

## Animals in Research and their Rights: A review

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**Abstract:** Animal have extensively been used in the research as a method of study, which shows the anthropocentric nature of humans. Till now major important medical advances have benefited directly or indirectly from animal research. Animals are usually exposed to painful techniques or toxic exposures that leave them injured, living them impaired or even dead. These techniques also result in high levels of stress in animals and altered physiological functions often leading to inconclusive results. Now a day's replacement of animal methods is being practices by many known companies. The advantage of using non-animal techniques like Computer models, Cells and tissue cultures techniques wouldn't yield any ethical conflicts. The exploration and implementation of non-animal methods should be a priority for investigators and research institutions, and should take advantage of a wide variety of viewpoints to ensure progress toward scientific, human health, and animal protection goals.

**Key words:** Animal right, research, advantages, disadvantages, alternative method

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### Introduction

Animals have moral standing; that is, they have properties (including the ability to feel pain), which qualifies them for the protections of morality. According to this, humans have moral obligations towards animals, and since rights are logically correlative to obligations, animals have the rights. Animal rights imply that the interests of animals deserve some attention, regardless of, whether they are beautiful, useful to humans, with any value for people or not (just as a mentally ill person has certain rights, despite the fact that he often doesn't bring any benefit, and sometimes even being burdensome to others). [1]Based on the foregoing, it should be recognized that animals are not our property, their life itself has a value (Intrinsic Value), so we have no right to use them to meet our needs. That is, the person should not eat meat of animals, wear their fur and skin, use for the experiments or for the entertainment purpose.

Animal research has been used as a method of study, when the study of humans is deemed impractical or unethical. In the last century major important medical advances have benefited directly or indirectly from animal research.[2] However, serious ethical issues arise regarding the use of animals. Animals are subjected to painful procedures or toxic exposures that leave them injured, living impaired or even dead. In addition, these techniques result in high levels of stress in animals and altered physiological functions often leading to inconclusive results. The replacement of animal methods as much as possible with non-animal techniques would yield both ethical and technical advantages. The exploration and implementation of non-animal methods should

be a priority for investigators and research institutions, and should take advantage of a wide variety of [1]viewpoints to ensure progress toward scientific, human health, and animal protection goals.

### **Animal research history**

Animals have been used repeatedly all the way through the history of biomedical research. It started with early Greek physician-scientists, such as Aristotle, (384 – 322 BC) and Erasistratus, (304 – 258 BC), this scientist performed experiments for medical purposes on living animals. The likes of Galen (129 – 199 / 217 AD), a Greek physician who practiced in Rome and was well known in the history of medicine, the physician carried out experiments on animals to advance the understanding of anatomy, physiology, pathology, and pharmacology. Ibn Zuhr (Avenzoar), an Arab physician in twelfth century Moorish Spain, introduced animal testing as an experimental method for testing surgical procedures before applying them to human patients.[2]

In modern years, practicing with the use of animals for biomedical research came under severe criticism by animal protection and animal rights groups. Laws have been passed in several countries to make the practice more ‘humane’. Debates on the ethics of animal testing have raged since the seventeenth century. Theodore Roosevelt in the nineteenth century stated, “Common sense without conscience may lead to crime, but conscience without common sense may lead to folly, which is the handmaiden of crime.”[3]

Drug testing using animals became important in the twentieth century. In 1937, a pharmaceutical company in the USA created a preparation of sulfanilamide, using diethylene glycol (DEG) as a solvent, and called the preparation ‘Elixir Sulfanilamide’. DEG was poisonous to humans, but the company's chief pharmacist and chemist was not aware of this. He simply added raspberry flavoring to the sulfa drug, which he had dissolved in DEG, and the company marketed the product. The preparation led to mass poisoning causing the deaths of more than a hundred people. No animal testing was done. The public outcry caused by this incident and other similar disasters led to the passing of the 1938 Federal Food, Drug, and Cosmetic Act requiring safety testing of drugs on animals before they could be marketed.[4]

One of the tragic that happened is the drug fiasco this occurred late in 1950s and early 1960s with thalidomide. This drug was supposed to act as an effective[4] tranquilizer and painkiller and was proclaimed a ‘wonder drug’ for insomnia, coughs, colds, and headaches. It being meant to have an inhibitory effect on morning sickness, hence, thousands of pregnant women took the drug to relieve their symptoms. Consequently, more than 10,000 children in 46 countries were born with malformations or missing limbs (phocomelia, from the Greek meaning ‘limb’). The drug was withdrawn in 1961 and 1968 after a long campaign.

