

NTTI Media-Rich Lesson

Pauline B. Washington

NAME

EXTRA! EXTRA! READ ALL ABOUT IT: GENETIC MUTATIONS

LESSON TITLE

10th Grade Biology

GRADE LEVELS

Two 90-Minute Sessions

TIME ALLOTMENT

OVERVIEW

As scientists learn to read the instructions in our genes, they are discovering that much of our DNA is riddled with errors. Fortunately, most of these errors are harmless. Students will become familiar with the fact that we each inherit hundreds of genetic mutations from our parents, as they did from their forbearers. In addition, the DNA in our own cells undergoes an estimated 30 new mutations during our life time, either through mistakes during DNA copying or cell division, or more often, because of damage from the environment.

Mutations are changes that occur in the sequence of DNA of an organism. A mutation may involve the deletion, insertion or duplication of a portion of a DNA molecule or the substitute of one or more bases in the molecule. There are bizarre mutations, such as the striking expansion of repetitive tracts of DNA (such as CAG CAG CAG ...) that give rise to Huntington's disease. Through the activities presented in these lessons, students will gain knowledge on genetically connected mutations. Students will become aware of certain diseases and will be able to address bioethical questions that arise from genetic disorders.

After examining web sites and video clips, students will participate in hands-on activities designed to simulate activities that occur in the cell. Students will be able to apply knowledge of DNA errors to real life situations.



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SUBJECT MATTER

10th Grade Biology

LEARNING OBJECTIVES

Students will be able to:

- Use simple tips to identify and simulate the causes of genetic mutations;
 - Use idiot-proof strategies to describe ideas for coding mistakes of DNA in the manufacturing of human proteins;
 - Apply incredible ideas to study the consequences of a single change of amino acids in proteins to human disorders;
 - Use simple tips to explain that some genetic variations are related to disease and to be able to provide examples of such diseases.
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STANDARDS

2. Topic: Research
 - 2.1 Use media resources such as print, audiovisual, and online services to find information
 3. Topic: Nature of Biology

Standard: Explain the significance of biology (impact on our daily lives)
 8. Topic: Biochemistry (Protein Synthesis)

Standard: Explains the structure of DNA and RNA, and their role in protein synthesis
 10. Topic: Genetics (Mendelian Genetics)

Standard: Explains the use of the basic Mendelian genetic principles
 11. Topic: Genetics (Patterns of Inheritance)

Standard: Describes the patterns of inheritance and genetic engineering

 - 11.1 Relates normal patterns of inheritance and genetic engineering
Relates abnormal patterns of genetic inheritance to genetic variation
 - 11.2 Relates abnormal patterns of genetic inheritance to genetic disorders and diseases
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MEDIA COMPONENTS



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Video

The Science of Life: DNA The Master Molecule of Life, #140

Cornell notes

□ HYPERLINK "<http://www.cssdesigns.com/learningtoolbox/cornell.html>"

□ <http://www.cssdesigns.com/learningtoolbox/cornell.html> □

This reference will assist students in taking and organizing notes from videos, websites, and discussions.

Websites

These websites show base pairing and mutation changes in base sequence of a DNA molecule (translation)

1. □ HYPERLINK "<http://biology.umt.edu/bio/z21/lecture-notes/translation.ppt>"

□ <http://biology.umt.edu/bio/z21/lecture-notes/translation.ppt> □

2. □ HYPERLINK "<http://www.accessexcellence.org/AB/GG/mutation.html>"

□ <http://www.accessexcellence.org/AB/GG/mutation.html> □ - mutation of chromosomes: information and pictures

3. PointMutationTypes/graphics/information

4. <http://www.accessexcellence.org/AB/GG/deletion.html>

5. <http://www.accessexcellence.org/AB/GG/insertion.html>

6. <http://www.accessexcellence.org/AB/GG/duplication.html>

7. □ HYPERLINK "<http://www.accessexcellence.org/AB/GG/genetic.html>"

