Alba’s Case

Since the early 1990s, scientists have been creating bacteria, roundworms, mice, and other animals that glow green by inserting a jellyfish gene into their genomes. The modification helps researchers study cell processes, including the movement of certain proteins, because glowing proteins can be visualized whereas normal proteins cannot. In 2008, three U.S. scientists were awarded the Nobel Prize in Chemistry for developing the jellyfish green fluorescent protein (GFP). GFP has become “one of the most important tools used in contemporary bioscience,” according to the Nobel Prize Web site (http://nobelprize.org). This tool has allowed researchers “to watch processes that were previously invisible, such as the development of nerve cells in the brain or how cancer cells spread.”

Researchers have also created more than 100 glowing albino rabbits. GFP is inserted into a rabbit zygote, and the rabbit grows with the jellyfish gene in each of its cells. The cells glow under blue light.

An artist found out about the GFP research and asked to have a rabbit created for him to use in his art show. Alba, the rabbit shown here, is an albino rabbit that glows green under blue light. The research group that created her did not release her to the artist, but newspaper reports indicate that she was specifically genetically engineered for him.

The risks of genetic engineering include disturbing the appropriate expression of the animal’s genome. Researchers haven’t discovered any problems yet with GFP-altered animals. There is also the possibility that the gene could enter the wild population if the lab animals with it leave the lab and breed with wild ones.

So far, there is no alternative to genetic modification for creating glowing cells.

Was it ethically acceptable to make a glowing rabbit for an art show? Why or why not?
Contrasting Cases of Animal Modifications

Disease-Model Mice

How similar are you to a mouse? It turns out that an astonishing 99 percent of mouse genes have equivalent or homologous genes in humans. This genetic kinship means that mice can serve as very useful models in studying many human diseases. Mice have been used as models for research on cancer, diabetes, Parkinson’s disease, and a whole host of other disorders. Medical researchers choose animal models when they believe it would be unsafe, unethical, or premature to conduct the research using humans. To ensure that animals used in research are treated humanely, research funded by the National Institutes of Health must adhere to the Guide to the Care and Use of Laboratory Animals. This manual covers in great detail how to house, feed, care for, and use research animals.

Researchers create transgenic mice by transferring foreign DNA into mouse cells to produce specific traits. Mice that have successfully incorporated the gene and developed the disease of interest can then be used to study the course of the disease and to look for potential treatments. For example, if there were a gene known to cause lethal brain tumors in humans, it could be transferred into mice to make them grow brain tumors. The way the tumor grows and ways to treat it could be studied with the hope that the findings could eventually be applied to humans.

Hundreds of thousands of transgenic mice are being used in research. Besides the risks of genetic engineering, discussed in other cases here (for example, mad-cow-disease cows, spider-silk goats, and immunoglobulin cows), these mice will suffer symptoms of the disease under investigation. The mice are killed at the end of the research, or earlier if they appear to be suffering too much.

There are as yet no equivalent alternatives for doing this type of research. Animals with simpler nervous systems, such as fruit flies and nematode worms, are often used as models. Their genes do not have the same high degree of similarity to humans’ as mouse genes do, so they may not be as effective as model systems for studying disease.

Is it ethically acceptable to use mice as human-disease models? Why or why not?
Dyed Feathers

People dye bird feathers for different reasons, such as to observe the movement of wild birds or to tell one hatchling group from another. They also do it for human enjoyment.

To color the whole chick, including the feathers, people dye the embryo as it develops. A small hole is drilled into the shell, the tip of a needle on a syringe filled with dye is inserted just through the shell membrane, and the dye is injected. Harmless vegetable dyes like food coloring sold in stores can be used. The hole is covered with wax, and the egg is returned to incubation. If the shell is broken or the needle penetrates the embryo, the embryo dies. However, if the embryo survives the injection process, the bird’s health and growth appear not to be affected by this treatment. As the chicks grow, they molt, or shed, their feathers, and in adulthood, the birds have normal-colored feathers. The number of people who modify birds like this is unknown, as is the number of birds that have been dyed.

An alternative to creating colored feathers through dying them is to paint them, but as of 2009, injecting dye into the egg is the only way to color the entire bird.

Is it ethically acceptable to dye birds for human enjoyment? Why or why not?
**Ear Mice**

The scarcity of organs for tissue transplantation has created a serious medical problem. However, the ability of scientists to grow an ear on the back of a mouse may lead to viable alternatives to organ donation as a source of organs and other body parts (such as corneas) for transplantation.

