

Overview:

In this lesson, students first kinesthetically explore what happens to DNA as mutations occur. Then, students explore a website and play an online mutation game to gain a deeper understanding of possible mutation outcomes.

Objectives:

The student will:

- demonstrate what happens to DNA codons when various types of mutations happen; and
- identify at least two positive and at least two negative outcomes from gene mutation.

Targeted Alaska Grade Level Expectations:**Science**

[7] SC1.2 The student demonstrates an understanding of how science explains changes in life forms over time, including genetics, heredity, the process of natural selection, and biological evolution by describing possible outcomes of mutations (i.e., no effect, damage, benefit).

Vocabulary:

amino acid— a type of chemical compound that proteins are made of; Amino acids are made up mostly of carbon, oxygen, hydrogen, and nitrogen. Some amino acids are made by the body's cells, but others can only be obtained from food

codon— sequences of three nucleotides within the DNA that code for a particular amino acid

DNA— (deoxyribonucleic acid) the main component of chromosomes and the genetic information of life

frameshift mutation—(deletion, insertion)— this mutation removes (or adds) a portion of the DNA sequence, resulting in improper grouping of nucleotides into codons

gene— a basic unit of heredity that transfers a trait from one generation to the next. point mutation (inversion, substitution)— change in one nucleotide, which alters the amino acid designated by the codon

protein— a molecule that is made up of long chains of chemical compounds called amino acids; Living cells are made up largely of proteins. Proteins are an important part of the diet of many animals and are found in foods like meat, cheese, and beans

mutation— a permanent change in the DNA sequence of a gene; Mutations that are passed through the genes from one generation to the next can be harmful or can improve the ability of a living thing to survive

nucleotide— a building block of DNA and RNA

Materials:

- STUDENT WORKSHEET: "Mad Mutations WebQuest"
- Computer with Internet access

Activity Preparation:

This activity requires minimal preparation. Be sure to make enough copies of the STUDENT WORKSHEET: "Mad Mutations WebQuest" question packet and check to be sure the website and the accompanying links work.

Hook:

"Mutation Telephone"

- Instruct students to form a line.
- Start by whispering a phrase to the first student in the line. The first student whispers what s/he heard to the next student, and so on down the line.

- Students are not allowed to repeat the phrase, or ask for the phrase to be repeated.
- The student at the end of the line will share the message aloud with the class.
- Discuss how the phrase changed, and lead into the topic of cell structure randomly changing as a result of mutations.

NOTE: Text of teacher note g Depending on class size, you may want to form two lines and start with two different phrases.

Phrase suggestions:

“Archimedes coined the phrase “Eureka, I’ve found it!”

“What does a tree bark sound like?”

“He was as mad as a mule chewing on bumblebees!”

“Well, if that don’t put pepper in the gumbo!”

“Tie me to an anthill and fill my ears with jam!”

Pre-Assessment:

Quick-write

- Write on the board: “How do you think gene mutation happens? Why might gene mutations be helpful? Harmful?”
- Allow three minutes for students to brainstorm.
- Students should write down every idea that comes into their head.
- In the last two minutes of the activity, have students take their brainstorm ideas and answer the questions in two complete sentences.
- Have students share their ideas with a partner.
- Have one partner from each pair come to the board and write down one answer to either question.
- Review student ideas as a whole class. Be sure to define “mutation” and give examples how they can: have no effect, be harmful (cancer, sickle cell anemia), or be beneficial (increasing genetic diversity, sickle cell malaria resistance). Explain point mutations sometimes have no effect because there are multiple codons for each amino acid. If the amino acid does not change, there is no change to the resulting protein.

Activity Procedure:

1. Explain mutations occur during DNA replication and cell division. To demonstrate this, ask for nine volunteers.

NOTE: Depending on class size, you may use fewer students. Be certain, however, to have a minimum of 3, although the demonstration will work better with at least 6.

Line the nine students up in front of the class with a slight separation between every third student. These sequential groups of three represent a codon. To demonstrate point mutations like substitution, switch a student from the front of the room with a student who is sitting at his / her desk. To demonstrate inversion, switch the placement of two students in a single codon. Emphasize the point mutations do not change the frame, or the codon grouping. To illustrate frameshift mutations like deletion, ask one student to sit back down. Regroup the students to make new codon groupings. To show insertion, add a student from those sitting at their desks to somewhere in the middle of the line. Regroup the students to form new codons. Ask students to predict the effect frameshift mutations have on the translation of amino acids. Which is more harmful, a point mutation or a frameshift mutation?

NOTE: It’s okay if students cannot answer these questions yet. They are addressed at the end of the WebQuest packet.

