Cleveland Museum of NATURAL HISTORY

Teacher's Guide

Genetic Revolution

A 40-minute lesson
Grades 7 through 12

Description

The Human Genome Project has unveiled information that presents new and exciting potentials in biomedical research and practice. This expanding ability to affect life at its basis is also causing society to face ethical and moral decisions that may have no guidelines. *Genetic Revolution* is an introduction to biotechnology, how genomic information is used for bioscience applications, and biomedical ethics. During this lesson, students will view illustrations and models of DNA molecules and discuss various applications of genomic research. They will also model DNA analysis using evidence from a mock crime scene and DNA gel electrophoresis. Participants will also chart new territory into questions regarding human life, privacy, and access to the cutting edge of medicine and bioscience.

Objectives

Students will:

- Describe the structure and function of the DNA molecule.
- Define gene sequencing, DNA fingerprinting and genetic transformation.
- Demonstrate DNA gel electrophoresis.
- Discuss how biotechnology affects society, including specific applications in bioscience research and consumer products.
- Discuss ethical and moral questions presented by applications of DNA biotechnology.

Before Your Program

If this will be the first trip to the museum for some of your students, you may want to discuss the following questions:

- What is a Museum?
- Why are we going to the Cleveland Museum of Natural History?
- What issues do you think are affected by current genetic technology?

Distance Learning:

- If this is your students' first experience with videoconferencing, we suggest that you take some time before your program to familiarize them with proper microphone use.
    - Your Museum Educator will instruct you as to how they will acknowledge questions. Students should raise their hands to get the Educator's attention.
    - It is not necessary to yell. Students should speak in a slow, clear voice when asking questions.
    - We also strongly recommend that you conduct a test call before your program. Please call 216-231-4600 x 3215 to set up this test.

Academic Content Standards

Program content includes many of the indicators incorporated in Ohio's Academic Content Standards in Science and the National Health Education Standards.
Although this program may be tailored to your individual class needs and student questions, the information routinely includes the following indicators:
Grade 7: Life Sciences: 8
Grade 8: Life Sciences: 2, 3
Grade 10: Life Sciences: 1, 5, 6, 7, 27, 28
Grade 12: Life Sciences: 1, 5, 6
Grades 6-8: National Health Education Standards: 1.8.4, 2.8.6
Grades 9-12: National Health Education Standards: 1.12.4, 2.12.6

Vocabulary

biotechnology – the use of biological processes to manufacture products.
chromosome – a packet of tightly wound DNA found within a cell nucleus.
cloning – the process of creating an exact copy of all or part of an organism's genetic material.
deoxyribonucleic acid (DNA) – the material found primarily in a cell's nucleus that carries the instructions for making all the structures and functions of an organism.
ethics – the philosophical study of moral values and rules, good and bad, right and wrong.
eugenics – a scientific movement to improve the human race through heredity and genetics.
forensic science – the application of scientific or medical knowledge to legal investigations.
gel electrophoresis – a technique where nucleic acids or proteins are separated according to size and charge by subjecting them to an electric current in a suitable gel and buffer system.
gene – a section of DNA that determines an inherited characteristic.
gene therapy – the insertion of normal or genetically altered genes into cells, usually to replace defective genes especially in the treatment of genetic disorders.
genetic counseling – education and guidance offered by professional advisors in order to help people make informed decisions based on genetic knowledge, usually discussing risks of birth defects or genetic disorders.
genetic or DNA fingerprinting – techniques used to distinguish individuals of the same species using DNA samples; also known as DNA testing, DNA profiling and DNA typing.
genetically modified organisms (GMOs) – living things that have had their genetic material altered in some way through genetic engineering.
genetics – the field of science that looks at how traits are passed down from one generation to another, through the genes.
gene sequencing – A laboratory technique for identifying nucleotide sequences in a DNA fragment.
genetic engineering – the technology used to genetically manipulate living cells to produce new chemicals or perform new functions; also known as recombinant DNA technology.
genome – the complete genetic material of an organism.
genotype – the genes that an organism possesses.
heredity – the transmission of characteristics from parent to offspring, by means of their genes.
Human Genome Project – a 13-year government-funded effort to sequence all the nucleotides of human chromosomes and map locations of all the genes and make this information available to everyone; completed in 2003. This project also addressed ethical, legal and social issues that might arise from this research.
nucleotide – subunits that join together in long chains to make DNA, know as adenine (A), cytosine (C), guanine (G) and thymine (T).
polymerase chain reaction (PCR) – a method used to rapidly make multiple copies of DNA segments.
phenotype – observable traits of an organism that may be determined by genes, environment or a combination of both.
stem cell – an undifferentiated cell from which specialized cells develop.
trait – a distinguishing characteristic or feature.

