

TECH ED: Gene Therapy - Biotechnology (HST)

Summary

This unit will provide students with an opportunity to explore the exciting new field of gene therapy.

Time Frame

4 class periods of 45 minutes each

Group Size

Large Groups

Materials

Your World Gene Therapy --Biotechnology and You. Volume 4

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Case Study 1 and 2

Case Study Patient Record 1 and 2

Connection to Careers

Needed for DNA extraction - raw wheat germ, liquid detergent, rubbing alcohol, tap water, test tube, measuring spoons, paper clips, eye dropper or paper towels.

Background for Teachers

1. In order to get the most of this activity, it is important the teacher (and the students) understand some basic information about ethics, DNA, genetics, and gene therapy. A basic overview of these concepts is provided here.

2. **Ethics** deals with what is right and wrong. It is also concerned with the actions or behavior of members or employees of a certain group or company. (Most health care workers have professional organizations that determine standards of behavior for their members. Ethics becomes a gray area because people may disagree with what is right or wrong.

3. **Bioethics** is the branch of ethics dealing with issues related to science and medicine. Some bioethical issues include organ transplantation, stem cell research, the use of animals in research, the right to die and genetic research (including gene therapy). There are Health Informatics careers as Ethicists and Bioethicists which help hospitals, health care workers, research scientists and centers as well as law makers deal with the complex issues related to human life and our expanding technological advances.

4. **Law** includes sets of formal rules called laws to help people live together in a society without harming one another. Lawbreakers may be fined, imprisoned, or both as punishment for breaking the law (or laws). Laws include common things such as speed limits and contracts as well as licensure for some health care professionals.

5. The Structure of DNA

In the early 1950's, two researchers -- James Watson and Francis Crick -- pieced together the structure of Deoxyribonucleic Acid or DNA. DNA is made of two twisted strands of phosphate and sugar (deoxyribose) and are similar to the side rails of a ladder. The rungs are composed of pairs of nitrogen bases. DNA is found in the nucleus of most of the body cells (mature red blood cells do not have nuclei) in structures called chromosomes. Humans have 46 chromosomes. The sequence of the nitrogen bases contains the genetic code or the code for proteins. Each set of three nitrogen bases codes for an amino acid. These amino acids eventually bond together to form proteins. These proteins help form our cells, skin and other tissues, digestive enzymes, antibodies to fight infection,

muscles, and pigments to color our skin and eyes.

6. One important aspect of DNA's structure is its ability to replicate. **Replication or duplication** allows DNA to make more of itself. When a cell gets ready to divide, the chromosomes are doubled so the next generation of cells will have 46 chromosomes when the DNA and the cells divide. Male sperm and female eggs are formed with half the chromosomes or 23 chromosomes so when the egg is fertilized by a sperm, the newly formed cell called a zygote will have 46 chromosomes.

7. Most of the time, cell division and chromosome replication work without any problems. Occasionally, there are errors. Many times, the internal mechanisms of the DNA can take care of the problem. Sometimes, they cannot. Errors can include nitrogen bases that have been accidentally added, deleted, or substituted which may change the amino acid and eventually the structure of the new protein. Sometimes, during formation of egg and sperm, the chromosomes do not divide correctly which again can alter the DNA. **Mistakes** called **mutations** occur. Mutations occurring in the eggs or sperm may be passed on to the offspring. Some of the disorders caused by mutations include cystic fibrosis, sickle cell anemia, muscular dystrophy, hemophilia, Down's syndrome, and PKU (phenylketonuria).

8. **Molecular Biologists** (which are careers in the Biotechnology Research and Development Health Care Pathway), have determined the sequence of the nitrogen bases found in the 46 human chromosomes. This effort is known as the **Human Genome Project**. The research has determined there are over 30,000 genes in those 46 chromosomes. A gene is a segment of the DNA that codes for a specific protein like eye color. There are two genes for every trait -- one gene from each parent. Genes contain inheritable information that is passed from parent to offspring. Each gene has a specific place on the chromosome. Most genetic disorders cannot yet be cured -- but with continued research, progress is being made.

