

Cloning: A critical analysis of myths and media



Middle school students are generally aware of science-technology-society issues from the media, but their awareness is fraught with misunderstandings.

—National Science Education Standards: 5–8

Media literacy is defined as the ability to access, analyze, critically evaluate, and produce communication in a variety of forms (Scheibe and Rogrow 2004). Students' media literacy skills have a tremendous impact on their perception of the science concepts presented in both fictional and nonfictional print, television, film, radio, and internet sources. As such, media literacy education has become a critically important activity for teachers over the last three decades. With an abundance of information at students' fingertips, those who are able to apply critical-thinking skills and inquiry thought when examining media sources are empowered to make well-grounded and unbiased decisions about the issues under study.

Because the topic of this issue is genetics, I've chosen cloning as the platform on which we can examine how the media

influences science perceptions among our students, and how we as science teachers can use the media available to teach science and media literacy in our classrooms. Recently, I spoke with some students about cloning and asked what they knew about it, and how they had learned what they knew. Their responses contained some of the most often-cited inaccuracies about cloning and the myths perpetuated by film and television—the media to which they are most often exposed. Here's a sampling of their comments:

A clone is a copy of a person that gets made in a lab.

Clones look and act exactly like the person they came from.

Clones (humans) do bad things, like they kill people and are evil.

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No students were able to explain exactly how a clone was made or the science behind cloning. Their overall perception of cloning was that it was cool but a bad thing to do, based on what they had heard—albeit limited to a few news reports—about the U.S. government’s proposals to ban certain types of cloning. Also clear from their comments was that the words *clone* or *cloning* were synonymous in their minds with reproductive cloning of entire individuals—students knew nothing about therapeutic cloning, monoclonal antibodies, or other approaches in which cloning technology is applied. It became obvious very quickly that public media was the sole source of students’ knowledge about this very important topic.

Facts about cloning

Cloning is the production of identical genetic copies of a donor cell or individual. Clones exist naturally when a cell or an organism reproduces asexually (e.g., mitosis, binary fission, budding, sporulation, parthenogenesis), or when two genetically identical individuals are produced naturally (which is the case with naturally occurring identical twins or other identical multiple siblings). Horticultural propagation by grafting and cuttings is also technically cloning, because the plant produced by the process is a genetic copy of the original, but the term *cloning* is rarely used to describe these methods. The term *clone* today typically is construed to represent a genetically identical copy of a cell, tissue, organ, or individual created by deliberate human effort.

DNA cloning

Aimed at producing large quantities of DNA, *DNA cloning* technology has been around for more than 30 years and is common practice in molecular biology labs today. Also referred to as *recombinant DNA technology*, *molecular cloning*, and *gene cloning*, DNA cloning refers to the process of transferring a DNA fragment from one organism into a cloning vector, such as a bacterial plasmid or virus. After the vector is introduced into suitable host cells, the recombinant DNA can then be reproduced (along with the host cell DNA) and harvested for further study in the laboratory. Bacteria are most often used as the host cells for recombinant DNA experiments. Once the bacteria multiply, the bacteria cells are killed with antibiotics and the DNA extracted for further study.

This technique is the first stage of most genetic engineering experiments, such as production of DNA libraries, PCR (polymerase chain reaction), and DNA sequencing. DNA cloning was essential to the success of the Human Genome Project, a U.S.-led international research effort that sequenced all of the genes in a human being, reveal-

ing our complete genetic blueprint and opening countless possibilities in the world of genetics and genomics. PCR is also the basis on which DNA collected at a crime scene is replicated and then mapped for the purposes of using it as evidence in criminal investigations.

It is worth noting that DNA cloning technology is also used in genetic engineering efforts, such as *transgenic technology* (where DNA from one species is inserted into another) and/or *gene pharming* (where scientists alter an animal’s DNA so that it can make human proteins, drugs, or compounds that have medicinal or other applications). Transgenic animals are created most often for the purposes of studying disease. By inserting disease-causing DNA into the animal models, scientists are able to experiment on animals rather than humans in their efforts to find effective treatments and cures. In addition, by using transgenic technology, extremely rare human or animal diseases can be produced in a sufficient number of animal subjects for study and experimentation, rather than relying only on naturally occurring cases as subjects.