Activities

1) Use the included *"Scenarios"* sheet to introduce your students to moral and ethical questions often raised by genetics research.
2) Challenge your students to think outside the box with the included *"Genetics: Media Awareness"* worksheets. Students are asked to locate one magazine or news article focused on the field of genetics, and answer questions that focus on media literacy.

Websites

Here are some sites that we have used in the past as resources for program content. Please note that the Museum is not affiliated with and does not endorse these websites.
www.genome.gov
http://genomics.energy.gov/
http://www.ncbi.nlm.nih.gov/ - National Center for Biotechnology Information.
http://science.howstuffworks.com/dna8.htm - This is the link within the "How Stuff Works" website specifically for DNA, but this site has lots of good health and science information on other topics.

Books for Students

Baker, Catherine, (1997). *Your Genes, Your Choices – Exploring the Issues Raised by Genetic Research.* American Association for the Advancement of Sciences.
Balkwill, Fran & Mic Rolph, (2002). *Gene Machines.* Cold Spring Harbor Laboratory Press, MA.
Caselli, Giovanni, (1987). *The Human Body and How It Works.* Grosset & Dunlap, New York.

Nicolson , Cynthia Pratt, (2001). *Baa! The Most Interesting Book You'll Ever Read About Genes and Cloning.* Kids Can Press, Ltd., NY.

Sheely, Robert, (1993). *Police Lab – Using Science to Solve Crimes.* Silver Moon Press, NY.

Snedden, Robert, (2003). *Cell Division and Genetics.* Heinemann Library, Chicago. IL.

Wiese, Jim, (1996). *Detective Science.* John Wiley & Sons, Inc. NY.

Books for Teachers

Baker, Catherine, (1997). *Your Genes, Your Choices – Exploring the Issues Raised by Genetic Research.* American Association for the Advancement of Sciences.
Cogdell, Christina, (2004). *Eugenic Design – Streamlining America in the 1930s.* University of Pennsylvania Press, Philadelphia, PA.
Walker, Pam & Elaine Wood, (1998). *Crime Scene Investigations – Real-Life Science Labs for Grades 6-12.* The Center for Applied Research In Education, NY.

Written by Lee D. Gambol and Thomas Bills. Produced and published by the Education Division, Cleveland Museum of Natural History, 1 Wade Oval Drive, University Circle, Cleveland, OH 44106-1767. Revised October 2007.