In this instance, scientists molded sterile, biodegradable mesh into the shape of a human ear and placed cartilage from a cow knee onto the mesh. The mesh was then implanted into the back of the mouse. The mouse provided energy and nutrients needed for cartilage to grow over the scaffolding through extra blood vessels grown by the mouse. The strain of mouse used in this experiment was modified to have little or no immune system and, therefore, the mouse did not reject the foreign material. The goal of the research was to determine whether this approach would be a viable method for growing organs, such as human livers, for transplantation in larger animals, such as pigs. Scientists used to think that they could grow only simple human tissues in culture in the laboratory, but this research shows that growing more complex structures is possible.

The risks to the mouse include the surgery to implant the scaffolding and living with an ear on its back. How many people this might benefit and how soon are not known, nor is the ultimate number of mice to be used in this research.

There are as yet no equivalent alternatives for doing this type of research. To date, organs (including skin) and body parts can only be obtained from living human donors and cadavers.

**Is it ethically acceptable to use mice to research the growing of body parts? Why or why not?**
Giant Panda Breeding

The giant panda is an endangered animal, mainly because of the loss of habitat from human incursion into its territory. Only about 1,600 of them are living in the wild, and about 170 are in captivity. The reproductive rate of pandas is low, even in the wild, because female pandas are only fertile two days each month and they are very picky about their mates, and male pandas have low sexual desire. When in captivity, the stress of contact with humans adds to their low ability to reproduce.

To save the species from extinction, starting about 50 years ago, zoos and conservatories have been using artificial insemination for females that do not mate or that mate unsuccessfully. Semen collected from a male panda is injected into a female while she’s anesthetized. About 100 pandas have been successfully born in captivity using this approach.

Artificial insemination introduces a slight risk of infection to the mother panda as well as some risks associated with undergoing anesthesia. The male panda must also be put to sleep for a short time so that his semen can be collected. Pandas born in captivity show few natural survival instincts and have not been successfully introduced back into the wild. When panda cubs are born, they are the size of a stick of butter and have a high mortality rate. Once a panda cub is 100 days old, it is considered to be out of immediate danger.

There are currently no alternatives to natural panda breeding other than artificial insemination.

Is it ethically acceptable to artificially assist giant panda breeding? Why or why not?
Immunoglobulin Cows

The immune system makes antibodies in response to viruses, bacteria, fungi, allergens, cancer cells, and other foreign matter. Some people are not able to make enough or any of their own antibodies, so they are more likely to get infections and have difficulty recovering from illness. Exactly how many people suffer from deficiencies of disease-fighting antibodies, or immunoglobulins, is unknown, but the number is significant—in part because many different conditions lead to immune deficiency.

Immunoglobulins can only be obtained from human donor blood. Human donor immunoglobulins are expensive because they can’t be mass-produced. Using current human-based technologies, one year of IVIG (intravenous immune globulin) treatment can cost $50,000. IVIG is approved by the U.S. Food and Drug Administration (FDA) to treat many different conditions such as leukemia and AIDS. If there were a larger supply of immunoglobulins, the cost of treatment would probably be significantly reduced.

In one experimental approach to treating immunoglobulin deficiency, a cow was genetically engineered with human DNA to produce milk and blood containing human immunoglobulins and then cloned. There are now four such cows, and cloning them will allow the genetically engineered trait to be passed on to their offspring. The number of cows that may eventually be used for this purpose is unknown.

Cloning occurs when a somatic cell is fused to an egg cell whose nucleus has been removed. The embryo is then grown in a surrogate animal mother. Cloning is not a perfect science and often produces animals with life-threatening deformities and conditions. Because this approach is relatively new, the health of cloned cows over the long run is still unknown. Some researchers have reported compromised immune systems, accelerated aging, and premature death in cloned animals.

Animals that have had other species’ DNA inserted into their cells are called “transgenic.” Two risks of genetic engineering include possibly disrupting the functioning of certain genes of the cow and the possibility that the introduced gene could enter the wild population from unregulated breeding.

Human donor blood is still the only available source of immunoglobulins.

Is it ethically acceptable to genetically engineer cows to produce immunoglobulins that will be used to treat human diseases such as leukemia? Why or why not?
Mad-Cow-Disease Cows

Mad cow disease, also known as bovine spongiform encephalopathy (BSE), is a fatal, neurodegenerative disease of cattle that results in destruction of the brain and spinal cord. Mad cow disease was first identified in Great Britain in 1986, when a large herd of cattle was found to be affected.