2. Pass out the six-page STUDENT WORKSHEET: “Mad Mutations WebQuest.” Guide students to the Web page http://www.nature.ca/genome/03/c/03c_e.cfm and allow students to search the website looking for the answers to the worksheet.

Ensure that students go to each of these pages:

- The Basics
 - Inside the cell (imbedded within The Basics section)
 - Proteins (imbedded within The Basics section)
 - We are all mutants! (imbedded within The Basics section)
 - The Mighty Mutation Maker (http://nature.ca/genome/04/0413_e.cfm)
3. Ask students to complete the worksheet.

Assessments:

- Have students line up so as to represent three codons.
- From the WebQuest, students should have learned different types of mutations and diseases that are caused by those mutations.
- Take 5 minutes at the end of class to call out the names of some diseases and ask students to reconfigure themselves based on the type of mutation (e.g., "Huntington's disease!" [if students do not remember what type of mutation this is, then say, "This is an insertion mutation."] Students then reconfigure themselves by adding one student from the desk area.)
- Once students have reconfigured, ask them to (1) determine if this is a beneficial or harmful mutation and (2) explain why.

Extension Idea:

"Evolutionstechnik or Selection and Variation in the Egyptian Origami Bird (*Avis papyrus*)" by Karin Westerling
http://www.accessexcellence.org/AE/AEC/AEF/1995/westerling_selection.php

This lesson plan involves making and flying various origami birds; using dice and pennies to determine the type of mutation the offspring would have. In this lesson, students demonstrate that:

- mutations occur randomly;
- selection is based on the immediate needs of the organism for survival and reproduction;
- inherited characteristics (whether mutated or not) are contingent;
- divergent evolution may occur when sub-populations face different environments;
- convergent evolution may result in different populations independently solving a similar problem;
- and
- one cause of speciation is isolation of sub-populations.

NOTE: If you have more time (a second day), this lesson would be a great additional activity to deepen students' understanding of mutations.

Sources:

1. "The Gee! in Genome" by nature.ca http://www.nature.ca/genome/03/c/03c_e.cfm
2. "Lesson 3: Mutation" http://www.history.uh.edu/cph/tobearfruit/__docs/curriculum/hs/science/mutations/lessonplan_mutations.pdf
3. Some Vocabulary terms and definitions from The American Heritage Children's Science Dictionary ©2005, Houghton Mifflin Company.

Answers:

1. one, 100 trillion
2. different types of tissue
3. From left to right: (top row) bone cell, fat cells, skeletal muscle cells; (bottom row) nerve cells, skin cells, blood cells
4. oxygen

5. defend against foreign invaders (disease)
6. four, bone
7. axons
8. nucleus, polynuclear
9. fat
10. skin, skin
11. DNA molecules
12. gene, protein
13. proteins
14. Mutations, sickness
15. cells
16. life
17. chloroplasts or cell walls
18. amino acids
19. 20, 12, eight
20. biochemical, antibodies
21. DNA
22. harmless
23. silent mutations
24. sickness, death
25. A mutation is caused by mistakes that happen when cells copy their DNA. Mutations can be caused by outside agents, like ultraviolet light.
26. Cancer
27. germ
28. A point mutation changes one piece of the DNA sequence. An example would be substitution, deletion, or addition.
29. inherited a particular genetic mutation that causes a disease.
30. codon
31. codon, amino acid
32. silent mutation
33. one nucleotide
34. Missense
35. Sickle cell anaemia
36. STOP codon
37. point
38. thalassemia
39. It removes a portion of the DNA sequence, causing a change in how the rest of the code is read.
40. Cystic fibrosis
41. The insertion mutation adds a nucleotide to the DNA sequence. This causes the DNA code to be regrouped and read differently.
42. Huntington's disease is a neurodegenerative condition. It is caused by the repeated insertion of nucleotides in the Huntington gene.