Bacteria, yeast, and some plants are used to produce such compounds as insulin, growth hormone, and medicinal drugs through gene pharming. Mammals, such as sheep, cows, and goats, are often used when certain proteins can’t be grown in other hosts and therefore require the use of mammalian host animals. These mammals have a distinct advantage over other hosts in the recovery process of the proteins—the proteins are designed to be excreted in the milk from the transgenic mammal.

Transgenic goats that can produce the dragline form of spider silk are a vivid example of gene pharming technology. Dragline silk is regarded as the strongest material known, six times stronger than steel and twice as strong as Kevlar. Spider farming efforts are hampered by the aggressive nature of the spiders (they are highly territorial and also eat each other). Attempts to produce dragline silk in bacterial and mammalian cell cultures also failed. However, when the genes were spliced into goat DNA and designed to be genetically expressed (active) only in the mammary gland tissues (meaning the spider genes are not active in any other tissue in the goat—there are no eight-legged spider-goat creatures here), the goats produced by this process excreted silk proteins in their milk that could be spun into a fine thread with all the properties of spider-made silk. This silk can be used to make lighter, stronger bulletproof vests,



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thinner thread for surgery and stitches, or indestructible clothes; now several hundred goats have been produced with the silk genes included in their DNA.

Cloning of cells

Efforts to clone cells are primarily aimed at cloning for therapeutic purposes, and are generally referred to by the terms *therapeutic cloning* or *biomedical cloning*. Most often, the desired goal of therapeutic cloning is to produce cells, tissues, or organs that would be a perfect match for their recipient, into whom they would be transplanted in order to treat or cure debilitating diseases or conditions.

Significant controversy exists around the process used in most therapeutic cloning efforts in humans, as they are most often centered on the use of human *embryonic stem cells* (see *Science Scope's* Summer 2004 issue, pp. 44–48, for a review of the technology and the ethical implications). Despite the complex ethics of the technology, the scientific process behind the technology is fairly straightforward. The nucleus of an egg cell is removed and replaced by the nucleus of a body cell from the intended recipient. This process is referred to as *somatic cell nuclear transfer* (SCNT). Then, the egg is permitted to grow to the embryo stage from which embryonic stem cells—potentially able to develop into any type of cell—may be extracted. This process, in turn, destroys the embryo. The stem cells can then be exposed to cells of the desired type for transplant, develop into the desired cells/tissues/organs, and be used for medical transplantation purposes. In 2002, the first successful transplantation of cloned kidney-like organs in cows was documented. In January 2006, embryonic stem cells were used to successfully treat sickle cell anemia in mice, correcting the genetic mutation that causes the life-threatening disease.

Cloning at the whole organism level

Cloning of a complete organism is generally referred to as *reproductive cloning*. The goal of reproductive cloning is to produce a new individual that is an exact genetic copy of the donor. The first successfully cloned animal produced from an adult cell was Dolly, a sheep born in 1996. The SCNT process described previously was the method by which Dolly was produced, and has been used several times over the last 10 years to produce additional animals including cows, mice, goats, rabbits, pigs, a deer, a cat, a horse, a mule, and a few recently extinct or endangered species. Thus far, the greatest achievement in SCNT cloning of an animal is the 2005 birth of a dog, an Afghan hound named Snuppy, in South Korea. Snuppy was the result of years of research

and 1,000 attempts to clone a dog by that research team. It should be noted that while a South Korean scientist's claim of successfully cloning a human embryo was found to be falsified, Snuppy has been scientifically proven by independent review to be the first successful clone of a dog.

Another cloning process, called *chromatin transfer* (CT), was established in 2003 and involves pretreating the donor cell to remove molecules associated with cell differentiation. This technology is considered superior to SCNT by its patent-holder, Genetic Savings & Clone, where it has been used successfully to clone domestic cats. The company offers its customers the ability to collect and store DNA from their cats and dogs for future use. Although the company has not yet successfully produced a cloned dog using CT, dog DNA sent to the company by dog owners is being stored in the hopes that the company will be able to provide dog cloning in the future.

