the z statistic. I used $p < 0.05$ (two-tailed test; $Z_{crit} > 1.96$) to indicate significant differences between two proportions. The phrase “no significant difference” or similar terms means that z _< 1.96 and $p > 0.05$.

Results

Of all bows observed in this study, the total percentages performed either immediately before or immediately after bites accompanied by rapid side-to-side shaking of the head were 74%, 79%, and 92% for the dogs, wolves, and coyotes, respectively.

(1) *What proportion of bites directed to the head, neck, or body of a play partner and accompanied by rapid side-to-side shaking of the head are immediately preceded or followed by a bow?* Results are presented in Table 1. Cross-species comparisons showed that the percentage of bites accompanied by rapid side-to-side shaking of the head preceded immediately by a bow was not significantly different between the dogs (there were no differences between the adult and infant dogs so data were combined) and the wolves. However, for coyotes this measure was significantly greater than for either the dogs or the wolves. For all groups, the percentage of bites accompanied by rapid side-to-side shaking of the head and immediately followed by bows was significantly greater than the percentage immediately preceded by bows. There was no significant difference between the percentage of bites accompanied by rapid side-to-side shaking of the head followed immediately by a bow between the dogs and the wolves, however, for coyotes, a significantly greater percentage of bites accompanied by rapid side-to-side shaking of the head was immediately followed by bows when compared to the dogs and to the wolves. Within species, the difference between the percentage of bites accompanied by rapid side-to-side shaking of the head immediately preceded by a bow and immediately followed by a bow was largest for the coyotes ($z > 3.5$, $p < 0.001$).

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TABLE 1. The proportion of different behavior patterns that was immediately preceded or immediately followed by bows in adult and infant dogs (N, number of sequences, 649), infant wolves (N = 215), and infant coyotes (N = 292)

Action	Species	Percentage of bows: Preceding action	Percentage of bows: Following action
BHSH	Dogs	4.9*	11.0+
	Wolves	7.0*	16.0+
	Coyotes	13.0**	27.0++
B/NOHSH	Dogs	1.8*	1.4+
	Wolves	3.1*	2.6+
	Coyotes	6.8**	7.2++
MOUTHING	Dogs	1.3*	1.5*
	Wolves	2.8*	2.3*
	Coyotes	3.4*	4.2*
SO	Dogs	1.5*	1.8+
	Wolves	2.3*	1.9+
	Coyotes	4.8*	9.9++

BHSH = biting directed to the head, neck, or body of a play partner accompanied by rapid side-to-side shaking of the head; B/NOHSH = biting in the absence of side-to-side shaking of the head; MOUTHING = chewing or gentle biting without closing the mouth tightly; SO = STANDING-OVER (see text). For each action, the differences in percentages between numbers labeled with * or + are not statistically significantly different (z 1.96, $p > 0.05$; see text); the numbers labeled with ** or ++ are statistically significantly different from the numbers labeled with * or +, respectively ($z > 1.96$, $p < 0.05$). See text for discussion of within- and cross-species comparisons.

(2) *What proportion of behavior patterns other than bites accompanied by rapid side-to-side shaking of the head are immediately preceded or followed by a bow?* Temporal relationships between bows and eight behavior patterns were analyzed. Only biting without rapid side-to-side shaking of the head, mouthing in the absence of rapid side-to-side shaking of the head, and standing-over (one individual places its forepaws on the shoulder or back of another animal and incompletely or fully extends the forelegs) occurred in social play frequently enough (> 5% of the total number of individual actions performed) to make useful comparisons (Table 1). Within-species comparisons showed that dogs, wolves, and coyotes all performed the same percentage of bows before biting without rapid side-to-side shaking of the head, mouthing, and standing-over, and significantly higher percentages of bows before bites accompanied by rapid side-to-side shaking of the head. Dogs and wolves performed the same percentage of bows after biting without rapid side-to-side shaking of the head, mouthing, and standing-over, and significantly higher percentages of bows after bites accompanied by rapid side-to-side shaking of the head. Coyotes performed the same percentage of bows after biting without rapid side-to-side shaking of the head and mouthing, and a significantly higher percentage of bows after standing-over than after mouthing. Coyotes also performed a significantly higher percentage of bows after biting accompanied by rapid side-to-side shaking of the head than after the other three behavior patterns (Table 1).

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Cross-species comparisons showed that there was no difference in the proportion of biting without rapid side-to-side shaking of the head immediately preceded or immediately followed by a bow between the dogs and wolves, however, a significantly higher proportion of biting without rapid side-to-side shaking of the head was immediately preceded or immediately followed by a bow in the coyotes when compared to the dogs and the wolves. The percentage of mouthing immediately preceded by bows did not differ significantly between the dogs, wolves, or coyotes. Likewise, the percentage of mouthing followed immediately by a bow did not differ significantly between the dogs, wolves, or coyotes, and was not significantly different from the percentage of mouthing immediately preceded by bows. There were no significant differences for the proportion of stand-overs immediately preceded by a bow between the dogs, wolves, and coyotes, however, the proportion of stand-overs immediately followed by a bow was significantly higher ($z > 3.5$, $p < 0.001$) for the coyotes when compared to the dogs and the wolves. For the coyotes, the proportion of stand-overs immediately followed by a bow was significantly higher than the percentage immediately preceded by a bow.

(3) What percentage of bows in play sequences occur either before or after bites accompanied by rapid side-to-side shaking of the head? There were no significant differences for the proportion of bows occurring before biting accompanied by rapid side-to-side shaking of the head between the dogs (43%), wolves (38%), and coyotes (48%). There were also no significant differences for the proportion of bows occurring after biting accompanied by rapid side-to-side shaking of the head between the dogs (31%; total percentage of all bows performed either immediately before or immediately after this action = 74) and the wolves (41 %; total percentage of all bows performed either immediately before or immediately after this action = 79). However, a greater percentage of bows occurred after bites accompanied by rapid side-to-side shaking of the head in the coyotes (44%; total percentage of all bows performed either immediately before or immediately after this action = 92) when compared to the dogs.

(4) What percentage of bows in play sequences occur either before or after behavior patterns other than bites accompanied by rapid side-to-side shaking of the head? For the three behavior patterns listed above that occurred at a high enough frequency to be included in the present analysis, the total percentage of bows that immediately preceded any of these acts was 6.6 (dogs), 8.2 (wolves), and 3.4 (coyotes), while the total percentage of bows that immediately followed any of these acts was 8.2 (dogs), 7.1 (wolves), and 2.3 (coyotes). There were no significant differences for within-species comparisons for the total percentage of bows that immediately preceded or immediately followed these behavior patterns. However, the total proportion of bows that immediately preceded or immediately followed these actions was significantly lower in the coyotes when compared to the dogs or wolves. In light of the data presented in (3) this result is not unexpected because coyotes perform a larger percentage of bows either immediately before or immediately after bites accompanied by rapid side-to-side shaking of the head than either the dogs or the wolves.

M. Bekoff, 'Play Signals as Punctuation: The Structure of Social Play in Canids'. *Behaviour*. 132 5/6, 419-428 (1995).

Discussion

Bows, the maintenance of social play, and species differences.

The present results, the nonrandom performance of bows during ongoing sequences of social play, support the inference that bows might serve as a form of punctuation that clarifies the meaning of other actions that follow or precede them. In addition to sending the message "I want to play" when they are performed at the beginning of play, bows performed in a different context, namely during social play, might also carry the message "I want to play despite what I am going to do or just did – I still want to play" when there might be a problem in the sharing of this information between the interacting animals. The species differences that were found can be interpreted by what is known about variations in the early social development of these canids (BEKOFF, 1974; See also FEDDERSEN-PETERSEN, 1991). For example, infant coyotes are much more aggressive and engage in significantly more rank-related dominance fights than either the infant (or adult) dogs or the infant wolves who were studied. During the course of this study, no consistent dominance relations were established in either the dogs or the wolves (see also Fox, 1971; BEKOFF, 1974), and there were no large individual differences among the play patterns that were analyzed in this study. Social play in coyotes typically is observed only after dominance relationships have been established in paired interactions. Coyotes appear to need to make a greater attempt to maintain a play atmosphere, and indeed, they seem also to need to communicate their intentions to play before play begins more clearly than do either dogs or wolves who have been studied (BEKOFF, 1975, 1977). Indeed, one dominant female coyote pup was successful in initiating chase play with her subordinate brother on only 1 of 40 (2.5%) occasions, her lone success occurring on the only occasion in which she had signaled previously with a play bow (BEKOFF, 1975). Furthermore, subordinate coyote infants are more solicitous and perform more play signals later in play bouts (BEKOFF, 1975). These data suggest that bows are not non-randomly repeated merely when individuals want to increase their range of movement or stretch their muscles. However, because the head of the bowing individual is usually below that of the recipient, bowing may place the individual in a non-threatening (self-handicapping, see below) posture.

The present results, considered together, support the inference that signals such as the bow can reinforce ongoing social play when it is possible that it could be disrupted due to the aggressive, predatory, or sexual behavior of one of the interacting animals. The comparative evidence presented here also supports the claim that in situations in which it is more likely that play (or play-fighting) might spill over into real aggression (e.g. in infant coyotes), there is a greater attempt to prevent this from occurring by performing bows. Play in canids (and in other animals) requires a mutual sharing of the play mood by the participants (BEKOFF, 1976). This sharing can be facilitated by the performance of bows immediately before or immediately after an individual performs actions that can be misinterpreted, especially biting accompanied by rapid side-to-side shaking of the head. Standing-over, which usually is an assertion of dominance in infant coyotes (BEKOFF, 1974) but not in infant beagles or wolves of the same age was followed by a significantly higher proportion of bows in coyotes when compared to dogs or to infant wolves. Because bows embedded within play sequences were followed significantly more by playing than by fighting after actions that could be misinterpreted were performed (unpublished data), it does not seem likely that bows allow coyotes (or other canids) more readily to engage in combat, rather than play, by increasing their range of movement (as suggested by an unidentified reviewer), although this possibility can not presently be ruled out in specific instances.

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How might information between sender and recipient be shared? It is possible that the recipient shares the intentions (beliefs, desires) of the sender based on the recipient's own prior experiences of situations in which she performed bows. In an important paper on human behavior that has yet to find its way into comparative ethological circles, GOPNIK (1993, p. 275) has argued that "… certain kinds of information that comes, literally, from inside ourselves is coded in the same way as information that comes observing the behavior of others. There is a fundamental cross-modal representational system that connects self and other." GOPNIK claims that others' body movements are mapped onto one's own kinesthetic sensations, based on prior experience of the observer, and she supports her claims with discussions of imitation in human newborns.

In addition to the use of signals such as bows, it is also possible that the greater variability of play sequences when compared to sequences of agonistic behavior (BEKOFF & BYERS, 1981) allows animals to use the more varied sequences of play as a composite play signal that helps to maintain the play mood; not only do bows have signal value but so also do play sequences (BEKOFF, 1977, 1995). Self-handicapping (e.g. ALTMANN, 1962), occurring when a dominant individuals allows itself to be dominated by a subordinate animal, also might be important in maintaining on-going social play.

Bows as punctuation.

It is possible that bows in canids might be punctuational signals, as has been suggested for tail-wagging in mallard ducks (Anas platyrhynchos). Tail- wagging in these birds is performed before and after certain displays (HAILMAN & DZELZKALNS, 1974; HAILMAN, 1977, p. 267 f and appears to clarify the meaning of other signals. As with other signals that have been identified as possibly being punctuational signals, bows occur relatively frequently and are of relatively short duration (HAILMAN, 1977, p. 268).

While the search for possible functions of play remains a challenge for future research (ALLEN & BEKOFF, 1994, 1995), it is clear that play does serve some and perhaps different functions in most animals in which it has been observed (BEKOFF & BYERS, 1981 ; FAGEN, 1981; CARO & ALAWI, 1985; BURGHARDT, 1988; BYERS & WALKER, in press). Social play does seem to be an important activity, but one that is not engaged in for large amounts of time by individuals who play (FAGEN, 1981; MARTIN & CARO, 1985; BEKOFF & BYERS, 1992). One way for animals to insure that at least some play will occur when they want to begin to play or after they have begun to play is to communicate messages such as "what follows is play" or "this is still play". Most animals in which play has been observed appear to communicate their intentions to play or to maintain ongoing play based on casual observations or anecdotes, although the data base remains scanty. The present data suggest that stereotyped signals can be used to maintain social play, and more comparative data are needed to determine how widespread is this phenomenon.

M. Bekoff, ‘Social Play and Play-soliciting by Infant Canids’. *American Zoologist*, 14/1, No. 8-9, 324-328 (1974).

DESCRIPTIONS OF ACTIONS USED TO INITIATE SOCIAL PLAY

Bow (B): The soliciting animal crouches on its forelegs and elevates its hind-end (Fig. 1); from this position the animal is able to perform a wide range of other movements such as leaping, dodging, and springing back-and-forth.

Exaggerated approach (EA): The soliciting animal approaches its prospective play-mate in a “loose, bouncy” gait, at a speed greater than that observed during normal walking; this has also been called a “play rush” and “gamboling” in the non-human primate literature; during the approach, the shoulders and head are frequently moved from side-to-side in an exaggerated fashion.

Approach /withdrawal (A/W): The soliciting animal approaches its prospective playmate and then withdraws; withdrawal may involve stepping away slowly, or running away for a few meters and then approaching (and withdrawing) once again; it is not uncommon to observe the soliciting animal approach, stop, and then rock back-and-forth in one spot, making intention movements of running away.

General movements (GM): These include movements of the head and eyes, such as head-tossing and eye-rolling, and also body movements such as shoulder swaying; stalking of the prospective playmate is also included–one animal slowly circles its partner, and then slowly, stealthily approaches; the approach after a stalk may be exaggerated, and may also involve rapid approach/withdrawals.

Face-pawing (FP): This action involves extension of one of the forelimbs toward the face of the other animal (Fig. 2); it is not uncommon to observe rapid extension and flexion of the forelimb when the animals are at a few meters from one another (in this case the action is called a “paw intention”).

Leap-Leap (LL): This action involves two high-amplitude leaps in which the fore? limbs are lifted off the ground, and hit the ground, simultaneously.

Barking (Bk): See below. We have also had the opportunity to observe some red foxes (Vulpes vulpes) (Bekoff and Fox, personal observation). Some actions which they perform to initiate social play, that are not observed in other Canidae include high-leaping (Fig. 3), flattening out (the animal lies flat on the ground and moves its head from side-to-side), and “high-stepping” with the hind-legs.

FIG. 1. A “bow” performed by the dog on the right. (After Bekoff 1972a, with kind permission of the Quarterly Review of Biology.)

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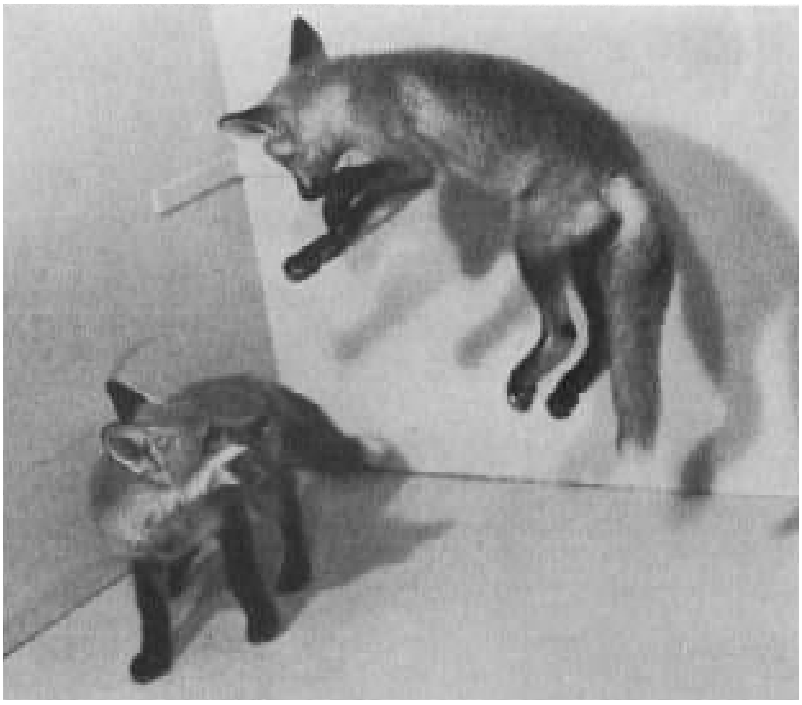
FIG. 2. Face-oriented pawing by the beagle on the right.

FIG. 3. High leaping during play soliciting by a red fox.



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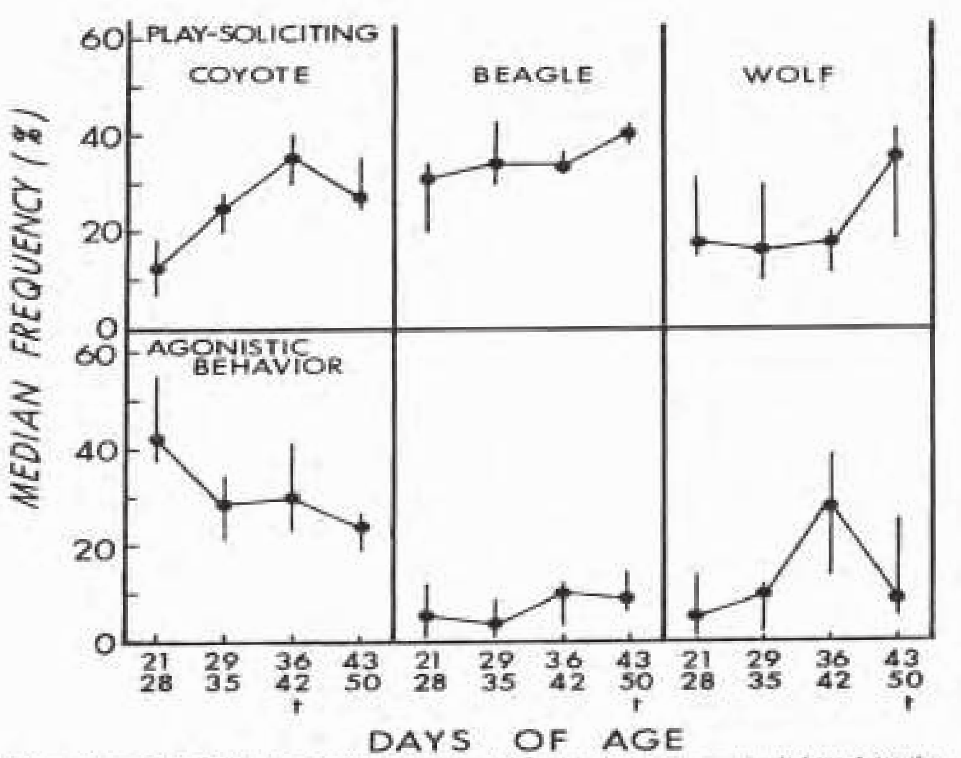

FIG. 4. The median frequency of occurrence (%) of action patterns observed during both play soliciting and agonistic interactions, in relation to the total number of actions performed during the stated time periods. ↑ = animals housed together in pairs at the beginning of this time period; vertical bars = range.

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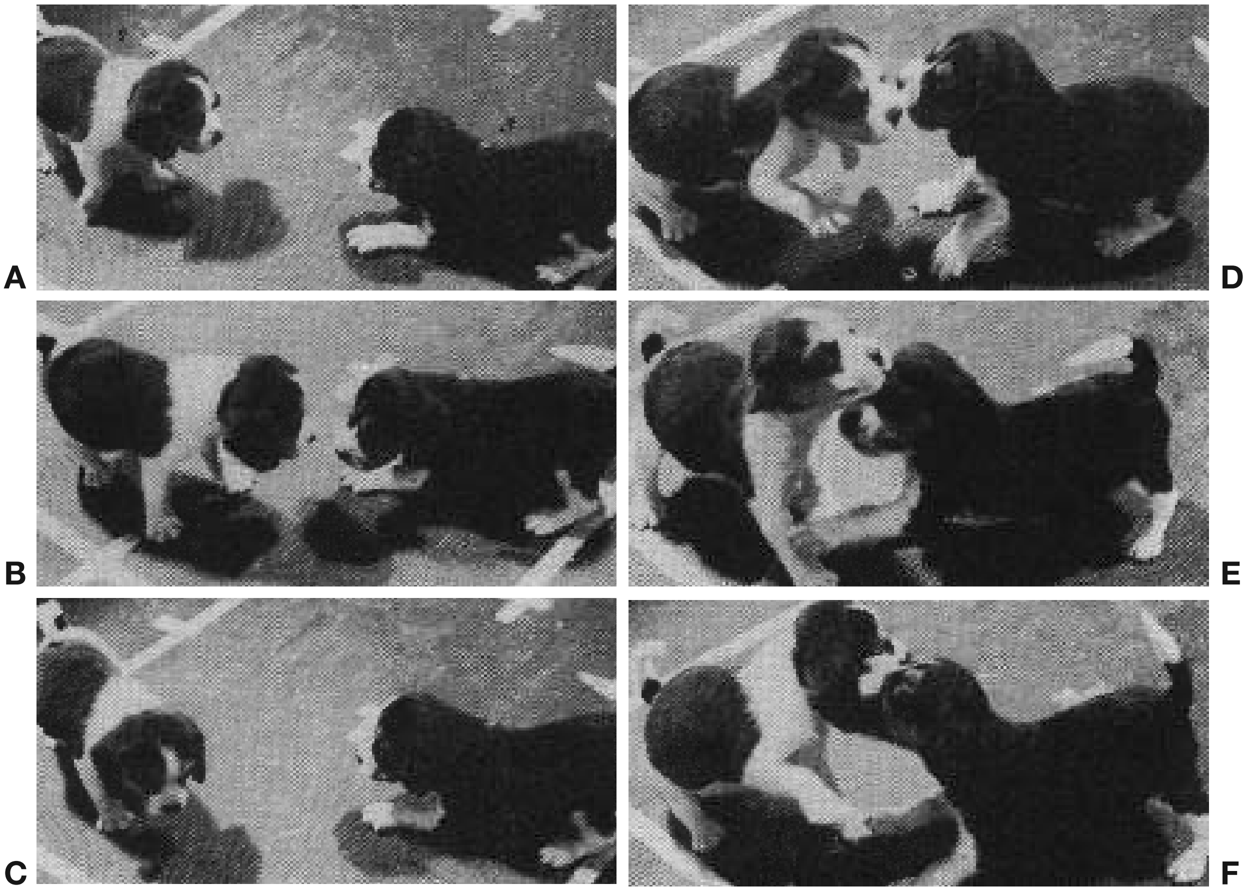

FIG. 8. This sequence of photos shows a play sequence between two 30-day old beagles. The beagle on the right performs a bow (A) and his littermate approaches (B). As she approaches he makes direct eye-contact and she turns her head away for a brief moment (C). D, the female (on the left) rears and leaps off the ground; E, the male responds by moving closer. A play bout consisting of wrestling, rolling, and inhibited face-biting occurred (F).

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Social Play in Kaka (*Nestor meridionalis*) with Comparisons to Kea (*Nestor notabilis*)

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Summary

Social play in the kaka (*Nestor meridionalis*), a New Zealand parrot, is described and contrasted with that of its closest relative, the kea (*Nestor notabilis*), in one of the first comparative studies of social play in closely related birds. Most play action patterns were clearly homologous in these two species, though some contrasts in the form of specific play behaviors, such as kicking or biting, could be attributed to morphological differences. Social play in kakas is briefer, more predictable, and less sequentially diverse than that shown by keas. Kaka play also appears to be restricted to fledglings and juveniles, while the behavior is more broadly distributed among age groups in keas. Play initiation behaviors were relatively more frequent in kakas and more tightly intercorrelated in occurrence. A primary grouping of action patterns in kakas consisted of arboreal play, which was rare in keas. The most striking species difference was exhibited in social object play, which is pervasive among keas, but which was not observed in kakas. Although the two species are morphologically similar, they differ strikingly in several aspects of their ecology and social behavior, including the duration of the association between juveniles and adults, the degree of exploratory behavior, and the flexibility of their foraging strategies. The observed species differences in play behavior are discussed in relation to the contrasting life histories in the two species, suggesting that many features of social play may reflect evolutionary responses to particular ontogenetic and ecological constraints.

Introduction

Although play has long been recognized in birds, it is not nearly as prevalent as it is in mammals (reviews in Fagen, 1981; Ortega & Bekoff, 1987; Power, 2000). Play has been described in only ten avian orders (Fagen, 1981; Skeate, 1985; Ortega & Bekoff, 1987), and in our review of social play in birds (Diamond & Bond, 2003), we found only five avian orders in which there was unambiguous evidence of social play. Three of these, the parrots, corvids and babblers, showed evidence of such extensive social play as to be on a par with that of many groups of mammals. Within these orders, social play has been most extensively studied in keas, ravens (*Corvus corax*), Australasian magpies (*Gymnorhina tibicen*) and Arabian babblers (*Turdoides squamiceps*) (reviewed in Diamond & Bond, 2003).

There is a well-established literature on the definition of play and the criteria by which it can be distinguished from other forms of social behavior (*e.g.* Bekoff & Byers, 1981; Fagen, 1981; Barber, 1991; Bekoff, 1995; Pellis & Pellis, 1996; Power, 2000; Burghardt, 2001; Spinka *et al.*, 2001). Social play involves at least two individuals that interact with and respond to each other, it incorporates actions from a variety of contexts into labile temporal sequences, and the actions are often repeated by mutual initiative (Bekoff, 1974; Ficken, 1977; Fagen, 1981). The interactions in social play lack consummatory behaviors; thus, they are frequently not resolved, but rather are repeated until the play partners are distracted by other stimuli (Lorenz, 1956). Social play may include components that are facilitated, but facilitation alone does not constitute sufficient evidence for social play (Diamond & Bond, 2003). Social play is characteristic of juvenile animals, but its incidence among different developmental stages varies across species and types of play (Bekoff, 1974; Fagen, 1981; Simmons & Mendelsohn, 1993; Diamond & Bond, 1999; Power, 2000). In this study, we categorized behaviors as constituting social play if they fell within the limits of the readily identified play categories described in Diamond & Bond (2003): Play chasing, play fighting, play invitations, and social object play.

