

Assignment Discovery Online Curriculum

Lesson title:

Genetic Engineering

Grade level:

9-12, with adaptation for younger students

Subject area:

Contemporary Issues

Duration:

Two class periods

Objectives:

Students will

1. discover ethical issues surrounding the practice of genetic engineering in reproductive medicine; and
2. understand key terms and concepts related to the science of genetic engineering.

Materials:

- Computer with Internet access (optional but very helpful)
- Library resources for research
- Paper, pens, and pencils
- Copies of Take-Home Activity Sheet: Different Perspectives on Genetic Engineering

Procedures:

1. Begin the lesson by grouping students into pairs. Ask partners to discuss genes and why they are important. Give students five minutes to discuss and write down their ideas.
2. Have a class discussion about genes. Explain that genes are inherited from parents and are important because they determine much about behavioral, mental, and physical traits. Every gene contains a DNA (deoxyribonucleic acid) code that gives the cell instructions about how to make specific proteins. These proteins form the basis for the structural framework of life.
3. Explain that medical science has progressed and that now genes can be changed through genetic engineering. In this process, scientists insert the genetic instructions to make a specific protein into a cell's DNA. The cell will manufacture the protein, which affects a particular characteristic, and the cell will also pass the new instructions on to its offspring. Genetic engineering gives scientists the ability to improve and alter the basic composition of a living cell. This is called biotechnology.

4. Have students brainstorm the risks and benefits associated with biotechnology. For example, the removal of hemophilia or other serious disorders from the gene pool is a benefit because people would no longer suffer from a chronic condition. An example of a risk is going too far in selecting the genetic makeup of future children.

Possible risks:

- Relying on eugenics, or selecting the genetic makeup of future children. This practice may give people the power to control some personal traits, such as having blond hair or being tall. Taken to an extreme, this could eliminate some traits.
- Using biotechnology before exploring other options, particularly in reproductive medicine. For example, technology enables scientists to implant an egg from one woman into the uterus of another. But it may not be a good idea to use this technique before trying less extreme techniques first.

Possible benefits:

- Eliminating genetic diseases. For example, geneticists think it may be possible to eliminate genetic diseases such as Tay-Sachs through careful and methodical screening programs.
 - Screening unborn babies. This refers to screening for genetic disorders either before a pregnancy takes place or in the early months of a pregnancy. More information would give prospective parents more options in dealing with their infants' problems.
 - Treating diseases. For example, scientists are working on ways to insert cells from embryos into cancerous cells as a way to stop the growth of cancer.
5. Point out that biotechnology is a powerful tool and that scientists have had to consider many ethical issues surrounding it. As a result, the new field of bioethics has emerged. Bioethics is the study of the ethical implications of biological research and applications, especially in medicine; it involves examination of the benefits and the risks of biotechnology.
 6. Tell students that they will think about ethical issues associated with biotechnology in the area of reproductive medicine. Distribute the Take-Home Activity Sheet: Different Perspectives on Genetic Engineering. Explain that students will read a scenario concerning cystic fibrosis and genetic engineering. They will examine the scenario from the perspective of one of six individuals, including a religious person and a molecular biologist. (Assign each student an individual by having students count off one through six.)
 7. For homework, have each student read the scenario and write a position statement from the individual's perspective. Students may use quotations from the individuals in their position statements. Share the following Web sites with students to help them research this topic:

National Center for Biotechnology

<http://www.ncbi.nlm.nih.gov>

Access Excellence

<http://www.gene.com/ae>

Medical College of Wisconsin Bioethics Online

<http://www.mcw.edu/bioethics>

University of Pennsylvania Center for Bioethics

<http://www.bioethics.net>

8. During the next class period, group students according to their assigned individuals. Groups should meet for 15 minutes to discuss their position statements and develop a consensus. Have each group select one person to present its position to the class.
9. After the groups have presented their positions, have a class discussion. Can the class develop a policy statement about the government's role in biotechnology? Should biotechnology in reproductive medicine be prohibited? Would government regulations solve any ethical dilemmas? Help students understand that these are complex issues and that no easy solutions exist.

