

ANIMAL EXPERIMENTATION AND XENOTRANSPLANTATION

WHAT ARE VIVISECTION, DISSECTION, AND XENOTRANSPLANTATION?

Vivisection, from the Latin words "vivis" (life) and "sectus" (to cut), means cutting, performing surgery or other invasive treatment, on a living organism for the purposes of scientific investigation. The earliest references to animal testing are found in the writings of the Greeks in the second and fourth centuries BCE.

Dissection means the process of cutting apart or separating tissue—to study anatomy, for example. This term usually applies to work on dead animals, nonhuman or human.

Xenotransplantation is the transplanting of living organs, tissues, or cells from one species to another, such as from nonhuman animals to humans.

HOW MANY EXPERIMENTS ARE PERFORMED ANNUALLY AND WHERE?

Accurate, worldwide figures for the number and species of animals used in experiments are not readily available to the public because regulations do not require that these figures be reported.

- The British Union for the Abolition of Vivisection (BUAV) estimates that 100 million animals are experimented on around the world annually, 10–11 million of them in the European Union.
- The U.K. Nuffield Council on Bioethics reports that the number of animals experimented on worldwide ranges from 50 to 100 million, not including animals bred for research and killed as surplus or used for breeding purposes.
- The U.S. Department of Agriculture (USDA) lists the total number of animals used in the U.S. in 2002 as 1,137,718, not counting birds, mice, and rats, who make up around 85% of research animals. The species used, as listed by the USDA in 2004, were 64,932 dogs, 23,640 cats, 54,998 nonhuman primates, 244,104 guinea pigs, 175,721 hamsters, 261,573 rabbits, 105,678 farm animals, and 171,312 other mammals, a total of 1,101,958 animals, a figure that includes all mammals except purpose-bred mice and rats.
- A U.S. Congress Office of Technology Assessment report stated that the number of animals used in the U.S. each year ranges from 10–100 million, and their own best estimate is at least 17–22 million.

Experiments on living animals are performed in universities, medical schools, pharmaceutical companies, farms, defense-research establishments, and commercial facilities that provide animal-testing services to industries. Most animals are bred for research purposes, but some are caught in the wild or supplied by municipal pounds.

Nearly 6 million dissections of dead animals are performed annually in the U.S. and as many as 20 million or more worldwide. Most animals used in dissection—including amphibians, birds, snakes, turtles, fish, and invertebrates—are taken from the wild, even though many species have been declining in population. Smithsonian Institution researchers who surveyed 14 major dissection supply catalogs found only one that offered "farm-raised" amphibians; none of the others verified their sources. Analysts estimate that as many as 6 million wild frogs are destroyed each year in the U.S. alone for dissection, even though one-third of amphibian species, including frogs, are threatened with extinction.

WHAT HAPPENS TO THE ANIMALS AFTER THE EXPERIMENTS ARE FINISHED?

Most animals who are the subjects of vivisection die during the experiments or are euthanized afterwards. Many who survive the experiments are "recycled" into additional experiments. Some are kept for years in barren holding facilities until they die. A lucky few are rescued by animal organizations that negotiate their release and transport them to sanctuaries.

WHO FUNDS THE EXPERIMENTS?

Most experiments performed in the U.S. are funded by the government, from taxpayer dollars. The National Aeronautics and Space Administration (NASA), the Departments of Defense, Energy, and Agriculture, the National Science Foundation, and the National Institutes of Health (NIH) all fund animal experiments. The use of monkeys, rats, mice, dogs, hamsters, guinea pigs cats, and other species costs U.S. taxpayers approximately \$8.5 billion annually and has increased over 37% in the last 10 years. Many of the projects funded by the NIH are duplicates. For example, in one recent year, the NIH funded 286 studies on the effect of cocaine in rats.

WHAT TYPES OF EXPERIMENTS ARE DONE?

The categories of research are basic—to satisfy curiosity and with no practical purpose; applied—with a specific, practical aim; or conducted by educational institutions, including dissection of animals in schools.

Applied research includes toxicity testing of agricultural and industrial chemicals, pharmaceuticals, cosmetics, and household products. Common toxicity tests include the Draize and the LD-50 (lethal dose 50) tests.

In the Draize test, a substance to be tested is applied to an animal's eye (most commonly a rabbit) for four hours or more. Often, the substance is applied a second time. The animals are observed for up to two weeks to see if their eyes become swollen, ulcerated, hemorrhage, or if they go blind. After the test, the animals are killed. Critics of the Draize test claim it is cruel and unscientific because of the differences between rabbit and human eyes and because the results are often not accurate. There is also a Draize test for skin irritation. In this test, the fur and top layer of skin are removed. The substance is applied (repeatedly in some cases) and covered so it cannot be rubbed or licked off.