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Age and sex can generally be determined at a distance in these parrots. Fledgling and juvenile kakas are identifiable by a pale periophthalmic ring until they are nearly a year old, and as they age, their eye rings gradually fade. Females appear to retain eye-rings longer than males (Moorhouse *et al*., 1999). Keas are even more amenable to age categorization, displaying distinctive morphological features for up to four years after fledging (Diamond & Bond, 1991). Adult females of both species have conspicuously shorter bills than males and are significantly smaller, though sex differences are less conspicuous and less reliable in younger birds (Bond *et al*., 1991; Moorhouse & Greene, 1995).

Method

In 2001 and 2003, we observed the behavior of kakas that aggregated at a sugarwater feeder adjacent to a private residence in the village of Oban on Stewart Island. Below the feeder and extending to each side was a cultivated flower garden that sloped down away from the lawn, terminating in a thick growth of native forest, primarily tree fuchsia (Fuchsia excorticata), kamahi (Weinmannia recemosa), and tree ferns (Dicksonia spp.). In addition to the sugar water, kakas fed on both the flowers and fruits of the fuchsia and took nectar from the kamahi and most of the flowers in the garden. This was a well-established resource, in that kakas had been making use of the feeder during the spring months for at least ten years. The kaka population using the feeder was unbanded, but we were able to reliably identify about twenty individuals on the basis of unique patterns of erosion and fracture lines on their bills (Pepper, 1996). Several of these individually identified birds appeared to be local residents, in that they visited the feeder several times each day. One mated pair held territory in the tree ferns and tree fuchsia adjoining the feeder, giving song and aggressively asserting their priority at the resource. Several other mated pairs of recognizable individuals also made regular, but less frequent, use of the feeder, sometimes temporarily displacing the primary residents. The feeder was visited by up to 20 kakas at a time in 2001 and up to 13 in 2003 during the early morning and again during late afternoon and early evening. Over the course of 110 hours of observations at this site, we recorded 41 instances of social play among juvenile and fledgling kakas on the lawn below the feeder, on the top of tree ferns, and in the nearby tree fuchsia.

Observations of kaka play behavior were contrasted to a database of records of kea play that we accumulated between 1988 and 1991 from a population at the Halpin Creek refuse dump, adjacent to Arthur’s Pass National Park (Diamond & Bond, 1991, 1999; Bond & Diamond, 1992). Additional observations of kea play were made during the spring of 2000 at a refuse dump near Fox Glacier in Westlands National Park. From these studies, totaling over 450 hours of observation, we obtained 21 instances of kea social play on open ground, on piles of rock scree, or among beech trees surrounding the refuse dumps. Both settings offered numerous objects that could potentially be incorporated into play. The garden on Stewart Island was littered with shells, small stones, sticks of all sizes, and pieces of flowers. The refuse dump at Arthur’s Pass and Fox Glacier contained many similar small objects, ranging from food containers and pieces of plastic to bones, stones, sticks, and flowers.

Instances of play in both species were generally recorded on video (18 instances for kakas; 3 for keas), as time-event sequences on a computer-based event recorder (8 instances for keas), or documented in detailed, written field notes (23 instances for kakas; 10 for keas). Each play instance consisted of one or more bouts. A bout was defined as beginning with the first recognizable play behavior, usually a play invitation, and terminating when the individuals separated, either when there was a pause in the action long enough for the birds to begin to engage in other behaviors or as a result of one of the play partners’ leaving the area. When a pair of birds terminated a play bout by engaging in other behaviors for up to two minutes and then subsequently resumed social play, they were recorded as beginning a new bout within the same play instance.

We constructed ethograms of the play repertoire of each species, and we recorded the time of day and duration for each play bout, which we subsequently analyzed for species differences. To avoid biased sampling, we used only the time of the first bout in each play instance in the analysis of time of day.

J. Diamond, **A. Bond**, ‘Social Play in Kaka (*Nestor meridionalis*) with Comparisons to Kea (*Nestor notabilis*)’. *Behaviour*. 141/7, 777-782, 787, 792-795 (2004).

Discussion

The social play of kakas on Stewart Island is as robust and interactive as that of keas, and many of the action patterns appear to be homologous. Kakas and keas do, however, differ in the structure and context of their play behavior. Kakas play in smaller groups, they play in shorter bouts, and they are less likely than keas to play in the early morning. There were also striking differences between the species in the relative frequency of particular action patterns and in the correlational structure of play interactions. Ritualized play initiation behaviors, such as head cocking or rolling over, were relatively more frequent in kakas and clustered in a tighter, more coherent grouping. The other primary cluster of action patterns in kakas was dominated by arboreal play, which was relatively uncommon in keas. Keas generally showed a less tightly correlated behavior structure, with one cluster of intense, close-contact action patterns and another, looser collection of larger-scale movements and play initiation behaviors. Actions involving social object play collected in a third, virtually independent cluster for keas, but these were not observed in kakas at all.

The size of the displayed play repertoire increased significantly with bout length in kakas, something that was not observed in keas. Short bouts in kaka consist mainly of initiation behaviors, with long bouts displaying a larger portion of the repertoire. Keas exhibit a repertoire of behaviors that does not vary with bout length, suggesting greater variability in the sequence of action patterns. The implication of the cluster results, as well as the analysis of the relationship between repertoire size and bout duration, is that social play in kakas is in some ways more predictable and less sequentially diverse than that shown by keas.

Other species differences in play behavior may be dictated in part by differences in morphology. The frequency of bite attempts did not differ between the species. Kakas appeared less likely to grasp their play partners with their bills, seldom locking bills or biting down on legs or feathers. This may reflect a species difference in how hazardous a bite can be. Kakas have a powerful, shearing bill that can break open the toughest nuts and bark. Keas tend to grasp and twist or pry, rather than to crush or shear, and when they bite other keas, they do not generally draw blood. The contrast between keas and kakas in the use of the bill during play may, thus, be evolutionarily similar to the differences in aggressive behavior that Serpell (1982) observed among species of lorikeets, in which the birds with the most formidable weaponry were the least likely to use them in conspecific interactions.

Both species use their feet to push and kick at each other during fighting play, but keas are far more likely to kick their partner from a standing position. Again, this may be a morphological difference. Keas have much longer legs than kakas; the individual leg bones are 16-24% longer in keas than in the South Island kaka subspecies (Holdaway & Worthy, 1993) presumably as an adaptation to foraging on the ground. It may be that kakas cannot readily stand on a level surface and kick forward. The absence in kakas of the mutual jumping and flapping that is a dominant element of kea play may also be a consequence of the kaka’s primary adaptation to arboreal movement. During this display, keas generally hold their bodies and heads almost vertically while striking out with wings and feet, and it may not be possible for kakas to adopt the same erect stance.

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In kakas, social play appears to be restricted to fledglings and juveniles, while play is much more broadly distributed among age groups in keas. Birds with a clearly adult appearance were not observed to participate in kaka play interactions, though we did see several instances of kakas that were morphologically adult unsuccessfully attempting to solicit play from younger birds. In contrast, we have commonly observed play between juvenile and subadult keas, and we recorded a number of instances of social play between adult females and younger birds. Keas also exhibit a separate, distinctive form of social play between adult or subadult males and females ('toss' play; Diamond & Bond, 1999), which may be part of the process of courtship and pair formation. No such behavior was exhibited in our kaka population.

…

Kakas and keas do exhibit a variety of significant differences in the structure and context of their social play, however. Kakas engage in play bouts that are shorter and less variable than those in keas, they play only during a more limited developmental period, and they do not display social object play. This suggests that ontogenetic and ecological factors, such as differences in the length of association of juveniles with adults, degree of exploratory behavior, or flexibility in foraging, may also influence the structure of social play.

Two conspicuous differences in the biology of these species may have been influential in determining the manifestation of their social play. First, young kakas remain in the presence of adults for a much shorter period than do keas (6 months *vs*. 2 years), and social play is commonly less extensive in species with more limited associations between juveniles and adults (Pellis & Iwaniuk, 2000; Diamond & Bond, 2003). Our observations provide some support for this interpretation, in that kaka play is less structurally complex than that of keas, and individual bout lengths are shorter.

Secondly, kakas are more neophobic and far less flexible and exploratory in their behavioral ecology than keas, and the occurrence of play behavior has often been linked to exploratory behavior (Vandenberg, 1978; Hall, 1998; Power, 2000), innovation (Fagan, 1982; Spinka *et al*., 2001), or ecological generality (Fagan, 1981; Ortega & Bekoff, 1987). Although kakas do play socially, they do not engage in social object play, and it is this behavior that may show the strongest relationship to foraging flexibility. Social object play is relatively common among the larger Corvidae, suggesting that it may be related to their reliance on exploration and neophilia in foraging contexts, which is more characteristic of keas (Diamond & Bond, 2003).

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J. Diamond, **A. Bond**, ‘Social Play in Kakapo (*Strigops habrotilus*) with Comparisions to Kea (*Nestor notabilis*) and Kaka (*Nestor meridionalis*)’. *Behaviour.* 143/11, 1405-1409 (2006).

Table 1. Comparative ethogram of play in keas, kakas, and kakapos.

Behaviour	*Occurrence in kakapo*	*Comparison to kaka*	*Comparison to kea*
Bite	Kakapos use their bill to nuzzle against and occasionally gently grasp another bird's feathers, bill, or feet. The partner does not react to this as if pain were inflicted. Painful bites were not observed in kakapos.	Kakas use their bill to surround another's body part and gently and briefly hold it. The partner does not react to this as if pain were inflicted. Painful bites were an infrequent component of play in kakas.	Bites are a common component of play in keas. During play, keas repeatedly grasp the tail, feet, or legs of their partner with their bills, and the partner reacts by vocalizing or by jerking away suggesting that some pain may have been inflicted (Keller, 1976; Diamond & Bond, 1999).
Head Cock	Not observed in kakapos.	Kakas frequently turn their head on one side while looking at or approaching another in play. Often the head turning movement is extreme, resulting in the head being nearly upside down. This behaviour is conspicuous at the onset of play interactions and often leads to rolling over.	Keas sometimes initiate play by approaching another while head cocking, but it is not as conspicuous as in kakas.
Wing Flap	Kakapos may briefly flap their Outstretched wings while approaching another individual.	Kakas rapidly flap their outstretched wings while hanging upside-down from a tree branch. This also occurs during play on the ground in kakas that are attempting to maintain their position on top of a supine partner.	Keas that are trying to keep their balance on a supine partner use wing flaps, but they also engage in mutual jumping and wing flapping as a separate, distinctive component of social play.
Foot Push	Kakapos sometimes push a play partner with a foot as an isolated action or while engaged in bill lock. Foot pushes are not generally reciprocated by the other individual.	Mutual foot pushing is one of the most common features of kaka social play. It occurs while one bird is standing on another's stomach, while it is lying on its side next to its partner, or while it is hanging upside down next to another. Kakas sometimes grasp a partner with one foot to attempt to draw them back into a play interaction.	Keas engage in vigorous mutual foot pushing, most commonly from a standing position. Keas sometimes fly over another bird and hit them with their feet.

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SHORT WRITTEN TEXTS (JOURNALS)

J. Diamond, **A. Bond**, 'Social Play in Kakapo (*Strigops habrotilus*) with Comparisions to Kea (*Nestor notabilis*) and Kaka (*Nestor meridionalis*)'. *Behaviour.* 143/11, 1405-1409 (2006).

Table 1. (cont.) Comparative ethogram of play in keas, kakas, and kakapos.

Behaviour	*Occurrence in kakapo*	*Comparison to kaka*	*Comparison to kea*
Hang	Kakapo fledglings were rarely observed to hang by the their bill from branches in the enclosure, but they did not engage in social interactions while hanging.	Kakas frequently hang from a branch by the bill or by one or both feet with head and body upside-down, sometimes flapping the wings. It occurs during social play, during solitary displays of hanging when they demolish vegetation and vocalize loudly, and also as a component of locomotion during foraging.	Keas sometimes hang during social play and as a component of general locomotion during foraging. Keas less commonly hang by one foot in arboreal play and will bite or fly into a bird that is hanging, attempting to knock him off (Diamond & Bond, 1999).
Hop	Kakapos sometimes approach Another bird while hopping, using both feet simultaneously in short bouncy movements, often accompanied by wing flapping.	Kakas hop by moving to or from another bird along the ground using both feet simultaneously in short bouncy movements. Such oblique, bouncy hops are often a means of soliciting or maintaining play.	Keas often hop toward other birds during play, but less often as a prelude to it. Hopping often accompanies vertical tossing of objects in play
Jump	Kakapo jump towards another individual, sometimes accompanied by wing flap. Kakapo have been observed to hop up to and jump onto another slumbering chick's back and the slumbering chick normally wakes with alarm and a loud call (Eason, personal communication.).	Kakas repeatedly jump on the stomach of a supine partner as part of play. They also jump over another bird, and sometimes jump in the air next to a play partner. Kakas jump and wing flap in play, but we did not observe them to do this in unison or repeatedly	Keas often jump on the stomach on a supine partner as part of play (Potts, 1969). They also jump over another bird, and sometimes in the air next to a play partner. Keas engage in repeated mutual jumping and wing flapping as a major component of social play.
Bill Lock	Kakapos gently touch bills, nuzzling the bills together rather than twisting them. Bill touching occurred frequently with chin over.	Kakas sometimes touch their bills to each other very briefly in play. Locking and twisting bills is very seldom observed in kakas.	A kea will grasp another's maxilla in its bill, twisting and pushing, using its own body weight for leverage (Keller, 1975). This behaviour is a common feature of kea play.

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Table 1. (cont.) Comparative ethogram of play in keas, kakas, and kakapos.

Behaviour	*Occurrence in kakapo*	*Comparison to kaka*	*Comparison to kea*
Manipulate Object	Kakapos grab leaves and branches in their bills, twisting or pulling at them. Social manipulation of objects was not observed.	Kakas sometimes grasp tree fronds or branches in their bill while playing in trees or tree ferns, but they do not appear to manipulate these or other objects in the course of their play.	Keas often pick up small rocks or other small objects on the ground in the course of a play interaction. They will also try to grasp an object with their bill that is already being held by another kea, resulting in a tug-of-war or a chase to retrieve the object. Object play is a very common component of kea play.
Roll Over	Kakapos were observed to roll over on their backs with their feet in the air, but they were not approached by others while in this position.	In play, a kaka rolls its entire body over and lies on its back while gently moving its feet. The roll may begin with turning the head or wing under. When it begins with the head, the action may produce a somersault or sideways roll. When it begins with the wing, the action ends with the bird lying on its back. Kakas roll over on their backs and wave their feet in the air as a major component of play interactions. In kakas, rolling over often follows from a head cock.	Keas perform a virtually identical action pattern to kakas, rolling over on their backs and waving their feet in the air, as a component of play interactions.
Toss	Tossing was not observed in kakapos.	Tossing was not observed in kakas during play or in any other context.	In play, a kea typically holds an object in its bill and then jerks the head vertically, releasing the object in the air, sometime in the direction of the play partner. The bird hop or flap its wings just before releasing the object (Potts, 1969). It may persist in tossing the object for several minutes. Tossing occurs in keas as a component of solitary play, social play between juveniles, and courtship play between adults (Diamond & Bond, 1999).
Chin Over	Kakapos place their chin over The back or neck of another individual, while standing next to them.	Chin-over was not observed in kakas.	Chin over was not observed in keas.

J. Diamond, A. Bond, 'Social Play in Kakapo (*Stringops habrotilus*) with Comparisons to Kea (*Nestor notabilis*) and Kaka (*Nestor meridionalis*)'. *Behaviour*. 143 No. 11, Leiden: Brill © 2006, Reproduced by permission of Brill.

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Table 2. Percentage of play bouts including one or more occurrences of the specified action pattern, based on samples of 114 bouts from kakapos, 55 from kakas and 28 from keas.

Behaviour	Kakapo	Kea	Kaka
Bite	58.77	60.71 NS	67.27 NS
Head Cock	—	10.71	61.82
Wing Flap	43.86	82.14 **	87.27 **
Foot Push	16.67	71.43 **	69.09 **
Hang	0.88	3.57 NS	36.36 **
Hop	4.39	53.57 **	56.36 **
Jump	15.79	82.14 **	56.36 *
Bill Lock	47.37	35.71 NS	1.82 **
Manipulate	0.88	21.43 **	—
Roll Over	4.39	39.29 **	69.09 **
Toss	—	10.71	—
Chin Over	50.88	—	—

Dashes indicate that the behaviour was not observed in the given species. Significance of differences between kakapos and each of the other two species were tested with Fisher's exact tests: ** = $p < 0.01$; * = $p < 0.05$; NS = not significant.

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SHORT WRITTEN TEXTS (JOURNALS)

M. Spinka, **R.C. Newberry**, **M. Bekoff**, ‘Mammalian Play: Training for the Unexpected’. *The Quarterly Review of Biology*, 76/2, 141-145 (2001).

ABSTRACT

In this review, we present a new conceptual framework for the study of play behavior, a hitherto puzzling array of seemingly purposeless and unrelated behavioral elements that are recognizable as play throughout the mammalian lineage. Our major new functional hypothesis is that play enables animals to develop flexible kinematic and emotional responses to unexpected events in which they experience a sudden loss of control. Specifically, we propose that play functions to increase the versatility of movements used to recover from sudden shocks such as loss of balance and falling over, and to enhance the ability of animals to cope emotionally with unexpected stressful situations.

To obtain this “training for the unexpected,” we suggest that animals actively seek and create unexpected situations in play through self-handicapping; that is, deliberately relaxing control over their movements or actively putting themselves into disadvantageous positions and situations.

Thus, play is comprised of sequences in which the players switch rapidly between well-controlled movements similar to those used in “serious” behavior and self-handicapping movements that result in temporary loss of control. We propose that this playful switching between in-control and out-of-control elements is cognitive& demanding, setting phylogenetic and ontogenetic constraints on play, and is underlain by neuroendocrinological responses that produce a complex emotional state known as “having fun. “Furthermore, we propose that play is often prompted by relative& novel or unpredictable stimuli, and is thus related to, although distinct from, exploration.

We argue that our “training for the unexpected” hypothesis can account for some previous puzzling kinematic, structural, motivational, emotional, cognitive, social, ontogenetic, and phylogenetic aspects of play. It may also account for a diversity of individual methods for coping with unexpected misfortunes.

The “Training For The Unexpected” Hypothesis Of Play

THE ADAPTIVE VALUE OF PLAY

We hypothesize that a major ancestral *function* of play is to rehearse behavioral sequences in which animals lose full control over their locomotion, position, or sensory/spatial input and need to regain these faculties quickly. Animals learn how to improvise their behavior by chaining conventional movements with atypical movements to get themselves back into a standard position. Sequences that link highly efficient species-typical motor patterns and standard body positions with atypical movements necessary for recovery from awkward positions often occur in biologically significant situations. For example, when fleeing a predator, an animal tries to use the most efficient pattern of flight, but may be disoriented or interrupted unpredictably by rapid changes in visual input, actions of the predator, or collisions with other herd members or inanimate obstacles. The ability of the animal to recover rapidly using atypical movements could mean the difference between life and death in a predator attack. Similar mishaps may occur during intraspecific interactions and during pursuit of prey. The opponent (or the prey) adds significant unpredictability to the environment. Skilled movements often cannot be completed or properly sequenced because of interruption by the other animal.

Besides the development of locomotor versatility in unanticipated situations, we hypothesize that animals in play learn how to deal with the emotional aspect of being surprised or temporarily disoriented or disabled. Loss of control in a serious situation, despite active attempts to cope, will normally result in activation of both sympathetico-adrenomedullary and pituitary-adrenocortical systems (von Holst 1998). These systems prepare the animal for immediate action, but can have long-term costs, especially in suppressed immunocompetence (Apanius 1998). In adverse social situations, emotional overreaction may lead to undue escalation of conflicts. In the presence of a predator, emotional overreaction leading to aimless panic will decrease an animal's chance of survival. In general, adaptive responses in serious situations depend upon the animal's ability to avoid incapacitation via negative emotions. We propose that the experience of “self-induced” mishaps during play helps animals to avoid emotional overreaction during unexpected stressful situations.

M. Spinka, R.C. Newberry, M. Bekoff. ‘Mammalian Play: Training for the Unexpected’. *The Quarterly Review of Biology*, June 2001, Vol 76, No. 2,

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The ultimate benefits obtained from play are probably low, judging from the fact that play is dropped from the behavioral time budget under harsh conditions (Baldwin and Baldwin 1974; Berger 1980; Barrett et al. 1992). However, it may be that individual differences in retaining play during harsh times were beneficial during evolution. All in all, play could probably be counted among "opportunity behaviors" (a term coined by Fraser and Duncan 1998); that is, those behaviors that bring low ultimate benefit and are therefore actuated at moments when the cost of performing them drops to an even lower level.

In short, we propose that play: (i) results in increased versatility of movements used to recover from sudden "gravitational," "kinematic," or "positional" shocks such as losing ground underfoot, falling over, being knocked over, being pinned down, or being shaken vigorously; and (ii) enhances the ability of animals to cope emotionally with unexpected situations. These may include both "locomotor" shocks as described above, and "psychological" shocks such as suddenly being faced with frightening or dangerous stimuli, unexpectedly meeting a stranger, or experiencing a sudden reversal in dominance.

SELF-HANDICAPPING—SEEKING AND CREATING THE UNEXPECTED IN PLAY

If play has the function of training for the unexpected, then unforeseen situations should occur frequently in play. We suggest that mammals actively seek and create unexpected situations in play. Specifically, we propose that mammalian play is a sequential mixture of: (a) well-controlled vigorous locomotor movements similar to those used in "serious" behavior that load heavily on fitness traits such as escape from predators, intraspecific agonism, or hunting fast or dangerous prey; and (b) movements during which postural control is compromised, or the chance for random factors to influence movement is increased so that the animal is more likely to be knocked off balance, fall over, lose control of a play object, or fail to counter the actions of another animal.

Animals can actively seek and create unexpected events in play through self-handicapping; that is, deliberately relaxing control over their movements or actively putting themselves into disadvantageous positions and situations. For example, animals may self-handicap by moving in a way that is less than fully stable or efficient, or by performing object manipulation while positioned in a way not best suited for full control over the object. They may also impair their sensory and spatial orientation through high-speed angular and rotatory movements of the head, putting their head into unusual positions in relation to gravity or horizon, or twisting their body in an unusual way. By using physical properties of the environment such as deep soft snow, a slippery slope, or gravity-attenuating water, animals can enhance the probability that they will be thrown off balance into unusual positions. They can also increase the probability of experiencing unexpected events by playing with or among relatively novel environmental features or among features that are moving in unpredictable ways (e.g., due to wind). In social interactions, animals can self-handicap by using positions and movements that impair their competitive ability and enable their playmates to gain the "attack" position. For example, they may inhibit the force of their bites and pushes, and allow themselves to be pushed over and chased, even when they have the ability to harm or dominate a playmate. They may also put themselves at a self-induced disadvantage by playing with larger, stronger, or more experienced play partners, or even with animals of a different species. Because play is only performed when its costs remain low, however, there is an upper limit of unpredictability and loss of control above which animals will not play.

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THE RELATIONSHIP BETWEEN EXPLORATION AND PLAY

Exploration can be viewed as a serious counterpart to play. During an initial encounter with a novel environmental feature, animals first investigate it through "serious" exploration, examining whether it is dangerous and whether it has any resource value to them. If they find the novel feature to be relatively nonthreatening, play may follow. Through their playful behavior the animals seem to address the question, "What if it really were dangerous?" Although exploration is often temporally associated with play, it differs from play in three important aspects. First, a function of exploration may be to learn how to avoid getting into trouble (by gathering information), whereas we propose that an important aim of play is to learn how to get out of trouble (through enhanced improvisation skills). Second, there is no deliberate self-handicapping in exploration. Third, whereas play is associated with a relatively relaxed and secure state, exploration is more closely associated with fear and perceived danger. If an animal loses control in play and has too much difficulty regaining it, or the situation becomes dangerous, the animal should withdraw and reassess the situation through further exploration.

HAVING FUN—THE UNDERLYING EMOTION IN PLAY

According to our hypothesis, play enables animals to develop emotional flexibility by rehearsing the emotional aspect of being surprised or temporarily disorientated or disabled. Although unexpected events that occur in a dangerous situation would likely magnify fear in inexperienced animals, we suggest that fear is modulated in play by the relatively safe context in which play occurs and the improbability that losing control will have serious consequences. In addition, regaining control following an unexpected challenge is likely to be rewarding, and the positive nature of this experience may be intensified by the rapid repetition of in-control and out-of-control elements that occur in play. Thus, we hypothesize that play is emotionally *exciting* (perhaps even thrilling, though not intensely frightening) and rewarding, maybe even *pleasurable*, while at the same time being *relaxed*. We suggest that this combination of affective attributes is unique to play, producing the complex emotional state that is referred to as "having fun" in human folk psychology. We propose that the three phenomenological aspects of this "having fun" feeling are directly reflected in the kinematic, structural, and motivational character of play behavior. The excitement is revealed in the vigor and speed of play movements and sequences, the pleasurable aspect in the fact that animals actively seek out and work for opportunities to play, and the relaxation by the willingness of animals to self-handicap in play and play only when they are relatively safe or unstressed. It may also be that play behavior is supported by a unique pattern of neurobiological response in the brain centers associated with complex somatosensation, motor pattern control, emotionality, and reward.

M.T. Phillips, 'Savages, Drunks, and Lab Animals: The Researcher's Perception of Pain'. *Society & Animals*, 1/1, 61-77 (1993).