The above-mentioned incidents and others illustrate the harm to humans from the use of elements that have not been first tested on animals and underline the importance of animal experimentation to avert or prevent human tragedy. The practice of using animals in biomedical research has led to significant advances in the treatment of various diseases.

Issues such as ‘cruelty’ to animals and the humane treatment of animals are valid concerns, and hence, the use of animals in experimentation is greatly regulated. This has led to the 3Rs campaign, which advocates the search for the replacement of animals with non-living models; reduction in the use of animals; and refinement of animal use practices. However, total elimination of animal testing will significantly set back the development of essential medical devices, medicines, and treatment. By employing the 3Rs when continuing to use animals for scientific research, the scientific community can affirm its moral conscience as well as uphold its obligation to humanity to further the advancement of science for civilization and humanity.

### **Anthropocentric fields that use animals**

**1. Basic research,**

In which experiments are conducted with no direct commercial application or other practical end in mind. The ultimate goal is to gain knowledge and many Scientifics argue that valuable findings have often risen from these experiments. This kind of research is most often performed in universities. [5]

**2. Applied research,**

Which is conducted to solve specific biological problems or to develop commercial products. It can be done for medical or non-medical use. Compared to basic research, which is more academically oriented, applied research experiments are more likely to be carried out in the pharmaceutical industry although some universities may conduct these experiments in commercial partnership Applied research has often been related to the treatment or cure of disease and disorder in humans and other animals. [6]

**3. Animals are also used in toxicology,**

In where commercial products are tested on subjects to measure potential adverse reactions to chemicals. The biological responses to these ingredients are also measured. This type of study focuses on the symptoms, mechanisms, treatment and detection of poisoning. The observed criteria used to measure the toxicity of chemicals are dose and the amount of exposure to the chemical. [7]

**4. Toxicology tests, including drug testing, and cosmetic testing. Due to the serious, adverse**

side effects that some drugs have presented in the past. Many countries passed new laws to ensure that all new pharmaceutical products have to go through rigorous animal testing before being licensed for human use. Cosmetics testing is probably the most controversial of the categories mentioned above. Individual or several ingredients are tested in animals as well as finished products such as lipstick and mascara. Cosmetic testing is banned in several countries in the European Union such as the Netherlands, Belgium, and the UK. In 2002 the European Parliament agreed with EU members to ban the use of animals for cosmetics testing starting in 2009. This agreement would also include a ban on the import and marketing of cosmetic products that have used animal's experiments in their manufacture. [8]

5. Because of the strong feelings that some of the public has against cosmetic animal testing, most cosmetic manufacturers would state in their labels that the products are not tested on animals. However, they are still required by consumer protection laws to maintain rigorous standards so their products are not toxic and dangerous to public health, and make sure that the ingredients are not dangerous in large quantities. The United States and Japan require animal testing to meet legal requirements for which they are strongly criticized by groups that disagree with testing animals for cosmetics. Although some companies have stopped animal testing as they state on their product label, some animal organizations suspect that several companies may falsely claim that they do not do perform tests in animals or not state it .[9]

### **Pros and cons of animal testing**

**Pros**

● **Helps researchers to find drugs and treatments.**

The major pro for animal testing is that it helps researchers with finding drugs and treatments that will improve human health and medicine. Numerous medical treatments have been made possible by animal testing, this includes cancer and HIV drugs, insulin, antibiotics, vaccines and many more.

- **It enhances the safety of the products being released.**

Another important aspect to note is that animal testing helps to ensure the safety of drugs and many other substances humans use or are exposed to regularly. Drugs in particular can carry significant dangers with their use but animal testing allows researchers to initially gauge the safety of drugs prior to commencing trials on humans. This means that human harm is reduced and human lives are saved – not simply from avoidance of the dangers of drugs but because the drugs themselves save lives as well as improve the quality of human life.[10]

- **Some animals are almost carbon copies of humans.**

The reason why mice are frequently used in animal research is that their genetic profile is 98% similar to humans. Chimpanzees were popular to use in the past, and still are in some areas of the world, because their genetic profile is 99% similar to a human. With similar organs, circulatory systems, and reactions to an illness, researchers can look at how animals react and be able to make comfortable prediction about how humans might react.

- **It gives an opportunity to examine a complete life cycle.**

In many countries, the average life expectancy of a human exceeds 70 years of age. Some nations have an average life expectancy of over 80 years. In comparison, a mouse has a lifespan of 2-3 years, allowing researchers the opportunity to study through research and experimentation how something may affect the life cycle. [11]Any long-term research involves mice and rats because of this unique aspect to the research.