In the LD-50 test, a substance is force-fed or injected into animals, or the animals are irradiated, and the point at which half of them die is considered the lethal dose. This test is not reliable and results may vary greatly between testing facilities because of factors such as the genetic characteristics of the sample population, the species tested (what is safe for a rat may be toxic to humans, for example, and vice versa), environmental factors, and the mode of administration. Results can vary greatly even between members of the same species, because of gender and genetic make-up. The LD-50 measures only acute toxicity, not chronic toxicity at lower doses, and it does not take into account effects that are serious but not lethal, such as brain damage, loss of memory, headaches, numbness in limbs, loss of hearing, or other long-term effects.

These represent only a few of the kinds of experiments done. Others include testing for military purposes and psychological experimentation, such as Harry Harlow's infamous maternal deprivation experiments on monkeys. In Harlow's experiments, infant monkeys were separated from their mothers and given wire mother figures or nothing. Critics, including mental health professionals, noted that human society includes countless babies and children abandoned by their mothers, and that they would make more relevant subjects for maternal deprivation studies than baby monkeys forcibly taken from their mothers.

WHAT LAWS PROTECT ANIMALS IN EXPERIMENTS?

In the U.S., the Animal Welfare Act is the only legislation governing animal experiments. Well over 90% of animals used in experiments in the U.S., mostly mice, rats, and birds, are explicitly excluded from protection under this Act. Some sources report that as few as 1% of the animals used in research in the U.S. are protected by legislation, and that even this minor protection can be amended to accommodate the researchers. No restrictions limit what type of experiments can be done. Animals are routinely given addictive drugs, poisonous chemicals, and electric shocks; they are burned, blinded, deprived of food and water, and isolated and confined in small enclosures.

Experiments, often referred to as procedures, can last a few minutes, several months, or many years, and a large number do not include relief for pain or distress or post-procedure care. According to researchers, over half the experiments in Britain in 2004—1,710,760—either did not require anesthesia, or anesthetics were not used because, they stated, doing so might interfere with the results of the experiment. Painkillers (analgesics) were frequently not used.

In March 2009, the European Union (EU) banned animal testing during the production of cosmetic products within Europe, and it banned any products that have been tested on animals or contain animal-tested ingredients from being imported and sold in EU member countries. (Three categories of tests were exempted from the ban until 2013.) Cosmetic companies worldwide will now be required to implement animal-free testing programs for their ingredients and products in order to compete in the European market. An estimated 38,000 animals are used and killed to develop cosmetics in the EU every year.

In September 2010, the EU banned the use of great apes (such as chimpanzees, gorillas, orangutans, and bonobos) in all animal testing.

ARGUMENTS FOR AND AGAINST ANIMAL EXPERIMENTATION

Supporters of animal research believe that nonhuman animals are essential tools to be used for potential human benefit. Opponents of animal research, including many scientists, argue that animal testing is unnecessary and bad science, that it diverts funds and time from more productive research and actual help to suffering people, that it is poorly regulated and gives the public a false sense of security about substances tested on animals, that its costs outweigh its benefits, or that animals have an intrinsic right not to be used for experimentation. Animal experimentation is one of the most controversial of all the animal issues because of the long-held belief that such experiments are essential to achieve medical progress. Experimenting on animals and treating symptoms are accorded a higher priority than preventative medicine (preventing disease from occurring).

Ethical issues

Is it morally acceptable to experiment on other species who cannot give their consent? Once, it was considered morally acceptable to conduct painful experiments on people of a different race, or those considered to be intellectually inferior. It is now generally agreed that this is unethical.

Supporters of experiments on animals believe it is acceptable to cause suffering to other species if the experiments have the potential to help humans. Opponents of animal experimentation believe that causing suffering to non-voluntary subjects is morally wrong regardless of the possible benefits to humans.

Scientific issues

Scientific issues include the accuracy of methods and results, and the best use of financial and other resources.

Supporters of animal experimentation believe there is no substitute for living systems to study the interaction among cells, tissues, and organs. They see animals as useful surrogates because of their similarities to humans, and they believe animal experiments are the best use of resources.