Society & Animals Journal of Human-Animal Studies

Historically, treatment for pain relief has varied according to the social status of the sufferer. A similar tendency to make arbitrary distinctions affecting pain relief was found in an ethnographic study of animal research laboratories. The administration of pain-relieving drugs for animals in laboratories differed from standard practice for humans and, perhaps, for companion animals. Although anesthesia was used routinely for surgical procedures, its administration was sometimes haphazard. Analgesics, however, were rarely used. Most researchers had never thought about using analgesics and did not consider the subject worthy of serious attention. Scientists interviewed for this study agreed readily that animals are capable of feeling pain, but such assertions were muted by an overriding view of lab animals as creatures existing solely for the purposes of research. As a result, it was the exceptional scientist who was able to focus on anything about the animal's subjective experience that might lie outside the boundaries of the research protocol.

As Martin Pernick tells it, "The Case of McGonigle's Foot" is a horror story (Pernick, 1985, pp. 3-8). On a summer day in 1862 a Philadelphia laborer named McGonigle took a fall and fractured his ankle. He was rushed to a hospital, where doctors immediately amputated the man's foot –*without anesthesia*. This occurred 16 years after a public demonstration of ether anesthesia at the Massachusetts General Hospital had shown an astonished world that surgery could be painless. The Pennsylvania Hospital, where McGonigle was taken, had been among the last of the major medical institutions in the United States to introduce anesthetic drugs, but even there ether had been in use for a good 10 years. Chloroform and nitrous oxide had been in general use for almost as long as ether, and all were inexpensive and readily available in 1862. So why no anesthesia for poor McGonigle? (Who, incidentally, died of shock two days later.)

The case was not an isolated incident. For several decades after its discovery, anesthesia was withheld in a large proportion of surgical operations. According to records unearthed by Pernick and discussed in his fascinating study of 19th-century attitudes toward pain, about 32 percent of all major limb amputations performed at the Pennsylvania Hospital from 1853 to 1862 were done without anesthesia. Pernick gives a comparable figure for amputations done at New York Hospital during the five years following the introduction of ether there (Pernick, 1985, p. 4).

The reasons for this drew upon a complex ideology of pain that attributed sensitivity to pain selectively, according to social status (sex, race or ethnic origin, age, education, social class) and personal habits (especially alcohol and drug use) as well as the nature of the surgical operation. People considered most sensitive to pain (and therefore the most likely to receive anesthesia) were women, the educated and wealthy classes, whites (except for recent immigrants), children and the elderly, and people with no history of alcohol or drug abuse. Their social opposites — males, the uneducated, the poor, "savages" (meaning blacks and Indians), Irish and German immigrants, young adults, and alcoholics — were considered least likely to need anesthesia because of their relative insensitivity to pain. McGonigle fit perfectly the model for insensitivity: the man was an uneducated Irish immigrant who had been drinking when he fell (Pernick, 1985, pp. 4, 148-167).

Down at the bottom of the hierarchy of sensitivity, along with the lower classes, was the place of animals. Silas Weir Mitchell, 19th-century physician and pioneer in neurology, wrote: "[I]n our process of being civilized we have won, I suspect, intensified capacity to suffer. The savage does not feel pain as we do; nor, as we examine the descending scale of life, do animals seem to have the acuteness of pain-sense at which we have arrived" (JAMA, 1967, p. 124).

M.T. Phillips, 'Savages, Drunks, and Lab Animals: The Researcher's Perception of Pain'. *Society & Animals*, 1/1, 61-77 (1993).

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This hierarchical view of life, so much a part of the 19-century ethos of colonialism, casts differences of skin color and class and culture (and species, the extreme case) as unbridgeable chasms. Such a perspective did not foster much empathy for the suffering of others, as this episode from the history of anesthesia illustrates. "The descending scale of life," however, is a metaphor from a bygone age. Already in the Victorian era (a time of great humanitarian and antivivisectionist movements), the scope of empathy was growing. Social historians have remarked upon the dawning, at about this time, of a distinctly modern sensitivity to the feelings of a widening circle of others. By the turn of the century, social station was no longer considered a relevant consideration in the decision to administer anesthetic drugs. Today we would no more condone operating on a Native American without anesthesia (or an Irish immigrant, drunk or not) than we would condone calling him or her a savage.

If we were to document the use of anesthesia in veterinary surgery over the past century, we would probably find a pattern similar to that of the less fortunate classes of humans. Animal surgeons in the 19th century were slow to adopt surgical anesthesia, in spite of a strong campaign by the British antivivisection movement to counter the belief that animals were insensitive to pain (Pernick, 1985, p. 178). Antivivisectionist pressure prompted the British Association for the Advancement of Science to publish guidelines in 1871 that contained a requirement for the use of anesthetics in experimentation, but a study by Stewart Richards (1986; 1987) suggests that even the authors of these guidelines often did not follow them. John Scott Burdon Sanderson, who was one of the authors of the 1871 guidelines, omitted any mention of anesthesia in describing many experiments in his *Handbook for the Physiological Laboratory* (1873). Richards' detailed analysis of the *Handbook* reveals that about 15 percent of the potentially painful experiments did not specify the use of any anesthetic.

Nevertheless, the use of anesthesia for all major surgery, both animal and human, is now routine. This says something about how attitudes have changed, but it is hardly the end of the story. In a 3-year study of animal research laboratories in New York, I found that the administration of pain-relieving drugs to animals used in scientific experiments differs considerably from the standards for human patients — and, I suspect, for pets in veterinary hospitals. In the remainder of this paper, I will present some empirical findings from the study, and I will suggest a framework for understanding scientists' beliefs and practices regarding pain in laboratory animals. As will be seen, researchers tend to view lab animals as somehow different from other animals, belonging to an altogether distinct category of being. Now, as in centuries past, such rigid categorization schemes can have far-reaching consequences. Among these consequences are beliefs about the other's pain, and measures taken — or not taken — for its relief.

Methods and Procedures

This report is based on an ethnographic study of laboratories located in two research institutions in the New York City area. At one of the institutions (hereafter referred to as the Institute), participants were selected using a random sampling technique, weighted to assure adequate representation of behaviorists and of those using species other than mice and rats. At the other, smaller, institution (hereafter referred to as the University), every eligible researcher was selected. A total of 27 scientists in 23 laboratories participated in the study, for an overall participation rate of 77% of those selected.

From January, 1985 through November, 1987 I spent hundreds of hours observing experiments on rats, mice, hamsters, toads, birds, rabbits, cats, monkeys, and fish. I took notes during these observations, from which I later typed a detailed account of each session. After several weeks or months (or, in one case, years) in a given laboratory, I interviewed the lab's study participant, using a structured, open-ended interview guide. Interviews, which lasted about two hours, were tape recorded and later transcribed. In addition, each study participant filled out a questionnaire which provided background information on such variables as gender, age, marital status, pet ownership and educational background. All data reported below are from observation notes, interview transcripts, or background questionnaires.

M.T. Phillips, 'Savages, Drunks, and Lab Animals: The Researcher's Perception of Pain'. *Society & Animals*, 1/1, 61-77 (1993).

Society & Animals Journal of Human-Animal Studies

Anesthesia in Animal Research

Until the passage of the Laboratory Animal Welfare Act (P.L. 89-544) in 1966, experimenters in this country had free rein to do whatever they wanted to animals in their laboratories. Even after 1966, researchers were not required to use anesthesia or any other pain-relieving drugs, since the Act was primarily intended to ensure that animals purchased by scientific laboratories were not stolen pets. The legislation also established some minimum standards for the humane care of animals awaiting experimentation. However, it covered only facilities that used dogs and cats, and it expressly exempted from regulation the treatment of animals "during actual research or experimentation." (For a more detailed discussion of the Animal Welfare Act and relevant guidelines, see Phillips and Sechzer, 1989, pp. 17-34.)

The Act has been amended three times: in 1970, 1976, and 1985. The 1970 amendments changed its name to the Animal Welfare Act (dropping "Laboratory"), extended coverage to zoos and circuses and to many more species, and inserted a provision requiring "the appropriate use of anesthetic or tranquilizing drugs, when such use would be proper in the opinion of the attending veterinarian of such research facilities." This was backed by a requirement (still in effect) that each research facility covered by the Act submit an annual report to the government showing how many animals of each species were used in experiments during the previous year, how many of these animals received pain-relieving drugs, and how many animals were used in painful experiments without receiving any pain relief. The report must include an explanation for any instances of the latter. These annual reports are public record, available by request under the Freedom of Information Act. I will return to this subject presently for a close look at the reports filed by the particular institutions examined in this study.

The 1976 amendments were concerned with issues irrelevant to this discussion (interstate transportation of animals and animal fighting ventures), but in 1985 the pain-relief provisions were strengthened somewhat. An explicit prohibition was placed on the use of paralytic drugs without anesthesia (once a popular procedure in vision research), and more authority was vested in the facility's veterinarian to make decisions about pain relief. In addition, the 1985 amendments required that an Institutional Animal Committee be established at each facility to review experiments that might involve pain, and to ensure that research meets all the standards of the Act, including these other new provisions: that the principal investigator consider alternatives to painful procedures; that animal pain and distress be minimized; and "that the withholding of tranquilizers, anesthesia, analgesia, or euthanasia when scientifically necessary shall continue for only the necessary period of time."

These regulations merely codified recommendations already established in the animal research guidelines of numerous professional scientific societies, as well as the guidelines of the National Institutes of Health (NIH). Compliance with the NIH guidelines, first published in 1963, is mandatory for researchers receiving NIH funds — and that means the majority of them (USDHHS, 1985). Moreover, the NIH guidelines cover *all* warm-blooded animals used in research, thus filling a gap left by the Animal Welfare Act's exclusion (until recently) of mice, rats and birds from its coverage.

The cumulative effect of these regulations and guidelines is constraining, despite the loophole that allows scientists to withhold anesthesia when "scientifically necessary." I observed no instances in which surgery was performed on unanesthetized animals, and without exception researchers told me they would consider it unacceptable to do so. Legal, political, and technical/scientific reasons for using anesthesia are overwhelming, quite aside from the ethical qualms that many researchers expressed. They feared the consequences of breaking the law and bringing down the wrath of animal advocates. They pointed out that it is more convenient to operate on anesthetized animals than on struggling ones. In addition, scientists have come to appreciate the many ways in which pain and stress can alter physiological functions and thereby affect the validity of research results. The clincher, perhaps, is that most reputable scientific journals will not publish results of painful research done on unanesthetized animals. One researcher told me frankly that he had wanted to curarize some monkeys without anesthesia for vision experiments, but he was deterred by the knowledge that he could never get the work published.

M.T. Phillips, 'Savages, Drunks, and Lab Animals: The Researcher's Perception of Pain'. *Society & Animals*, 1/1, 61-77 (1993).

However, none of these rules or regulations can prevent a researcher from becoming inattentive or careless in monitoring an animal's level of anesthesia during surgery. While one laboratory I visited had an elaborate array of equipment to monitor the physiological state of the cats and monkeys undergoing surgery there, many scientists who worked with rats and mice relied on nothing more than the animal's general appearance. Unlike human operating rooms, animal laboratories have no full-time anesthesiologist standing by whose sole responsibility is to administer and monitor the anesthesia. Sometimes, during very long experiments, anesthetized animals are even left alone for hours at a time.

One morning when I arrived at a neuroscience laboratory to observe the finale of an experiment on a cat that had begun the day before, I found the investigators sitting around glumly. They had worked until about 1:00 o'clock the night before, they told me, leaving the cat anesthetized with a combination of drugs (urethane and surital) administered continuously through a vein. When a graduate student arrived the next morning at about 6:00 am, the cat was dead. There is no reason to suppose that the cat ever gained consciousness, but if it had, its open wounds would have caused intense suffering. Leaving anesthetized animals unattended through the night was standard practice in this laboratory, and is apparently so in many neuroscience labs, where experiments often last for 36 hours or longer. The intention is never to cause pain (nor, certainly, to kill the animal prematurely), but it is implausible to believe it never happens.

In another laboratory, I was present when a rat regained consciousness during brain surgery. The rat was one of 20 given brain transplants on one day by a team consisting of the senior investigator (study participant), a postdoctoral fellow, the facility's veterinarian, and an undergraduate student. The procedure was for the veterinarian to inject each rat with anesthetic (chloropent, a commercially available drug containing pentobarbital and chlorohydrate) about 10 minutes prior to surgery. Then an incision was made in the top of the rat's head, the skin drawn back, and a drill used to make a small hole in the skull. Into this opening the researcher injected a tiny amount of material that had been extracted from the brain of a rat fetus a few hours earlier. The incision was then closed with surgical staples and the rat was placed on a warming pad to recover. The whole procedure took about 20 minutes.

My notes for the afternoon show that at 2:35 pm, the postdoctoral fellow began drilling into the skull of a rat, which immediately began to squirm and struggle. The rat's hind legs began scrambling in a coordinated running movement, eventually running right off the small cardboard box being used as a makeshift operating platform. While its hind quarters were hanging over the edge of the platform, the rat's head was still held firmly in place by ear bars, part of the stereotaxic device that keeps the animal's head correctly aligned for precise placement of the drill. The researcher kept on working on the skull, paying no attention to the rat's frantic struggles. After several minutes of this, the rat managed to kick over the box-platform, making it impossible for the researcher to continue. At that point, he asked the veterinarian for more anesthesia, which the latter immediately injected. The researcher righted the box, repositioned the rat on it, and at once resumed drilling. The rat again struggled until half of its body had slipped off the box. The researcher continued drilling for about 30 seconds, then once more repositioned the rat. By this time—it was 2:45, ten minutes after the rat's first movements—the booster dose of anesthesia had taken effect, and the animal became quiet, and remained so for the duration of the surgery. During all this time, the senior investigator, seated a few feet away performing an identical operation on another rat, did not look up from his work. The others paid no attention, either. They all acted as though nothing unusual or untoward was going on.

I asked the senior investigator about this incident when I interviewed him some three months later. I described what I had seen, and asked if he thought the rat had been in pain. He replied that "in that kind of situation, it's probably more uncomfort than anything else." But then he asked, rhetorically, "Is it worthwhile giving a general anesthetic to prevent the animal from feeling those two minutes of pain that would be involved in surgery and risk killing the animal?" He continued, explaining at some length the statistical probability of accidents due to anesthetic overdose. Out of every 20 animals, he said, one or two are likely to be more resistent to the anesthesia than the others. But "99 percent of the animals that die before you want to terminate them, it's because of anesthetic." "I think that in order to eliminate all pain," he concluded, "the chances are that you would be killing a lot more animals."

M.T. Phillips, 'Savages, Drunks, and Lab Animals: The Researcher's Perception of Pain'. *Society & Animals*, 1/1, 61-77 (1993).

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This scientist did not seem very convinced, himself, that the rat felt "more uncomfort than anything else." But the question was not really important for him. Much more important was the possibility of losing data by inadvertently killing animals with too much anesthesia. The risk is not that animals might die — they were all to be killed a week or two later — but that they might die "before you want to terminate them." In this passage, the scientist has subtly clothed his interest in the success of his experiment in the nobler garb of concern for the animal's life.

Analgesia in Animal Research

In spite of these kinds of lapses, there is a wide consensus among researchers that anesthetics should be used in pretty much the same situations as for humans, and in practice this is usually followed. At any rate, researchers have virtually no latitude in deciding when to administer anesthetics. Analgesics — painkillers, such as aspirin — are an entirely different matter. The use of analgesics in animal research, in practice, if not in theory, is left almost entirely to the discretion of the investigator. For this reason, the administration of analgesics can provide us with a far more sensitive indicator of the view of animal pain and suffering held by scientific researchers than can the use of anesthetics.

On the face of it, the federal regulations require the use of analgesics no less than anesthetics. The Animal Welfare Act mandates that "animal pain and distress [be] minimized, including adequate veterinary care with the appropriate use of anesthetic, analgesic, tranquilizing drugs, or euthanasia" (1966, P.L. 89-544 Sec. 13 [3][A]) and that "in any practice which could cause pain to animals — (i) that a doctor of veterinary medicine [be] consulted in the planning of such procedures; (ii) for the use of tranquilizers, analgesics, and anesthetics" (1966, P.L. 89-544 Sec. 13 [3] [C] [i,ii]). The NIH *Guide* is more specific. It states: "Postsurgical care should include observing the animal to ensure uneventful recovery from anesthesia and surgery; administering supportive fluids, analgesics, and other drugs as required . . ." (USDHHS, 1985, p. 38).

Analgesics are routinely given to human patients following surgery, and in fact a number of commentators have made much of modern Westerners' dependence on painkillers (e.g., Illich, 1976; see also Pernick, 1985, pp. 233-234). In the animal laboratories, however, analgesics were rarely used. No one (with the possible exception of some animal welfare advocates) considers this a violation of the regulations, but rather a (more or less) legitimate interpretation of the "appropriate use" and "as required" clauses. Whereas the regulations were invariably interpreted to require anesthesia for surgery, they were not construed to require analgesic drugs under any specific conditions. Analgesics were considered—when they were considered at all—to be a matter for individual judgement.

In the 23 laboratories I visited, I never saw an analgesic administered, although two researchers reported regular analgesic use: monkeys were said to be given Tylenol (acetaminophen) after brain surgery in one laboratory; and rats that had had brain surgery in another laboratory were reportedly given Talwin (pentazocine, a potent nonnarcotic analgesic), at the veterinarian's suggestion. I was not present immediately after surgeries in either laboratory, but I have no reason to doubt these reports.

In a third laboratory, the senior investigator told me that he gives post-operative rats an aspirin in their water "all the time." (He later modified this claim to "sometimes," and, when pressed, "not normally.") However, this laboratory chief had his graduate students do all the surgeries, and the student I had observed not only did not administer aspirin, but she told me that she never did so because aspirin is not appropriate for rats. It was her belief that "there just are no analgesics appropriate for rats." In a fourth laboratory, monkeys received no analgesics after head surgery at the time of my visits, but both scientists interviewed here stated their intention to begin the use of opiates for this purpose soon.

Table 1.
Use of analgesics by study participants

Category	No. of Laboratories
A. Inapplicable (Animals killed before regaining consciousness from surgical anesthesia; or no painful procedures)	5
B. Analgesic use after surgery reported on a regular basis	2
C. Analgesic use after surgery (for monkeys only) to be instituted soon	1
D. Analgesic use reported but contradicted by observations	1
E. No analgesic use reported or observed, nor any plans to consider it	14

M.T. Phillips, 'Savages, Drunks, and Lab Animals: The Researcher's Perception of Pain'. *Society & Animals*, 1/1, 61-77 (1993).

Society & Animals

It should be noted that in five laboratories there was really no opportunity to administer analgesics, either because the animals were killed while still under surgical anesthesia or because nothing that would normally be considered painful was done to them. This discussion, which assumes that the question of whether or not to administer an analgesic is an applicable one, should be understood to refer only to the remaining 18 laboratories. In most of the latter, major survival surgery provided a situation in which one could reasonably wonder if an analgesic might be appropriate (see Table 1).

The large majority of researchers interviewed for the present study who did not administer analgesics (Table 1, Category E) appeared surprised when I asked about them. Some answered as though they thought I meant anesthetics; others said the idea had never occurred to them; many assured me that their animals did not seem to need painkillers; a few, like the graduate student performing rat surgery, thought none was available; and a sizable proportion added that, in any event, they would not want to introduce the unpredictable effects of a new variable into their research results.

The following interview excerpts are drawn from many that illustrate these themes:

MTP: Do the rats suffer much coming out of anesthesia, after the surgery?
Researcher: Well, I can imagine they have a headache.
MTP: Do they ever get analgesics?
Researcher: Um [pause] No, I don't think so. Of course, they are certainly anesthetized for surgery. Um [trails off]
MTP: Is that something you've ever given any thought to?
Researcher: I've never given it any thought. I'm not sure I would, anyway. I give *myself* as few drugs as possible, even when I'm in pain... That's tricky, to dwell on that issue. One could turn down all sorts of alleyways of thought.

***

MTP: Is there any pain recovering from that surgery [rats recovering from ovariectomies]?
Researcher: I would imagine that after *any* surgery there must be some pain. They don't seem to show any discomfort. They eat as well. They drink as well. They walk around as well as before. But I can't ask them.
MTP: Do you ever use, or have you ever considered using, analgesics?
Researcher: No, we don't use that.
MTP: Is there any particular reason?
Researcher: I think simply because it would add another variable to the experiment. And because you don't see the animal in any apparent discomfort.

***

MTP: Do you ever give analgesics to rodents or monkeys, or cats when you work with them?
Researcher: Anesthetics.
MTP: No, analgesics. Painkillers. [pause] Things like aspirin, Tylenol.
Researcher: Uh [pause] No. I never have...You would first have to ask the question, is the aspirin going to affect any phenomena you're looking at. In order to investigate that, and what dose, and how long....you'd have to do an experiment...You'd have to add an extra control group...It would just be adding another variable.
MTP: Has this ever been a subject of discussion with anybody?
Researcher: Never. (chuckles) Never mentioned whether animals should take aspirin or not...If you give an animal an aspirin to overcome its discomfort, then what about sleeping on a wire mesh floor? I mean, shouldn't you have some shavings for the animal to sleep on? Wouldn't they be more comfortable if you did that?...The goal of your research then becomes providing a pleasant surrounding for your animals.

M.T. Phillips, 'Savages, Drunks, and Lab Animals: The Researcher's Perception of Pain'. *Society & Animals*, 1/1, 61-77 (1993).

Most researchers had never sought a veterinarian's advice on this subject, and the last quoted above even seemed amused by the idea. Yet they had had very little training in this area, and often admitted ignorance about available drugs. The only scientist who did consult a veterinarian — an endocrinologist who was worried about the poor appearance of her rats after surgery — was advised to administer a painkiller, a practice that she told me had since become routine in her laboratory (this was the laboratory in which I was told Talwin was given). In only two other laboratories were discussions about the issue reported to have taken place, and in both cases the decision was subsequently made to give analgesics. Elsewhere, the question was not treated as worthy of serious discussion.

Inaccurate beliefs were sometimes given as reasons for not considering analgesics. For instance, a scientist told me that he could not give cats morphine-related analgesics, because "cats don't tolerate morphine drugs." Another told me that "Demerol drives [cats] crazy; they go bananas if you give them Demerol." In fact, a standard veterinary manual recommends Demerol (the trade name for meperidine, a morphine-like narcotic) and other opioids, such as buprenorphine, for cats (Flecknell, 1987). In another laboratory, a neuroscientist assured me that the nembutal anesthesia he used in monkey surgery had an analgesic effect that lasted for "half a day" after the animals regained consciousness. On the contrary, the veterinary manual states that one of nembutal's undesirable characteristics is its *poor* analgesic activity (Flecknell, 1987, p. 35). Recovery from nembutal anesthesia (as from other barbiturates) is prolonged, causing the animal to remain groggy for hours afterwards; that effect may have led the researcher to think, mistakenly, that nembutal is also an analgesic.

M.T. Phillips, 'Savages, Drunks, and Lab Animals: The Researcher's Perception of Pain'. *Society & Animals*, 1/1, 61-77 (1993).

I do not mean to imply that all of the animals were in pain after the surgical operations I observed or that they *should* have been given painkillers. I am not claiming a privileged position from which to judge such matters. In fact, I was amazed, just as some scientists said they were, by how active and normal many of the animals appeared as they emerged from anesthesia. (On the other hand, there were also some that looked miserable.) However, at the time of my field work, there was growing discussion of this issue in the animal science and veterinary literature. Elsewhere I have documented a sharp rise in publications on this topic beginning in the mid-1970s (Phillips and Sechzer, 1989, pp. 58-60). Experts in the field of animal pain were pointing out that pain may be present in spite of an animal's "normal" appearance (Dawkins 1980), and many were urging the use of analgesics, especially after surgery. Manuals and papers with advice on appropriate drugs and dosages for various species were readily available (e.g., Heidrich and Kent, 1985; Kitchell et al., 1983; Soma, 1985; Wright et al., 1985). The new climate of opinion was summed up in one pain specialist's comment that "one of the psychological curiosities of therapeutic decision making is the withholding of analgesic drugs, because the clinician is not absolutely certain that the animal is experiencing pain. Yet the same individual will administer antibiotics without documenting the presence of bacterial infection. Pain and suffering constitute the only situation in which I believe that, if in doubt, one should go ahead and treat" (Davis, 1983, p. 175).

This attitude toward analgesics can be found in at least two sets of interdisciplinary animal research guidelines drawn up by organizations with a broad representation (including veterinarians and pain specialists). One, adopted at an international conference on animal research held under the auspices of the World Health Organization and UNESCO, stated that "Postoperative pain should be prevented or relieved by analgesics" (CIOMS, 1985, VIII). The other is the New York Academy of Sciences' *Interdisciplinary Principles and Guidelines for the Use of Animals in Research, Testing, and Education*, which states that "Post-surgical analgesia must be provided appropriate for the type of surgical intervention" (NYAS, 1988, p. 5).

It is against this background that one must consider the almost total lack of interest in animal analgesia that I found among researchers. The subject was being treated very seriously by specialists in veterinary medicine and pain, while researchers in the laboratories included in this study were ignoring it. The point being made here is not so much that analgesics were withheld, but that so few researchers even considered the subject worth thinking about.

USDA Data on Pain in Animal Experimentation

Statistics compiled by the United States Department of Agriculture show that nationwide, scientists report that the majority of research animals are not exposed to painful or distressing procedures: the percentage of animals in this category has ranged from about 58% to 62% in recent years. Of the others, most received "appropriate pain relief." The percentage of animals reported to have actually experienced pain or distress, without any pain relief, ranges from about 6% to 8% each year (see Table 2). These figures are provided by the animal facilities themselves, in the annual reports mentioned earlier that are required under the provisions of the Animal Welfare Act.