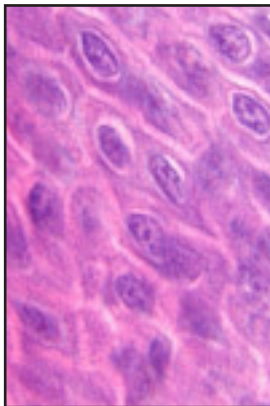
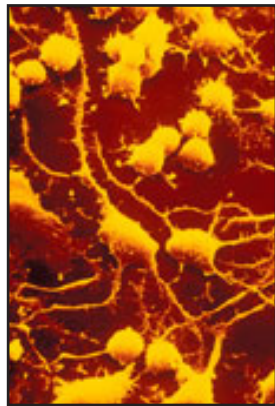
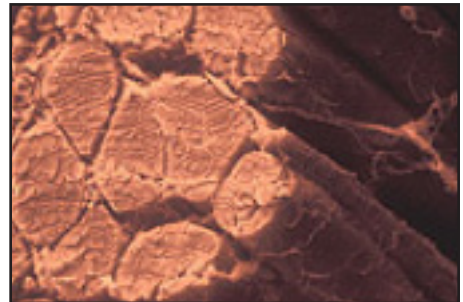
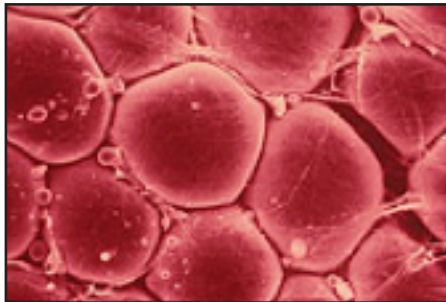
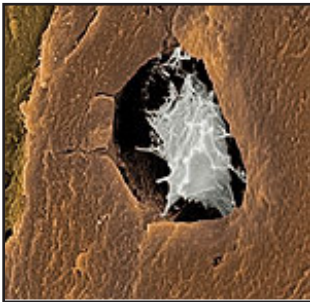
NAME: _____
MAD MUTATIONS WEBQUEST

STUDENT WORKSHEET
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Directions: At a computer, go to the following website and learn about cells, mutations, and more!
http://www.nature.ca/genome/03/c/03c_e.cfm

The Basics

1. A bacterium is composed of _____ cell(s). A human being has about _____.
2. What do cells group together to form? _____
3. Label the following pictures according to the type of cell they show.



4. Red blood cells carry _____ through the body. (**Hint:** On the Web page, click on the various pictures to find more information.)
5. What do white blood cells do? _____
6. An osteoblast is one of _____ different kinds of _____ cells.
7. Nerve cells have extensions, called _____
8. Muscle cells have more than one _____. This means they are _____.

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MAD MUTATIONS WEBQUEST

STUDENT WORKSHEET
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9. The adipose tissue created by _____ cells serve as an energy bank and heat insulator.
10. The _____ is the biggest organ in the body. There are different kinds of _____ cells to form each of three types of tissue: epidermis, dermis, and the hypodermis.
11. _____ are found within the nucleus of the cell.
12. A _____ is one section of a DNA molecule that contains the code for the production of a _____.
13. _____ are essential to life.
14. _____ in genetic instructions can alter the proteins, which can lead to _____.

Inside the cell

15. The more we study _____, the more we discover about their complexity.
16. The cell is the basic unit of _____.
17. Unlike plant cells, animal cells do not have _____.

Proteins

18. Proteins are strings of _____ that are the active elements of cells.
19. Of the _____ amino acids the body needs to make proteins, the human body can produce _____ of them on its own. The other _____ must come from the food we eat.
20. Proteins that are enzymes are catalysts for _____ reactions. Proteins that are _____ react with foreign substances to defend the body.

We are all mutants!

21. Because our differences are made from slight changes in our _____, we are all mutants!
22. Most mutations are _____.
23. Harmless mutations are called _____.

24. If a mutation affects the composition of a gene, it can cause _____ or even _____!
25. What causes a mutation? _____

26. Give an example of something bad that can happen because of a mutation. _____

27. If a mutation happens in a _____ cell, it is passed from parent to offspring.
28. Explain what happens to the DNA in a "point mutation." _____

29. Some people are at higher risk for certain cancers because they have _____

The Mighty Mutation Maker

30. A _____ is a sequence of three nucleotides in the DNA.
31. A silent mutation changes the _____ sequence for one amino to another codon of the same _____.
32. Often, _____ goes unnoticed in proteins.
33. This missense mutation changes _____ in a codon, which can result in a completely different amino acid being added to the protein.
34. _____ is a type of point mutation.
35. _____ is caused by a missense mutation that doesn't allow the hemoglobin protein to fold correctly.

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MAD MUTATIONS WEBQUEST

36. The nonsense mutation changes the codon sequence for one amino to a _____
(TAA, TGA, TAG) that stops the cell from adding more amino acids to the protein.

37. The nonsense mutation is a _____ mutation. It shortens the protein.

38. One nonsense mutation, which is common in Mediterranean countries, is called _____

39. What does the deletion mutation do? _____

40. What is the most common deletion mutation disease? _____

41. What does the insertion mutation do? _____

42. What kind of disease is Huntington's disease? What causes it? _____