Cloning of individual humans, human reproductive cloning, is even more highly controversial than therapeutic cloning, and is prohibited in many countries for ethical and scientific reasons. Because many of the cloned animals produced by reproductive cloning research have suffered from genetic abnormalities, it is considered by most persons to be immoral to attempt to create human cloned embryos specifically for the purpose of reproductive cloning. Some private researchers, however, have attempted human reproductive cloning, and a few scientists over the past five years have reported that cloned human babies have been successfully born, although none of these reports has yet been confirmed by independent sources.

Myths perpetuated by the media about cloning

The following are some of the widely held myths about cloning, and examples of these inaccuracies from media with which students are likely to be familiar:

MYTH: Cloned individuals (such as animals) are grown in a laboratory.

MEDIA EXAMPLE: *Star Wars Episode II: Attack of the Clones* (film released in 2002)—Shows the human clone army being grown inside thousands of jars. Same concept seen in *Alien Resurrection* (film released in 1997), and *The Island* (film released in 2005).

FACT: Cloned individuals are gestated within surrogate animals.

MYTH: Clones are the age of the donor when they are produced.

MEDIA EXAMPLE: *Multiplicity* (film released in 1996)—An overworked dad has himself cloned in order to be able to meet all the demands on his time. Clones are the same age as the dad when they are produced.

FACT: Cloned animals are born as infants the same as any other animal. Therefore, they are behind the host in age accordingly (e.g., a sheep cloned at age five will have a clone five years younger). An easy way to represent this concept to students is “think identical twins, with different birth dates in years.” Also, unlike the films *Star Wars Episode II* and *The Island*, in which the developmental process of the clones is accelerated, no such techniques to age clones more rapidly than the natural aging process exists.

MYTH: Cloned human individuals are produced in order to serve as the source of transplant organs for the donor individual.

MEDIA EXAMPLE: *The Island*—Unknowing clones are eager to be sent to the island under an elaborate hoax, only to discover their true purpose for existence. This plot is strikingly similar to *Parts: The Clonus Horror*, a film released in 1979.

FACT: Whole-organ cloning is still in experimental stages, but it does *not* involve growing the organ or tissue within human clones for transfer to the donor humans.

MYTH: Clones have the memory of the host and/or act the same as the host.

MEDIA EXAMPLE: *Godsend* (film released in 2004)—Eight-year-old boy is killed in a car accident and his parents clone a replacement. Also represented in *Multiplicity* (see above), and in *The Island* (only for the “Echo” and “Foxtrot” clone generations).

FACT: “Cellular memory”—The idea that cells, or in this case a DNA sample, have the memory of the donor—is widely disputed by scientists. While a clone is genetically identical to the donor, a significant percentage of personality and behavior are caused by environment and experience and *not* by one’s DNA. It is a classic example of nature versus nurture.

MYTH: Cloning of prehistoric extinct species is possible.

MEDIA EXAMPLE: *Jurassic Park* (1993, plus later sequels)—Extinct prehistoric dinosaurs are cloned.

FACT: DNA used in cloning must be extremely well preserved; it is likely that very few, if any, prehistoric sources will be successfully cloned. However, more recently extinct species may be cloned; work is currently underway with a few species that have recently become extinct and had well-preserved DNA available, as well as a closely

related species able to serve as the surrogate mother, such as the bucardo (a Spanish mountain goat species of which the last individual recently died and was immediately frozen and cells preserved for future cloning).

MYTH: Cloning is a relatively easy process and highly successful.

MEDIA EXAMPLE: All films in which cloning is represented for dramatic reasons.

FACT: Cloning is an extremely difficult process; it typically takes hundreds—if not thousands—of attempts before a successful clone (cell or animal) is produced and the scientific process to do so takes a number of years, *if* it is ever successfully achieved. Additionally, the process is very expensive and out-of-reach for the typical person or family (for example, Genetic Savings & Clone currently charges \$32,000 for a cloned domestic cat).

While all of the media examples above are from film, additional examples of cloning are available from television programming, books and novels, and the internet (see Resources for ideas).

Student applications and media literacy

The issue of cloning provides teachers with an opportunity to use media with their students in a variety of ways that stress critical thinking. *Critical thinking* refers to a body of intellectual skills and abilities that enable one to decide rationally what to believe or do. Because cloning technology is extremely promising for its scientific and medical applications, its ethical concerns and the immediacy of the advances of cloning technology pose today’s adolescents to be members of the generation that will make major policy decisions on the applications of this technology.