Adaptation for younger students:

Have students in grades 6-8 do the homework activity as a classroom activity. Have them work in six cooperative groups to write their position papers. They can use the Web sites given in the lesson for background information. Discuss the position of each group as a class. Have the students try to reach a consensus about what they think the government's role should be concerning biotechnology in reproductive medicine.

Discussion Questions:

1. Discuss issues involved with biotechnology and reproductive medicine. For example, the technology may allow a 60-year-old woman to have a baby. Is that a positive or negative outcome? Consider its ramifications. How does this example illustrate some of the complex issues that arise from the use of biotechnology?
2. Discuss ways in which biotechnology is becoming a powerful presence in our lives. What areas have been affected by biotechnology? Give at least two examples.
3. What safeguards must society adopt to handle the rapid advances in biotechnology?
4. To what extent should religious ideology influence bioethics? To what extent should a religious perspective affect the use of biotechnology?
5. What are some positive long-term effects of biotechnology? What are some negative long-term effects?

6. During World War II, Nazis in Germany conducted experiments to selectively breed blond, blue-eyed men and women. This is an example of eugenics that was detrimental to society. Explain why.

Evaluation:

You can evaluate your students using the following three-point rubric:

Three points: demonstration of a thorough understanding of the topic; ability to write a clear, succinct, well-researched position paper; cooperative work in a group to develop a consensus of opinion; active participation in the final class discussion

Two points: demonstration of an adequate understanding of the topic; ability to research the topic adequately and write a concise position paper; cooperative work in a group to develop a consensus of opinion but with some disengagement from the group; some involvement and interest in the final class discussion

One point: demonstration of a weak understanding of the topic; inability to write a clear, well-researched position paper; minimal success with work in a group to develop a consensus of opinion; little involvement in the final class discussion

Extensions:

Stranger than Fiction

Have students read the science fiction classic *Brave New World*, by Aldous Huxley (1932). Then have each student write a critical essay that compares and contrasts the ethical and societal conflicts in Huxley's society with our society's use of biotechnology.

Cloning Complications

It took scientists 277 attempts to clone a normal, healthy sheep (Dolly). But what happened to the other 276 sheep? Have students research these previous attempts. The following Web site is a good place to start:

<http://www.accessexcellence.org/AE/AEPC/BE02/gentest/fail15.html>. What do you think would happen if it took 277 attempts to clone a human being? What does this information tell us about the consequences of cloning?

Suggested Reading:

Private Choices, Public Consequences: Reproductive Technology and the New Ethics of Conception, Pregnancy, and Family

Lynda Beck Fenwick. Dutton, 1998.

This book takes a close look at a number of complex legal and ethical issues surrounding reproductive technology, such as having a child who will inherit genetic abnormalities to surrogate parenting. Much of the personal information included in the book resulted from a survey, which is contained in the appendices.

Does It Run in Families? A Consumer's Guide to DNA Testing for Genetic Disorders

Doris Teichler Zallen. Rutgers University Press, 1997.

We now have genetic testing available for many inherited disorders, like muscular dystrophy, as well as disorders that occur randomly, like Down's syndrome. Participating in genetic testing is more complicated than it looks and raises many issues. While the information presented in the book is occasionally difficult, it is an excellent overview of the topic. Consumer resources, as well as further reading, and a glossary are included.

Vocabulary:

bioethics

Definition: The study of the ethical issues of biological research and applications, especially in medicine.

Context: Scientists must consider **bioethics** to make appropriate decisions about some medical procedures.

biotechnology

Definition: The techniques of managing biological systems for human benefit.

Context: Advances in **biotechnology** allow scientists to separate sperm by gender.

deoxyribonucleic acid (DNA)

Definition: The chemical inside the nucleus of a cell that carries the genetic instructions for making living organisms.

Context: Scientists examine **DNA** from a developing embryo to find out whether it will have any serious birth defects.

ethics

Definition: A system of moral principles.