The U.S. Department of Agriculture (USDA) has reported only two cases of mad cow disease in the 96 million U.S. cows. In June 2004, USDA began a BSE surveillance program and is testing the 446,000 U.S. cattle considered at highest risk of infection. The strict regulations for controlling mad cow disease include killing infected animals to make sure they do not get into the animal or human food supply. If a few cows within a herd are infected, the entire herd must be destroyed.

The disease in cattle is similar to a neurodegenerative condition in humans, Creutzfeldt-Jakob disease (CJD). Both diseases are caused by the presence of abnormally folded proteins called prions. Classical CJD is generally considered a disease of people over age 63 that develops slowly over a long period of time and is caused by contact with infected human tissue. However, a new form of CJD has been found in young people (ages 17 to 24) that progresses rapidly and causes death within 13 months of the first symptoms. This form appears to come from eating beef from cattle that have BSE. By October 2008, 164 deaths worldwide had been attributed to CJD contracted from infected beef.

Researchers are currently working to genetically modify cows to make them resistant to mad cow disease. If this approach proves to be effective, entire cattle populations may be made resistant to the disease. The risks of genetic engineering include the possibility that the appropriate expression of the animals’ own genes is altered and that the modified gene enters the general population through unregulated breeding. Although the safety of eating genetically modified organisms is debated, there are no established adverse health consequences.

Since cattle can contract BSE by consuming feed made from infected animals, an alternative approach to genetic modification is to feed cattle only grains or grass, not meat byproducts. Another alternative is to detect the disease early. Research is under way to create a rapid way to screen for early signs of infection by detecting disease-causing prions in blood. Today, the only way to prevent the spread of BSE is to slaughter animals suspected of being exposed to it.

Is it ethically acceptable to genetically engineer cows to be resistant to mad cow disease? Why or why not?
Malaria Mosquitoes

Malaria is a parasite-caused disease that produces fever, headache, chills, and vomiting in humans. If severe enough, it can lead to death. Certain species of mosquito carry and transmit the malaria parasites. Malaria affects 300 to 500 million people worldwide every year. It takes a huge toll on the health and economies of those people and their countries. More than 1 million people, mostly infants, die every year from malaria. There are drugs to treat it, but parasite resistance to the drugs is increasing as funding for medications and mosquito eradication efforts in the most-affected countries is decreasing.

If mosquitoes could be genetically modified so that they can’t carry or transmit malaria, they would not be able to infect humans with the disease. Scientists are considering releasing genetically modified mosquitoes into the wild to eliminate native malaria-carrying mosquitoes. The modified mosquitoes would compete with the disease-carrying ones, and the altered mosquitoes would pass on to their offspring the trait that keeps them from transmitting the disease. In addition to the risks of genetic engineering discussed in previous cases, there’s the unknown risk of releasing genetically engineered mosquitoes into the wild.

Spraying insecticides and reducing mosquito breeding sites (such as pools of stagnant water) are two methods for managing mosquito populations, but reducing their number is a continual battle. Other methods of malaria prevention include sleeping under nets, applying insect repellent, and covering up with clothing.

Taking antimalaria medication and following prevention methods may be easy for tourists, but hundreds of millions of people can’t afford these protections, and millions suffer and die each year. Nets to cover sleeping quarters cost around $10 each, but this is expensive in a society where people may live on less than $1 per day. Several organizations are raising funds to provide millions of nets to those in need.

Is it ethically acceptable to genetically engineer mosquitoes to be resistant to malaria parasites? Why or why not?
Purebred Dogs

Humans have genetically modified dogs for thousands of years by breeding them to have traits humans find desirable—for hunting, herding, guarding, sport, and companionship, among other reasons. For example, the sheep dog is bred for herding and has the characteristics that are good for that job. There are over 45 million purebred dogs in the United States and millions of dog owners.

To create a new breed, humans breed dogs with the desired traits. Offspring with some of the desired traits are bred with each other until dogs with all the desired traits are achieved. These dogs are then bred over several generations to ensure that the desired traits are inherited and that no undesirable traits appear or reappear. These are called purebred dogs, and they are highly valued by many people. These are the dogs that compete in kennel club dog shows.

Because of inbreeding (breeding within a family of a certain type of dog), some purebred dogs have inherited problems that are passed on through generations. For example, many breeds of dog, especially the medium to large ones, have problems with hip dysplasia, a disease that can cause painful arthritis and crippling lameness. Sometimes puppies that have been overly inbred (bred with close relatives) are born dead or with such grave problems that they are not able to survive.

