Key: Yellow highlight = required component

Mutation Modeling

Subject Area(s) (Select from TE subject areas)
Biology

Associated Unit

Genetic Engineering

Associated Lesson

Mutations

Activity Title

Mutation Telephone

Header

Image 1

Image file: Whippets.png

ADA Description: Two dogs (Whippets) are shown, the one on the left is small and lean while the one on the right is large and muscular.

Source/Rights: Copyright © Pleple2000, Wikimedia Commons (https://commons.wikimedia.org/wiki/File:WhippetWhiteSaddled_wb.jpg)

And Pwoolf, Wikimedia Commons (https://en.wikipedia.org/wiki/File:MyostatinMutantWhippet.jpg)

Caption: A mutation in the gene encoding for the Myostatin protein causes extreme muscle growth in some animals, such as the Whippet shown here

Grade Level

9 (7-10)

Activity Dependency

Time Required

15 minutes

Group Size

10+

Expendable Cost per Group

US $0.00

Summary

Students perform an activity similar to the "telephone" game many of them have probably played. For this activity each step represents a biological process related to the passage of DNA from one cell to another. This illustrates how mutations in DNA can happen over several generations of cells and the effects that these mutations can have on the proteins the cell needs to produce.

Engineering Connection

Genetic engineers alter the DNA of an organism to change the properties or traits by modifying the proteins that are produced from the DNA. These changes happen in controlled manner to reduce the possibility of errors occurring, but even being careful is not always enough to prevent mistakes. Sometimes the DNA will experience mutations spontaneously when replicating, such as when a scientist is trying to grow many bacteria from a single modified version. It is important to understand how these mutations occur and what effects they may have on the intended outcome of the DNA modification. Engineers often use models to simplify complex processes; in this activity, students model how DNA can mutate using an easy to understand model to illustrate where errors can occur.

Engineering Category = 1

Choose the category that best describes this activity's amount/depth of engineering content:

1. Relating science and/or math concept(s) to engineering
2. Engineering analysis or partial design
3. Engineering design process

Keywords

DNA, Gene, Mutation, Protein

Educational Standards (List 2-4)

National and State

Texas, science, 2010, Biology 6 (A): Identify components of DNA, and describe how information for specifying the traits of an organism is carried in the DNA.

Texas, science, 2010, Biology 6 (E): Identify and illustrate changes in DNA and evaluate the significance of these changes.

ITEEA Educational Standard(s)

ITEEA, Standard 14, Grades 9-12, M. The sciences of biochemistry and molecular biology have made it possible to manipulate the genetic information found in living creatures.

NGSS Standard

NGSS, Life Sciences, Middle School (6-8), MS-LS3-1, Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

Pre-Requisite Knowledge

Students should have an understanding of the relationship between DNA and proteins or how a cell makes proteins from DNA. This activity focuses on small-scale mutations, so a basic knowledge of the differences with large-scale mutations is important.

Learning Objectives

After this activity, students should be able to:

- **List the different types of small-scale mutations**
- **Describe when/where mutations occur**

Materials List

Each group needs:

- Nothing

To share with the entire class:

- Dry Erase markers
- White Board
- Set of instructions to pass along, at least 1 set for each group

Introduction / Motivation

Can anyone tell me how the X-men got their powers? (Answer: they're mutants) We call them mutants, but what does that really mean? It means that they are still considered humans, but somewhere along the way there was a mutation in their DNA that gave them some powers. Other than giving them super powers, how does a change in DNA really effect the X-men? (Answer: changes the proteins that cells produce) Of course, would a single mutation in DNA really cause such a drastic change in abilities or appearance? (Answer: No). Today we will perform an activity to show how these mutations can occur and illustrate the possible effects of different mutations.

Vocabulary / Definitions

Word	Definition
Deletion	The removal of a nucleotide base pair during DNA replication
DNA	Deoxyribonucleic acid, molecule which contains an organisms complete genetic information
DNA Replication	The process by which DNA is copied and passed on to new cells
Gene	Subset of DNA that provides instructions for a cell to build a single protein
Insertion	The addition of a nucleotide base pair during DNA replication
Small-Scale Mutation	A spontaneous accidental change in the DNA nucleotide sequence during DNA replication
Protein Synthesis	The process by which the instructions contained in DNA are used to produce proteins for a cell or organism
Substitution	The switching of one nucleotide base pair for another base pair during DNA

	replication

Procedure

Before the Activity

- Prepare as many sets of instructions as you will need for a single class. The instructions can be used from class to class, but it is not advisable to reuse the instructions in a single class

With the Students

1. Separate the students into groups of 10 or more. The larger the group, the more likely you will see various mutations in the instructions

2. Have the students in each group form a single file line. The students should be spaced far enough apart that they can only hear the instructions when passed directly to them. Each student will represent a cell/organism that is produced from the previous cell/organism (student).