Opponents of animal experiments believe that animal testing is bad science because in nature animals would never contract the diseases that are artificially induced in them in the laboratory, and the results do not mimic the disease process in humans. Physiological and social differences between humans and animals cause misleading results. Symptoms like numbness, pain, and memory or vision loss that result from procedures, products, or drugs can be accurately observed in humans but not in nonhuman animals, because animals cannot express to the scientists in words what they are feeling.

Drugs tested safe in animals can be dangerous or lethal to humans. Over 85% of drugs tested on animals are rejected at the clinical trial stage. Over 90% of all new drugs proven effective in animals do not work on humans. Approximately 15% of U.S. hospital admissions are caused by adverse drug reactions, which kill approximately 100,000 Americans annually, at a cost to the public of over \$136 billion annually.

Financial and other resources that could fund the development of more accurate alternatives or provide immediate relief to suffering people, such as drug addicts, go instead to fund experiments on animals that waste financial resources and animals' lives. Attitudes have begun to change, however.

Examples of changing scientific perspectives on animal testing

- For years, scientists claimed that tests on rodents' pancreases were essential to save the lives of human diabetics, but a 2006 report from the prestigious Diabetes Research Institute at the University of Miami Miller School of Medicine stated that rodent pancreases were so different from human pancreases, they were not "relevant for human studies."
- For many years, the NIH performed tests on and sacrificed thousands of mice in toxicity tests, until a September 2008 article in the *New England Journal of Medicine* revealed that the test results had no greater accuracy than the "flip of a coin." Shortly thereafter, the NIH switched to tests on humans.
- After performing toxicity tests on thousands of animals, the U.S. Environmental Protection Agency turned to a new strategy, described as follows in a report they issued:

"The overall goal of this strategy is to provide the tools and approaches to move from a near exclusive use of animal tests for predicting human health effects to a process that relies more heavily on *in vitro* assays, especially those using human cell lines."

Instead of using animals, they will focus on computer models, molecular biology, and cell cultures, using data from the human genome project, clinical trials, exposure assessments, and other technologies.

Examples of drugs tested safe on animals that harmed humans

In 1961, thalidomide, which had been tested on animals, was withdrawn from the market. Up to that point, this drug was responsible for severe birth defects in thousands of children. Since that well-known example, numerous other drugs tested on animals and prescribed for the treatment of various conditions have been withdrawn by the FDA because of significant adverse effects. These unexpected side effects include blindness, paralysis, cancer, kidney failure, liver failure,

cardiovascular events, seizures, psychosis, anemia, and death. See Resources, below, for links to lists of specific examples of these drugs.

Examples of wasteful experiments

- Adult cats with screws inserted into their skulls and who have the sound center of their brains removed still produce brain waves in response to loud noises. (UCLA Medical Center. Cost: \$2,018,000)
- Old rhesus monkeys do not learn as quickly or remember as well as young monkeys. (Boston University and Yerkes Regional Primate Research Center. Cost: \$1,225,000)
- Labrador Retriever puppies whose ankles have been surgically destroyed suffer weakness and loss of bone mass in the mutilated limb. (Case Western Reserve University. Cost: \$365,000)
- Rats continuously immersed in cold water eat more than do rats who are not immersed. The immersed rats, however, still have unusually low body weights. (Washington University School of Medicine. Cost: \$214,000)
- Six female baboons were implanted with catheters and then burned on over 50% of their body by immersion in boiling water. Liver biopsies were taken at varying intervals for 18 hours to observe effects of burn shock on liver function. (Cornell Medical Center. Cost of NIH grant: \$280,000)
- When white noise is played at unpredictable times and lengths to marmosets locked in cages side by side so they cannot see one another, they adapt their calls to one another to accommodate periods of silence between them. (Johns Hopkins University researchers, funded by the National Institutes of Health. Cost: over \$500,000 in 2012, \$3.4 million from 2003 to 2012, and is approved to continue through 2017)

Examples of delay of approval to release helpful drugs caused by animal tests

- The release of Digoxin to treat heart disorders was delayed because animal tests showed that it caused high blood pressure in animals, though digitalis, an analogue of digoxin, has been used by herbalists for centuries to treat heart disorders. How many lives were lost because its release was delayed?
- Penicillin was almost not used because it did not work in tests on rabbits. Alexander Fleming, its discoverer, said "How fortunate we didn't have these [government required] animal tests in the 1940s, for penicillin would probably never have been granted a license, and possibly the whole field of antibiotics might never have been realized."
- Fluoride was initially withheld from dental use because it causes cancer in rats.
- Because of animal studies, many scientists did not believe the pancreas was involved in diabetes or that a hormone such as insulin existed.
- Printing a health warning on cigarette packages was delayed for 15 years after the connection between cancer and cigarette smoking was known because scientists wanted to duplicate the results in nonhuman animals. Other species were and continue to be forced to inhale cigarette smoke.