Context: Manipulating genes violates the **ethics** of some people.

eugenics

Definition: The science of improving the qualities of a breed or species by different strategies, such as the careful selection of parents or the use of genetic testing. Context: Some people argue that designing traits for offspring is reminiscent of **eugenics**.

gene

Definition: The functional and physical unit of heredity passed from parent to offspring. Context: Introducing healthy **genes** into diseased cells is becoming an established medical practice.

genetic code

Definition: The instructions in a gene that tell the cell how to make a specific protein. Context: By studying a person's **genetic code**, a scientist can detect certain abnormalities.

genetic engineering

Definition: The techniques used to manipulate genes in an organism. Context: A great number of innovations may arise in the next 20 years because scientists are making progress in **genetic engineering**.

Academic standards:

Grade level:

9-12

Subject area:

Life Science

Standard :

Understands the principles of heredity and related concepts.

Benchmark:

Knows the chemical and structural properties of DNA and its role in specifying the characteristics of an organism (e.g., DNA is a large polymer formed from four kinds of subunits; genetic information is encoded in genes as a string of these subunits; each DNA molecule in a cell forms a single chromosome and is replicated by a templating mechanism).

Grade level:

9-12

Subject area:

Life Science

Standard:

Understands the principles of heredity and related concepts.

Benchmark:

Knows ways in which genes (segments of DNA molecules) may be altered and combined to create genetic variation within a species.

Grade level:

9-12

Subject area:

Nature of Science

Standard :

Understands the scientific enterprise.

Benchmark:

Understands the ethical traditions associated with the scientific enterprise (e.g., commitment to peer review, truthful reporting about the methods and outcomes of investigations, publication of the results of work) and how their peers censor scientists who violate these traditions.

Credit: Winona Morrissette-Johnson, government teacher, T.C. Williams High School, Alexandria, Virginia.

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Different Perspectives on Genetic Engineering

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In this activity, you will consider ethical issues regarding a scenario about genetic testing.

1. Read the following scenario regarding genetic testing and cystic fibrosis.
2. Write a position statement regarding the issues in this scenario from the perspective of one of the six individuals listed on the next page. Your teacher can provide Web sites to help guide your research. You may wish to use the quotation included for each individual. Address the following questions:
 - Who should be responsible for answering these ethical questions? (Political leaders? Individuals? Religious leaders? Lawyers?)
 - Should an issue such as the one presented here be regulated by federal laws, by state laws, or by regulations enforced by a federal agency such as the Federal Drug Administration? Which group should be the one to take on the responsibility of monitoring this industry?
 - What benefits does this technology offer us? What risks should we be aware of?

PART 1

Scenario: Genetic Testing and Cystic Fibrosis

A couple has undergone genetic testing and discovered that both parents are carriers for cystic fibrosis, a disease characterized by a deficiency of certain enzymes needed for digestion and respiratory health. Some specialists have recommended against the couple's having children, stating that cystic fibrosis is a serious disease that usually shortens an individual's life span. On the other hand, great advances have been made in research, and people with cystic fibrosis are now living longer lives of a higher quality than ever before. In addition, it's possible that a cure for cystic fibrosis could be found within the next 25 years. The couple is trying to decide what to do and is interested in the viewpoints of the people listed below.

Different Perspectives on Genetic Engineering

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PART 2

Individual Perspectives

1. Religious person:

“I am opposed to the manipulation of human genes for any purpose. It’s just not right. Who are we to be playing God?”

2. Bioethicist:

“I am undecided about the use of genetic engineering in reproductive medicine. What we want is to enjoy the benefits of the technology while minimizing the risk.”

3. Lawyer:

“I think we should accept human gene engineering, make it legal, regulate it, and make sure it's done in a responsible way.”

4. Expectant father with an inherited heart condition that may be passed on to children:

“Although the technology to diagnose my child’s susceptibility to my heart condition is available, it still is a scary piece of knowledge to have in reproductive decision making, and I’m not sure I want to go through with the screening.”

5. Molecular biologist:

“I am in favor of genetic engineering for reproductive purposes. It is just a better way of doing what animal breeders and botanists have already done to improve their livestock and agriculture.”

6. Eugenicist:

“Eventually it will be possible to pick genes for virtually any inherited human characteristic. I support this technology because it will make it possible for parents to correct genetic defects and improve the genes of our their children.”