Note: For the first round, the instructor may wish to tell the students what each step in the activity is modeling, and have the students tell what each step represents in subsequent performances of the activity. Alternatively, the instructor may wish to have the students deduce what each step represents as a class or on their own. This is also reiterated in the attached *Mutation Telephone Worksheet*.

3. Give the first student in line a set of instructions; the set of instructions represents a single gene from an organism's DNA. This will be the only person in the group to read the instructions. The instructions can be to perform a series of actions or to draw a specific picture. Examples sets of instructions are given in the attachment *Sample Mutation Telephone Instructions*.

4. The first student will whisper the instructions to the second student, the second student to the third, and so on until the last student in line has received instructions. This step models what will happen to the DNA (instructions) after several generations of DNA replication (passing the instructions).

5. The last student will then come to the front of the room and perform the instructions that he/she was told. The newest cell (last student) has been given DNA (instructions) from the previous cell and must now perform use the DNA to build a protein (protein synthesis). Protein synthesis is represented by converting the instructions from text to some action.

6. Next have the first student in line perform what is given on the initial instructions. Depending on the complexity of the instructions and the effort by the students this may be the same or entirely different than the instructions the last student performed.

7. Have the students identify which types of mutations in the instructions occurred between the first and last students. They should be able to pick one of the three types:

- **Substitution –** One of the steps/instructions was replaced by a slightly different one
- **Deletion –** One of the steps/instructions was dropped

- **Insertion** – An entirely new step/instruction was added

Examples of possible mutations are also shown in the *Sample Mutation Telephone Instructions* attachment as well as Figure 1.

8. Change the order of the students and repeat with a new set of instructions to identify additional types of mutations.

9. Have the students fill out the *Mutation Telephone Worksheet* to help reinforce what each step in the activity represented and where the mutations occur.

Image Insert Image # or Figure # here (use Figure # if referenced in text)

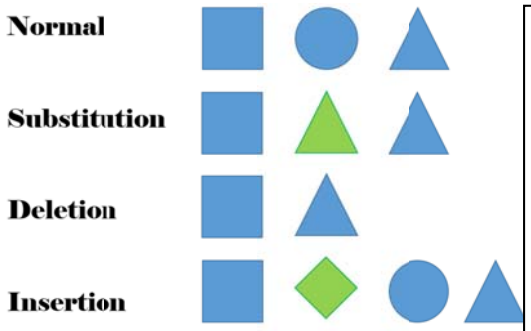

Figure 1

Image file: Sample.png

ADA Description: Four rows of shapes are shown. The first row has a square, circle, and triangle and is labeled as "normal." The second row has a square, triangle, and triangle and is labeled as "substitution." The third row has a square and a triangle and is labeled as "deletion." The fourth row has a square, diamond, circle, and triangle and is labeled as "insertion."

Caption: Figure 1. Sample mutations. The first line represents the initial instructions, and the other lines show some of the possible mutations that could occur in the activity.

Attachments

Mutation Telephone Worksheet

Mutation Telephone Worksheet (key)

Sample Mutation Telephone Instructions

Safety Issues

- None

Troubleshooting Tips

Investigating Questions

Assessment

Pre-Activity Assessment

Brainstorming: Ask the students "What effect will a mutation in the DNA have on an organism?" Let the students think individually for 2-3 minutes then see what solutions the students have thought of.

Activity Embedded Assessment
Mutation Identification: the students identify what mutations they find in the instructions during each round of the activity

Post-Activity Assessment
Mutation Telephone Worksheet: have the students complete the attached worksheet to review the concepts covered in the activity.

Activity Scaling

This activity can be slightly scaled up or down by changing the complexity of the instructions.