Robert Ennis (1962) summarizes critical thinking in a checklist of activities that help students in

- distinguishing between verifiable facts and value claims,
- determining the reliability of a claim or source,
- determining the accuracy of a statement,
- distinguishing between warranted and unwarranted claims,
- detecting bias identifying stated and unstated assumptions,
- recognizing logical inconsistencies, and,
- determining the strength of an argument.

A typical mass-media issue, such as cloning, involves a blending of intellectual, affective, and moral responses.

Many issues carried in the media—and based in the science-technology-society domain—demand that we move back and forth between opposing points of view. I've applied the principles from Ennis's critical-thinking checklist to some of Scheibe and Rogrow's suggestions in *12 Basic Principles for Incorporating Media Literacy and Critical Thinking into Any Curriculum* to provide some concrete examples of activities that teachers can use to raise students' media literacy via an examination of cloning as portrayed in public media.

- Students can identify ways in which they are already familiar with cloning through media by giving examples from popular media content, including the films previously cited, to illustrate what they might already know about it and their misconceptions. If done as an assignment, students could be given the task to find four or five examples of cloning from varied media sources, examine the media themselves, and then present their findings to other students in the class.
- Teachers can incorporate a variety of media (print, visual, internet; see Resources section) on cloning into their lessons and have students practice general observation, critical thinking, and analysis when they use these materials, pointing out ways in which media messages about cloning might be interpreted differently by people from different backgrounds or groups.
- Students can be taught to develop an awareness of issues of credibility and bias in the media by teaching how to recognize the source (speaker) of a media message about cloning and the purpose of producing the message, and how that might influence the objective nature of information. Media sources that provide information specifically for or against cloning, and sources that provide cloning commercially, would be useful for this activity.
- The class as a whole, or students in smaller discussion groups, can analyze the effect that specific media have had on the public's perception of cloning historically and/or around different cultures. The Cloning's Historical Timeline table (see Resources), as well as many articles that discuss how cloning laws differ across the world, would provide a good base for this activity.
- A student debate on the pros and cons of cloning would be an excellent way to have students synthesize all of the information they have learned, and allow them to practice critical thinking in real time as they analyze the arguments presented during the debate.
- Students can summarize their knowledge about genet-

ics and cloning in a final report that employs forms of media beyond the standard written report (e.g., computer-illustrated reports, audio or video productions, photographic illustrations) as an end product for the unit. Such products could be shared with the school via closed-circuit television, exhibition display, or in a school newspaper.

Conclusions

The science behind cloning, and its long history, provide teachers with a real-life, high interest topic through which they can launch an effort to raise students' media literacy skills. By blending science content with critical thinking and reflection through activities like the ones proposed here, teachers can help to impart to their students the observation and reflection skills necessary when examining media content in all subjects so that students might become independent and inquiring thinkers.

References

- Ennis, R. 1962. A concept of critical thinking. *Harvard Educational Review* Winter: 38.
- Scheibe, C., and F. Rogrow. 12 principles for incorporating media literacy into any curriculum—www.ithaca.edu/looksharp/resources_12principles.php.

Resources

Here are sources that may be helpful to you and your students in exploring the science behind cloning, and for use with media literacy activities on this topic and others:

- Center for Media Literacy—www.medialit.org.
- Cloning's Historical Timeline—www.nsta.org/middleschool
- Genetically Modified Cinema web page provides a list and analysis of films featuring genetics and cloning—<http://homepage.ntlworld.com/christine.reeves4/cinema.htm>.
- Genetics Savings & Clone website provides science and historical information on cloning, and their responses to why they believe cloning of domestic pets is ethical and worthwhile—www.savingsandclone.com.
- The Genetics Science Learning Center of the University of Utah has an outstanding website on cloning, funded by the NIH's Science Education Partnership Awards. It contains an overview of the science, an interactive quiz about cloning myths, and much more—<http://gslc.genetics.utah.edu/units/cloning/index.cfm>.
- National Human Genome Institute has a host of educational resources for the study of genetics and cloning, including lesson plans and student activities—www.genome.gov/Education.