□ <http://www.accessexcellence.org/AB/GG/genetic.html> □ - Genetic Code

8. <http://www.wadsworth.org/chembeme/heme/microscope/sicklecellanemia.htm>

Materials needed for each group of 4 students

- 12 legal size envelopes
- 10 copies of normal and abnormal sequences of amino acids (preprinted)
- 54 pushpins in assorted colors/project board for 4 groups
- 12 legal-size envelopes
- Strips of white paper (2" X 12") containing a sequence of a portion of a DNA molecule in envelope
- Note paper, pen/Cornell note pad
- Microscopes (4)
- Prepared slides – normal sickle hemo worksheet D
- Human Genome Chart – hard copies
- Normal and sickle cell blood cells – hard copies
- TV, Internet connection
- VCR
- Video - #104 – Biology: The Science of Life – DNA
- Why Map Y – The Master Molecule of Life
- mRNA code chart – codons
- Overhead projector



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PREP FOR TEACHERS

Before teaching this lesson, make sure that all websites are bookmarked on all of the computers in the classroom, and that all the necessary links are valid and running. Cue videotape to the first segment to be used: Evolution – Genetics – Mutations. Make sure that all handouts are available for hands-on activities.

1. Prepare pre-printed copies of normal/abnormal sequences of amino acids. Prepare for student use.
2. Obtain hemo slides.
3. Obtain Cornell note pads for students.
4. Obtain assorted push pens/project boards.
5. Prepare video for viewing.
6. Prepare student copy for microscopic observation.
7. Make all materials available to students at the beginning of class.

Materials for Students

1. Cornell note pad
2. Pencil and paper

INTRODUCTORY ACTIVITY: SETTING THE STAGE

Background Information -Teacher will discuss the following with students:

Begin the activity by telling the class about the work and historic efforts of Victor McKusick, the grandfather of medical genetics and that there are more than 5,000 distinct genetic disorders. In more than 1,000 cases, we know the gene(s) and mutation(s) responsible for these diseases. All it takes is the slightest misspelling, affecting just one of the 3 billion letters of the genome to have profound, often distressing, consequences. Explain that in this activity students will investigate human gene variations at a molecular level.

Prerequisite Knowledge: Students should be familiar with and understand basic Mendelian patterns of inheritance; the basic structure of DNA; transcription of DNA to messenger RNA; and the translation of messenger RNA to proteins.



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Section A

Step 1 Introduce lesson by asking students to view photos of normal and abnormal blood cells. Tell the students that we observe similar cells using the microscope.

Title of Lab: Mystery of the Crooked Cells

Purpose: This lab is designed for visual observation of normal and sickle cell blood cells.

Directions:

Step A Students will view slides of normal and abnormal red blood cells under lower power (LP) and high power (HP) sketch cells. Sickle cell anemia is an example of a genetic disease that can serve as a vehicle for teaching many biology concepts. This is an opportunity to make connections with various aspects of genetics, molecular biology, physiology, evolution and societal and ethical issues as well.

Step B Students will view the three dimensional structure of hemoglobin on the Internet.

Step 2 The students will view unmarked slides of hemoglobin under both low and high power magnification. Students will sketch, label and identify cells as normal or sickle cells. Students will use prepared microscopic observation sheet.

Section B

Step 3 Provide students with a Focus For Media Interaction by saying: "Graphics of these cells also appear at this website:

<http://www.wadsworth.org/chemheme/heme/microscope/sicklecellanemia.htm>.

Step 4 The teacher will ask the students to compare their diagrams with the ones on the Internet. This site of micrographs on red blood cells in a sickle cell anemia patient will broaden their understanding of the genetic disorder.

Step 5 The teacher will check for comprehension and use this genetic disorder as a vehicle for teaching many other biology concepts. This is an opportunity to make connections with various aspects of genetics, molecular biology,



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physiology, evolution, and societal/ethical issues through effective questioning.

Section C

Step 6 Students are asked to summarize/reflect on this lesson via Cornell note taking (on-going)

Section D

Step 7 Students will complete Section D. Discuss the following:

- 7.1 What was the shape of normal red blood cells observed under the microscope?
- 7.2 Were the sickle cells identical to the normal red blood cell?
- 7.3 What was the shape of the sickle red blood cells?
- 7.4 What is the function of red blood cells?
- 7.5 What affect will this have on the function of the cells?
- 7.6 How do you account for this change in shape of the sickle cells?
- 7.7 Does genotype give rise to phenotype? Yes / No
- 7.8 Two inherited alleles for a gene determine the phenotype for a trait. Yes / No
- 7.9 DNA provides instructions for building proteins. Yes / No
- 7.10 The genetic information is encoded in DNA. Yes / No

Step 8 The teacher will collect worksheet D for evaluation.