#### Cons

- **Many of the items that are tested are never used.**

Animal testing may provide safety benefits for new products, but some of the items that are tested will never be used. That means animals will likely be sacrificing their lives to determine the safety of a product that a human will never even know was being developed.

- **It can be an expensive practice.**

Caring for an animal requires a large investment. Some of the animals that are used for testing are bought at auction or taken from the wild, which brings additional costs into the process. According to Pet finder, the total cost of caring for a single dog could be over \$9,000 per year. Even at the low end of the scale, the car cost is over \$500. Now multiple those costs over an entire laboratory and the cost of animal research becomes very high, very quickly.[12]

- **It may not offer valid results.**

The structure of an animal's body is very different from the structure of a human's body. That means animal research can be more unreliable than even researchers claim it may be. Several drugs have passed animal testing, but have been found to be harmful to humans. In 2004, the FDA estimated that 92% of drugs that pass their pre-clinical tests, including animal research, fail to reach the market. Recent data suggests that failure rates from animal research to human research could be even higher, at 96%, according to the NIH. Nearly 100 vaccines for HIV showed potential in primates, but failed in humans. That means the results that animal research can produce may not even be valid. [13]

- **Many facilities are exempt from animal welfare laws.**

About 4% of the animals that are involved in ongoing research projects are covered by animal welfare laws. That means there are more than 20 million animals who could be at a high risk of abuse or neglect in the name of research. Even when the facilities are in compliance with the law, they are governed by committees that are self-appointed and only a direct inspection of the facility would let someone know there are issues going on.

- **Animals don't need to be the only method of research.**

Although testing living tissues will be beneficial compared to computer simulations for the recent future, there are methods of research that can involve living tissues that don't put the lives of animals at risk. From living cell lines to cultures and other forms of cell harvesting, there are possibilities available. A cell line from cervical cancer cells taken in 1951 is still being researched, even though the individual died from that cancer in the same year. [14]

- **Poor research practices invalidate the data obtained.**

Data discrepancies are not the only issue that face animal research transitioning to human research. When poor research practices are used, the data that is obtained could be invalidated. There is also the possibility that poor research practices could create false positive data that could then place human lives at risk. Unless there is accurate and complete oversight over the current field of animal research, this threat to the data will always exist.

- **Reverse data can also be a problem with animal research.**

There are drugs and products that could be harmful to animals, but highly beneficial to humans, and the current state of research priority would make it extremely difficult to know if this was the case. Animal testing occurs before human testing. An example of this issue is aspirin. It is a dangerous product for animals to have, but think of the millions of lives that have been improved or saved because of the drug. Insulin causes animal birth defects, but it saves lives every day. That is the reality of animal research.[15]

### **What rights should animals have?**

The needs of people and animals should be considered equal. For example, a dog is undoubtedly suffering from pain, therefore we should pay attention to it and not cause the dog pain. However, the animals not always have the same rights as humans, because some human needs are simply not applicable to animal life. For example, the dog is not interested in participating in the elections, so there is no need to give her the right to vote. For the dog it is just as absurd as for a small child. However a few basic rights which are minimally necessary to ensure justice for all animal species (including man) can be identified:[16]

- *All animals have a right to live out their lives according to and in harmony with their nature, instincts, and intelligence.* In the most general sense this requires that we govern our way of living so as to live in harmony with all our fellow creatures. It also requires that we cease interfering with the ecological and ethological relationships between animals that have evolved over the millennia.
- *All animals have a right to live in a habitat ecologically sufficient for normal existence.* This right recognizes the seamless web of life in which all animals on this planet are enmeshed. There is almost universal agreement that the single greatest killer of animals is the destruction or degradation of habitat. It is obviously in our self-interest to protect and preserve the environment. Moreover, because all animals have a right to live in a healthy and sustaining environment, it is also our duty to do so. [17]

- *All animals have a right to be free from exploitation.* Once a legal right has been conferred, a correlative duty exists for all others not to infringe upon that right." Necessity is an insufficient rationale for denying any of the above-mentioned rights to animals. We need to share the earth with animals; however, we do not need to eat their flesh, wear their skins, hunt or trap them, amuse ourselves at their expense, or experiment on them.