Comparable data for the University and the Institute alone are given in Table 3. The years 1985-1987 represent the period during which my field work was carried out (most of it in 1985). University scientists reported *no* animals subjected to "pain or distress without administration of appropriate anesthetic, analgesic, or tranquilizer drugs" (Category D) during all three years. Researchers are required to attach explanations for all Category D cases; the explanations attached to the Institute's reports for these years reveal that none of the experiments in Category D was performed in any laboratory included in this study. We can only conclude that *not one* investigator included in the present study reported *any* instances of unrelieved pain for *any* of the experiments performed during this three-year period. These experiments included not only many instances of major survival surgery (with no post-operative analgesics), but also mice injected with cobra venom, LD-50 tests in which rats died from large doses of a toxic substance, and cancers in mice and rats. No anesthetics or analgesics were administered in these non-surgical situations.

M.T. Phillips, 'Savages, Drunks, and Lab Animals: The Researcher's Perception of Pain'. *Society & Animals*, 1/1, 61-77 (1993).

Since the USDA data reflect only the scientists' own evaluations of animal pain and distress in their research, these figures cannot be used to "prove" that there is very little painful experimentation. All they show is that researchers *report* very little painful experimentation. When the biomedical research establishment uses USDA figures uncritically to refute complaints about animal pain, as the American Medical Association did in a recent white paper, one cannot but wonder if the authors are really as unsophisticated as all that. The AMA paper smugly states, "The fact that most experiments do not expose animals to pain was confirmed by a report issued by the Department of Agriculture . . ." (AMA, 1989, p. 17). This gives the impression that the USDA conducts independent evaluations using standardized criteria, which is far from the case.

One can easily understand why scientists might not want to fan the flames of the animal research controversy by reporting many Category D animals. Animal rights activists can easily obtain copies of these reports under the Freedom of Information Act—just as I did—and target individual research facilities for harassment. These fears probably underlie some decisions to report animals in Category B (no pain or distress) rather than Category D, and to put all animals that received anesthetics in Category C (pain relieved by drugs), regardless of whether analgesics had been withheld. However, the researchers I studied appeared convinced—and they clearly hoped that by opening their laboratories to me, I would also become convinced—that nothing painful or distressing was going on.

Over and over researchers assured me that in their laboratories, animals were never hurt. "I love animals... I would not feel that I'm doing the right thing if I would do anything to animals that is not being done to human beings," said one. "I do believe in not causing pain to them," said another. "We certainly aren't inflicting pain on the animals," said a third. Another insisted, "I limit the kinds of experiments that I think about [doing] to those that are not going to cause pain and suffering to the animal."

Scientists could tell me these things with apparent conviction because they defined pain and suffering very narrowly. "Pain" meant the acute pain of surgery on conscious animals, and almost nothing else. Most felt that their humane obligations were fulfilled when they relieved that pain with anesthesia. Although the USDA reporting forms refer to "pain or distress" and ask for information regarding "anesthetic, analgesic, or tranquilizer drugs," no annual report for any of half a dozen research facilities that I examined ever included a category D explanation of why analgesics were not administered. As we have seen, one certainly cannot assume that this is because analgesics always *were* administered.

Conclusions

The scientists I studied were full participants in "the modern sensibility." There were no latter-day Cartesians among them who claimed that animals do not feel pain. The majority of them had pets at home, with whom they seemed capable of empathizing enormously. But their pets were individuals whom they knew by name, and whom they would *never* use in an experiment. Laboratory animals were (usually) nameless, de-individualized creatures, whose sole purpose in life was to serve in a scientific experiment. Researchers continually made distinctions between lab animals and pets, on the one hand, and between lab and wild animals on the other.

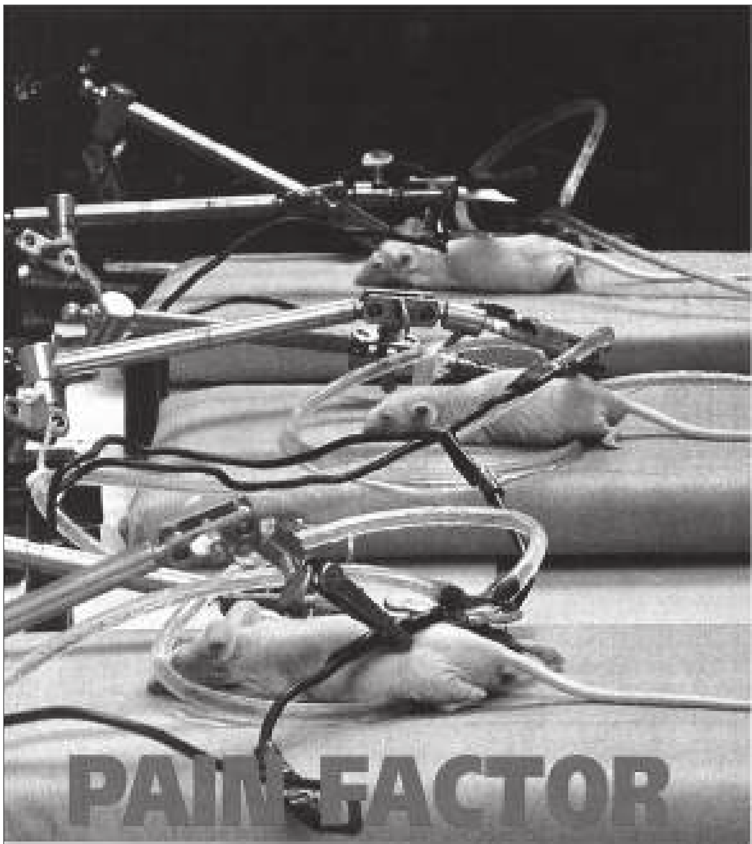
Although researchers always acknowledged the ability of animals to feel pain, this knowledge remained an abstraction for most. Scientists rarely saw any pain or suffering in their labs. Their view of lab animals as statistical aggregates overshadowed any perception of an individual animal's feelings at any given moment. And when I went beyond the issue of physical pain to ask about psychological or emotional suffering, many researchers were at a loss to answer. Typical was the comment of one neuroscientist who, when asked about possible boredom of monkeys kept in bare metal cages, answered with a palpable lack of interest: "We can speculate about those things, but I think it's pointless." Another responded more impatiently: "Oh, how would anybody know that? I mean, anybody? How could anybody know that? There's a danger of being anthropomorphic about anything. I just, I wouldn't even venture a guess."

The savage and the drunk of yesteryear find their counterpart in the 20th-century laboratory, but not because of any simple belief that the lab animal is insensitive to pain. Laboratory animals are categorized and perceived as distinctive creatures whose purpose and meaning is constituted by their role as bearers of scientific data. Researchers believe that all animals are *capable* of feeling pain, but what they actually *see* when they look at lab animals is a scientific objective, not the animal's subjective experience. The result is that it rarely occurs to them to consider whether an animal is in pain, is suffering – or whether it is feeling anything at all, outside the boundaries of the research protocol.

SCIENCE/BIOLOGY TEXTS

SHORT WRITTEN TEXTS (MAGAZINES)

A. Bone, ‘Pain Factor: How much do animals suffer in this country in the name of science?’ *New Zealand Listener*, p. 34 (2002).



PAIN FACTOR

How much do animals suffer in this country in the name of science? BY ALISTAIR BONE

Determining how much an animal suffers during vivisection is a tricky business, due mostly to their inability to complain. The Ministry of Agriculture and Fisheries (MAF) provides helpful tips for all species. Three hundred horses or donkeys were used in animal testing last year, three percent were eventually killed. In prolonged pain horses exhibit symptoms from "... restlessness to depression ... When near collapse, the horse may stand very quietly, rigid and unmoving." Cats (309 used, eight percent killed) should be young, healthy, socialised to humans and "... in severe pain may howl and show demented behaviour with desperate attempts to escape". With rabbits (2785 used, 90 percent killed) "... acute pain may result in vocalisation".

Research organisations sent reports to MAF on how much animals in their care have suffered. MAF in turn provides them with a guiding reference document to animal pain. Examples of procedures that should be reported as "severe suffering" include "recovery from major surgery without the use of analgesics, marked social or environmental deprivation, the induction of severe diarrhoea, severe infectious pneumonia or severe aggressive behaviour". Actions causing "very severe suffering" include "conducting major surgery without the use of anaesthesia where animals are immobilised physically or with the use of muscle relaxants, studies of the recovery from third degree burns or serious traumatic injuries, induction of psychotic-like behaviour or agonistic interactions that lead to severe injury or death". David Bayvel, MAF's director of animal welfare, says that in his experience institutions tend to err on the side of caution, reporting experiments as more rather than less severe.

Last year 10 rabbits, 188 rats, 798 guinea pigs and more than 13,000 mice suffered "very severely" – the official definition is an act that "... causes stress or pain of a severe intensity for a long duration or of a very severe intensity for any duration".

Mice bred specifically for experimentation: they are hairless to imitate human skin.

The National Animal Ethics Advisory Committee (NAEAC), which advises the Minister of Agriculture on animal testing, says that over 318,000 animals were used in research experiments in 2001, with 17,265 subjected to "severe" or "very severe suffering".

But who is doing exactly what to which is difficult to know. Animal rights groups say that the system is not sufficiently transparent. Specific details of animal use may be obtained under the Official Information Act where that applies, but 24 percent of animal testing last year was commercial work, where procedures may be commercially sensitive. MAF also advises, "It would be acceptable to withhold the names of persons involved in a protocol and the specific location of where the manipulation is taking place", due to threats from "extremists".

Anyone wanting to work on live animals has to gain approval from one of 46 Animal Ethics Committees (AECs). Each AEC contains three independent members, who have to determine that the pain caused to an animal is justified by the knowledge gained. Members can inspect premises and witness experiments any time they want. No complaints have ever been received from an AEC about the conduct of an experiment. Bayvel has faith in the system. "Some people are not convinced that the AECs are effective. But from our point of view, with the three external members, there are plenty of checks and balances to ensure complaints would be aired. In many cases they are weighing up a very difficult decision."

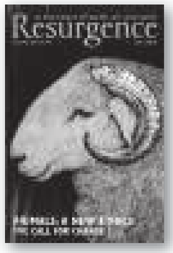
The NAEAC has a policy of "Reduction, Replacement and Refinement" (the three R's) toward animal testing. This may be a bit of a misnomer. Last year's use of 318,583 animals was second only to 324,395 in 2000. "What is driving the total is the quantum of authorised, ethically justified research," says Bayvel, the need for which may fluctuate with such things as outbreaks of animal diseases and the appearance of new drugs that have to be tested.

A newsletter from the Australian and New Zealand Council for the Care of Animals in Research and Teaching (ANZCCART) notes that the number of animals used will not necessarily fall. It says that the ethical imperative in the application of the three R's is "the use of the appropriate number of animals to achieve meaningful results. This may, or may not, involve a decrease in animal numbers. Indeed, in certain circumstances, more animals may be needed." ■

SCIENCE/BIOLOGY TEXTS

SHORT WRITTEN TEXTS (MAGAZINES)

J. Creamer, 'Vivisection: "The blackest of all crimes"'. *Resurgence*. 27, 24-27 (2012).



Vivisection

"The blackest of all crimes"

– Gandhi

Animal research is fundamentally flawed, outdated and inhumane, writes **Jan Creamer**

I nod a greeting to the security guard as I walk silently with my colleague towards the lift. We prepare our cameras as we travel to the upper floors. My task is stills photography today. Will we get what we need?

First stop is the monkey-holding rooms, where different species are caged side by side, sharing their common hell for their last days on Earth. They scream at the sight of humans in lab gear entering the room.

We move to the experimental rooms, and there she is. She's beautiful, intelligent, brutalised. Large circular metal casings are cemented into her head and she constantly picks painfully at the scabs around the implants. The lovely Elisa, destined to end her days being forced to perform tasks while plugged into a computer connected to her brain. Chosen for her large, dextrous, human-like hands – she can push and pull levers. Food is the reward for doing as she's told.

On the other side of the lab is Alice. Poor Alice, constantly circling her cage, unaware of what is going on outside of her own head. She is in her own hell. Alice and Elisa are different species, so they cannot communicate in any meaningful way. There's no solace here.

I take my photographs and vow that their story will be told.

Opposite: Elisa; photo courtesy of the National Anti-Vivisection Society

Vivisection

Vivisection, the cutting up of a live body, is also generally described as "animal procedures" or experiments. Every year in the UK around 3 million animals suffer and die in unreliable and unethical experiments; that's roughly one animal every 10 seconds. Worldwide, it is estimated that over 100 million animals die in laboratories each year.

Animals are used to test all manner of products, for the household, the car, the garden, food colouring, additives and pharmaceuticals. Animal tests are the yardstick that government regulators use to pronounce something 'safe' for human use.

Currently most UK animal experiments take place in academic institutions, primarily for so-called fundamental research seeking information with no specific application in mind.

Regulatory safety testing is the other huge sector, where millions of animals are force-fed, injected or coerced to inhale products to test for toxic effects. These 'safety' tests allow products onto the market. Animal experiments include a wide range of work:

- Catheters implanted under the skin of primates, who were placed in a chamber where they received regular injections to mimic human drug abuse. The vivisectors commented: "The longevity of non human primates is an important consideration, allowing for long-term studies to be conducted and repeated-measures designs to be employed. A single venous catheter can be readily maintained for over a year, and multiple implants permit the conduct of self-administration experiments for several years in individual subjects."
- Monkeys who were used to test the poisonous effects of an incontinence drug; they suffered rectal prolapses as they were restrained in experimental chairs. On this study

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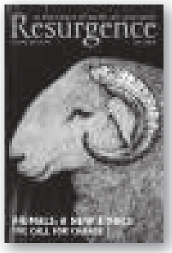


the animals were dosed by a tube being pushed down their throats, then the product was poured directly into their stomachs, every day for 52 weeks. The lab reported that some animals vomited every time they were dosed.

- Monkeys who vomited and salivated repeatedly. One animal was so stressed that she almost chewed off her own finger. Others pushed their fists into their mouths, tried to bite through the metal food hopper, pushed sawdust into their mouths or dragged their teeth along the cage bars. The government licence classified this test as likely to cause 'moderate' pain and suffering.
- Three monkeys on an inhalation study died or were euthanised due to partially collapsed or blocked lungs. Three other animals collapsed, but were revived. Necropsied animals were shown to have blackened lungs. This was licensed as a 'mild' procedure.
- A scientific review on animal models of obesity concluded: "Most of the interest in the study of non-human primates and obesity has been with respect to their responses to high fat diets and epigenetic effects," and "Despite all this work, there are many gaps in our understanding of how composition and energy storage are regulated, and a continuing need for the development of pharmaceuticals to treat obesity. Accordingly, reductions in the use of animal models, while ethically desirable, will not be feasible in the short to medium term, and indeed an expansion in activity using animal models is anticipated as the epidemic continues and spreads geographically."

> The suffering of non-human primates, with their intelligence, emotions and family bonds, epitomises all that is wrong with this cruel and secret world

All animals suffer terribly in laboratories, but the suffering of non-human primates, with their high intelligence, emotions and family bonds, epitomises all that is wrong with this cruel and secret world.

The primates

All primate species are intelligent, good at problem solving. Some use tools, others show self-awareness. Most species live in family groups, in organised social structures. Some non-human primate species have shown an aptitude for rudimentary arithmetic; many have demonstrated reasoning. Chimpanzees have been taught to communicate using human sign language and subsequently they were observed teaching each other independently of their human captors. Non-human primates have been seen to display similar emotions to ours, such as affection, anger and sorrow – even empathy.

Such similarities are frequently used to justify their use in laboratories, but this ignores the fundamental differences at the cellular, genetic and immune-system level – differences that are so important to experimental results.

Although we human primates share over 90% of our DNA with most of our non-human primate cousins, Nature demonstrates what a difference this small percentage can make. Moreover, when these animals are snatched from the wild, caged, confined, transported, restrained, injected with drugs, force-fed chemicals, deliberately brain damaged, we are close enough to them to know they suffer.

Comparisons of genes and immune systems have revealed the unreliability of using results of chimpanzee experiments for human safety. Scientists have recently discovered crucial differences in the way that genes are expressed in the brain, and just as importantly, there are immune-system differences too.

In the UK and elsewhere, the use of great apes in laboratories has been banned for many years, and currently no great apes are used in Europe. The US is now the only major Western nation where great apes remain in laboratories, although in 2007 the US National Institutes of Health announced it was ending the breeding of chimpanzees for research purposes.

Over 10,000 primates (macaques and marmosets, for example) die in European laboratories each year, and the UK is a major user. It is estimated that 10% of primates in EU labs still come from the wild, and the dealers supplying European laboratories regularly trap from the wild to replenish their breeding stock.

The International Union for Conservation of Nature (IUCN) advises that a quarter of primate species are threatened with extinction. Governments in primate home ranges make desperate efforts to prevent poor and hungry people from eating some species to oblivion. Yet Western countries demand the right to take primates for unnecessary and unreliable experiments.

Whether wild-caught or captive-bred, the majority of monkeys used in Europe are imported from China, the Philippines, Vietnam, Indonesia, Mauritius, Kenya, Israel and Guyana. They endure long, arduous journeys, isolated and trapped in small boxes. The cynomolgus macaque is the most commonly used species of lab monkey in Europe, yet it has been described as the macaque that is least able to handle transport satisfactorily.

A new European directive on animals used for scientific purposes (2010/63/EU) was adopted in 2010, and the UK government is currently preparing to transpose this into UK law. One of the provisions of the new directive is a seven-year phase-out of the use of F1 primates (primates born of wild-caught parents). Whether this will be implemented in the UK remains to be seen.

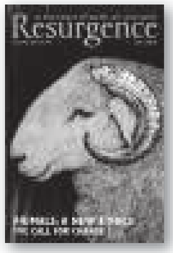
Animal research: fundamentally flawed

It is often claimed that animal experiments are vital to progress, but modern research takes place at the genetic

SCIENCE/BIOLOGY TEXTS

SHORT WRITTEN TEXTS (MAGAZINES)

J. Creamer, ‘Vivisection: “The blackest of all crimes”’. *Resurgence*. 27, 24-27 (2012).



and cellular level, where new technology, focusing on human data, allows greater precision than ever before.

Animal research is crude and unscientific, a relic of the past and fundamentally flawed, due to 'species differences'. The biological and genetic differences between species mean that they respond differently to chemicals or drugs.

These differences are apparent in some critical areas: the way a drug is metabolised (works through the body) varies from species to species, and even within the same species. Studies of test results have found differences between humans and laboratory monkeys, on average, a third of the time.

A simple aspirin is known to cause birth defects in monkeys, dogs and cats, but not in humans, despite extensive use by pregnant women. Morphine drugs are depressant in rats, dogs, hamsters and other species, but produce tremors and convulsions at comparable doses in mice and cats. Herpes B virus in monkeys may cause lesions on the face, lips, mouth and body, but monkeys can carry the virus without suffering the disease, which is rare but almost always fatal in humans.

These difficulties are compounded when the stress caused by laboratory life causes biochemical changes, which can also affect results. And artificial disease created in the laboratory is not the same as naturally occurring conditions in humans in the real world.

Misleading results from animal tests have caused injury to patients

The anti-inflammatory drug Vioxx had unexpected effects on human patients after being passed as safe in laboratory animal tests; a reported 88,000–140,000 extra heart attacks may have been caused by Vioxx in the five years from its introduction.

Fialuridine, a hepatitis B medication, killed five people and caused serious illness in others although it had been tested on dogs, rats and monkeys. A review found: "unfortunately, there is nothing to indicate that other laboratory animal studies would have been more appropriate or capable of better prediction of the fatal outcome."

It is time to start dismantling this archaic system

The experimental drug TGN1412 caused serious, permanent and life-threatening damage to trial volunteers, yet the drug had been given to laboratory monkeys at 500 times the human dose, without such side effects.

Many scientists now agree this could have been avoided by using microdosing, where tiny amounts of a substance are given to human volunteers, and samples analysed using Accelerator Mass Spectrometry (AMS). The doses are so small that there are no harmful effects, but the AMS analysis gives accurate and speedy results.

On the other hand, the breast-cancer drug Tamoxifen was designed as an oral contraceptive; it worked in rats, but in women it has the opposite effect. It is now used in the treatment of breast cancer, despite causing cancer in rats in some studies.

Progress without animals

The reality is that the majority of current medical and scientific research does not use animals; advances in science and technology provide non-animal techniques that are faster, more accurate and of direct relevance to humans. These include modern scanning systems, computer analysis and simulation, modelling – for example Quantitative Structure-Activity Relationship (QSAR) – high-throughput screening, human cell cultures and three-dimensional human-tissue engineering.

These new advances in sophisticated techniques are not the only answer, however. Many medical discoveries were made in the past using standard research and observation methods: for example the early anaesthetics, beta blockers for blood pressure, digitalis for heart failure, morphine as a painkiller, and quinine for malaria. Surgical procedures such as removal of the appendix, repair of cardiac aneurism and removal of cataracts were all also introduced and carried out without the need for testing on animals.

It was the study of people and their lifestyles that uncovered the link between cancer and smoking, and the causes of heart disease.

The new legislation in the UK

The new European directive contains some key principles we need to see applied in the UK; for example, "full replacement of procedures on live animals for scientific and educational purposes".

The UK must set limits on the pain animals are allowed to endure. It must end the capture of wild monkeys by dealers, increase transparency and public accountability, remove the current secrecy clause (section 24 of the current Act), and introduce retrospective assessment of experiments to establish what actually happened during the project.

A major advance would be the introduction of a system of thematic review of specific animal experiments or animal use, an important step-by-step approach to the replacement of the use of animals in research and testing. It would allow binding targets to be set, a strategy that has proved to be effective in other areas, for example in the testing of cosmetics on animals.

It is time to start dismantling this cruel and archaic system.

Jan Creamer is Chief Executive of the National Anti-Vivisection Society and President of Animal Defenders International.
www.ad-international.org www.navs.org.uk

D. Graham-Rowe, 'Could lab rats be replaced by a lung on a chip?' *New Scientist*, 202/2712, 20 (2009).

Could a 'lung-on-a-chip' replace countless lab rats?

"MICROLUNGS" grown from human tissue might one day help to replace the vast numbers of rats used to check the safety of drugs, cosmetics and other chemicals. The work is part of a growing drive to develop toxicology tests based on human cells as a replacement for animal testing.

Such efforts are made partly for ethical concerns, and partly because animal testing is so time-consuming and expensive. For example, the European Union's REACH regulations require about 30,000 chemicals to be tested for toxicity over the next decade. Yet testing the effects of inhaling a single dose of a particular chemical typically requires more than 200 rats, while testing the chronic effects of breathing it in over time can take more than 3000. Meanwhile the EU Cosmetics Directive – which covers items from deodorants and perfume to air-fresheners - seeks to ban all tests of cosmetics on animals by 2013.

The obvious alternative is to test chemicals on human cells grown in the lab. The difficulty, however, lies in enticing those cells to form complex tissue that responds as our organs do.

Cell biologist Kelly BéruBé at the University of Cardiff, UK, has managed to grow human lung cells into flat differentiated layers that resemble the inner lining of the lungs. Her method is already being used for drug testing by companies such as Unilever and AstraZeneca. But when allowed to grow in three dimensions, as in the body, cells arrange themselves very differently, and this can change how they respond to chemical stimuli. "We need to move from something flat to 3D structures," says BéruBé.

> **"Cells grow on little plastic spheres, essentially producing a tiny inside-out lung around each bead"**

A popular approach is to seed plastic scaffolds with stem cells to grow artificial "organs", but BéruBé and her colleagues have found an alternative which could allow thousands of drugs to be screened at once.

Instead of large scaffolds, BéruBé has grown lung cells on the surface of plastic spheres half a millimetre in diameter, essentially producing a tiny inside-out lung around each bead. The ultimate aim is to develop a chip on which thousands of microlungs can be grown then tested simultaneously, she told the Cheltenham Festival of Science in the UK last week.

The big challenges will be getting the technique accepted by regulatory authorities and convincing academia that tiny globs of lab-grown tissue can tell us as much in tests as whole animals. But BéruBé points out that rat models are less relevant to humans than most people realise. Chocolate, for example, is lethal to rats and their anatomy is such that they can only breathe through their noses. Duncan Graham-Rowe ■

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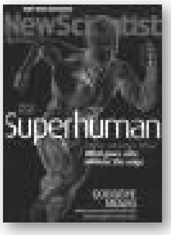
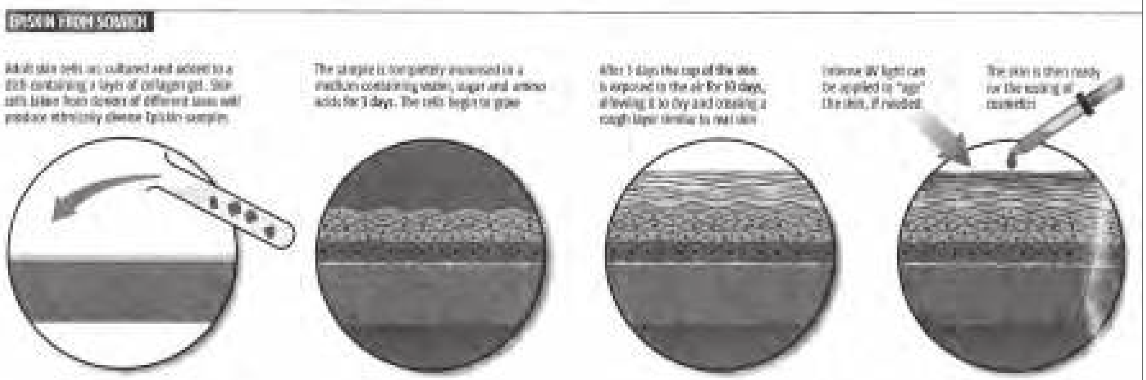
SCIENCE/BIOLOGY TEXTS

SHORT WRITTEN TEXTS (MAGAZINES)

Z.M. Lyon, ‘Human skin to replace animal tests’. *New Scientist*, 195/2614, 14 (2007).



This week



Tests to use human not animal skin

ZEEYA MERALI, LYON

STRETCHED taut across the top of a vial, the thin cream-coloured material feels almost like rubber. Barely 1 centimetre in diameter, this is a sample of Episkin – a reconstructed human skin which has been approved for testing if cosmetics are likely to irritate the skin. It is the first complete replacement for animal testing.