An alternative to breeding purebred dogs is to accept more cross-breeding and “mutts” as pets.

Is it ethically acceptable to breed purebred dogs? Why or why not?
Sheared Wooly Sheep

The sheep population in the United States is nearly 7 million. Farmers raise sheep for milk, meat, and wool. Animal farming has environmental consequences; the land is being used for animal production instead of other purposes or instead of remaining wild, and the sheep produce a lot of waste. On the other hand, sheep are a renewable resource that can be raised in a sustainable manner and produce natural fiber that can substitute for synthetic fibers. The multimillion-dollar sheep industry in the United States accounts for 350,000 jobs.

One sheep produces between about 1 and 14 kg (2 and 30 lbs.) of wool, or fleece, annually, depending on its breed. Wool is used in many products including clothing, upholstery, carpets, mattress filling, and the covers of tennis balls.

To get the fleece, farmers shear the sheep. Shearing involves cutting or shaving the wool off. It does not hurt the animals, but it can be stressful to them and they can be cut or injured. Sheep are usually sheared once a year, in the late spring or early summer. This helps keep them from overheating in the summer heat. Right after shearing, though, without their effective insulation, the animals need to eat more food so that they can regulate their body temperature effectively, and they need protection from the cold. It takes up to six weeks for the fleece to start growing back.

Synthetic materials and other animals’ fibers can also be used to make products such as clothing and upholstery. Production of synthetic fibers has its own environmental consequences, though. It may require the use of petroleum-based products, which are energy intensive to manufacture and produce certain toxic industrial pollutants as waste. For some uses, synthetic materials have characteristics that are superior to wool’s, but in other cases, wool’s are far superior.

Is it ethically acceptable to raise and shear sheep for wool? Why or why not?
Spider-Silk Goats

Spider silk is stronger and more flexible than any other known fiber. Five times stronger for its weight than steel, it can be used in many products. Medical uses could include making artificial tendons and ligaments, bandages, sutures, and artificial limbs. Because it can be woven into fiber, it can be used to make protective clothing, bulletproof vests, and body armor. Its flexibility makes it valuable as paper. Other products could include ropes, nets, parachutes, seatbelts, and airbags. In addition to being one of the toughest materials on Earth, spider silk is also environmentally friendly; no toxic substances are used to make it and it is biodegradable.

To date, no one has successfully farmed spiders for silk, nor has anyone been able to produce spider silk artificially on a large scale. However, researchers have been able to create goats that produce spider silk, by inserting spider genes into goat eggs. In these genetically engineered goats, the gene is expressed in the mammary glands, and the transgenic goats secrete silk fibers in their milk. The fibers are removed from the milk and spun into thread. These transgenic goats have since been bred, and their offspring pass on their silk-producing genes to their offspring. In this way, thousands of goats capable of producing the silk-fiber-containing milk can be generated.

Cloning is not a perfect science and often produces many animals with deformities and conditions that are fatal. Because this is a relatively new science, there are uncertainties about the long-term health of the resulting cloned goats. Issues such as accelerated aging, compromised immune systems, and premature death have arisen. The risks of genetic engineering may include disrupting certain genes of the goat so they no longer function and allowing the introduced gene to enter the wild population through unregulated breeding.

In addition to the environmental concerns of farming animals discussed in other cases, raising dairy animals requires techniques that some consider problematic. Females produce milk (lactate) when they are nursing their young. Female goats that are already lactating can be bred while they are nursing and will produce milk for over a year. They are bred again about every 12 months and are given a 2-month dry interval when they are not milked. Some people believe that goats need more time to rest between breeding cycles.

There is no alternative to creating transgenic goats as a profitable source of spider silk.

Is it ethically acceptable to genetically engineer goats to produce spider silk? Why or why not?
Super-Sized Salmon

Salmon can be bred and raised in tanks on fish farms. Most salmon consumed in the United States are from fish farms. Fish farming is an over-$100-million-a-year industry. The farms have separate tanks for fertilized eggs, for newly hatched fish, and for each size fish as they grow.

Scientists have been able to make transgenic salmon that grow 11 times bigger, on average, than a regular salmon of the same age. A growth-hormone gene is injected into fertilized eggs to produce the super-sized fish. Not only do they grow larger than wild-type salmon, but they reach sexual maturity more quickly and can be bred earlier. Because of their large size and their ability to reproduce earlier, these transgenic fish can help meet the growing consumer demand for salmon.