ALTERNATIVES TO ANIMAL TESTS

Humane alternatives are often far more accurate and cost effective than animal models. They include computer and mathematical models, cell and tissue cultures, stem cell research, genetic research, clinical pharmacology, diagnostic imaging (MRI, CAT, and PET scans), post-marketing drug surveillance (to rapidly identify dangerous drugs and any unexpected beneficial side effects of drugs), and autopsies. Fewer and fewer autopsies are performed, despite the fact that they have been crucial to our understanding of heart disease, appendicitis, diabetes, Alzheimer's, and other diseases. They have also led to improved safety standards in cars and planes, alerted officials to growing threats of infection or drug addiction, and showed that "accidents" are sometimes suicides or homicides.

Epidemiology—population studies—offer an additional important alternative. Such studies uncovered Legionnaire's disease and many occupation-induced diseases, revealed that industrial chemicals are poisonous, and led to reforms in industrial health. They are also capable of analyzing cancer or birth-defect sufferers, for example, to learn the causes of these afflictions and prevention and treatment approaches.

Scientists at Brown University are now building three-dimensional structures out of living cells that will contain blood vessels and be able to simulate human organs. These structures will provide better models than animals to test drugs and procedures. The microtissue used to build the structures came from human surgical waste (neonatal foreskins, circumcised from newborns).

Massachusetts Institute of Technology professor, Linda Griffith, is developing a computer chip embedded in lab-cultured liver tissue. The chip will tell scientists how the cells—which behave like a normal human liver—react to new drugs or to other experiments. Griffith's goal is to build a full set of human organs with embedded chips that will enable scientists to study body functions without using animals.

MatTek Corporation already produces cultured skin tissue that can be used to test commercial products and to see how human skin will respond to chemicals or treatments. A European regulatory body recently validated MatTek's Modified Epiderm Skin Irritation Test as an accurate and reliable replacement for animal testing. Spokesperson for MatTek, Dave Ingalls, says "we've found that using [human equivalent] tissue is better science, more cost effective, and much more accurate than doing the same tests on animals."

XENOTRANSPLANTATION

Transplants of animal organs into humans have ultimately failed. Many transplant recipients died because their immune systems rejected the foreign organs. Researchers suggest that genetically engineered pigs without proteins that elicit an immune response could solve the rejection problem, but creating them involves invasive and potentially painful procedures. Primates, mainly baboons, used as experimental subjects to receive genetically engineered pig organs suffer enormously during experimental procedures.

A professional committee appointed by the British government to study the issue—the UK Xenotransplantation Interim Regulatory Authority—determined that the chances of xenotransplantation becoming a successful procedure are very small and the danger of pig viruses mutating and producing novel diseases in humans is unacceptably high.

Allotransplantation is the transplanting of organs, tissues, or cells sourced from a genetically non-identical member of the same species as the recipient. Encouraging people to donate organs is one solution to the problem of a shortage of organs for transplantation. Some European countries, including Austria, Belgium, and France, assume consent unless the deceased ordered that his or her organs should not be used. This approach has reduced the list of patients waiting for transplants. Preventive health measures, such as education about proper nutrition, can reduce the risk of chronic diseases that lead to organ malfunction, thereby eliminating the need for transplants.

Resources

Lesson Plan:

Learning About Life?

Fact Sheet:

Humane Science Projects

Books:

Bekoff, Marc. *The Emotional Lives of Animals: A Leading Scientist Explores Animal Joy, Sorrow, and Empathy—and Why They Matter*. Novato, CA: New World Library, 2008.

Greek, C. Ray and Jean Swingle Greek. *Specious Science: How Genetics and Evolution Reveal Why Medical Research on Animals Harms Humans*. New York: Continuum, 2002.

Greek, C. Ray and Jean Swingle Greek. *Sacred Cows and Golden Geese: The Human Cost of Experiments on Animals*. New York: Continuum, 2002.

Websites:

Anderegg, Christopher, et al. *A Critical Look at Animal Experimentation*. Medical Research Modernization Committee, 2006.

<http://www.mrmcmed.org/Critcv.html> OR <http://tinyurl.com/47bmau>

Brody, Jane E. "PERSONAL HEALTH; A Price to Pay as Autopsies Lose Favor." *The New York Times*, 9 January 2001.