Although cosmetics and skincare giant L'Oréal has been developing reconstructed skin since the 1980s, the search for animal alternatives became urgent in recent months with the introduction of two pieces of legislation. In December 2006, the European Union introduced REACH, which calls for more than 10,000 chemicals used in cosmetics to be tested for skin irritancy by 2019. At the same time, the EU's cosmetics directive bans the use of animals in such tests from 2009. "Europe is in conflict with itself, calling for both a decrease in animal testing and for significantly more products to be tested," says Estelle Tessonneaud, who developed Episkin with her colleagues at L'Oréal's labs in Lyon, France. "People don't have any choice but to adopt alternative methods."

Tessonneaud's team grows the skin layers on collagen, using skin cells called keratinocytes left-over from breast surgery (see Diagram). The team can test the safety of cosmetics by simply smothering the skin in the product. They can then check the proportion of cells that have been killed off by adding a yellow chemical called MTT which turns blue in the presence of living tissue. "To be validated we had to show that we could reproduce results as effectively as animal tests," says Patricia Pineau, scientific director at L'Oréal. Independent tests showed that in some cases Episkin was able to predict more accurately how a person would react to products than animal tests, she says.

Episkin improves on animal testing in other ways too. For example, it can be adapted to resemble older skin by exposing it to high concentrations of UV light. Adding melanocytes also results in skin that can tan, and by using donor cells from women of different ethnicities, the team has created a spectrum of skin colours which they are using to measure the efficiency of sunblock for different skin tones.

"This is a great advance – not just for animals but for people, who will finally have a safety test that is relevant to them," says Kathy Archibald of the anti-vivisection group Europeans for Medical Progress, London. She says animal skin often differs dramatically from human skin in terms of sensitivity.

> "This a great advance, not just for animals but for people who will finally have a cosmetics safety test that is relevant to them"

Chris Flower of the Cosmetic Toiletry and Perfumery Association in London also welcomes the move. "The fact that it has taken 20 years of research to come to this point shows just how difficult it is to replace animal testing," he says. "Now it has been validated it can potentially be applied, not only to testing new shampoos and cosmetics, but more widely, in medical research."

L'Oréal already has a skin to help study a rare genetic disease that affects so-called "moon children" who are hyper-sensitive to sunlight (*Photochemistry and Photobiology*, DOI: 10.1111/j.1751-1097.2005.tb01527.x). Tessonneaud and her colleagues are also working on a skin substitute for treating major burns and ulcerations. ●

TISSUE SCAFFOLDS CAN REPLACE KNOCKOUT MICE

Genetically modified animals play a huge role in helping researchers to understand the role of specific genes in human disease. Now, Paul Genever at the University of York, UK, and his colleagues are developing an alternative based on human tissue, that could cut the number of animals used in research.

The team has already grown a 3D "tissue scaffold" from mesenchymal stem cells taken from human bone marrow, and is now trying to "knock out" individual genes in the stem cells, enabling them to discover the precise roles the missing genes play. Genever's team is just one of those to receive a grant from non-animal medical research charity the Dr Hadwen Trust, in Hitchin, UK. Another team, led by Rachel Tribe at King's College London, is attempting to silence genes in human uterine tissue, to better understand why premature labour occurs. "Knockout mice are currently used for this, but mice can give birth to 14 babies at a time, so they aren't a very good model for human pregnancy," says Tribe.

Sophie Petit-Zeman of the Association of Medical Research Charities says that any advance that helps reduce the number of animals needed in research is to be welcomed, although researchers will still need to confirm their results in a whole animal.

K. Chug, 'Animal death toll ends cloning trials'. *The Dominion Post*, (2011).

THE DOMINION POST

Animal death toll ends cloning trials

Unacceptable death rates of laboratory animals have forced AgResearch to end its cloning trials.

But the science agency says it will continue to create more genetically engineered animals using new research methods.

The state research organisation has issued reports into trials conducted at its Ruakura centre that detail chronic arthritis, pneumonia, lameness and blood poisoning among the causes of cattle, sheep and goat deaths.

The reports, made available to The Dominion Post under the Official Information Act, refer to trials including those carried out on genetically engineered animals being developed to produce a kind of super milk, as well as animals being cloned.

Other trials where deaths occurred included those looking for resistance to eczema in sheep, exploring feeding motivation in pregnant sheep, and collecting tissue from genetically modified embryos.

Applied biotechnologies general manager Jimmy Suttie said that after 13 years of studying how to prevent abnormalities forming in cloned animals, AgResearch had ended its cloning research.

"The decision was made, enough is enough."

Only about 10 per cent of cloned animals survived through the trials, with the main problems being spontaneous abortions and hydrops – where a cow's uterus filled up with water, leading to the mother being euthanised as well.

Animal Ethics Committee reports from Ruakura show that 16 foetuses or calves from mid gestation onwards either spontaneously aborted or died in the neonatal period last year.

Another 10 foetuses or calves were euthanised, as were 14 cows during last year's cloning trials.

Although cloning trials would no longer be conducted, AgResearch would continue to develop transgenic cattle, sheep and goats. Dr Suttie said new technology using embryonic stem cells was unlikely to cause the same death rates as cloning.

However, at only four months into the research, it was difficult to say how successful the trials would be. "There is a step that is very similar [to cloning], so the losses are similar in the first generation of transgenic animals. However, once the animal reproduces it does that the same as any other animal."

Last year, two out of 12 kids that were delivered at term in a trial to develop transgenic goats died at birth. One suffered from chronic arthritis in its front legs.

Four other animals died or were euthanised in another trial to produce transgenic cattle.

SAFE campaign director Hans Kriek said he did not believe New Zealand had seen the end of cloning research.

"While the cloning has been halted for now, it just takes another company to ask for more research."

Genetic engineering trials would also cause unnecessary suffering to animals, but would continue to be conducted in attempts to make money, he said.

"It's absolutely not going to be different. There will be a different set of circumstances, but there will be problems."

However Dr Suttie said AgResearch's work would result in benefits to New Zealand.

"We're trying out new technologies, and new opportunities to add value to our primary products going forward."

AgResearch is developing transgenic cattle, goats and sheep to produce proteins that cannot be readily produced in any other way – the trials include creating animals that will produce proteins with pharmaceutical benefits.

One goal was to produce a drug like Herceptin, but one that was more cost-effective and readily available. "There's very definitely a human benefit associated with this kind of research."

The work was being done ultimately for the benefit of humans, but Dr Suttie said scientists took animal welfare standards and ethical issues very seriously.

S. Collins, 'Animal experiments jump 21pc says ethics group'. *New Zealand Herald*, A8 (2004).

Animal experiments jump 21pc says ethics group

RESEARCH: Hundreds of thousands suffer in the cause of science

by Simon Collins
science reporter

Scientists slaughtered 141,532 animals in New Zealand last year in the interests of research.

A further 179,379 animals were used in experiments but survived after varying degrees of suffering.

The annual report of the National Animal Ethics Advisory Committee, published yesterday, recorded a jump of 21.7 per cent in the number of animals used in experiments to 320,911, equivalent to the human population of Manukau.

The number of genetically modified animals quadrupled to a record 6711. Scientists predicted in February that increasing GM medical research could push the total number of animals used in experiments to more than 1 million in the next five to 15 years.

Animal rights activists protested outside the head office of the Ministry of Agriculture and Forestry in Wellington after the report was released.

Spokesman Mark Eden said the wide use of animals to test medicines for humans could not be justified because of the differences between animals and people.

"For example, an artificially induced cancer tumour in a mouse is not an accurate model for cancer occurring in a sick human," he said.

The medical director of the Multiple Sclerosis Society, Dr Ernie Willoughby, warned MS patients this week that they should not be confident that new treatments that worked in mice would work in people.

"Not all the treatments or effects in the animal model have always worked out in humans," he said.

But the chairman of the Auckland University animal ethics committee, Dr Don Love, said modern genetics enabled scientists to be much more precise than they used to be.

"Now we are going for a more targeted approach," he said.

"We need to target a particular gene to make it faulty, or express a particular gene in the animal that we would hope would replicate a human disease.

"Now we can use [technology] to return [the animal] back to normal health. You first have to make it crook to replicate the disease, and then you have to treat it to make it normal."

GM mice alone at Auckland University accounted for 4592 of the 6711 genetically modified animals used in experiments nationally.

The university also accounted for the largest total number of animals used in university experiments, 41,091, up from just over 10,000 the previous year.

Dr Love said the increase was partly because animals used in several three-year experiments were all reported in the last year of the experiment.

However, the biggest animal experimenter overall was Hamilton-based AgResearch, which used 55,928 animals including 104 GM cattle and 847 GM mice.

» ON THE WEB
www.nzherald.co.nz/documents

» Death and suffering

Main species used in experiments were:

- Mice: 82,912 used; 11,440 experienced "severe" or "very severe" suffering; 82,083 killed.
- Fish: 71,993 used; 81 suffered severely; 10,799 killed.
- Cattle: 53,706 used; 27 suffered severely; 537 killed.
- Sheep: 51,063 used; 23 suffered severely; 10,723 killed.
- Rats: 19,463 used; 1491 suffered severely; 19,074 killed.
- Possums: 7963 used; 243 suffered severely; 2707 killed.
- Birds: 6108 used; 35 suffered severely; 3359 killed.
- Marine mammals: 5385 used; none suffered severely; none killed.
- Deer: 5039 used; none suffered severely; 302 killed.

E. Gibson, 'GM Mutant cows die in trial'. *New Zealand Herald*, A1-2 (2010).

Mutant cows die in trial

Calves' ovaries as big as tennis balls — scientists' human gene experiment goes dramatically wrong

BY ELOISE GIBSON
ENVIRONMENT REPORTER

Genetically modified cows were born with ovaries that grew so large they caused ruptures and killed the animals.

The bungled experiment happened during a study by AgResearch scientists at Ruakura, Hamilton, to find human fertility treatments through GM cows' milk.

AgResearch is studying tissue from one of three dead calves to try to find out what made the ovaries grow up to the size of tennis balls rather than the usual thumbnail-size.

Details of the deaths — in veterinary reports released to the *Weekend Herald* under the Official Information Act — have reignited debate over the ethics of GM trials on animals.

AgResearch's applied technologies group manager, Dr Jimmy Suttie, said he did not see the deaths as a "big deal", and they were part of the learning process for scientists.

But GE-Free NZ spokesman Jon Carapiet said details of the calf trial showed the animal welfare committee overseeing AgResearch's work was "miles away from the ethics and values of the community".

The calves died last year, aged six months. They were formed when human genetic code injected into a cow cell was added to an egg from a cow's ovary and put into a cow's uterus.

The scientists hoped that the genetic code, a human follicle stimulating hormone (FSH), would enable the cows that were produced to produce milk containing compounds that could be used as a human fertility treatment.

Under permits issued by the Environmental Risk Management Authority last month, AgResearch can put human genes into goats, sheep and cows for 25 years to see if the animals produce human proteins in their milk.

The proteins could eventually be used to treat human disorders.

Anti-GM groups said the cost to animal welfare was too high, citing cases of aborted and deformed fetuses, deformed calves and respiratory conditions among animals bred at Ruakura.

WHAT HAPPENED TO THE GM COWS

- Their ovaries grew so large they caused ruptures.
- Calves grew faster than their clone sister, who did not have the gene.
- The cows had noticeably bigger abdomens and thicker necks.
- One easily grew short of breath.

The Official Information Act documents show a Ministry of Agriculture and Forestry (MAF) investigation found deformities and respiratory problems among animals at the facility — something AgResearch had been open about — but said that was a foreseeable by-product of the project.

Overall, the investigator found cows were better cared for by vets at Ruakura than they would be on a standard dairy farm.

Scientists noticed that four calves carrying the FSH gene grew more quickly than their clone sister, which did not have the gene.

The FSH calves had bigger abdomens and thicker necks but seemed otherwise healthy, apart from one that easily grew short of breath, said a vet's report.

Dr Suttie said the abnormalities were reported to the animal ethics committee, which told the company to monitor the calves.

■ Continued on A2

SCIENCE/BIOLOGY TEXTS

SHORT WRITTEN TEXTS (NEWSPAPERS)

E. Gibson, 'GM Mutant cows die in trial'. *New Zealand Herald*, A1-2 (2010).

Mutant cows die when GM trial goes wrong

■ **Continued from A1**

Tests five months later found three of the four calves had abnormally large ovaries.

When the calves were six months old, one died suddenly of a haemorrhage to her uterine artery, probably because of stretching and distortion caused by her deformed ovaries.

Five days later, a second calf died, after her ovary became twisted and separated from her uterus.

The third calf with over-sized ovaries was killed the same day so scientists could study her tissue.

Dr Suttie said the root of the trouble was that the human FSH genes had affected the whole calf and not the mammary glands only, as was intended — a problem that did not show up in trials on mice.

"This was not intended to happen. But, bluntly, this is what research is all about."

Emails between AgResearch and MAF reveal Agriculture Minister David Carter sought more information about animal welfare when he learned of the calves deaths last year.

He said yesterday that he was satisfied with AgResearch's response.

NZPA. ‘Animal testing body seeks rigid record keeping’. *New Zealand Herald*. (2003).

Animal testing body seeks rigid record keeping

VIVISECTION: Ethics committee wants to control humane deaths for research

Animals killed humanely for research, testing and teaching are being excluded from figures kept by advisers on the ethics of vivisection.

The Animal Welfare Act 1999 excludes such deaths from its formal definition of "manipulation", an area overseen by the National Animal Ethics Advisory Committee.

But the committee said yesterday in its annual report that before the act took effect in 2000 it had recommended to Agriculture Minister Jim Sutton that the slaughter of animals for research, testing or teaching should be defined as "manipulation" of the animals.

"The minister declined to seek an amendment at that time, but indicated a willingness to reconsider the matter if the issue continued to generate concern after the act had been in force for a period," the committee said in its report for 2002.

It said it still believed such deaths should require specific ethical approval, and be included in figures kept on animal manipulation.

"NAEAC expects to make a formal recommendation to the minister on this matter," it said.

The committee said there was a 17 per cent drop in the number of live animals used for research, testing or teaching last year from 318,503 in 2001 to 263,684. The latest figures included 474 unborn mammals and 2454 birds' eggs.

"Last year's figures also showed a drop of over 90 per cent in the number of animals being used by the Government sector, which in 2001 reported higher numbers due to large pesticide trials," said a committee member, MAF animal welfare director David Bayvel.

The main animals used were cattle, sheep, mice and fish, and the two biggest drops in terms of animal percentages were possums and fish.

Dr Bayvel said mice were still the most commonly used animals for research and product testing.

There was an increase in the numbers of marine mammals, reptiles and a class of molluscs called cephalopods — which includes octopuses, squids and cuttlefish — and crustaceans, including crayfish, used for basic biological research.

Basic biological research was the main reason for animal use during 2002, which increased by 18 percentage points to 32.6 per cent of animals used. Other categories of research included medical (11.5 per cent) teaching (10 per cent), commercial work (20.1 per cent) and veterinary (10.6 per cent).

Most (78 per cent) animals used experienced little (43.6 per cent) or no (34.7 per cent) suffering on the lowest two rungs of a five-point severity scale.

But 4.9 per cent experienced "very severe suffering" in manipulations which caused severe stress or pain for a long duration or pain of very severe intensity.

Only 1.1 per cent experienced "severe suffering" and 15.7 per cent experienced "moderate suffering".

Nearly 90 per cent of animals used were "normal" and only 0.6 per cent were genetically engineered, with the actual number dropping from 1556 in 2001 to 1510 last year — the lowest number of transgenic animals in six years.

— NZPA

>> Animal suffering

Level of stress or pain during experiments:

- Very severe: 4.9 per cent.
- Severe: 1.1 per cent.
- Moderate: 15.7 per cent.
- Little: 43.6 per cent.
- None: 34.7 per cent.

Source: National Animal Ethics Advisory Committee.

SCIENCE/BIOLOGY TEXTS

SHORT WRITTEN TEXTS (NEWSPAPERS)

C. Woulfe, ‘Headless chickens put to the test’. *Sunday Star Times*. A5 (2008).

SUNDAY STAR★TIMES
www.sstlive.co.nz

Headless chickens put to the test

RESEARCH SCIENTISTS at Massey University are using scissors to decapitate young chicks in an experiment to test whether the euthanasia method is humane.

The chicks are under general anaesthesia so they do not actually feel anything – instead the scientists use electrodes to measure electrical pain signals to their brains.

The world-first study is to confirm that chicks used for research are treated as humanely as possible.

Professor David Mellor, co-director of the university’s Animal Welfare Science and Bioethics Centre, says the chicks are a few weeks old when they are anaesthetized and tiny needle electrodes are slid into their scalps.

Mellor emphasises that the birds are already unconscious and the decapitation takes less than a second. Any electrical signals for what the scientists call ‘noxious sensory inputs’ show up in the chick’s brains which tells the scientists how painless and quick the method would be for unaaesthetised chicks.

At the moment decapitation is widely considered humane, but not used commercially. It is mostly used when researchers need to study an animal’s brain after its death when drugs would complicate the research.

Mellor says all the scientific evidence from other studies suggests decapitation is humane: “[it] is thought to stretch the brain stem then you immediately go unconscious”.

This study is “an opportunity to double check … We’re just having a look because if it is [humane], that’s good to have confirmation. If it isn’t we need to know so that we can change practices.”

The study is expected to continue for about a year.

Massey’s ethics committee has approved the study and scientists follow strict ethical guidelines. No industry funding is involved.

Four or five birds have been decapitated so far, Mellor says. This will continue until they have conclusive results – “you can start with three or four, and review the results, and then you can go and do another two or three … you can stop when you have enough … Researchers do the very best they can to minimise the harm they do”.

Hans Kriek, from animal rights group SAFE, says the group is against any animal testing, but because anaesthetics are used in this study it is on the “lower level” of those SAFE is concerned about.

Consumer awareness about the treatment of chickens is running high after celebrity chef Jamie Oliver gassed a cage of chicks to death for his show *Jamie’s Fowl Dinners* which screened in New Zealand last month.

Later in the Massey study some chicks will be euthanased in this way. Mellor says they want to reevaluate this method too, because of concern that high concentrations of CO_2 could irritate the mucous membranes of the chicks before they lose consciousness.

The euthanasia research is part of a larger study investigating when chicks become conscious, and therefore able to feel pain.

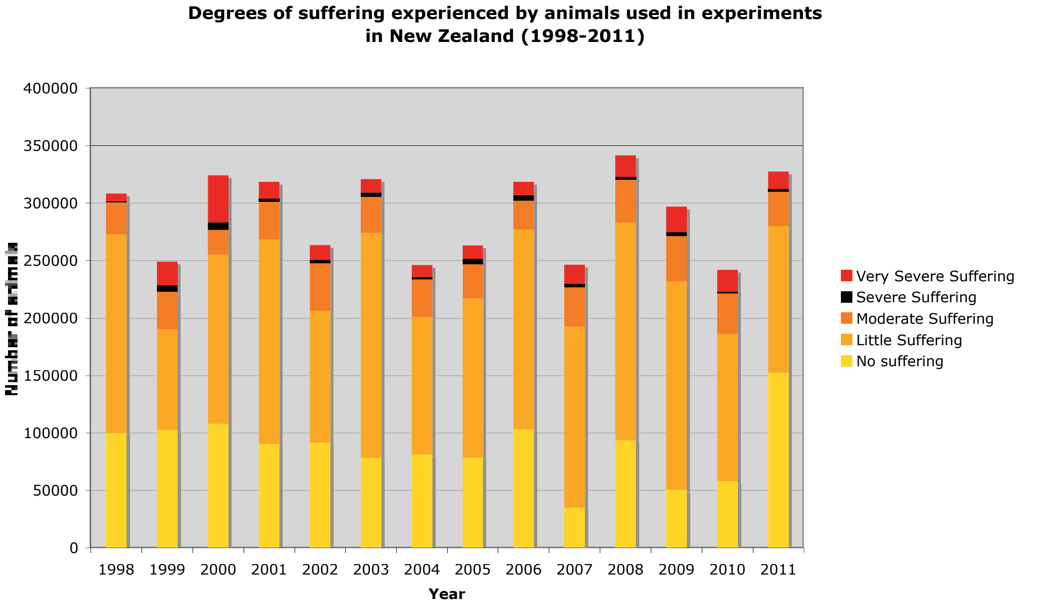
Michael Brooks, head of the Egg Produces Federation says that in New Zealand, CO_2 is used to kill about a million male chicks each year.

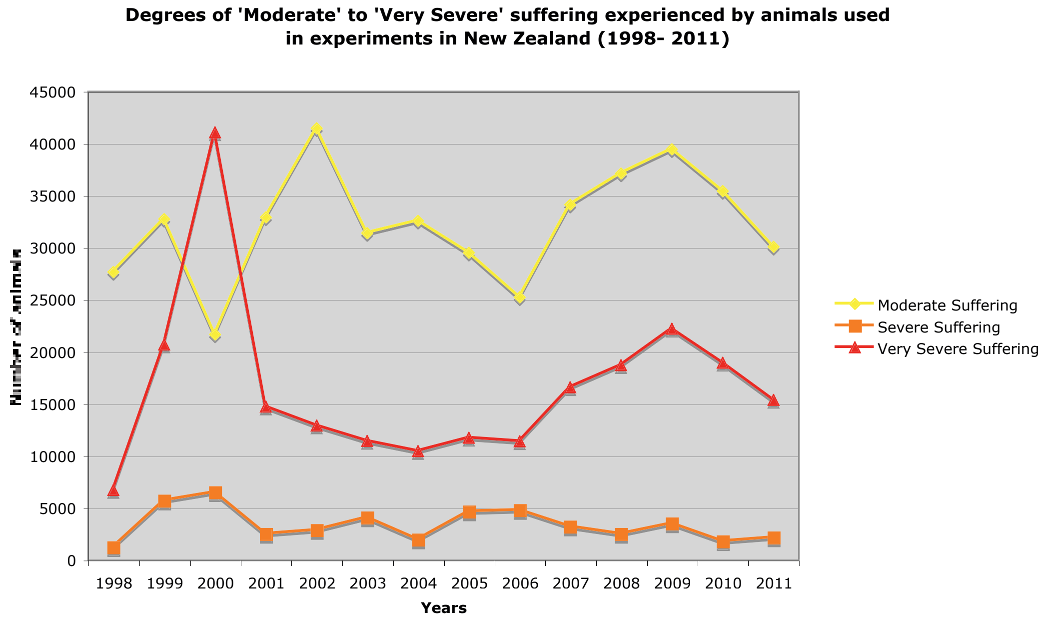
Another million are killed by instantaneous fragmentation – “basically they are put through a machine that’s like a very fast-moving blade he says.

Male chicks are superfluous to the poultry industry.

Regardless of the research results producers would not be making any decisions on their practices, Brooks says. Instead the research would be considered by the National Animal Welfare Advisory Committee.