- For higher grades, consider using a set of instructions requiring drawing. Have each student pass the instructions, and then draw what they were told on a piece of paper. This will allow the students to see where specific mutations occurred. This will not work if the students are allowed to draw while receiving the instructions, they must pass them on before drawing what they were told.

References

Other

Redirect URL

Contributors

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Supporting Program

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Classroom Testing Information

This activity was performed Fall 2014 at Clear Creek High School, League City, TX for 9th grade regular biology classes. Students were already introduced to the types of mutations and how mutations occur from the associated lesson. The activity was a fun way to reinforce the material and get the students a little more involved in the lesson. Many classes wanted to continue repeating the activity until they could pass the instructions perfectly.

Name:_____ Date:_____

Mutation Telephone Worksheet

1. Match the action or item from the mutation telephone activity on the left with the biological process that it models or represents on the right. Circle the process on the right where a mutation is most likely to happen.

Instructions	*DNA Replication*
Passing the Instructions	*Cells*
Performing the Instructions	*Protein Synthesis*
Students	*DNA/Gene*

2. List the three types of mutations that could occur, and give a brief description.

1.

2.

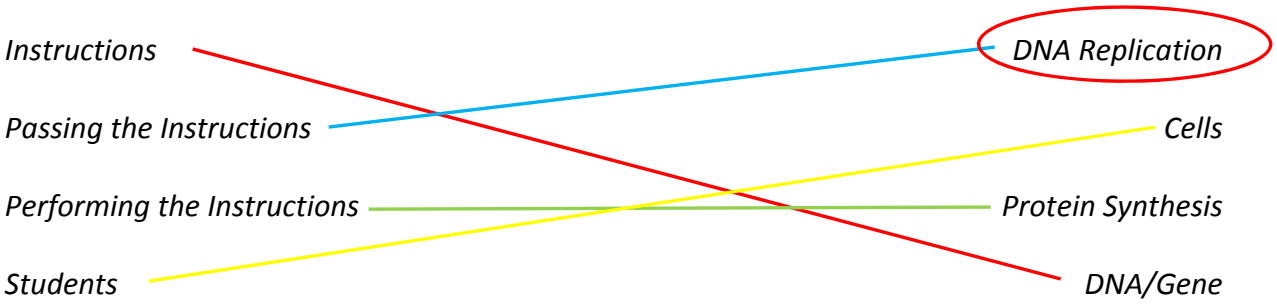
3.

3. The mutation telephone activity was used as a model used to simplify how mutations occur. List 1 way in which the model simplified the real biological processes that occur in real cells.

Name:_____ Date:_____

Mutation Telephone Worksheet

1. Match the action or item from the mutation telephone activity on the left with the biological process that it models or represents on the right. Circle the process on the right where a mutation is most likely to happen.



2. List the three types of mutations that could occur, and give a brief description.

1. Substitution, a nucleotide base pair is replaced by another base pair

2. Insertion, an extra nucleotide base pair is added to the DNA

3. Deletion, a nucleotide base pair is removed from the DNA

3. The mutation telephone activity was used as a model used to simplify how mutations occur. List 1 way in which the model simplified the real biological processes that occur in real cells.

- The instructions for the activity were much shorter than the DNA that a cell must copy
- Mutations occurred more rapidly than real cells
- Cells with mutations were able to survive and pass on the mutation
- Many other possible solutions…

Sample Mutation Telephone Instructions

Drawing instructions are the most simple to compare since the students can stare at the final result next to the original instructed drawing to compare. These instructions may be lengthened or shortened to get a reasonable mutation. The examples provided allowed for one or two mutations each for a 9th grade class if they were focused.

1. Draw a triangle, above the triangle draw a square, to the right of the square draw a circle.

2. In a vertical line, draw a circle, then a triangle, then a circle, then a square.

3. Draw a large square, inside the square draw a circle, inside the circle draw a square.
Possible mutations:

- **Substitution:** one shape is substituted for another shape, but three are still drawn
- **Insertion:** an extra shape is drawn
- **Deletion:** one shape is not drawn

For students who like to move a lot, you can substitute drawing for different actions.

1. Jump 3 times, pat your head twice, sit down.

2. Do 2 push-ups, jump 5 times, high-five the teacher.
Possible mutations:

- **Substitution:** one action is substituted for another action, i.e. a student does jumping jacks instead of just jumping
- **Insertion:** an extra action is performed
- **Deletion:** one action is not performed