There is very famous saying by a famous leader of India which demonstrated the biocentrism in humans

*"The greatness of a nation and its moral progress can be judged by the way its animals are treated."* - Mahatma Gandhi

### **Three Rs: reduction, refinement and replacement**

Alternatives to animal testing were proposed to overcome some of the drawbacks associated with animal experiments and avoid the unethical procedures. A strategy of 3 Rs is being applied which stands for reduction, refinement and replacement of laboratory use of animals. Different methods and alternative organisms are applied to implement this strategy. The concept of replacement of animals was first discussed in 1957 by Charles Hume and William Russell at the Universities Federation for animal welfares(UFAW) . Russell and Burch (1959) suggested some ways to make the animal experiments more humanly, which was later called as 3 Rs. [18] This approach motivates the use of minimum number of animals i.e. 'reduction' in the total number of animals used in an experiment. The use of animals must be planned and 'refined' carefully in such a way that pain and distress caused during the experiment should be minimized. Moreover, if possible higher animals should be 'replaced' with alternative methodologies and lower organisms. Animal replacement is defined as, 'any scientific method employing non-sentient material which may replace use of conscious living vertebrates in animal experimentation'. Two types of replacements were distinguished as 'relative' and 'absolute' replacement. In relative replacement the animals are used but not exposed to any distress during experiment. No use of animals at any stage of experiment is identified as the absolute replacement strategy.

### **Reduction**

With the help of statistical support and careful selection of study design one can produce meaningful scientific results of an experiment. For example, in vitro cell culture is a good way to screen the compounds at early stages. Use of the human hepatocyte culture gives the information about how a drug would be metabolized and eliminated from the body.[19] Inclusion of such method in study design helps to eliminate unsuitable compounds in preliminary stages only and minimizes the use of animals in further tastings. Live animals and embryos are used to study effects of some compounds on embryo development. In vitro embryonic stem cell culture test helps to reduce the number of live embryo used and the compounds which are toxic toward developing embryo

Also, sharing or providing the discovered data (like characteristics of excipients for the test drug) avoids the necessity of animal studies.[20]

### **Refinement**

Enriching the cage environment by taking care of animals reduces the stress on animals. Scientists should refine the animal facility so that pain, discomfort and distress during animal life and scientific procedures are reduced. Moreover, under the stress and discomfort there may be imbalance in hormonal levels of animals

leading to fluctuations in the results.[21] Hence, experiments need to be repeated which causes an increase in the number of experimental animals. So refinement is necessary not only to improve the life of laboratory animals but also to improve the quality of research. For example, it was observed that when mice genetically modified to study Huntington's disease were provided with a complex cage environment with opportunity to nest, hide, gnaw and forage, the disease progressed slowly than the mice in barren cage. Also, such mice were found to mimic the progress of the human disease more closely. Such a refinement provides a very good model to treat the disease and also minimize stress to the animals.

### **Replacement**

Various alternatives to the use of animals have been suggested, such as in vitro models, cell cultures, computer models, and new imaging/analyzing techniques. The in vitro models provide the opportunity to study the cellular response in a closed system, where the experimental conditions are maintained. Such models provide preliminary information for outcome of an experiment in vivo. For example, computer models were used to study the working of the heart and to select the potential drug candidates.[22] In many countries, in vitro cell cultures have replaced the skin irritancy test and Draize eye irritancy test and use of animals in those. Another example is, extraction of insulin from the pancreas of pigs and cow, but now it is obtained from the bacterial cultures which are lifeline drugs for diabetic patients. This extracted insulin needs to be checked for its purity, efficacy and dose. Use of animals was routine for such checking, but now chromatography techniques are used for checking the purity, efficacy and calculation of dosages of drugs. Overall, replacement substantially reduces the use of animals in various processes.

### **Animal research statistics methods and scenarios**

According to the Nuffield Council on Bioethics (2004) and The British Union for the abolition of Vivisection (BUAV, 2005), it is estimated that fifty to a hundred million animals worldwide are used annually and then killed afterwards in scientific procedures every year, 10–11 million of them in the European Union. In 2004 the U.S. Department of Agriculture (USDA) reported that 1.2 million mammals (not including rats and mice) were used in research, which included 64,932 dogs, 23,640 cats and 54,998 non-human primates (USDA, 2004). [23]Accurate figures for animal testing are difficult to collect. Animal organizations estimate that 23-25 million animals are used in experiments each year solely in the US (LPAG, 2004). Is impossible to know exactly how many animals are being used in research because U.S. laws do not require scientists to report how many mice, rats, or birds they use. Rodents such as rats (15%), Mice (68%) and other rodents (1%) are used in the majority of the procedures. They constitute 85% of the total. Most of the remaining procedures use fish (8%), birds (4%), reptiles and amphibians (1%), and other mammals such as monkeys, dogs and cats (3%) (U.K. home office, 2005). (Figure 1)