SAFE Inc 2012





Source information from: Ministry for Primary Industries. National Animal Ethics Advisory Committee Annual Reports 1998-2011.
www.biosecurity.govt.nz/regs/animal-welfare/naeac/annual-reports

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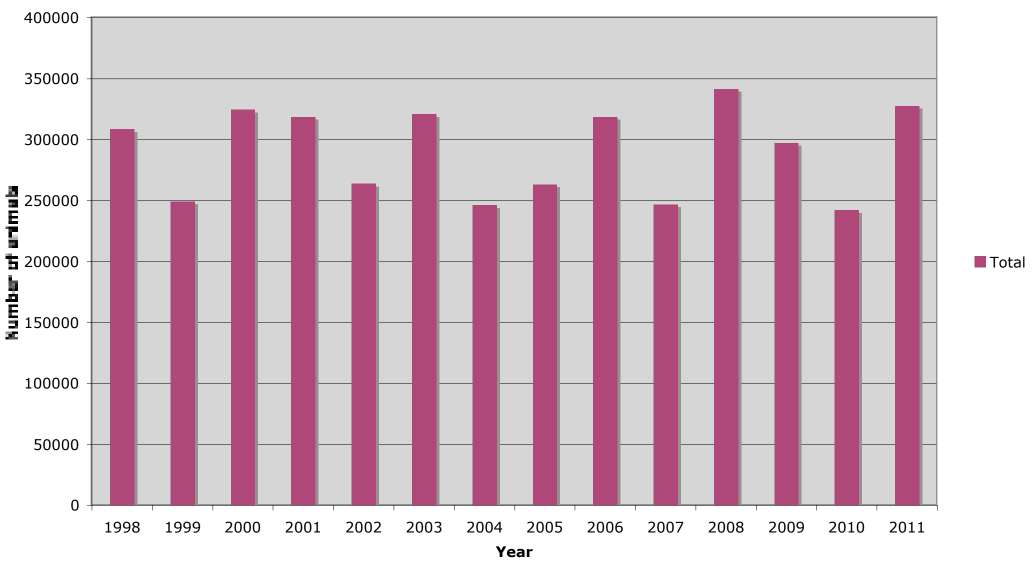
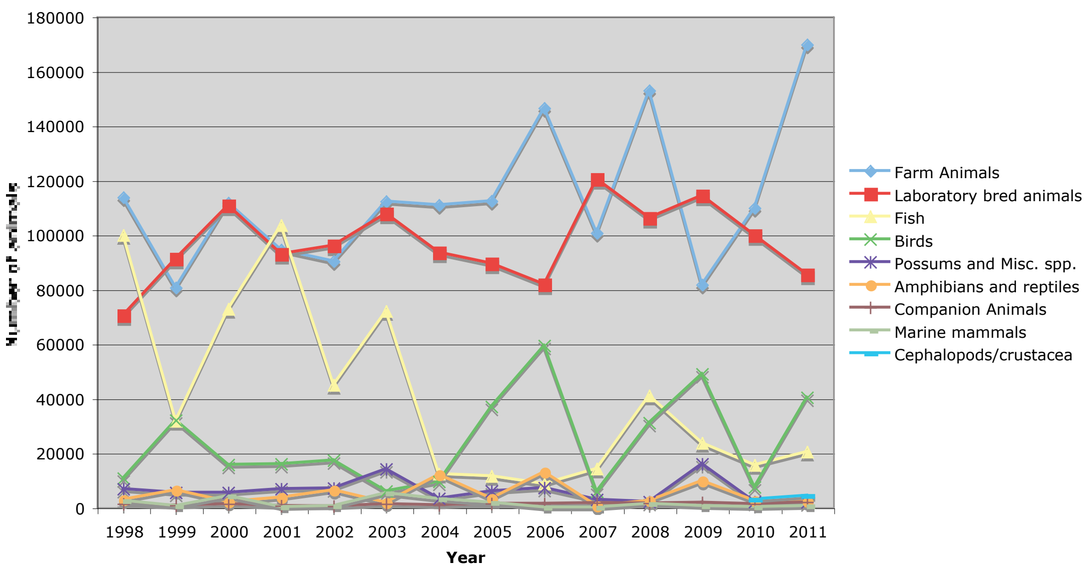
Total number of animals used in animal experiments in New Zealand (1998-2011)



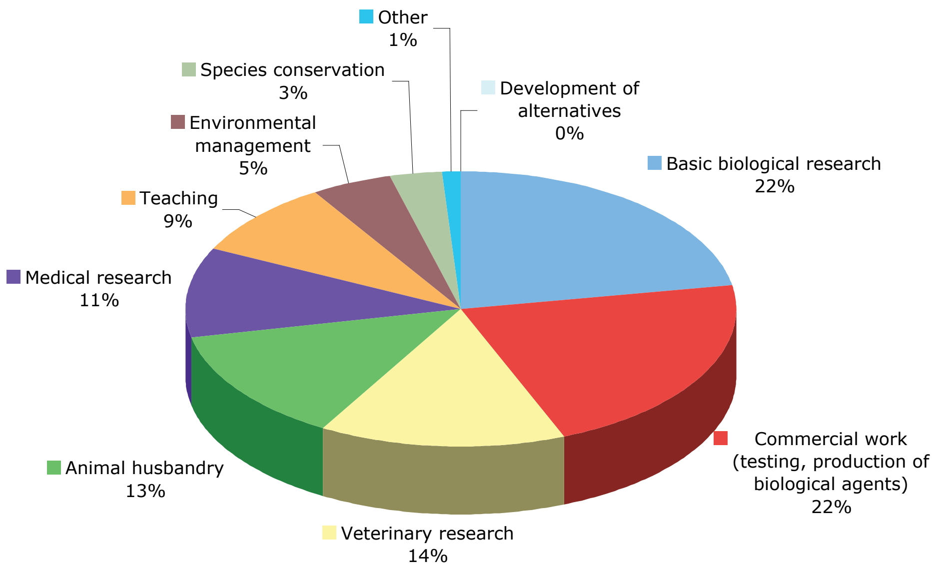
Types and number of animals used in animal experimentation in New Zealand (1998 - 2011)



Source information from: Ministry for Primary Industries. National Animal Ethics Advisory Committee Annual Reports 1998-2011.
www.biosecurity.govt.nz/regs/animal-welfare/naeac/annual-reports

SAFE Inc 2012

Purpose of animal experimentation in New Zealand (average percentage 2000-2011)



Basic biological research

Basic or pure research investigates how organisms behave, develop, and function. Those opposed to animal testing object that pure research may have little or no practical purpose, but researchers argue that it may produce unforeseen benefits, rendering the distinction between pure and applied research – research that has a specific practical aim – unclear.[102] Pure research uses larger numbers and a greater variety of animals than applied research. Fruit flies, nematode worms, mice and rats together account for the vast majority, though small numbers of other species are used, ranging from sea slugs through to armadillos.[103] Examples of the types of animals and experiments used in basic research include:

- Studies on *embryogenesis* and *developmental biology*. Mutants are created by adding transposons into their genomes, or specific genes are deleted by gene targeting.[104][105]

- Experiments into *behavior*, to understand how organisms detect and interact with each other and their environment, in which fruit flies, worms, mice, and rats are all widely used.[108][109] Studies of brain function, such as memory and social behavior, often use rats and birds.[110][111]

- Breeding experiments to study *evolution* and *genetics*. Laboratory mice, flies, fish, and worms are inbred through many generations to create strains with defined characteristics.[113] These provide animals of a known

genetic background, an important tool for genetic analyses. Larger mammals are rarely bred specifically for such studies due to their slow rate of reproduction, though some scientists take advantage of inbred domesticated animals, such as dog or cattle breeds, for comparative purposes. Scientists studying how animals evolve use many animal species to see how variations in where and how an organism lives (their niche) produce adaptations in their physiology and morphology.

http://en.wikipedia.org/wiki/Animal_testing - Pure_research

Commercial work

e.g. toxicology testing, cosmetics testing

Veterinary research

e.g castration and pain experiments

Animal husbandry

e.g domestic animals, production animals

Source information from: Ministry for Primary Industries. National Animal Ethics Advisory Committee Annual Reports 1998-2011.
www.biosecurity.govt.nz/regs/animal-welfare/naeac/annual-reports

SECTION 3

OTHER RESOURCES LINKS & GLOSSARY

Other resources, links and glossary

Electronic Texts

226 WEBSITE

- **PUBMED – NCBI** (National Centre for Biotechnology Information).

226 BOOKS

- ***Clean, Green, and Cruelty Free? The True Story of Animals in New Zealand.*** Amey, Catherine. 2007.
- ***Common Sense, Cognitive Ethology and Evolution.*** Bekoff, Marc. ***The Great Ape Project.*** Cavalieri, Paola and Singer, Peter (eds). 1993.
- ***The Use of Animals in Higher Education: Problems, Alternatives & Recommendations.*** Balcombe, Jonathan. 2000.

226 JOURNALS

- **AATEX** (Alternatives to Animal Testing and Experimentation). Japanese Society for Alternatives to Animal Experiments.
- **ALTA** (Alternatives to Laboratory Animals). FRAME (Fund for the Replacement of Animals in Medical Experiments).
- **ALTEX** (Alternatives to Animal Experimentation). Johns Hopkins University Center for Alternatives to Animal Testing. CAAT.
- **Society and Animals.** Brill.

227 JOURNAL ARTICLES

- **Altern Lab Anim.** Knight, Andrew. 'Systematic Reviews of Animal Experiments Demonstrate Poor Human Utility'. 2007.
- **ALTEX Proc.** Knight, Andrew. 'The Potential of Humane Teaching Methods Within Veterinary and Other Biomedical Education'. 2012.
- **ALTEX Proc.** Knight, Andrew. 'Weighing the Costs and Benefits of Animal Experiments'. 2012.
- **Biology and Philosophy.** Bekoff, Marc. 'Wild Justice and Fair Play: Cooperation, Forgiveness, and Morality in Animals'. 2004.
- **Encyclopaedia of Human-Animal Relationships.** Horowitz, A. In M. Bekoff (ed.), 'Anthropomorphism'. 2007.
- **International Studies in the Philosophy of Science.** LaFollette, Hugh and Shanks, Niall. 'Animal Experimentation: the Legacy of Claude Barnard'. 1994.
- **Society and Animals.** Lyons, Dan. 'Protecting Animals versus the Pursuit of Knowledge: The Evolution of the British Animal Research Policy Process'. 2011.
- **Society and Animals.** Perlo, Katherine. 'Would You Let Your Child Die Rather than Experiment on Nonhuman Animals?' 2003.

228 MAGAZINE ARTICLES

- **Ecologist.** *'Animal testing: science or fiction'.* Published May 2005.
- **Organic NZ.** *'GE in NZ: Trials and errors'.* Published July/August 2010.

229 NEWSPAPER ARTICLES

- **AP.** 'Technology replaces animal testing'. Published 14 January 2010.
- **Fairfax NZ News.** 'Experiments on animals exposed'. Published 3 October 2011.
- **Fairfax NZ News.** 'The moment lab dogs first tasted freedom'. Published 30 November 2011.
- **Kapi-Mana News.** 'Dumped beagle bodies beg several questions'. Published 10 January 2012.
- **NZ Anti-Vivisection Society**. Press release. 'Comvita NZ misleads'. Published 18 October 2012.
- **Scoop.** 'Science of animal testing thrown into doubt'. Published 6 May 2013.
- **Waikato Times.** 'Strong opposition to GE milk'. Tocker, Ali. Published 2 October 2012.

230 REPORTS

- **Alliance Against Vivisection.** Bourke, D. & Eden, M. *Lifting the Veil of Secrecy on Live Animal Experimentation.* 2003.
- **London British Union for the Abolition of Vivisection.** Langley, G. *Next of Kin: A Report on the Use of Primates in Experiments.* 2006.
- **Medical Research Modernization Committee.** Anderegg, C., Archibald, K., Bailey, J., Cohen, M.J., Kaufman, S.R. & Pippin, J.J. *A Critical Look at Animal Experimentation.* 2006.
- **Nuffield Council on Bioethics**. *The Ethics of Research Involving Animals.* 2005.

230 ONLINE VIDEOS

- **TVNZ News.** Dommisse, Elvira. *Dr Elvira Dommisse Discusses Cow Experiment.* 2011.
- **University of Toronto.** Greek, Ray. *Animal, Science, & Research.* 2011.

230 MINISTRY FOR PRIMARY INDUSTRIES PUBLICATIONS AND LEGISLATION

- **Animal Welfare.** 'Animal Use Statistics'. Published by Ministry of Agriculture and Forestry. November 2010.
- **Animal Welfare.** 'New Zealand Three Rs Programme Strategic Plan 2010-2015'. Published by Ministry of Agriculture and Forestry. October 2010.
- **National Animal Ethics Advisory Committee**. 'Guide to the Preparation of Codes of Ethical Conduct'. Published by Ministry of Agriculture and Forestry. February 2012.
- **National Animal Ethics Advisory Committee.** 'NAEAC Annual Reports'. Ministry for Primary Industries.
- **Policy Information Paper.** 'The Use of Animals in Research, Testing and Teaching: User's Guide to Part 6 of the Animal Welfare Act 1999'. MAF Policy Information Paper 33. Published by Ministry of Agriculture and Forestry. May 2000.

232 WEBSITE LINKS

- American Anti-Vivisection Society (AAVS) www.aavs.org
- Americans For Medical Advancement (AFMA) www.curedisease.com
- Andrew Knight, Bioethicist www.andrewknight.info/index.html
- Animal Aid www.animalaid.org.uk/
- Animal Defenders International (ADI) www.ad-international.org/adi_home/
- Animal Learn www.animalearn.org/
- Animals and Society www.animalsandsociety.org/
- Animals Australia www.animalsaustralia.org/issues/animal_experimentation.php
- British Union Against Vivisection (BUAV) www.buav.org
- Center for Alternatives to Animal Testing (CAAT) caat.jhsph.edu/
- Centre for Animals and Social Justice (CASJ) www.casj.org.uk/
- Choose Cruelty Free (CCF) www.choosecrueltyfree.org.au/
- Digital Frog www.digitalfrog.com/
- Frogs are cool www.frogsarecool.com/
- Fund for the Replacement of Animals in Medical Experiments (FRAME) www.frame.org.uk/
- GE-Free NZ www.gefree.org.nz/
- Humane Research Australia www.humaneresearch.org.au/
- In Defense of Animals (IDA) www.vivisectioninfo.org/
- International Foundation for Ethical Research www.ifer.org/
- InterNICHE www.interniche.org/
- Johns Hopkins University Bloomberg School of Public Health: Alternatives to Animal Testing altweb.jhsph.edu/
- Medical Research Modernization Committee (MRMC) www.mrmcmed.org/main.html
- National Anti-Vivisection Society (NAVS – UK) www.navs.org.uk/home/
- National Anti-Vivisection Society (NAVS – US) www.navs.org/
- New Zealand Anti-Vivisection Society (NZAVS) www.nzavs.org.nz/
- People for the Ethical Treatment of Animals (PETA) www.peta.org/issues/animals-used-for-experimentation/default.aspx
- Physicians Committee for Responsible Medicine (PCRM) www.pcrm.org/
- Replace Animals in Australian Testing (RAAT) www.uow.edu.au/arts/research/raat/index.html
- SAFE Shopper (SAFE Inc) safeshopper.org.nz/
- Save Animals From Exploitation (SAFE Inc) www.safe.org.nz/
- Soil and Health Association/Organic NZ www.organicnz.org/
- The European Coalition to End Animal Experiments (ECEAE) www.eceae.org/
- The Green Party www.greens.org.nz/ge
- The Humane Research Trust www.humaneresearch.org.uk/
- The Lord Dowding Fund for Humane Research www.ldf.org.uk/research/49/50/0/
- Uncaged www.uncaged.co.uk/

Visual and Oral Texts on DVD [R13]

CURRENT AFFAIRS

- **Campbell Live** Lab test beagles looking for homes, 30 November 2011, 14.43 min
- **Campbell Live** Animal ethics expert responds to dog research, 5 December 2011, 7.20 min
- **Campbell Live** More disturbing stories emerge from beagle research lab, 5 December 2011, 8.46 min
- **Campbell Live** Locals outraged over animal disposal, 6 December 2011, 5.33 min

EDUCATIONAL FILMS

- **Wasted Lives** The Case Against Animal Experiments, 3 July 2006, 20.14 min, ©Animal Aid
- **Safer Medicines** Drug testing procedures – how much has changed?, 2006, 26.40 min, ©Safer Medicines Trust
- **Their Future in your Hands** 10 May 2012, 10.44 min, ©Animal Aid

PLAY FOOTAGE

- **Kea – Mountain Parrot** Play footage (+ slow motion), 1993, 1.42 min, ©NHNZ
- **Dog watch** Play footage (+ slow motion), 3.08 min

DISSECTION – VIRTUAL

- **Frog and human circulatory system** Comparison of human and frog circulatory systems, 6.26 min

LECTURE

- **Andrew Knight** Ethical Objections to animal experimentation, 2012, 16.28 min, ©SAFE Inc

UNDERCOVER FOOTAGE

- **Animal testing at Wickham Labs** BUAV investigation at Wickham Laboratories, 2009, 7.44 min, ©BUAV

- **Beauchamp, Tom L. and Frey, R.G. *The Oxford Handbook of Animal Ethics*.** Oxford University Press. New York. 2011.

  This book of original essays is the most comprehensive single volume ever published on animal minds and the ethics of our use of animals.

- **Bekoff, Marc. *Minding Animals: Awareness, Emotions, and Heart.*** 2002.

  This book discusses the emotional and mental world of animals. Animal cognition, intelligence and consciousness are considered, along with the importance of responsible scientific practice and the moral and ethical obligations of scientists when studying animals.

- **Blum, Deborah. *Love at Goon Park: Harry Harlow and the Science of Affection.*** Perseus Publishing. 2002.

  In Love at Goon Park*, Deborah Blum charts the work of psychologist Harry Harlow, who conducted maternal separation and social isolation experiments on rhesus monkeys to study neglect on primates. The results of these experiments contradicted the popular notion that bodily contact between parents and children be limited or avoided to avoid spoiling children. They also disproved the assertion of the dominant behaviourist school of psychology, that emotions are trivial. Harlow's work led to a revolution in psychology and demonstrated that touch ensures emotional and intellectual health.*

  Love at Goon Park *is the biography of both a man and an idea, and ultimately invites us to examine ourselves and the way we love.*

- **Blum, Deborah. *The Monkey Wars.*** New York: Oxford University Press, USA. 1995.

  The Monkey Wars *tells the story of the people involved in the controversy over the use of primates in research. This issue is often inflamed by the combative stance of both researchers and animal activists. Blum interviews a wide variety of researchers (many of whom are forced to conduct their work protected by barbed wire fences and alarm systems) and activists (from the moderate Animal Welfare Institute to the highly radical Animal Liberation Front).*

- **Darwin, Charles. *The Descent of Man in Relation to Sex.*** The project Gutenberg Etext, August 2000 (Etext #2300).

  Darwin's second landmark work on evolutionary theory (following The Origin of the Species*) marked a turning point in the history of science with its modern vision of human nature as the product of evolution. Of particular relevance to the topic of animal experimentation are Chapter three (Comparison of the mental powers of man and the lower animals) and Chapter four (Summary of the last two chapters).*

- **Fano, Alix. *Lethal Laws: Animal Testing, Human Health and Environmental Policy.*** Zed Books (1st Edition). 1997.

  For the last 150 years industrial, agricultural and household chemicals have been tested on animals for the alleged purpose of protecting the public from their dangerous effects. Lethal Laws *shows that using animals as human surrogates is not only unethical, it is bad science.*

- **Francione, Gary L. *Animals, Property and the Law*.** Temple University Press, Philadelphia. 2000.

  Animals, Property and the Law *explores the moral issues relating to the suffering of animals and their legal status. It investigates why the law has failed to protect animals from exploitation. Gary Francione, Professor of Law and Nicholas de B Katzenbach Scholar of Law at Rutgers University Law School, thoroughly documents the paradoxical gap between our professed concern with humane treatment of animals and the overriding system of abuse permitted by US law.*

- **Francione, Gary L. *Introduction to Animal Rights: Your Child or the Dog?*** Temple University Press, Philadelphia. 1995.

  More than 50 per cent of Americans believe that it is wrong to kill animals for their fur, or to hunt them for sport. Yet these same Americans often eat hamburgers, take their children to circuses and rodeos, and use products developed with animal testing. How do we justify our inconsistency? This is an easy-to-read introduction, in which animal rights advocate Gary Francione looks at our conventional moral thinking about animals. Using examples, analogies and thought-experiments, he reveals the dramatic inconsistency between what we claim to believe about animals and how we actually treat them.

- **Francione, Gary L. and Charlton, Anne E. *Vivisection and Dissection in the Classroom: A Guide to Conscientious Objection.*** American Anti-Vivisection Society. 1992.

  Federal and state law in America provides protection to students who have a conscientious objection to harming animals in an educational context. This book is an informative guide for those students, with over 130 pages of practical and theoretical assistance on the issue of students' rights at every education level.

- **Greek, Ray and Greek, Jean Swingle. *Specious Science: How Genetics and Evolution Reveal Why Medical Research on Animals Harms Humans.*** Continuum. 2003.

  In their previous book, Sacred Cows and Golden Geese: The Human Cost of Experiments on Animals*, these authors demonstrated how an amorphous, insidious network of companies (including drug manufacturers, researchers and even cage manufacturers) perpetuated animal research in spite of its unpredictability when applied to humans. In accessible language,* Specious Science *follows up on these revelations by examining paediatrics, diseases of the brain, new surgical techniques, in vitro research, the Human Genome and Proteome Projects, and an array of scientific and technological breakthroughs.*

- **Greek, Ray and Greek, Jean Swingle. *What Will We Do If We Don't Experiment on Animals?*** Trafford Publishing. 2006.

  Why do we still use animals in testing drugs and searching for cures? Does the use of animals result in medical advancements? Are there better methods? In their third book, the authors discuss these questions and elucidate how we should proceed if we want to see cures for diseases like Aids, cancer, heart disease and Alzheimer's disease.

- **Greek, Ray and Shanks, Niall. *FAQs About the Use of Animals in Science: A Handbook for the Scientifically Perplexed.*** University Press of America. 2009.

  FAQs About the Use of Animals in Science *provides readers who are not extensively educated in science with a balanced critique of the practice of using animals in scientific research. Greek and Shanks discuss the concepts in an easy-to-understand style, avoiding jargon. This makes the book easily accessible to those who are not members of the scientific community.*

- **Jukes, Nick and Chiuia, Mihnea. *From Guinea Pig to Computer Mouse: Alternative Methods for a Progressive, Humane Education.*** International Network for Humane Education (InterNICHE). 2003.

  From Guinea Pig to Computer Mouse *provides a comprehensive collection of resources concerning curricular transformation (rather than mere curriculum development) and alternatives to the harmful use of animals in education.*

- **Kalof, L. and Fitzgerald, A. *The Animals Reader: The Essential Classic and Contemporary Writings.*** Oxford: New York: Berg. 2007. (Particularly Chapter 9: Rene Descartes: From the Letters of 1646 and 1649.)

  The Animals Reader *brings together key classic and contemporary writings from philosophy, ethics, sociology, cultural studies, anthropology, environmental studies, history, law and science. As the first book of its kind,* The Animals Reader *provides a framework for understanding the current state of the multidisciplinary field of animal studies.*

- **Kean, Hilda. *Animal Rights: Political and Social Change in Britain since 1800*.** London: Reaktion Books Ltd. 1998.

  Animal Rights: Political and Social Change in Britain since 1800 *concerns the cultural and social role of animals from 1800 to the present. It examines the relationship between popular images and public debate and action, from early campaigns against the beating of cattle and ill-treatment of horses to concern for dogs in war and cats in laboratories. Kean further illustrates how interest in animal rights and welfare was closely aligned with campaigns by feminists, radicals and socialists for political and social reform.*

- **Knight, Andrew. *Learning Without Killing: A Guide to Conscientious Objection.*** International Network for Humane Education (InterNICHE). 2002.

  Countless animals have lost their lives to teach practical skills and demonstrate scientific principles which have, in most cases, been established for decades. However, thousands of humane educational alternatives now exist. These include computer simulations, videos, plasticised specimens, ethically sourced cadavers (obtained from animals that have died naturally or been euthanised for medical reasons), models, diagrams, self-experimentation and supervised clinical experiences. This book is a resource for students and faculty involved in veterinary and other life sciences. It is aimed at accelerating and facilitating the transition towards animal-friendly learning.

- **LaFollette, Hugh and Shanks, Niall. *Brute Science: Dilemmas of Animal Experimentation.*** Routledge (1st Edition). 1997.

  Brute Science: Dilemmas of Animal Experimentation *investigates whether biomedical research using animals is scientifically justified. Animal experimentation is often defended by its apparent success in terms of increasing medical knowledge. However, the authors show that in scientific terms – using the models that scientists themselves use – these claims are exaggerated, and sometimes even false.*

- **Lansbury, Carol. *The Old Brown Dog: Women, Workers and Vivisection in Edwardian England.*** Madison: The University of Wisconsin Press Ltd. 1985.

  In this fascinating, engagingly written book, the author uses a series of 1907 riots in London concerning the erection of a statue of a brown dog to explore the connections between labour, feminists and anti-vivisectionist forces. Lansbury's contention is that workers and feminists identified themselves with the trembling animal strapped to the operating table. If the inflicting of pain on animals was justifiable, then who might be next? Lansbury supports her case through analysis of novels and events of the time, and also illuminates feelings behind today's animal rights movement. The passions aroused against vivisection ultimately were of little aid to the animals of the book's period, but this investigation of them is enlightening. [Amazon library journal review]

- **Lyons, Dan. *The Politics of Animal Experimentation.*** Palgrave Macmillan. 2013.

  This book examines the evolution of animal experimentation policy in Britain, the first country to pass laws in this area in 1876. It looks at the power struggle between animal advocates, animal research groups and the government as they interact to produce and implement policies intended to control the practice. It reveals that animal research interests have dominated this policy field to the exclusion of animal protection groups. As a result, animal welfare has had little influence which, combined with extreme levels of secrecy, has allowed researchers to regulate themselves. Ultimately, this has led to the licensing of experiments that would be deemed unnecessary cruelty by the public and would breach legal limits on animal suffering.

- **Regan, Tom. *The Case for Animal Rights.*** Berkley, Los Angeles: University of California Press. Revised Edition. 2004.

  The Case for Animal Rights *is an acknowledged classic of moral philosophy, and its author is established as an intellectual leader of the animal rights movement. In a new preface, Regan responds to his critics and defends the book's revolutionary stance.*

- **Ruesch, Hans. *Slaughter of the Innocent*.** Civitas. 1992.

  An often harrowing read but an important work on the subject of vivisection, Slaughter of the Innocent *coherently describes the injustices that vivisection causes both humans and animals.*

- **Ryder, Richard. *Victims of Science: The Use of Animals in Research.*** National Anti-Vivisection Society. 1983.

  Ryder gives a brief history of vivisection and of anti-vivisection movements. Surveying the uses to which laboratory animals are put, the author is particularly critical of their extensive use in testing the toxicity of various substances.

- **Sankoff, Peter and White, Steven. *Animal Law in Australasia: A New Dialogue.*** Federal Press. 2009.

  Animal Law in Australasia *looks at the legal relationship between humans and animals in Australia and New Zealand. It asks whether existing laws really do protect animals and, where the law comes up short, how it could be improved. Australian, New Zealand and international experts cover topics ranging from core concepts and theoretical questions around 'animal welfare' and law, to specific matters of concern: animal cruelty sentencing, live animal export, recreational hunting, and commercial uses of animals in farming and research. The questions explored go beyond animal welfare and challenge the reader to think about the nature of legal interests, and practical and ethical contexts for a range of laws.*

- **Shanks, Niall and Greek, C. Ray. *Animal Models in Light of Evolution.*** Brown Walker Press. Florida. 2009.

  The central concern of this book is with the 'prediction problem' in biomedical research. In particular, the authors examine the use of animal models to predict human responses in drug and disease research. Animal Models in Light of Evolution *looks at both sides of the scientific arguments relating to the use of animals in science, and concludes that there are areas in science where animals can be viably used but there are also areas where they cannot be so used.*

- **Sharpe, Robert. *The Cruel Deception: The Use of Animals in Medical Research.*** Harpercollins. 1988.

  Dr Sharpe (a former research chemist at the Royal Postgraduate Medical School in London) argues that vivisection misleads scientists and has done more harm than good.

- **Singer, Peter. *Animal Liberation: Second Edition.*** London: Pilmico. 1995. (More recent editions available.)

  Since its original publication in 1975, this groundbreaking work has awakened millions of people to the shocking abuse of animals everywhere. It inspired a worldwide movement to eliminate much of the cruel and unnecessary experimentation of years past. Singer offers sound humane solutions to what has become a profound environmental, social and moral issue.

- **Spiegel, Marjorie. *The Dreaded Comparison: Human and Animal Slavery*.** Mirror Books. 1997.

