

The Effects of Mutations on Organisms

Lesson Overview

Using articles, videos, and online research, students will explore mutations and their effects on organisms. They will create an infographic of a genetic disease and participate in a Science Café to present their research.

Alignment

Standard/Indicator Addressed

Standard 7.L.4 The student will demonstrate an understanding of how genetic information is transferred from parent to offspring and how environmental factors and the use of technologies influence the transfer of genetic information.

7. L.4A.5 Construct scientific arguments using evidence to support claims for how changes in genes (mutations) may have beneficial, harmful, or neutral effects on organisms. **(NEW)**

Science and Engineering Practices

7. S.1A.7 Construct and analyze scientific arguments to support claims, explanations, or designs using evidence from observations, data, or informational texts.

Students should also ask questions and define problems; analyze and interpret data; use mathematical and computational thinking; plan and carry out investigations; construct explanations; develop, use, and refine models; and obtain, evaluate, and communicate information.

Crosscutting Concepts: Cause and effect, Systems and system models, Structure and function, Stability and change

ELA Inquiry Standards (as appropriate)

Standard 2: Transact with texts to formulate questions, propose explanations, and consider alternative views and multiple perspectives.

2.1 Formulate logical questions based on evidence, generate explanations, propose and present original conclusions, and consider multiple perspectives.

Standard 3: Construct knowledge, applying disciplinary concepts and tools, to build deeper understanding of the world through exploration, collaboration, and analysis.

3.1 Develop a plan of action by using appropriate discipline-specific strategies.

3.4 Organize and categorize important information, revise ideas, and report relevant findings.

Standard 4: Synthesize integrated information to share learning and/or take action.

4.1 Employ a critical stance to demonstrate that relationships and patterns of evidence lead to logical conclusions, while acknowledging alternative views.

4.2 Determine appropriate disciplinary tools and develop a plan to communicate findings and/or take informed action.

4.3 Reflect on findings and pose appropriate questions for further inquiry.

Standard 5: Reflect throughout the inquiry process to assess metacognition, broaden understanding, and guide actions, both individually and collaboratively.

5.1 Acknowledge and value individual and collective thinking; use feedback from peers and adults to guide the inquiry process.

ELA Writing

Standard 1: Write arguments to support claims with clear reasons and relevant evidence.

1.1 Write arguments that:

- a. introduce claims, acknowledge alternate or opposing claims, and organize the reasons and evidence logically;
- c. support claims with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text;
- e. develop the claim providing credible evidence and data for each;
- i. provide a concluding statement or section that follows from and supports the argument

Standard 6: Write independently, legibly, and routinely for a variety of tasks, purposes, and audiences over short and extended time frames.

6.1 Write routinely and persevere in writing tasks over short and extended time frames, for a range of domain specific tasks, and for a variety of purposes and audiences.

ELA Communication

Standard 1: Interact with others to explore ideas and concepts, communicate meaning, and develop logical interpretations through collaborative conversations; build upon the ideas of others to clearly express one's own views while respecting diverse perspectives.

1.2 Participate in discussions; ask probing questions and share evidence that supports and maintains the focus of the discussion.

1.5 Consider new ideas and diverse perspectives of others when forming opinions regarding a topic, text, or issue.

Connections

Active Learning Strategies

- [Graphic Organizer](#)
- [Highlighting](#)
- Infographic or Brochure (see attached)
- Science Café (see attached)

Computational Thinking:

- Formulating problems in a way that enables us to use a computer and other tools to help solve them.
- Logically organizing and analyzing data
- Representing data through abstractions such as models and simulations
- The ability to communicate and work with others to achieve a common goal or solution

Content Connections

- Science
- English Language Arts
- Computational Thinking

Content area literacy: Students should *analyze data from a variety of sources, including informational text, argue based on evidence, obtain data from various sources, and evaluate and communicate evidence.*

Lesson Plan

Time Required – Two 60 minute class periods

Disciplinary Vocabulary –genes, DNA, mutation, genetic disorder, acquired trait

Materials Needed:

- Internet access <http://kidshealth.org/en/kids/what-is-gene.html> or copies of “**When There are Problems with Genes**” section only from lesson 1 article: **What are Genes?**
- *Genetic Diseases and Disorders* Video (9:40): <https://www.youtube.com/watch?v=8s4he3wLgkM&feature=youtu.be>
- Printed copies from “Mutation Effects” at <http://www.ck12.org/book/CK-12-Biology-Concepts/section/4.10/>
- Internet access for research or copy or print a class set of fact sheets from <http://www.ygyh.org> and <http://learn.genetics.utah.edu/content/disorders/>
- Disease Fact Collection Sheet for Research
- Highlighters
- Paper for Infographic/Brochure (if not completed electronically)
- Colored Markers if designing Infographic on paper in class
- Copies of Research Guideline, Research Citation sheet, and Presentation Guideline

Formative and Summative Assessment Strategies: Students will be assessed by disease/disorder reports and presentations, student responses, and graphic organizers.