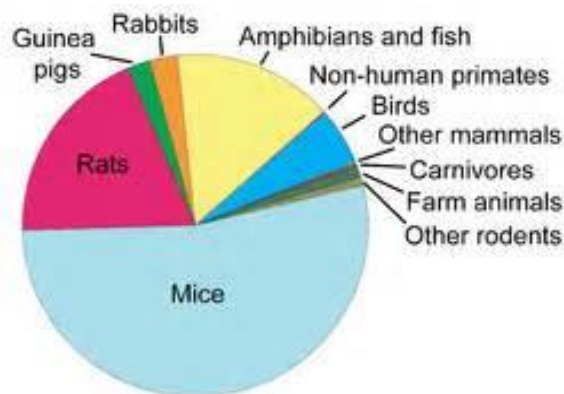


Figure 1. Statistics of animal testing.

### Animal rights in different countries

#### The European Parliament

In 1978, the European Parliament decided to ban testing of cosmetics on animals in Europe. Besides, in Europe the rights of cats and dogs are protected by the Convention for the protection of animals from cruel treatment. In some European countries dogs cannot be left locked in a car in a sunny day, since the cabin heats up quickly which may cause thermal shock for a dog. Seeing this, the police needs to break the glass and fine the owner of the dog.[24]

#### Netherlands

In 2006, Netherlands made a history as the first country in the world. In this country's Parliament there is a Party for Animals (PvdD), whose main aim is to improve animal rights. The party is seeking for consolidation of animal rights in the Constitution, as well as the elaboration of a separate law on animal protection.

#### Germany

In 2002, Germany became the first country in the world where the rights of animals are being protected by the Constitution. Under the new laws, there is prohibited (or in some cases limited) the use of animals for testing cosmetics, household chemicals and medicines. Animals in Germany are protected by the Act on the Protection of animals. There is also a special branch of law called "Animal Rights". In this region there are lawyers who can not only help in case of violation of the rights of the owners of animals or mistreatment of animals, but also to help with animals purchasing.[25]

#### Spain

In June 2008, the Spanish Parliament recognized the right of each APE for life, liberty, and protection from violence. This decision was the first in the world practice act, equalizing the rights of humans and animals.

#### Switzerland

Switzerland is a leading country in Europe in the field of animal rights. In 2007 the Canton of Zurich as experiment, first introduced the post "attorney of the animals", and the main event of 2008 in Switzerland, was the entry into force of the law on animal rights. [26]The law details handling of wild and domestic animals. Nowadays they are no longer treated as things.



### **India**

In 2013, India became the first country in the world that recognized the rights of dolphins as individuals and that dolphins should no longer be in the entertainment business. In addition, India became the first country in South Asia to ban the testing of cosmetics and its ingredients on animals. However, according to PETA, cosmetics tested on animals abroad, is still being sold in Indian market. PETA (People for the ethical treatment of animals) is the largest organization fighting for animal rights. It was founded in 1980. It is composed of 187 staff, and it has an 800 thousand supporters around the world.[27]

### **Alternative methods**

Various methods have been suggested to avoid the animal use in experimentation. These methods provide an alternative means for the drug and chemical testing, up to some levels. Advantages associated with these methods are, time efficiency, requires less man power, and cost effectiveness. These methods are described in detail as follows:

### **Computer models**

Computers can help to understand the various basic principles of biology. Specialized computer models and software programs help to design new medicines. Computer generated simulations are used to predict the various possible biological and toxic effects of a chemical or potential drug candidate without animal dissection. Only the most promising molecules obtained from primary screening are used for in vivo experimentation. Some of the softwares used are: Computer Aided Drug Design (CADD) is used to predict the receptor binding site for a potential drug molecule, Structure Activity Relationship (SARs) computer programs. It predicts biological activity of a drug candidate based on the presence of chemical moieties attached to the parent compound[28]

### **Cells and tissue cultures**

Use of in vitro cell and tissue cultures which involves growth of cells outside the body in laboratory environment can be an important alternative for animal experiments. The cells and tissues from the liver, kidney, brain, skin etc. are removed from an animal and can be kept outside the body, in suitable growth medium, for few days to several months or even for few years.[29]

In vitro culture of animal/human cells includes their isolation from each other and growing as a monolayer over the surface of culture plates/flasks. Cellular components like membrane