9. **Gene Therapy** is a type of gene technology that allows scientists to correct a genetic disorder by replacing the defective gene with copies of healthy ones. The first successful gene therapy in 1990 corrected a defected gene controlling CF or cystic fibrosis. Scientists continue to improve gene therapy by continuing to identify the specific genes that control disorders like breast cancer. A popular method of gene therapy is the use of viruses to transport the gene into the cell. Once inside the cell, the gene is spliced into the DNA correcting the mistake.

Intended Learning Outcomes

- Apply word roots, prefixes, suffixes, and combined forms used in constructing medical terms.
- Demonstrate various methods of giving and obtaining medical information.
- Evaluate and discuss ethical practices within the health care environment.
- Practice a biotechnology technique by extracting DNA from wheat germ.

Instructional Procedures

Day One

1. Begin class with a survey of blue/green/brown eye discrimination. Describe how students may be given certain jobs, positions or money based only upon the color of their eyes. Introduce gene therapy to alter eye color. Discuss with the students whether or not this is ethical. Is it something we should do because we know how to do it? You may want to refer to the movie "Jurassic Park" when Jeff Goldblum says "Yes, we know how to do it (in reference to the dinosaur egg technology) but should we?" You may also want to view the film GATTACA that depicts individuals being given various careers based solely upon their genetics. This film is NOT recommended to show in class, but offered to give you a background of genetic discrimination, which has caused great concern in the scientific community because of our supposed ability to create a "super" human race.
2. There are thousands of medical terms used in the field of medicine. Students can be given a small sample of medical words using some simple, basic terms. Students are given the following medical

terms and their definitions with an explanation that these terms are combined to form medical words:

hyper -- above, large amount

hypo -- below, small amount

an - without

cholesterol -- a fat that may accumulate in the blood

glyc/o -- sugar

-emia -- referring to a blood condition

Ask the students to define the following:

What is **hypercholesterolemia**?

high blood cholesterol

What is **hypocholesterolemia**?

low blood cholesterol

What is **hyperglycemia**?

high blood sugar

What is **hypoglycemia**?

low blood sugar

What is anemia

?

without (lack) of blood.

Do you remember the last time your family doctor tried to talk to you about why you were sick? Their words can be very complicated because of their use of medical terminology.

3. Provide students with an overview of Gene Therapy using the information provided in the background information and the booklet. (For additional information on Gene Therapy, purchase [Your World - Biotechnology and You.](#))

4. Review attached Case Study 1 and 2. Discuss and/or debate ethical issues that have been focused on in the case studies. You will function as a team of ethicists (Health Informatics Pathway careers) giving guidance to health care workers.

5. Develop a Patient Record from the demographic information provided for each case study. Sample Patient Records are attached. The forms are typically filled out by Health Informatics careers such as admitting clerks in a hospital or the medical assistant in a clinic.

6. Using the Connection to Careers document attached, explore a variety of related health care careers.

7. For enrichment purposes, students may explore the careers mentioned above via the Internet. Additionally, students could use the Internet to explore diseases that are being treated with gene therapy, such as cystic fibrosis, sickle cell anemia and Huntington's disease.

You will probably be able to get through one of the case studies during this class period. Emphasize ethical considerations that occur as the biotechnology pathway improves our technology, machines, and medications increasing our ability to save lives.

Day Two

1. Start the day with DNA Extraction. Instructions can be downloaded from the U of U genetics web site. The directions are easy to follow.

2. After DNA extraction is complete, reinforce with the students the importance of DNA in passing on traits from one generation to the next.

3. You may complete the second case study, find other ethical case studies from the web to discuss with the students, or trying other activities found on the U of U genetics web site.

Extensions

Have students reflect on the experiences of the activity. Have students report on a health care career that is interesting to them and explain why.

Bibliography

Your World Gene Therapy -- Biotechnology and You. Volume 4, Issue 2. Copyright 1995

Authors

[Denise Abbott](#)