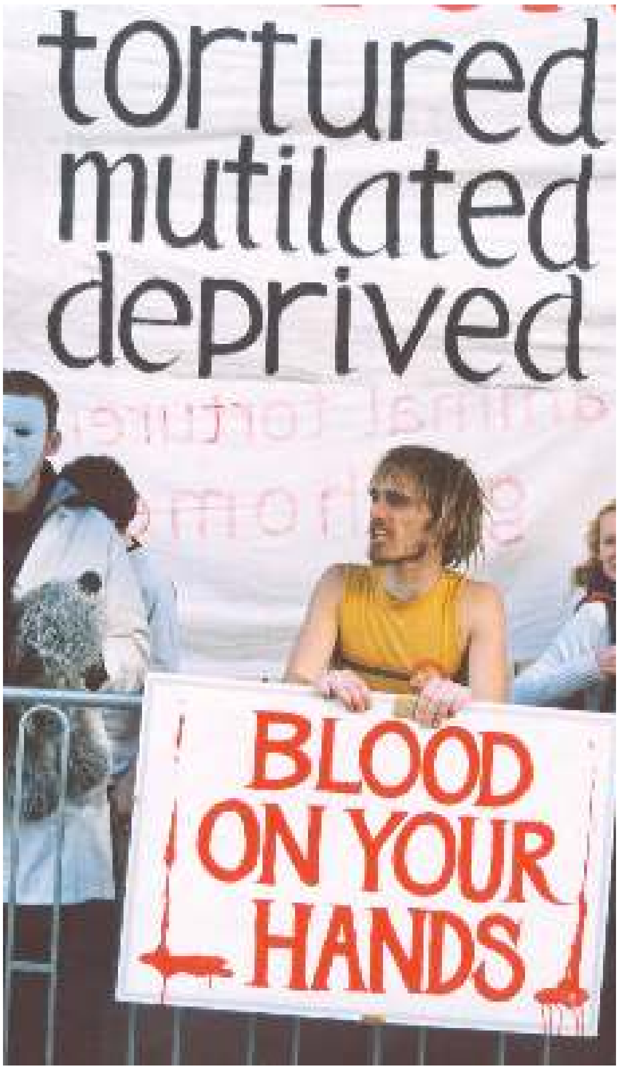
  Spiegel presents an in-depth exploration of the similarities between the violence humans have wrought against other humans and our culture's treatment of animals. The book links white oppression of black slaves with human oppression of animals. These comparisons include the brandings and auctions of both slaves and animals, the traumatic means of transport (slave ships, truckloads of cattle) and the tearing of offspring from their mothers. Spiegel's thesis is that the oppressions suffered by black people and animals share the same relationship between oppressor and the oppressed.

- **Wise, Steven M. *Drawing the Line: Science and the Case for Animal Rights.*** Basic Books. 2003.

  Are we ready for parrots and dolphins to be treated as persons before the law? Drawing the Line *is an exploration of animal cognition along the evolutionary spectrum – from infants and children to other intelligent primates; from dolphins, parrots, elephants and dogs to colonies of honeybees. Wise looks for answers to the big question in animal rights today: Where do we draw the line?*

- **Wise, Steven and Goodall, Jane. *Rattling the Cage: Toward Legal Rights for Animals*.** Perseus Publishing (1st Edition). 2001.

  In Rattling the Cage*, the authors argue that chimpanzees and bonobos (sometimes called 'pygmy chimpanzees') should be granted the status of legal personhood to guarantee the basic protections of bodily integrity and freedom from harm. This work presents a formidable challenge to the treatment of animals perpetrated by agribusiness, scientific research, the pharmaceutical industry, hunters, live-animal traders and others.*



Website

- **PUBMED – NCBI (National Centre for Biotechnology Information).** Retrieved 5 October 2012 from www.ncbi.nlm.nih.gov/pubmed

  PubMed comprises more than 22 million citations for biomedical literature from MEDLINE, life science journals and online books. Citations may include links to full-text content from PubMed Central and publisher websites. To search for published papers that involve animal experimentation, enter the animal and then the type of experiment (e.g. 'rat', 'cocaine'). This will bring up experiments performed on rats involving cocaine. If you want to know what experiments have taken place in New Zealand universities, enter the animal, experiment and location (e.g.'guinea pig', 'ear', 'Otago'). This will bring up experiments performed on guinea pigs that involve damaging the ears at the University of Otago.

Books

- **Amey, Catherine.** *Clean, Green, and Cruelty Free? The True Story of Animals in New Zealand.* Rebel Press. 2007. Retrieved 5 October 2012 from www.rebelpress.org.nz/publications/clean-green-and-cruelty-free

  Clean, Green, and Cruelty Free? *exposes the myth of New Zealand as a pristine and animal-friendly environment. Designed primarily as a resource for animal advocates, it will also be of interest to anyone concerned about animal suffering.*

- **Balcombe, Jonathan.** *The Use of Animals in Higher Education: Problems, Alternatives & Recommendations.* The Humane Society of the United States. 2000. Retrieved 5 October from www.humanesociety.org/assets/pdfs/parents_educators/the_use_of_animals_in_higher_ed.pdf

  Dr Balcombe has produced a masterly analysis of the pedagogical and ethical issues surrounding invasive animal study in the biology classroom and teaching laboratory. This volume should be required reading for every practising instructor in the life sciences at the high school and college levels. [George K Russell. PhD Professor Department of Biology, Adelphi University]

- **Bekoff, Marc.** *Common Sense, Cognitive Ethology and Evolution.* Marc Bekoff in *The Great Ape Project.* Eds Paola Cavalieri and Peter Singer. London: Fourth Estate. 1993, pp. 103-108. www.animal-rights-library.com/texts-m/bekoff01.htm

  In Common Sense, Cognitive Ethology and Evolution *Marc Bekoff urges that great apes be "admitted into the community of equals", on the basis of common sense, findings in cognitive ethology (the study of animal thinking, consciousness and mind) and the notion of evolutionary continuity.*

Journals

- **AATEX (Alternatives to Animal Testing and Experimentation).** Japanese Society for Alternatives to Animal Experiments. www.asas.or.jp/jsaae/e_aatex.html

  The JSAAE is an association of scientific professionals who are dedicated to promoting research, development, training and public awareness of alternatives to animal testing and the principle of the 'three Rs' concept of Russell and Burch (replacement, reduction and refinement). Replacement refers to adopting scientific methods that employ inanimate materials rather than sentient animals such as vertebrates. Reduction refers to decreasing the number of animals used in scientific research while maintaining an equivalent level of useful information. Refinement refers to modifying how animals are treated during experiments to lessen, minimise or eliminate pain and distress as well as to otherwise enhance animal welfare. The JSAAE is working to increase opportunities for Japanese researchers to promote their findings, and to gain greater worldwide recognition of Japan's efforts in this field.

- **ALTA (Alternatives to Laboratory Animals).** FRAME (Fund for the Replacement of Animals in Medical Experiments). www.frame.org.uk/page.php?pg_id=18

  An international, peer-reviewed scientific journal publishing articles on the latest research relating to the development, validation, introduction and use of alternatives to laboratory animals, ATLA has been a leading journal in the alternatives to animal testing field for more than 25 years and encourages informed debate through its editorials and comment section.

- **ALTEX (Alternatives to Animal Experimentation).** Johns Hopkins University Center for Alternatives to Animal Testing. CAAT. altweb.jhsph.edu/altex/archive.html

  ALTEX is dedicated to the publication of research on the development and promotion of alternatives to animal experiments according to the '3Rs'. ALTEX publishes original articles, short communications and reviews, as well as news and comments, meeting reports and book reviews.

- **Society and Animals.** Brill. www.ingentaconnect.com/content/brill/saa

  Society and Animals publishes studies that describe and analyse our experiences of non-human animals from the perspective of various disciplines within both the social sciences (e.g. psychology, sociology, anthropology, political science) and humanities (e.g. history, literary criticism). The journal specifically deals with subjects such as human-animal interactions in various settings, the applied uses of animals, the use of animals in popular culture (e.g. dog-fighting, circus, animal companion, animal research), attitudes towards animals as affected by different socialising agencies and strategies, *representations of animals in literature, the history of the domestication of animals, the politics of animal welfare and the constitution of the animal rights movement.*

Journal Articles

- **Bekoff, Marc.** 'Wild Justice and Fair Play: Cooperation, Forgiveness, and Morality in Animals'. *Biology and Philosophy* 19: 489-520. 2004. Retrieved 5 October 2012 from www.yale.edu/bioethics/documents/WildJusticearticle.pdf

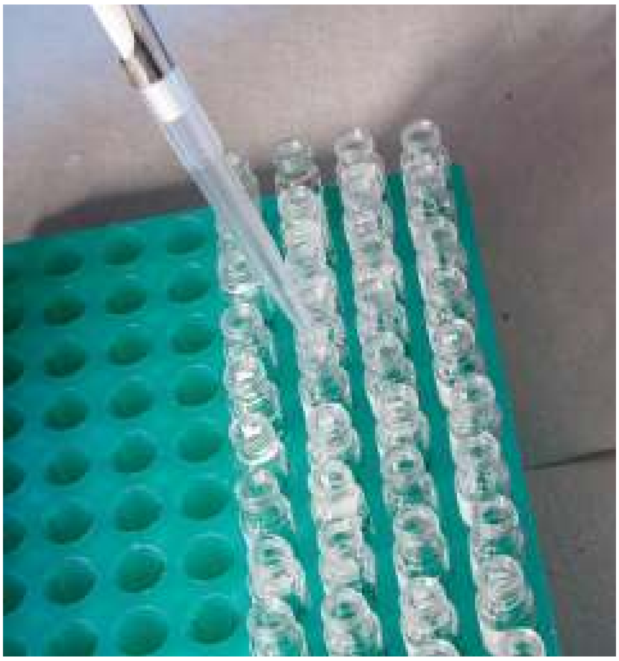
  In Wild Justice and Fair Play *Bekoff argues that we can learn much about 'wild justice' and the evolutionary origins of social morality – behaving fairly – by studying social play behaviour in group-living animals. He concludes that there is "strong selection for cooperative fair play in which individuals establish and maintain a social contract to play, because there are mutual benefits when individuals adopt this strategy, and group stability may also be fostered".*

- **Horowitz, A.** 'Anthropomorphism'. In M. Bekoff (ed), *Encyclopaedia of Human-Animal Relationships*. 60-66. 2007. Retrieved 8 October 2012 from crl.ucsd.edu/~ahorowit/publications.html

  Anthropomorphising (attributing human motivation, characteristics or behaviour to inanimate objects, animals or natural phenomena) is a natural human tendency, thought to be the result of a perceptual system designed to find order in a complex world. In this essay, Horowitz addresses questions about anthropomorphism such as: What is the history of our use of anthropomorphism? What does it mean – originally and by implication? Is it a bane or a blessing? Why do we anthropomorphise at all?

- **Knight, Andrew.** 'Systematic Reviews of Animal Experiments Demonstrate Poor Human Utility'. *Altern Lab Anim* 35(6): 641-659. 2007. Retrieved 5 October 2012 from www.andrewknight.info/publications/anim_expts_overall/sys_reviews/sys_reviews.html

  The assumption that animal models are reasonably predictive of human outcomes provides the basis for their widespread use in toxicity testing and in biomedical research aimed at developing cures for human diseases. Knight investigates the validity of this assumption by searching the comprehensive Scopus biomedical bibliographic databases for published systematic reviews of the human clinical or toxicological utility of animal experiments. In 20 reviews in which clinical utility was examined, Knight concludes that in only two cases were animal models either significantly useful in contributing to the development of clinical interventions or substantially consistent with clinical outcomes.



Journal Articles

- **Knight, Andrew.** 'The Potential of Humane Teaching Methods Within Veterinary and Other Biomedical Education'. *ALTEX Proc 2012*; 1: 365-375. Retrieved 5 October 2012 from www.andrewknight.info/publications/humane_educ/humane_educ/humane_educ.html

  Animal use resulting in harm or death has historically played an integral role in veterinary education, in disciplines such as surgery, physiology, biochemistry, anatomy, pharmacology and parasitology. Studies of veterinary students were reviewed, comparing learning outcomes generated by non-harmful teaching methods with those achieved by harmful animal use. The evidence demonstrates that veterinary educators can best serve their students and animals, while minimising financial and time burdens, by introducing well-designed teaching methods not reliant on harmful animal use.

- **Knight, Andrew.** 'Weighing the Costs and Benefits of Animal Experiments'. *ALTEX Proc 2012*; 1: 289-294. Retrieved 5 October 2012 from www.andrewknight.info/publications/anim_expts_overall/summaries/summaries.html

  By surveying the published literature to locate relevant systematic reviews, Knight examines the human benefits and animal impacts resulting from invasive animal research. Knight recommends a range of policy initiatives to address his finding that the actual human benefit is rarely – if ever – sufficient to justify the costs to the animals involved.

- **LaFollette, Hugh and Shanks, Niall.** 'Animal Experimentation: the Legacy of Claude Bernard'. *International Studies in the Philosophy of Science.* 195-210 (1994). Retrieved 5 October 2012 from www.hughlafollette.com/papers/BERNARD.HTM

  In the nineteenth century, physiologist Claude Bernard set out the principles of experimental medicine. He continues to be cited by scientists who wish to provide a scientific justification for animal experimentation. Bernard's pioneering work in physiology – particularly his methodological prescriptions – strongly influenced the institution of a paradigm governing biomedical research using animals. LaFollette et al argue that medical advance has likely been hindered by researchers' continued acceptance of the Bernardian paradigm.

- **Lyons, Dan.** 'Protecting Animals versus the Pursuit of Knowledge: The Evolution of the British Animal Research Policy Process'. *Society and Animals* 19: 356-367. 2011. Retrieved 5 October 2012 from doctordanlyons.wordpress.com/

  Blog title 'Paper reveals research cruelty and official wrongdoing'. September 30, 2011. Go to the second paragraph of this blog to download the article and click 'You can download a copy of the article from here'. Lyons describes a critical case study based on unprecedented primary data: pig-to-primate organ transplantation conducted between 1995 and 2000. He reveals that researchers and regulators significantly underestimated the adverse effects suffered by the animals involved, while overestimating the scientific and medical benefits likely to accrue. The author seeks to clarify not only what has been happening to animals in British laboratories but why, and how democratic or politically legitimate those outcomes are.

- **Perlo, Katherine.** 'Would You Let Your Child Die Rather than Experiment on Nonhuman Animals?' *Society and Animals* 11.1 51-67 (2003). Retrieved 5 October 2012 from www.animalsandsociety.org/assets/library/492_s1114.pdf

  In Would You Let Your Child Die Rather than Experiment on Nonhuman Animals?*, Perlo analyses the deceptiveness and inconsistency of the title question's implied claims. The author argues that while a 'No' answer does not necessarily support the experimental status quo, even a 'Yes' answer does not reflect a choice between one's own child and animals.*

Magazine Articles

- **'Animal testing: science or fiction'.** Published May 2005. *Ecologist*. Retrieved 7 November 2012 from www.theecologist.org/investigations/health/269704/animal_testing_science_or_fiction.html

  The above links to a sample of the original article, which shows how testing on animals does not necessarily mean drugs are safe for human use. Adverse drug reactions are one of the leading causes of death after cancer, heart disease and stroke, killing more than 10,000 people a year in the UK (and more than 100,000 in the US) and costing the NHS alone £466m per year.

- **'GE in NZ: Trials and errors'.** Published July/August 2010. *Organic NZ*. Retrieved 12 November 2012 from www.organicnz.org.nz/node/502

  Claire Bleakley provides an overview of the main field trials of genetically engineered animals and plants in New Zealand over the past two decades, with a focus on the recent acceleration of GE animal experimentation.

Newspaper Articles

- **'Comvita NZ misleads'.** Published 18 October 2012. Press Release: *NZ Anti-Vivisection Society.* Retrieved 19 October 2012 from www.scoop.co.nz/stories/PO1210/S00287/comvita-nz-misleads.htm

  A representative from natural health and beauty company Comvita stated that "Comvita does not carry out or fund any sort of animal testing". However, Comvita subsequently admitted their involvement in animal testing after being provided with evidence by NZAVS (The NZ Anti-Vivisection Society) that contradicted their earlier claims.

- **'Dumped beagle bodies beg several questions'.** Published 10 January 2012. *Kapi-Mana News.* Retrieved 19 October 2012 from www.stuff.co.nz/dominion-post/news/local-papers/kapi-mana-news/opinion/6233296/Dumped-beagle-bodies-beg-several-questions

  An opinion article by Dr Ian Schraa, an experienced veterinarian and the owner of Rappaw Veterinary Care. Schraa discusses a recent news story about the bodies of beagle dogs and pups found dumped in plastic bags in the backyard of Valley Animal Research Centre in Himatangi, near Palmerston North.

- **'Experiments on animals exposed'.** Published 3 October 2011. *Fairfax NZ News.* Retrieved 19 October 2012 from www.stuff.co.nz/life-style/wellbeing/5721727/Experiments-on-animals-exposed

  A new online product guide created by animal welfare group Save Animals From Exploitation (SAFE) will allow consumers to easily establish whether products on supermarket or pharmacy shelves have been tested on animals.

- **'Science of animal testing thrown into doubt'.** 6 May 2013. By Pat Dutt and Jonathan Latham, PhD. Retrieved 7 May 2013 from www.scoop.co.nz/stories/SC1305/S00025/science-of-animal-testing-thrown-into-doubt.htm

  New scientific research casts grave doubt on the safety testing of hundreds of thousands of consumer products, food additives and industrial chemicals.

- **'Strong opposition to GE milk'.** Published 2 October 2012. *Waikato Times.* Tocker, Ali. Retrieved 5 October 2012 from www.stuff.co.nz/waikato-times/farming/7756978/Strong-opposition-to-GE-milk

  Crown research institute AgResearch has announced a world-first breakthrough in genetic modification research, with the goal of producing hypoallergenic (low allergy) milk. GE Free New Zealand is strongly opposing AgResearch's use of genetic modification in pursuit of allergen-free milk for children.

- **'Technology replaces animal testing'.** Published 14 January 2010. *AP*. Retrieved 19 October 2012 from www.stuff.co.nz/life-style/beauty/3231525/Technology-replaces-animal-testing

  Technology allowing cosmetic makers to test for allergic reactions to their products without controversial animal trials is being developed by cosmetics maker L'Oreal. It is designed to replace tests on mice and guinea pigs used to predict skin reactions from drugs and cosmetics.

- **'The moment lab dogs first tasted freedom'.** Published 30 November 2011. *Fairfax NZ News*. Retrieved 19 October 2012 from www.stuff.co.nz/world/6060177/The-moment-lab-dogs-first-tasted-freedom

  Briefly discusses the rescue of 40 beagles from product-testing labs in Spain by The Beagle Freedom Group. The dogs had been kept in cages their entire lives, and were some of the first rescued by the group.

Reports

- **Anderegg, C., Archibald, K., Bailey, J., Cohen, M.J., Kaufman, S.R. & Pippin, J.J.** 'A Critical Look at Animal Experimentation'. *Medical Research Modernization Committee.* 2006. Retrieved 5 October 2012 from www.mrmcmed.org/Critical_Look.pdf

  In A Critical Look at Animal Experimentation *the authors argue that the value of animal experimentation has been grossly exaggerated by those with a vested economic interest in its preservation. They claim that considerable evidence demonstrates that animal experimentation is inefficient and unreliable, while newly developed methodologies are more valid and less expensive than animal studies.*

- **Bourke, D. & Eden, M.** 'Lifting the Veil of Secrecy on Live Animal Experimentation'. *Alliance Against Vivisection.* 2003.

  Lifting the Veil *takes a candid look at animal experimentation in New Zeland. It discusses the inadequate legislation that fails to protect laboratory animals. It outlines problems with reporting and the classification of experiments, and exposes a culture of secrecy in which is it almost impossible to find out what is happening in New Zealand animal laboratories. www.animalsandus.org.nz/animals_in_science.html*

- **Langley, G.** 'Next of Kin: A Report on the Use of Primates in Experiments'. *London British Union for the Abolition of Vivisection*. 2006. Retrieved 8 October 2012 from www.buav.org/_lib/userfiles/files/Science_Reports/Next_of_Kin_Primate_Report.pdf

  Langley discusses the increasingly contentious issue of primate use in research, from the perspective that there is no biological rationale for morally discriminating between humans and other primates.

- **Nuffield Council on Bioethics.** 'The Ethics of Research Involving Animals'. *Nuffield Council on Bioethics.* 2005. Retrieved 8 October 2012 from www.nuffieldbioethics.org/sites/default/files/The%20ethics%20of%20research%20involving%20animals%20-%20full%20report.pdf

  The complex ethical issues raised by research involving animals are discussed in detail. The report calls for a better understanding of the scientific and ethical issues involved, and for avoiding the polarisation of views, which the authors claim often stifles informed debate.

Online Videos

- **Dr Elvira Dommisse.** 'Dr Elvira Dommisse Discusses Cow Experiment'. 29 Dec 2011. *TVNZ News.* Retrieved 25 February 2013 from tvnz.co.nz/national-news/dr-elvira-dommisse-discusses-cow-experiment-video-3505454

  Dr Elvira Dommisse discusses the deaths of some cows involved in a GM experiment in New Zealand.

- **Dr Ray Greek.** 'Animal, Science, & Research' at the University of Toronto, 19 Sept 2011. Retrieved 19 February 2013 from vimeo.com/30357037

  Dr Ray Greek discusses the predictive value of using animals as models for disease and as test subjects during drug manufacture. He concludes that animals cannot predict human response to drugs and disease.

Ministry for Primary Industries Publications and Legislation

- **Animal Welfare.** 'Animal Use Statistics'. Published by *Ministry of Agriculture and Forestry*. November 2010. Retrieved 19 October 2012 from www.biosecurity.govt.nz/regs/animal-welfare/pubs/animals-used-in-research#3

  Provides information on legal requirements and guidance on how to provide the animal use information required by MAF.

- **Animal Welfare.** 'New Zealand Three Rs Programme Strategic Plan 2010-2015'. Published by *Ministry of Agriculture and Forestry*. October 2010. Retrieved 16 May 2013 from www.biosecurity.govt.nz/regs/animal-welfare/pubs/animals-used-in-research

  The above link provides information on New Zealand's three Rs programme (replacement, reduction and refinement), designed to minimise pain and distress to animals used for research, and to reduce the number of animals used in experiments.

- **National Animal Ethics Advisory Committee.** 'Guide to the Preparation of Codes of Ethical Conduct'. Published by *Ministry of Agriculture and Forestry*. February 2012. Retrieved 19 October 2012 from www.biosecurity.govt.nz/animal-welfare/naeac/papers/naeaccec.htm

  This guide is designed to assist persons wishing to apply for, or renew, a code of ethical conduct under section 87 of the Animal Welfare Act 1999 and gives additional information on what should be contained in such codes.

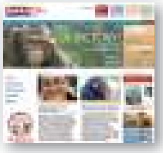
- **National Animal Ethics Advisory Committee.** 'NAEAC Annual Reports'. *Ministry for Primary Industries.* Retrieved 16 May 2013 from www.biosecurity.govt.nz/regs/animal-welfare/pubs/annual-reports-and-newsletters

  Links to the annual reports of the National Animal Ethics Advisory Committee (NAEAC), which plays an essential role in ensuring the integrity of the regulatory system governing the use of animals in research, testing and teaching (RTT) in New Zealand.

- **Policy Information Paper.** 'The Use of Animals in Research, Testing and Teaching: Users Guide to Part 6 of the Animal Welfare Act 1999'. MAF Policy Information Paper 33. Published by *Ministry of Agriculture and Forestry*. May 2000. www.biosecurity.govt.nz/regs/animal-welfare/pubs/animals-used-in-research#3

  Provides a general overview of the use of animals in research, testing and teaching, which comes under part 6 of the Animal Welfare Act 1999.

- **American Anti-Vivisection Society (AAVS)** www.aavs.org

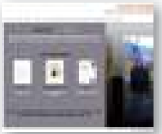


Founded in 1883, the American Anti-Vivisection Society (AAVS) is the first non-profit animal advocacy and educational organisation in the United States dedicated to ending experimentation on animals in research, testing and education.

- **Americans For Medical Advancement (AFMA)** www.curedisease.com

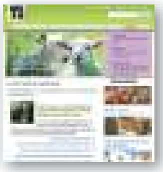
Americans For Medical Advancement (AFMA) is a not-for-profit organisation that promotes biomedical research and the practice of medicine based on critical thinking and our current understanding of evolutionary and developmental biology, complex systems and genomics.

- **Andrew Knight, Bioethicist** www.andrewknight.info/index.html



Australian bioethicist and veterinarian Andrew Knight is the Director of Animal Consultants International, which provides multidisciplinary expertise for animal advocacy campaigns.
He is a Fellow of the Oxford Centre for Animal Ethics, holds a postgraduate Certificate in Animal Welfare Science and is a Consultant Editor for the *Journal of Animal Ethics*. His book *The Costs and Benefits of Animal Experiments* was published by Palgrave Macmillan in 2011.

- **Animal Aid** www.animalaid.org.uk/



Animal Aid is the UK's largest animal rights group. It campaigns peacefully against all forms of animal abuse and promotes a cruelty-free lifestyle. It investigates and exposes animal cruelty, and its undercover investigations and other evidence are often used by the media, bringing these issues to public attention.

- **Animal Defenders International (ADI)** www.ad-international.org/adi_home/

This group of organisations – Animal Defenders International, the National Anti-Vivisection Society and the Lord Dowding Fund for Humane Research – work together globally for the protection of animals.

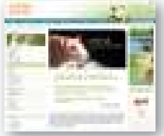
- **Animal Learn** www.animalearn.org/

Animal Learn works to foster an awareness of and a respect for animals used in education. It strives to eliminate the use of animals in education and is dedicated to assisting educators and students to find the most effective non-animal methods to teach and study science.