<http://www.nytimes.com/2001/01/09/health/personal-health-a-price-to-pay-as-autopsies-lose-favor.html> OR <http://tinyurl.com/mj92xw>

Choinski, Elizabeth. "Animal Testing Alternatives: Online Resources." Science and Technology Sources on the Internet. University of Mississippi Libraries. Summer 2000.

<http://www.istl.org/00-summer/internet.html> OR <http://tinyurl.com/n2jy43>

"Dangerous Prescription: A Dirty Dozen." *PBS: Frontline*. 2003.

<http://www.pbs.org/wgbh/pages/frontline/shows/prescription/etc/dozen.html> OR <http://tinyurl.com/ykkps38>

EPA Office of the Science Advisor. "The U.S. Environmental Protection Agency's Strategic Plan for Evaluating the Toxicity of Chemicals." EPA/100/K-09/001, March 2009

http://www.epa.gov/osa/spc/toxicitytesting/docs/toxtest_strategy_032309.pdf OR <http://tinyurl.com/cgqwed>

"EU bans cosmetic testing on animals." *Marie Claire*. 12 March 2009.

<http://au.lifestyle.yahoo.com/b/marie-claire/7455/eu-bans-cosmetic-testing-on-animals/> OR <http://tinyurl.com/l4nr54>

Gentleman, Amelia and Andrew Osborn. "Secret French move to block animal-testing ban." *The Guardian*. 19 August 2003.

<http://www.guardian.co.uk/world/2003/aug/19/eu.businessofresearch> OR <http://tinyurl.com/lft6gt>

Gruber, Franz P. and David G. Dewhurst. "Alternatives to Animal Experimentation in Biomedical Education." ALTEX (Johns Hopkins, Alternatives to Animal Experiments) 21, Suppl. 1/04, 26 November 2004.

http://www.altex.ch/resources/gruberdewhurst_suppl_2004.pdf **OR** <http://tinyurl.com/7l8qdvs>

"List of withdrawn drugs." *Wikipedia, The Free Encyclopedia*. 29 September 2009.

http://en.wikipedia.org/wiki/List_of_withdrawn_drugs

Lister, Sam. "Animal experiments could end in a generation." *Animal Earth Human: Helping humans see animals in society*. 5 June 2009.

Web: <http://www.animalearthhuman.org/wordpress/?p=316> **OR** <http://tinyurl.com/6u4zzn3>

"New EU rules on animal testing ban use of apes." *The Independent*. 12 September 2010.

<http://www.independent.co.uk/life-style/health-and-families/new-eu-rules-on-animal-testing-ban-use-of-apes-2077443.html> **OR** <http://tinyurl.com/33z3dx6>

Nickerson, Colin. "Are the lab rat's days numbered?" *The Boston Globe*, 30 March 2009.

http://www.boston.com/business/healthcare/articles/2009/03/30/are_the_lab_rats_days_numbered/ **OR** <http://tinyurl.com/dk6tsu>

"Psychological Experiments." Concern for Helping Animals in Israel (CHAI).

http://www.chai-online.org/en/compassion/experiment_psychological.htm **OR**

<http://tinyurl.com/yg4w695>

Roy, S., Miller, C. T., Gottsch, D., & Wang, X. (2011). "Vocal control by the common marmoset in the presence of interfering noise." *The Journal of Experimental Biology*, 214(21), 3619-3629.

Sharpe, Robert. "101 Misleading Results From Vivisection." International Association Against Painful Experiments on Animals (IAAPEA)

<http://www.iaapea.com/101.php> **OR** <http://tinyurl.com/4vbyhdn>

"V-Frog: Virtual Frog Dissection." A Tacitus Technologies White Paper. 2007

<http://www.tactustech.com/products/vfrog/documents/V-Frog-White-Paper.pdf> **OR** <http://tinyurl.com/kjet4u>

West, Larry. "Does Classroom Dissection Deplete Species, Encourage Cruelty to Animals?" *About.com*.

<http://environment.about.com/od/biodiversityconservation/a/dissection.htm> **OR**

<http://tinyurl.com/l66rg8>

"What's Wrong With Xeno?" The Campaign for Responsible Transplantation (CRT). 2000.

<http://www.crt-online.org/wrong.html> **OR** <http://tinyurl.com/6j2j7my>

"Xenotransplantation" *Wikipedia, The Free Encyclopedia*. 17 February 2011.

<http://en.wikipedia.org/wiki/Xenotransplantation>