The risks of genetic engineering are not well defined but may include altering the appropriate expression of the salmon genome, which could have undesirable consequences for the fish and its well-being. Researchers at Purdue University have investigated the effects of transgenic fish on wild populations of the same species. Using a fish called the Japanese medaka, scientists found that just 60 transgenic fish could drive a population of 60,000 wild fish extinct in only 40 generations. Whether these results would be the same for salmon is not yet known.

People disagree over the health benefits of farmed compared with wild salmon. Farmed salmon have more omega-3 fatty acids, which have proven health benefits, but also higher levels of chemical contaminants known to cause cancer. However, some studies indicate that transgenic organisms may have adverse health effects on consumers, such as unexpected allergic reactions.

Alternatives to the super-sized salmon include farming nontransgenic fish or continuing to catch wild salmon, which has environmental consequences of its own.

Is it ethically acceptable to genetically engineer fish to grow larger and thus provide more food for humans? Why or why not?
Veal

Veal is meat from calves that is valued for its tenderness and texture. Many people consider it a delicacy, and people in the United States eat, on average, a little less than half a kilogram (1 lb.) per year each. To produce veal, male dairy calves (baby cows) are taken from their mothers soon after birth and raised for about 18 to 20 weeks before they are slaughtered.

Male dairy cows are considered to be of little value because they cannot produce milk and are therefore killed or raised as veal. There are about 700,000 veal calves being raised in the United States. The calves undergo the stress of being separated from their mothers and transported from their birth site. They are at risk for pneumonia and diarrhea from being mixed with other calves from other sources, and from their diet. The mortality rate for these calves is not greater than for nonveal calves, however.

The most humane way to raise veal is under debate. Traditionally in the United States, the calves have been kept in small individual pens where they cannot turn around, and they are fed special milk-based diets to enhance their texture and flavor. It is believed that the calves must be kept confined because moving around too much makes their muscles tough. Changes in the industry are occurring due to mounting criticism, including and new regulations that address such things as pen size and tethering practices (another way to keep the calves in place).

Other than using more humane (but still confining) measures, there is no alternative for producing veal.

Is it ethically acceptable to raise calves for veal? Why or why not?
Assessment of Ethical Acceptability

**Instructions**

For each case, place a check mark in the box (cell). “Yes” means the modification should proceed, “no” means you do not think the modification should proceed, and “maybe” means you are not sure or want to be cautious in your decision. Round 1 is for your preliminary views, after the first day of this module; Round 2 is for your views at the end of the second day.

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Assessing Harms, Benefits, and Potential Alternatives

**Name(s)**

**Instructions**

Read each Master 6.2 case carefully (disease-model mice, dyed feathers, ear mice, giant panda breeding, immunoglobulin cows, mad-cow-disease cows, malaria mosquitoes, purebred dogs, sheared wooly sheep, spider-silk goats, super-sized salmon, and veal). Based on the facts of the case, decide what you think the magnitudes of harms to animals and benefits to humans are.

Write the case name in the box (cell) that matches your decision. Some cells may have more than one case, and some may have none. After making your choices, place an asterisk (*) beside any case that you think has an alternative in which humans can get the benefits while not harming the animals.

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Decision-Making-Continuum Terms and Definitions

Terms

Prohibition
Temporary Moratorium
Incrementalism
Restricted Pursuit
No Restrictions

Definitions

Prohibition: Activity is not permitted under any conditions; forbidden.

Temporary Moratorium: Activity is delayed or suspended until further review determines whether it should proceed.

Incrementalism: Each phase of the activity is evaluated step by step before proceeding to the next phase. Research starts with scientists conducting experiments on cells in the lab, for example. If goals are met, scientists move on to conduct research on animals; if goals are met, scientists move on to conduct research on humans; if goals are met, research moves from the lab into practice.

Restricted Pursuit: Activity is allowed but with strict guidelines on the extent of the activity.

No Restrictions: Activity is unrestricted.
Final Assessment of Alba’s Case

Relevant facts:

Likely harms

To Alba:

To other stakeholders:

Unknown harms:

Expected benefits

To humans:

To Alba:

Do the benefits to humans (and, possibly, to Alba) outweigh the harms to Alba? Why or why not?

Are there alternatives available that produce the same human benefits without modifying Alba? If so, what are they?

Does the ethical consideration of respect apply to this case? Why or why not?
**Policy question:** Should creating animals like Alba for art shows be allowed? What policy approach do you recommend?

**Policy recommendation (circle one):**

- Prohibition
- Temporary
- Incrementalism
- Restricted
- Moratorium
- Pursuit
- No Restrictions

**Argument for recommendation:**