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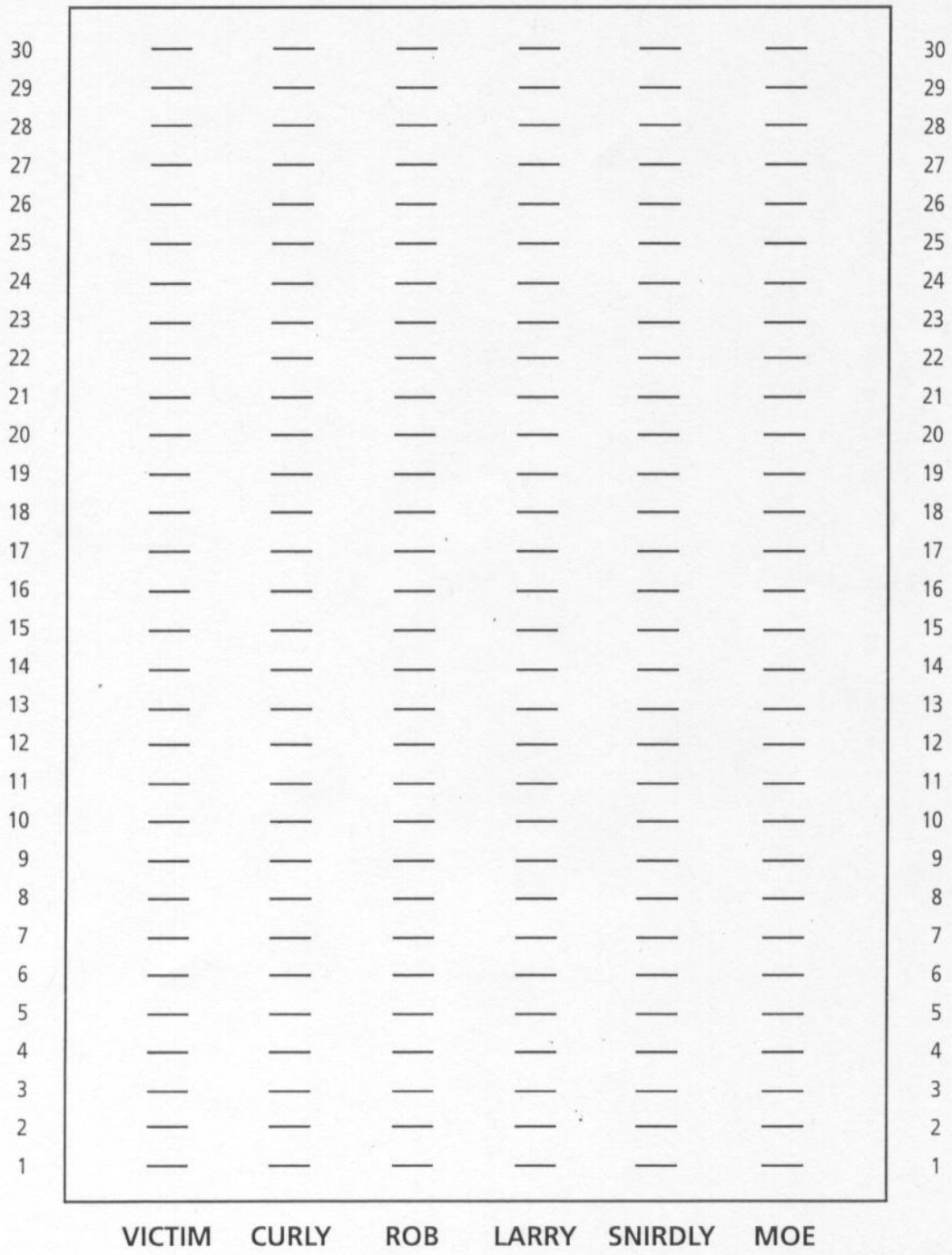
Genetic Revolution

Crime Sequence

Gel Electrophoresis of DNA Samples



try this

Name: _____

Genetic Revolution

Cleveland Museum of NATURAL HISTORY

DNA SEQUENCE OF SPECIMEN FOUND ON THE **VICTIM**

USE THE FOLLOWING ENDONUCLEASES: EcoRI GAATTC / CTTAAG BamHI GGATCC / CCTAGG

TACGAATTCCCTTGGATCCGGCCCTGAATTCAACCTTAGGATCCGAATTCCCCGGTGGATCCCCCGAATTCGGCTGGATCCAGAATTCCCGTCCAGC
ATGCTTAAGGGAACCTAGGCCGGGACTTAAGTTGGAATCCTAGGCTTAAGGGGCCACCTAGGGGGCTTAAGCCGACCTAGGACTAAGGGCAGGTCG