Learning Activity #1

HOW IDIOTS UNDERSTAND HOW MISTAKES OCCUR IN MAKING PROTEINS

Time Allotment: 45 Minutes

What happens when different kinds of mutations occur in the sequence of a gene and how these changes are reflected in traits determined by that gene?

Step 1 The teacher will engage students in discussion on amino acids. In this simulated activity, students will investigate DNA as a molecule that contains information for the traits of organisms and determine how this information is transferred into proteins. Students will model the processes of transcription (DNA – mRNA) and translation (mRNA – amino acid chain or protein). They will use pushpins to represent the 18 nitrogenous bases of a DNA sequence. All materials will be available for group participation. The teacher will cue the video (The Science of Life: DNA The Master Molecule of Life, #140, for [Media Interaction](#) to Evolution – Genetic – Mutation to transcription and translation. View this video for the order of amino acids in a protein. Turn the audio off to observe the genetic mutations (animation).



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- Step 2 Students should use Cornell notes to record data learned from the video.
- Step 3 Media Interaction - To explore mutation, use this website:
 HYPERLINK "<http://www.accessexcellence.org/AB/GG/mutation.html>"
 <http://www.accessexcellence.org/AB/GG/mutation.html> for information and pictures of mutation of chromosomes.
- Step 4 Prepared handouts of “Why Map Y and the Human Genome Chart” will be available for teacher-student discussion. Teacher will generate high level and effective questions related to these handouts.
- Step 5 Amino Acid Sequencing: Obtain the following push pins and project board. Diagram this sequence on your project board. Students will be arranged at 4 tables/groups in the classroom.

Procedure

Use the following color key to represent the bases:

Red push pins	=	adenine or A
Blue push pins	=	guanine or G
Yellow push pins	=	cytosine or C
Green push pins	=	thiamine or T
Clear push pins	=	uracil or U

TACCCACGGGTGGACTGAAGGACCCUUUGGA

- Step 6. The teacher will walk around and check for understanding. The teacher will provide students with a Focus for Media Interaction by asking students to define point mutation and to demonstrate the types of mutations using the various colors of pushpins.

Groups will view the following illustrations at these websites:

DELETION - GROUP 1

<http://www.accessexcellence.org/AB/GG/deletion.html>

INSERTION – GROUP II

- HYPERLINK "<http://www.accessexcellence.org/AB/GG/insertion.html>"
 <http://www.accessexcellence.org/AB/GG/insertion.html>

DUPLICATION – GROUP III

- HYPERLINK "<http://www.accessexcellence.org/AB/GG/duplicaiton.html>"
 <http://www.accessexcellence.org/AB/GG/duplicaiton.html>

GENETIC CODE – GROUP IV

- HYPERLINK "<http://www.accessexcellence.org/AB/GG/GENETIC.html>"
 <http://www.accessexcellence.org/AB/GG/GENETIC.html>



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Step 7 The other groups will rotate to observe sites and take notes on Cornell note pads. Follow directions for proper credit. The teacher will facilitate the activity.

Step 8 Question and Answer Session: Teacher will ask high level questions to evaluate understanding and application (i.e., Give examples of how this information may impact the medicine for individuals in the future).

Learning Activity II

Idiot Proof – Causes of Mutations
(Using pushpins and project board)

Step 9 Students will be grouped for this activity. The group will:

- Complete the mRNA sequence
- Complete the tRNA sequence
- Complete the sequence for this protein
- Give this frictious protein a name
- Group #1 - Substitute one base for another
- Group #2 - Insert one new base
- Group #3 - Delete one base
- Group #4 - Substitute two bases
- Transcribe the new sequence into mRNA, then translate the new developed protein
- Create a mutation and be prepared to discuss the creation with the class.

Follow-up Activity For Understanding

Teacher will ask questions of students. Students will compare and contrast the different situations.