- **Animals and Society** www.animalsandsociety.org/

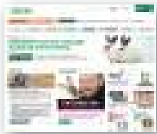
The Animals and Society Institute develops knowledge in the field of human-animal studies, supports practice to address the relationship between animal cruelty and other violence, and promotes action to protect animals through the adoption of ethical, compassionate public policy.

- **Animals Australia** www.animalsaustralia.org/issues/animal_experimentation.php



Animals Australia is Australia's foremost national animal protection organisation, representing some 40 member societies and thousands of individual supporters. Animals Australia has an unprecedented track record in investigating and exposing animal cruelty and conducting world-first strategic public awareness campaigns.

- **British Union Against Vivisection (BUAV)** www.buav.org

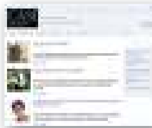


For over 100 years the BUAV has been campaigning peacefully to create a world where nobody wants or believes we need to experiment on animals. The BUAV is widely respected as an authority on animal testing issues and is frequently called upon by governments, media, corporations and official bodies for its advice or expert opinion.

- **Center for Alternatives to Animal Testing (CAAT)** caat.jhsph.edu/

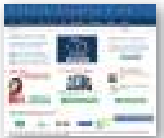
The Johns Hopkins Center for Alternatives to Animal Testing (CAAT) is a small non-profit centre.
The CAAT promotes humane science by supporting the creation, development, validation and use of alternatives to animals in research, product safety testing and education. It seeks to effect change by working with scientists in industry, government and academia to find new ways to replace animals with non-animal methods, reduce the numbers of animals necessary, or refine methods to make them less painful or stressful to the animals involved.

- **Centre for Animals and Social Justice (CASJ)** www.casj.org.uk/



The Centre for Animals and Social Justice (CASJ) is a new think tank founded by leading academics and animal advocates, which heralds a unique and innovative approach to advancing animal protection. It is dedicated to research, education and policy engagement that establish animals' rightful status as recipients of social justice.

- **Choose Cruelty Free (CCF)** www.choosecrueltyfree.org.au/



Choose Cruelty Free (CCF) is an independent, non-profit Australian organisation which actively promotes a cruelty-free lifestyle.

- **Digital Frog** www.digitalfrog.com/

Since 1995, Digital Frog International has been creating great educational natural science software that is in use in classrooms around the world. It started with a simple virtual frog dissection program, and grew to create award-winning programs covering all aspects of natural science, from ecosystems to the inner workings of cells, all with an interface unique to Digital Frog International.

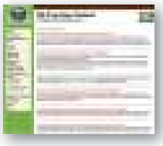
- **Frogs are cool** www.frogsarecool.com/

Frogs are Cool is a Canadian online resource for students seeking alternatives to animal dissection.

- **Fund for the Replacement of Animals in Medical Experiments (FRAME)** www.frame.org.uk/

FRAME's ultimate aim is the elimination of the need to use laboratory animals in any kind of medical or scientific procedure. It is dedicated to the development of new and valid methods that will replace the need for laboratory animals in medical and scientific research, education and testing.

- **GE-Free NZ** www.gefree.org.nz/



GE-Free New Zealand in Food & Environment (Rage Inc) is a non-profit organisation. Activities include writing and presenting submissions and calling expert witnesses on the problems of genetic engineering in New Zealand.

- **Humane Research Australia** www.humaneresearch.org.au/

Humane Research Australia Inc is a not-for-profit organisation that challenges the use of animals in research and promotes the use of more humane and scientifically valid non-animal methodologies.

- **In Defense of Animals (IDA)** www.vivisectioninfo.org/

IDA's mission is to end animal exploitation, cruelty and abuse by protecting and advocating for the rights, welfare and habitats of animals, as well as to raise their status beyond mere property, commodities or things.

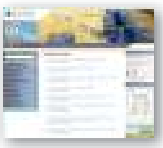
- **International Foundation for Ethical Research** www.ifer.org/

The International Foundation for Ethical Research is dedicated to supporting the development and implementation of scientifically valid alternatives that refine, reduce or replace the use of live animals in research, product testing and classroom education.

- **InterNICHE** www.interniche.org/

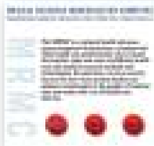
InterNICHE is the International Network for Humane Education. InterNICHE aims for high-quality, fully humane education and training in medicine, veterinary medicine and biological science. It supports progressive science teaching and the replacement of animal experiments by working with teachers to introduce alternatives and with students to support freedom of conscience.

- **Johns Hopkins University Bloomberg School of Public Health: Alternatives to Animal Testing** altweb.jhsph.edu/



Altweb, the Alternatives to Animal Testing Website, was created to serve as a gateway to alternative news, information and resources on the internet and beyond. Altweb now is the US home of the journal *ALTEX: Alternatives to Animal Experimentation*, which is the official publication of the Johns Hopkins Center for Alternatives to Animal Testing (CAAT).

- **Medical Research Modernization Committee (MRMC)** www.mrmcmed.org/main.html



The MRMC is a national health advocacy group composed of physicians, scientists and other health care professionals who evaluate the benefits, risks and costs of different healthcare and medical research methods and technologies.

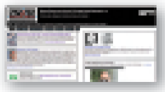
- **National Anti-Vivisection Society (NAVS – UK)** www.navs.org.uk/home/

The National Anti-Vivisection Society (NAVS) is the world's first organisation campaigning against animal experiments, having been founded in 1875 by Miss Frances Power Cobbe, a great humanitarian who published many leaflets and articles opposing animal experiments, and gathered many notable people of the day to support the cause.

- **National Anti-Vivisection Society (NAVS – US)** www.navs.org/

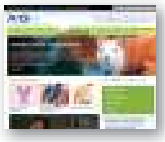
Founded in 1929, the National Anti-Vivisection Society (NAVS) is an educational organisation whose ultimate goal is the elimination of animal use in product testing, education and biomedical research. For more than 80 years, it has sought to identify the cruelty and waste of vivisection and to convince the general public to work actively for its ultimate abolition.

- **New Zealand Anti-Vivisection Society (NZAVS)** www.nzavs.org.nz/



Founded in 1978 by Bette Overell, the New Zealand Anti-Vivisection Society is an incorporated society that is working for the abolition of vivisection on the grounds that it is scientific fraud.

- **People for the Ethical Treatment of Animals (PETA)** www.peta.org/issues/animals-used-for-experimentation/default.aspx

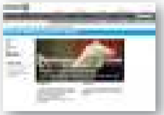


People for the Ethical Treatment of Animals (PETA) is the largest animal rights organisation in the world, with more than three million members and supporters. PETA focuses its attention on the four areas in which the largest numbers of animals suffer the most intensely for the longest periods of time: on factory farms, in the clothing trade, in laboratories and in the entertainment industry.

- **Physicians Committee for Responsible Medicine (PCRM)** www.pcrm.org/

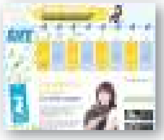
Since 1985, PCRM has been influencing advancements in medicine and science. PCRM advocates for preventive medicine, especially good nutrition, conducts clinical research and advocates for higher ethical standards in research. Its membership includes 150,000 healthcare professionals and concerned citizens.

- **Replace Animals in Australian Testing (RAAT)** www.uow.edu.au/arts/research/raat/index.html

  RAAT aims to create a network of researchers and other individuals or groups interested in advocating non-animal based research and in strengthening the Australian Government/NHMRC guidelines and their enforcement.

- **SAFE Shopper (SAFE Inc)** safeshopper.org.nz/

  The SAFE Shopper is designed to help you become a caring consumer when shopping anywhere – in your supermarket, pharmacy, department store and online.

- **Save Animals From Exploitation (SAFE Inc)** www.safe.org.nz/

  New Zealand's largest and most respected animal rights organisation. Founded in 1932, SAFE's aim is to make significant improvements in the lives of animals by raising awareness, challenging cruel practices, changing attitudes and fostering compassion so that they are no longer exploited or abused.

- **Soil and Health Association/Organic NZ** www.organicnz.org/

  The Soil and Health Association is the largest membership organisation supporting organic food and farming in New Zealand. It works to keep New Zealand farming, our food supply and the environment free of genetic engineering.

- **The European Coalition to End Animal Experiments (ECEAE)** www.eceae.org/

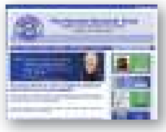
  The European Coalition to End Animal Experiments (ECEAE) was formed in 1990 by organisations across Europe to successfully campaign to ban cosmetics testing on animals.

- **The Green Party** www.greens.org.nz/ge

  The Green Party has opposed the release of GE into the environment and has worked in Parliament to improve legislation covering GE organisms. The Green Party remains committed to keeping the Aotearoa/New Zealand environment free of GE organisms.

- **The Humane Research Trust** www.humaneresearch.org.uk/

  The Humane Research Trust is a registered charity encouraging and supporting new medical research which does not include the use of animals, with the objective of advancing the diagnosis and treatment of disease in humans. The Trust encourages scientists to develop innovative alternatives to the use of animals, and so eliminate the suffering of animals which occurs in medical research and testing in this and other ways.

- **The Lord Dowding Fund for Humane Research** www.ldf.org.uk/research/49/50/0/

  The objectives of the Lord Dowding Fund for Humane Research are: to support and fund better methods of scientific and medical research for testing products and curing disease which replace the use of animals; to fund areas of fundamental research which lead to the adoption of non-animal research methodology; to fund, promote and assist medical, surgical and scientific research, learning, and educational training and processes for the purpose of replacing animals in education and training; and to promote and assist any research for the purpose of showing that animal research is harmful or unnecessary to humanity.

- **Uncaged** www.uncaged.co.uk/

  Founded in November 1993 by Angela Roberts and Lynn Williamson, and based in Sheffield, England, Uncaged campaigns against animal experiments and in particular against xenotransplantation (animal to human transplants).

Acoustic: relating to sound or the sense of hearing.

Adaptation: the process of change by which an organism or species becomes better suited to its environment.

Aetiology: the causation of diseases and disorders as a subject of investigation.

Agonistic: associated with conflict.

Altruism: *(zoology)* behaviour of an animal that benefits another at its own expense.

Anaesthesia: insensitivity to pain, especially as artificially induced by the administration of gases or the injection of drugs before surgical operations.

Anaesthetic: a substance that induces insensitivity to pain.

Analgesic: (of a drug) acting to relieve pain.

Anatomy: the branch of science concerned with the bodily structure of humans, animals and other living organisms, especially as revealed by dissection and the separation of parts.

Anthropomorphism: the attribution of human characteristics or behaviour to a god, animal or object.

Antibiotic: a medicine (such as penicillin or its derivatives) that inhibits the growth of or destroys microorganisms.

Antiphonal: sung, recited or played alternately by two groups.

Arboreal: relating to trees.

Atavistic: relating to or characterised by reversion to something ancient or ancestral.

Autocratic: taking no account of others' wishes or opinions; domineering.

Automaton: a machine which performs a range of functions according to a predetermined set of coded instructions.

Autonomous: having the freedom to act independently.

Autopsy: a post-mortem examination to discover the cause of death or the extent of disease.

Behaviour: the way in which an animal or person behaves in response to a particular situation or stimulus.

Bioassay: measurement of the concentration or potency of a substance by its effect on living cells or tissues.

Bioethics: the ethics of medical and biological research.

Biology: the study of living organisms, divided into many specialised fields that cover their morphology, physiology, anatomy, behaviour, origin and distribution.

Brand: an identifying mark burned on livestock with a branding iron.

Canid: a mammal of the dog family.

Carcinogen: a substance capable of causing cancer in living tissue.

Cardiovascular: relating to the heart and blood vessels.

Carnivore: an animal that feeds on other animals.

Castrate: remove the testicles of (a male animal or man).

Catheter: a flexible tube inserted through a narrow opening into a body cavity, particularly the bladder, for removing fluid.

Caudate nucleus: the upper of the two grey nuclei of the corpus striatum in the cerebrum of the brain.

Cauterise: burn the skin or flesh of (a wound) with a heated instrument or caustic substance in order to stop bleeding or to prevent infection.

Cephalopod: an active predatory mollusc of the large class *Cephalopoda*, such as an octopus or squid.

Cerebral cortex: the outer layer of the cerebrum, composed of folded grey matter and playing an important role in consciousness.

Clone: an organism or cell, or a group of organisms or cells, produced asexually from one ancestor or stock to which they are genetically identical.

Cognition: the mental action or process of acquiring knowledge and understanding through thought, experience and the senses.

Commensalism: an association between two organisms in which one benefits and the other derives neither benefit nor harm.

Conduction: the process by which sound waves travel through a medium.

Conspecific: belonging to the same species.

Coronary: relating to or denoting the arteries which surround and supply the heart.

Correlation: a mutual relationship or connection between two or more things.

Corticosterone: a hormone secreted by the adrenal cortex, one of the glucocorticoids.

Cull: reduce the population of (a wild animal) by selective slaughter.

Cytotoxic: toxic to living cells.

Democratic: favouring or characterised by social equality; egalitarian.

Desensitise: make (someone) less likely to feel shock or distress at scenes of cruelty or suffering by overexposure to such images.

Diagnostic imaging: the use of electromagnetic radiation to produce images of internal body structures for diagnosis.

Dialect: a particular form of a language which is peculiar to a specific region or social group.

Diuretic: (chiefly of drugs) causing increased passing of urine.

Diurnal: active in the daytime.

DNA: deoxyribonucleic acid, a self-replicating material which is present in nearly all living organisms as the main constituent of chromosomes. It is the carrier of genetic information.

Draize test: a pharmacological test in which a substance is introduced into the eye of a laboratory animal in order to ascertain the likely effect of that substance on the corresponding human tissue.

Ecological: relating to or concerned with the relation of living organisms to one another and to their physical surroundings.

Egalitarianism: of, relating to or believing in the principle that all people are equal and deserve equal rights and opportunities.

Embryo: an unborn or unhatched offspring in the process of development.

Empathy: the ability to understand and share the feelings of another.

Empirical: based on, concerned with or verifiable by observation or experience rather than theory or pure logic.

Encroachment: a gradual advance beyond usual or acceptable limits.

Endocrinology: the branch of physiology and medicine concerned with endocrine glands and hormones.

Enzyme: a substance produced by a living organism which acts as a catalyst to bring about a specific biochemical reaction.

Epidemiology: the branch of medicine which deals with the incidence, distribution and possible control of diseases and other factors relating to health.

Epigenetic: resulting from external rather than genetic influences.

Ethics: moral principles that govern a person's behaviour or the conducting of an activity.

Ethnology: the study of the characteristics of different peoples and the differences and relationships between them.

Ethogram: a catalogue or table of all the different kinds of behaviour or activity observed in an animal.

Ethology: the science of animal behaviour.

Eusocial: denoting social organisms (e.g. the honeybee) in which a single female or caste produces the offspring and non-reproductive individuals cooperate in caring for the young.

Euthanise: put (an animal) to death humanely.

Evolution: the process by which different kinds of living organism are believed to have developed from earlier forms during the history of the earth.

Evolve: develop over successive generations as a result of natural selection.

Exploit: make use of (a situation) in a way considered unfair or underhand.

Extinct: (of a species, family or other large group) having no living members.

Extrapolate: extend the application of a method or conclusion to an unknown situation by assuming that existing trends will continue or similar methods will be applicable.

Fauna: the animals of a particular region, habitat or geological period.

FDA: US Food and Drug Administration.

Fertilise: cause (an egg, female animal or plant) to develop a new individual by introducing male reproductive material.

Fledged/fledgling: having wing feathers that are large enough for flight; able to fly.

Flora: the plants of a particular region, habitat or geological period.

Foetus/fetus: an unborn or unhatched offspring of a mammal, in particular an unborn human more than eight weeks after conception.

Forage: search widely for food or provisions.

Gastrointestinal: relating to the stomach and the intestines.

Gene: a unit of heredity which is transferred from a parent to offspring and is held to determine some characteristic of the offspring.

Genetically modified (GM): (of an organism) containing genetic material that has been artificially altered so as to produce a desired characteristic.

Genetic engineering: the deliberate modification of the characteristics of an organism by manipulating its genetic material.

Genotype: the genetic constitution of an individual organism.

Habitat: the natural home or environment of an animal, plant or other organism.

Handicap: a condition that markedly restricts the ability to function physically, mentally or socially.

Hepatocyte: a liver cell.

Hominid: a primate of a family (*Hominidae*) which includes humans and their fossil ancestors.

Homologous: (*biology*) similar in position, structure and evolutionary origin.

Hypothesis: a supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation.

Immunocompromised: having an impaired immune system.

Impala: a graceful antelope often seen in large herds in open woodland in southern and East Africa.

Inbreeding: breed from closely related people or animals, especially over many generations.

Infrasound: sound waves with frequencies below the lower limit of human audibility.

Innate: inborn; natural.

Intercorrelation: a mutual relationship or connection between two or more things.

Interpolate: insert (an intermediate value or term) into a series by estimating or calculating it from surrounding known values.

Intraspecific: produced, occurring or existing within a species or between individuals of a single species.

***In utero*:** in a woman's uterus; before birth.

Invasive: (of medical procedures) involving the introduction of instruments or other objects into the body or body cavities.

Invertebrate: an animal lacking a backbone, such as an arthropod, mollusc, annelid, coelenterate, etc. Compare with vertebrate.

In vitro: taking place in a test tube, culture dish or elsewhere outside a living organism.

In vivo: taking place in a living organism.

Involuntary: done without will or conscious control.

Juvenile: relating to young birds and animals.

Kinematic: the features or properties of motion in an object.

Laboratory: a room or building equipped for scientific experiments, research or teaching, or for the manufacture of drugs or chemicals.

LD50: lethal dose (of a toxic compound, drug or pathogen). It is usually written within a following numeral indicating the percentage of a group of animals or cultured cells killed by such a dose.

Locomotion: movement or the ability to move from one place to another.

Magnetic resonance imaging: a technique for producing images of bodily organs by measuring the response of the atomic nuclei of body tissues to high-frequency radio waves when placed in a strong magnetic field.

Malamute: a powerful dog of a breed with a thick grey coat, bred by the Inuit and used to pull sledges.

Mammal: a warm-blooded vertebrate animal of a class that is distinguished by the possession of hair or fur, the secretion of milk for the nourishment of young, and (typically) the birth of live young.

Matriarch: a female who is the head of a family or tribe.

Maxilla: the jaw or jawbone, specifically the upper jaw in most vertebrates.

Metabolism: the chemical processes that occur within a living organism in order to maintain life.

Methodology: a system of methods used in a particular area of study or activity.

Microcinematography: the use of motion pictures taken through magnifying lenses to study an organ or system in motion. *(From http://medical-dictionary.thefreedictionary.com/)*

Morphology: the branch of biology that deals with the form of living organisms, and with relationships between their structures.

Mutualism: symbiosis which is beneficial to both organisms involved.

Necropsy: another term for autopsy.

Neophobia: extreme or irrational fear or dislike of anything new or unfamiliar.

Neuroanatomy: the anatomy of the nervous system.

Neurobiology: the biology of the nervous system.

Neuroendocrine: relating to or involving both nervous stimulation and endocrine secretion.

Neurophysiological: relating to the physiology of the nervous system.

Neuroscience: any or all of the sciences, such as neurochemistry and experimental psychology, which deal with the structure or function of the nervous system and brain.

Niche: a role taken by a type of organism within its community.

NIH: National Institutes of Health.

Nocturnal: done, occurring or active at night.

Noxious: harmful, poisonous or very unpleasant.

Olfactory: relating to the sense of smell.

Ontogenesis: the development of an individual organism or anatomical or behavioural feature from the earliest stage to maturity.

Opportunistic: exploiting immediate opportunities, especially regardless of planning or principle.

Organelle: any of a number of organised or specialised structures within a living cell.

Ovary: a female reproductive organ in which ova or eggs are produced, present in humans and other vertebrates as a pair.

Palliative: relieving pain without dealing with the cause of the condition.

Parasite: an organism which lives in or on another organism (its host) and benefits by deriving nutrients at the other's expense.

Pathology: the science of the causes and effects of diseases, especially the branch of medicine that deals with the laboratory examination of samples of body tissue for diagnostic or forensic purposes.

Perceptual: relating to the ability to interpret or become aware of something through the senses.

Periophthalmic: around the eye.

Pharmaceutical: a compound manufactured for use as a medicinal drug.

Phenomenology: an approach that concentrates on the study of consciousness and the objects of direct experience.

Phenotype: the set of observable characteristics of an individual resulting from the interaction of its genotype with the environment.

Philosophy: the study of the fundamental nature of knowledge, reality and existence, especially when considered as an academic discipline.

Phylogenesis: the evolutionary development and diversification of a species or group of organisms, or of a particular feature of an organism.

Physiology: the branch of biology that deals with the normal functions of living organisms and their parts.

Placenta: a flattened circular organ in the uterus of pregnant eutherian mammals, nourishing and maintaining the foetus through the umbilical cord.

Predator: an animal that naturally preys on others.

Premeditate: think out or plan (an action) beforehand.

Propagate: reproduce by natural processes.

Prosimian: a primitive primate of a group that includes the lemurs, lorises, bushbabies and tarsiers.

Psychological: of, affecting or arising in the mind.

Purloin: steal (something).

Reciprocity: the practice of exchanging things with others for mutual benefit.

Reflex: an action that is performed without conscious thought as a response to a stimulus.

Reproduce: produce offspring by a sexual or asexual process.

Sanctuary: a place where injured or unwanted animals of a specified kind are cared for.

Savannah: a grassy plain in tropical and subtropical regions, with few trees.

Sear: burn or scorch the surface of (something) with a sudden intense heat.

Seismic: relating to or denoting geological surveying methods involving vibrations produced artificially by explosions.

Semaphore: a system of sending messages by holding the arms or two flags or poles in certain positions according to an alphabetic code.

Sentient: able to perceive or feel things.

Serendipity: the occurrence and development of events by chance in a happy or beneficial way.

Socio-scientific: socio-scientific issues involve the deliberate use of scientific topics that require students to engage in dialogue, discussion and debate. They are usually controversial in nature but have the added element of requiring a degree of moral reasoning or the evaluation of ethical concerns in the process of arriving at decisions regarding possible resolution of those issues. The intent is that such issues are personally meaningful and engaging to students, require the use of evidence-based reasoning and provide a context for understanding scientific information.

Somatosensory: relating to or denoting a sensation (such as pressure, pain or warmth) which can occur anywhere in the body, in contrast to one localised at a sense organ (such as sight, balance or taste).

Spontaneous: (of movement or activity in an organism) instinctive or involuntary.

Stereotactic: relating to or denoting techniques for surgical treatment or scientific investigation that permit the accurate positioning of probes inside the brain or other parts of the body.

Stereotypic behaviour: a repetitive or ritualistic movement, posture or utterance, sometimes seen in captive animals, particularly those held in small enclosures with little opportunity to engage in more normal behaviours. This behaviour may be maladaptive, involving self-injury or reduced reproductive success.

Stimulus: a thing or event that evokes a specific functional reaction in an organ or tissue.

Stoicism: the endurance of pain or hardship without the display of feelings and without complaint.

Supererogation: the performance of more work than duty requires.

Synchronise: occur at the same time or rate.

Telemeter: an apparatus for recording the readings of an instrument and transmitting them by radio.

Teratogen: an agent or factor which causes malformation of an embryo.

Thalamus: either of two masses of grey matter lying between the cerebral hemispheres on either side of the third ventricle, relaying sensory information and acting as a centre for pain perception.

Thalidomide: a drug formerly used as a sedative, but withdrawn in the UK in the early 1960s after it was found to cause congenital malformation or absence of limbs in children whose mothers took the drug during early pregnancy.

Theological: relating to the study of the nature of God and religious belief.

Tomography: a technique for displaying a representation of a cross section through a human body or other solid object using X-rays or ultrasound.

Toxicology: the branch of science concerned with the nature, effects and detection of poisons.

Tranquilliser: a medicinal drug taken to reduce tension or anxiety.

Transgenic: relating to or denoting an organism that contains genetic material into which DNA from an unrelated organism has been artificially introduced.

Triangulation: formation of or division into triangles.

Tuberculosis: an infectious bacterial disease characterised by the growth of nodules (tubercles) in the tissues, especially the lungs.

Ultrasound: sound or other vibrations having an ultrasonic frequency, particularly as used in medical imaging.

Umwelt: the world as it is experienced by a particular organism.

UNESCO: United Nations Educational, Scientific, and Cultural Organization.

Vertebrate: an animal of a large group distinguished by the possession of a backbone or spinal column, including mammals, birds, reptiles, amphibians and fishes. Compare with invertebrate.

Veterinarian/veterinary surgeon: a person qualified to treat diseased or injured animals.

Vibrissae: long stiff hairs growing around the mouth or elsewhere on the face of many mammals, used as organs of touch; whiskers.

Vivisection: the practice of performing operations on live animals for the purpose of experimentation or scientific research.

Vocalise: utter (a sound or word).

Voluntary: under the conscious control of the brain.

Wean: accustom (an infant or other young mammal) to food other than its mother's milk.

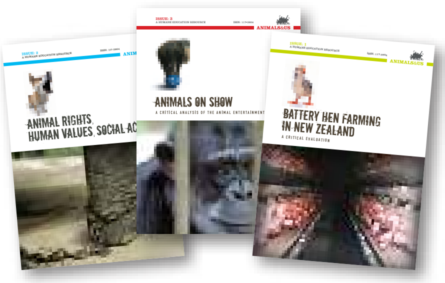
Xenotransplantation: the process of grafting or transplanting organs or tissues between members of different species.

Yearling: an animal that is a year old or that is in its second year.

ANIMALS&US

Animals & Us is a SAFE humane education programme designed to advance knowledge and critical thinking about the relationship between human and non-human animals, while fostering attitudes and values of compassion, respect and empathy.

www.animalsandus.org.nz



PUBLISHED RESOURCES:

ISSUE 1 – **Battery Hen Farming in New Zealand**

ISSUE 2 – **Animal Rights, Human Values, Social Action**

ISSUE 3 – **Animals on Show**

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