Fragments, cellular enzymes can also be used. Various types of cultures like cell culture, callus culture, tissue culture and organ culture are used for various purposes. Benefits associated with techniques are, easy to follow, less time consuming and are less expensive. These methodologies are routinely used for preliminary screening of potential drug molecules/chemicals to check their toxicity and efficacy. Almost all cosmetics, drugs and chemicals are tested for their toxicity and efficacy, using these tests. For example, eye irritancy test. To check the irritancy of chemicals previously Draize test was used, which requires animals (mainly rabbit). It is very painful and every time a new animal is used. Ke Ping Xu and coworkers suggested an alternative which uses bovine corneal organ culture. The bovine cornea is cultured up to three weeks in laboratory and various analytical methods are used to evaluate the toxicological effect of test chemical irritancy in vitro.[30]

### **Alternative organisms**

The ethical issues have posed many restrictions over the experimental use of higher model vertebrates

like guinea pig, rats, dogs, monkeys etc. Therefore, use of alternative organisms has been proposed. Different model organisms are used to replace experimental animals.

### **Lower vertebrates**

Lower vertebrates are an attractive option because of the genetic relatedness to the higher vertebrates including mammals. Moreover, there are less ethical problems involved in the experimental use of lower vertebrates.[31]

### **Invertebrates**

Invertebrate organisms are widely used as an alternative for laboratory use of animals. They have been used to study various diseases like Parkinson's disease, endocrine and memory dysfunction, muscle dystrophy, wound healing, cell aging, programmed cell death, retrovirus biology, diabetes [32]

and toxicological testing. Invertebrates have an undeveloped organ system and do not have the adaptive immune system, which poses some limitations for their use in human diseases. However, they hold numerous benefits, such as a brief life cycle, small size and simple anatomy, so that a large number of invertebrates can be studied in a single experiment within a short period with less ethical problems. Their cost of housing is less compared to the animals. [33]

### **Conclusion**

The question of the admissibility of using animal in the experiments is a complicated moral problem in the relationship between humans and animals, which humanity is trying but cannot solve. The modern representatives of the medicine argue that animal experimentation is a necessary source of knowledge for medicine and without it humanity will not be able to fight diseases. However, the experiments on animals, which began about 300 years ago, occupy a very insignificant part of the history of medicine, which has achieved considerable success at different times, without using experimental data.

That is, the opponent of using animals for the experiences, the philosopher Tom Regan (1938) believes that animals have moral rights, and their life is priceless. In addition, using animals in research, entertainment or food is wrong in principle. According to his opinion, it violates animal rights by denying the intrinsic ethical value they possess.

The philosopher Bernard Rollin (1943) argues that people have rights to animals and it is therefore unacceptable to use the latest for their own purposes.

In addition, there are more and more people fighting for animal rights and for banning use of animals in cosmetic testing. Scientists and governments of some countries require to reduce to minimum the use of laboratory animals.[34] In either way it requires the substitution experiments with animals' experiments without using them and the reduction in the number of animals in experiments. It also requires the improvement of research methods that minimize the pain and suffering of laboratory animals and improve the conditions of their detention. If possible, the methods that do not require the use of animals should be used.

Therefore, animal rights strongly believe that human beings have no moral right to use individual animals in ways that would not benefit those individuals. Currently there are alternatives to experiments on animals to test cosmetics, household chemicals and other products that can save the lives of millions of animals. By now, there are two major accepted alternatives, computer simulation and in vitro cell culture techniques. Many of these techniques are still under development and many of them would still need to use data from prior

animal experiments or other animal derived animals' cultures. However, these would significantly decrease the number of animals used in experiments. Examples of computer simulation models include diabetes asthma and drug absorption. Cell culture has proven to be the most effective and it has been used for more than 30 years for cosmetic and other tests by some laboratories. Micro-dosing using voluntary human subjects is also becoming popular. In these assessments, the drugs that are administered give doses below the doses that would produce a whole body effect. Some institutions that carry on alternatives to animal's testing include: The John Hopkins Center for Alternatives to animal testing, the university of California Center for animal testing.[33]

Thus, animal research is a very controversial topic. Although major medical advances that have benefited animal and human beings in the last century used animals in their experiments, some of the tests conducted indeed involve animal cruelty and they should be heavily regulated. The scientific community should take advantage of a wide variety of alternatives that are being developed, such as non-animal testing techniques. This will ensure progress toward science, human health, and animal protection goals.

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