Learning Activity #3

TYPES OF GENE MUTATIONS
(Using known and unknown portions of AA sequences)

Time Allotment: 20 Minutes

Materials Needed:

1. 10-12 envelopes
2. 5-10 prepared copies of normal and abnormal sequences of amino acids (codon)



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Step 10 Procedures – Post Viewing Activities

Using overhead projector and transparencies, the teacher will show samples of lesson. This activity provides for discovery and inquiry.

- (Teacher will direct students to work in pairs to participate in this activity.
- (Each group will receive an envelope containing copies of normal and abnormal amino acid sequences.
- (Students will examine the copies of known and unknown portion of an amino acid sequence.
- (Students will underline each codon in the normal amino acid sequence.
- (Students will compare these codons with the abnormal codon and will determine the type of mutation that is simulated in this activity.
- (Students will select the codon with the different sequences.
- (Each group will have 15 minutes to observe the copies and be ready to defend the analogies of their problem to the class. Students should be able to determine whether the mutation is due to (a) deletion, (b) insertion, or (c) substitution. Teacher should check for understanding of vocabulary from this lesson.
- (Groups will collaborate and complete notes/summary using Cornell note-taking techniques.

CULMINATING ACTIVITIES

HEARD IT THROUGH THE GRAPEVINE

Directions

Students will use newspaper headlines, heard it on the television, or use the Internet to report on a genetically inherited disease. This activity will be used to stretch and stimulate thinking and to apply to everyday experiences.

Introduction

Step 1 The teacher will talk about the newspapers, magazines, television, and the World Wide Web as being major sources of information about emerging developments in scientific fields.

Step 2 The teacher will ask students the following questions: (utilize wait time effectively)

- (A) What do you think about what you read or heard about these kinds of reports related to genetics?
- (B) What makes a story interesting and relevant to you?
- (C) Has studying genetics made you more aware of the number of discoveries and technological advances being reported almost daily?



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- Step 3. The teacher will list a few headlines or topics for students to explore.
- Step 4. The teacher will assign students to a group for this assignment. Group process strategies promote inclusion and brainstorming. Students are to articulate and clearly communicate with the group. Students will discuss with the group what he/she thinks would be a good headline or title. A student recorder will write the group's version with an opening paragraph for the article. A reporter from the group will be prepared to discuss the report in class in two days. A written report from the group will also be due at this time. Additional topics may be explored with permission from the teacher.

Journaling

Students may use the jigsaw method for this report. Use the Cornell note-taking technique.

The Blue People of Troublesome Creek. A story of an Appalachian Malady, an inquisitive doctor, and a paradoxical cure. Science, 82, November 1982, pp. 35-39

Answer these questions:

1. What physical traits did Martin Fugate and his wife pass on to their many generations of offspring?
2. Why did this condition occur?
3. What role did genes play in both the appearance of the trait and the passing of the trait?

Extra Credit: Complete a pedigree chart on this family.

Newspaper Reports/TV Report/Internet Research

- “Mutant Genes To Eliminate Obesity”
- “Stem Cells Are Used To Treat Sickle Cell Anemia”
- “Flawed Genes Linked To Diabetes”
- “Homosexuality Linked To Genetics”
- “Cigarette Smoking Affects The Telomeres On Chromosomes”
- “Scientist Discovers A Single Gene That Affects Sex Drives”
- “Are Mouse Genes In Your Tomatoes”

CROSS-CURRICULAR EXTENSIONS

Extends learning and challenges across disciplines



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Health/Medicine Research

Research bioethical questions that have arisen from genetic disorders. Examples of this include sickle cell anemia and Huntington's disease. Ask this question: Will employees or insurance companies use test results against an individual?

Language Arts/English

Complete reports from journal readings, Internet research and other media related to genetic disorders.

Art/Science

Complete a pedigree chart from data obtained from research on genetic disorders.

COMMUNITY CONNECTIONS

Creates shared visions and connects the students with others.

Bioethical Issues

- Invite a genetic counselor to discuss the genetic traits of the genetic disorders of interest.
- Invite a lawyer to come to the class and present a discussion on the social, legal and ethical aspects of genetic disorders.
- Invite someone to discuss biotechnology and food

Health/Medicine

- Invite a medical doctor to visit the class and discuss the symptoms, treatments, and possible gene therapy available to patients.



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