DNA SEQUENCE OF THE SUSPECT NAMED **CURLY**

USE THE FOLLOWING ENDONUCLEASES: EcoRI GAATTC / CTTAAG BamHI GGATCC / CCTAGG

TACGAATTCACTGCCTTTGGATCCGGAATTCATGGATCCCAGAGGAATTCCTTGGATCCGGATCCGAATTCAGGGGGATCCCGAATTCAGCAATCCT
ATGCTTAAGTGACGGAAACCTAGGCCTTAAGTACCTAGGGTCTCCTTAAGGAACCTAGGCCTAGGCTTAAGTCCCCCTAGGGCTTAAGTCGTTAGGA

DNA SEQUENCE OF THE SUSPECT NAMED **MOE**

USE THE FOLLOWING ENDONUCLEASES: EcoRI GAATTC / CTTAAG BamHI GGATCC / CCTAGG

TACGAATTCCCAAGGATCCAAACCCGAATTCAACCGCAGGATCCGAATTCCTAAGGGGATCCCGGGAATTCATTTGGATCCAGAATTCCCCTTAGGC
ATGCTTAAGGGTTCCTAGGTTTGGGCTTAAGTTGGCGTCCTAGGCTTAAGGATTCCCCTAGGGCCCTTAAGTAAACCTAGGTCTTAAGGGGAATCCG

DNA SEQUENCE OF THE SUSPECT NAMED **LARRY**

USE THE FOLLOWING ENDONUCLEASES: EcoRI GAATTC / CTTAAG BamHI GGATCC / CCTAGG

TACGAATTCCCGGGGATCCCTCTGAATTCCAAGAATTCGGATCCGAATTCGAATTCGGATCCCAAAGCCGAATTCGGATCCCGAATTCATCAATTCC
ATGCTTAAGGGCCCCTAGGGAGACTTAAGGTTCTTAAGCCTAGGCTTAAGCTTAAGCCTAGGGTTTCGGCTTAAGCCTAGGGCTTAAGTAGTTAAGG

DNA SEQUENCE OF THE SUSPECT NAMED **SNIRDLY**

USE THE FOLLOWING ENDONUCLEASES: EcoRI GAATTC / CTTAAG BamHI GGATCC / CCTAGG

TTTAACAATTGCGCATACTGGATCCGGGCCTTCCGAATTCACGTACTTAAGGATCCCGATACTACCGAATTCAATTCCGGATCCCCTTAAAAATTTT
AAATTGTTAACGCGTATGACCTAGGCCCGGAAGGCTTAAGTGCATGAATTCCTAGGGCTATGATGGCTTAAGTTAAGGCCTAGGGGAATTTTTAAAA

DNA SEQUENCE OF THE SUSPECT NAMED **ROB**

USE THE FOLLOWING ENDONUCLEASES: EcoRI GAATTC / CTTAAG BamHI GGATCC / CCTAGG

CCGGTACGGGAATTCAACCGGCCGGATCCCCCGAATTCGGCCAATTCATGGAATTCCCGGATCCCCGATTCATGAATTCGGATGAATTCGGATCGAA
GGCCATGCCCTTAAGTTGGCCGGCCTAGGGGGCTTAAGCCGGTTAAGTACCTTAAGGGCCTAGGGGCTAAGTAGTTAAGCCTACTTAAGCCTAGCTT

data

Cleveland Museum of NATURAL HISTORY

"Genetics: Media Awareness" Activity for
Genetic Revolution
Grades 7 through 12

During the *"Genetic Revolution"* program, you will explore the concept of media literacy. This means being able to analyze an author's use of language to add a bias to their writing.

1. **Find one magazine or news article focused on the field of genetics. Some topic ideas are:**
    a. Genetic diseases
    b. Gene therapy
    c. Biotechnology
    d. Genetic medical treatments
    e. Cloning
    f. Genetically modified foods

2. **Read the article and underline the author's main points.**

3. **Answer the following questions about your article:**
    a. Where did you find your article?
    b. Is the article factual, or opinion-based?
    c. Does the author use their language to put an opinion into the article?
    d. Is the author for or against the genetic technology discussed?

4. **Write a summary of your article.** Make your article as neutral as possible (do not include your personal opinion toward the genetic technology discussed).

5. **Be prepared to discuss your findings in class.** Do your classmates agree with your analysis of the author's use of language?

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Suggested here are a series of scenarios that present some of the ethical and legal questions raised by the concepts of genetic engineering. Some are hypothetical situations, and others are based on actual circumstances. These can be used as starting points for class discussion or as themes for opinion papers. As the use of genetic engineering becomes more common in the medical field, more of the general population will be faced with ethical decisions like these, and students should be prepared to understand the challenges of incorporating this type of technology into society. Please note that these are examples only; Cleveland Museum of Natural History Instructors do not introduce any personal ethics or morals into their programming.

1. You are a parent. You and your partner have been trying to have a baby girl for 15 years. Instead, you have had five boys. At a very early stage of pregnancy, your learn that another boy is on the way. If there were a genetic treatment to change the gender of your fetus, would you use it?

2. You are a doctor. Your patient has a family history of colon cancer. Physical examinations indicated that she is healthy at this time. Because of her family history, your patient requests genetic screening, and the results show that there is a 15% chance that your patient will develop colon cancer in the next 20 years. It is your job to advise this patient, but you do not want to alarm her with these inconclusive results. Do you tell her that she is at risk?

3. When you were just a baby, your grandfather died of Huntington's Disease. This is a debilitating mental disease that develops in middle age and often results in death before the age of 50. There is no known cure. You know that you may carry the gene that causes Huntington's, and that there is a simple genetic test to screen for it. Do you get tested, or would you rather remain ignorant? How would your life change if you knew that you would eventually develop the disease?

4. You are a judge. You have just heard closing arguments of a trial and are in chambers to make your decision. The attorneys for a major insurance company argued that genetic profiles of prospective clients should be available to all insurance companies upon request. They asserted that insurance companies have a right to know about pre-existing conditions of their clients, including the genetic predisposition to develop a disease. If insurance companies remain ignorant of genetic profiles, individuals without genetic flaws will be forced to subsidize the cost of those who develop genetic diseases.
    a. The attorneys from the American Civil Liberties Union (ACLU) challenged this argument. The ACLU asserted that genetic information is private, and therefore protected by the Fifth Amendment. If genetic information were made public, individuals with genetic flaws would face discrimination from insurance companies and employers.
    b. Do you rule in favor of the insurance company, or the ACLU? Why?

5. The year is 2020. You are preparing to vote on a new bill that would require all citizens to provide blood samples to their local police department. The samples would be used to create a database of genetic information. The police would use this database to identify and apprehend crime suspects and clear innocent people of criminal charges. Supporters of the bill say that it is an essential step in the war against crime. Opponents claim that the information could be misused and that genetic information should remain private. Do you vote in favor of, or against the new bill? Why?

OTHER POSSIBLE OPINION TOPICS FOR CLASS DISCUSSIONS OR PAPERS:

- All prospective parents should be required to meet with a genetics counselor to evaluate the potential for hereditary problems in their children.
- Due to the rapid rate of genetic technological advancement, these areas of science should be controlled by society. (Government, ethics committees, etc.)
- Our growing ability to conduct genetic screening will result in new kinds of discrimination.
- Genetic engineering of new variations of plants and animals is a good idea.
- The use of genetic technology in human reproduction creates more problems than benefits.
- Cloning humans will benefit humanity.
- Coursework in Bioethics should be a requirement in High School, in order to inform young people about the impact of genetic research and how it will affect society.
- The three things I wish could be solved through genetic engineering are _____. Explain why you chose these three ideas, and how genetic research would be involved.

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