Computational Thinking: This lesson addresses computational thinking by allowing students to interact with authentic data to organize and analyze data about mutations, use an infographic to represent the data, use evidence, apply logic, and construct arguments for their proposed explanations, and evaluate and communicate the information scientifically.

Misconceptions:

Two common misconceptions concerning mutations from http://knowgenetics.org/common_misconceptions/:

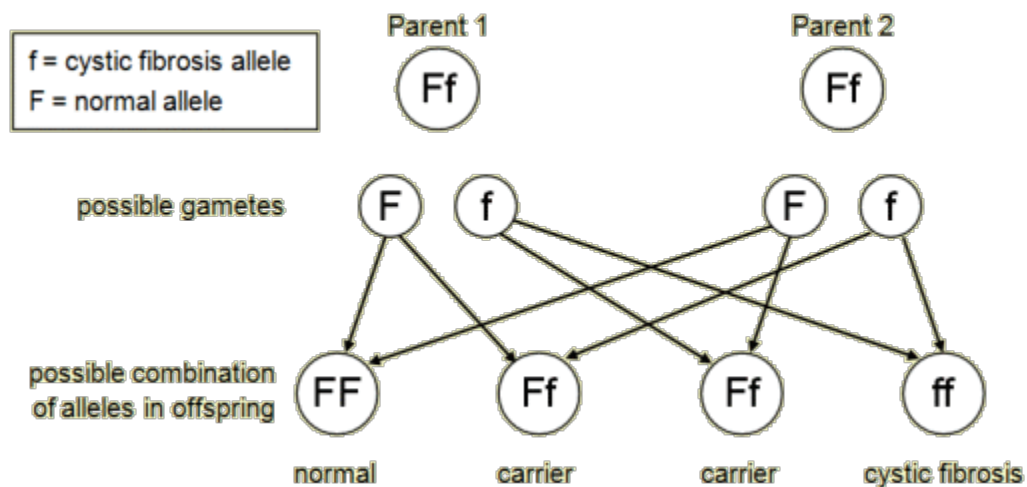
1. All mutations are harmful.
2. Once a mutation is discovered, it can be “fixed”.
3. *Benchmarks for Science Literacy* also adds that another common misconception about mutations is that whole organisms can “mutate” during their own lifetimes.

Engage

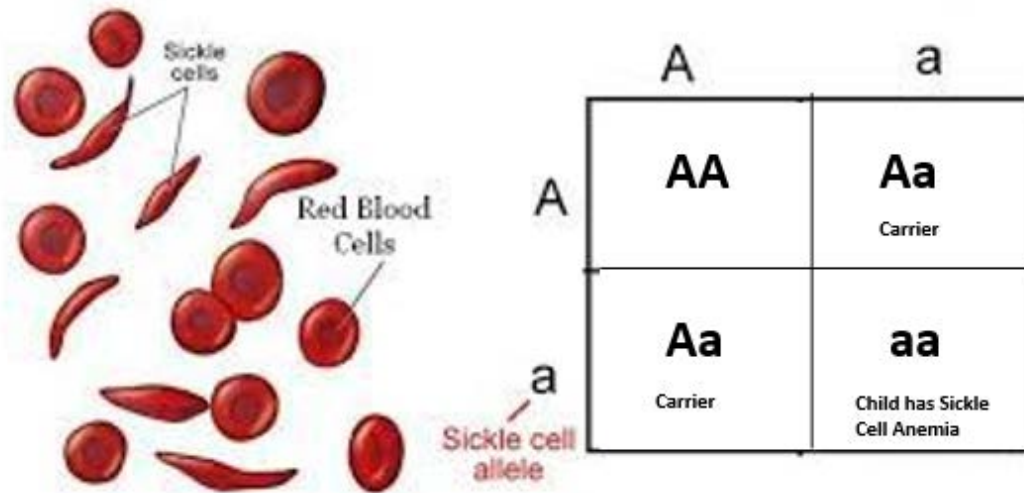
- Have students finish reading the article: *What are Genes?* from earlier in the unit. This time they should begin reading with the section: **When There are Problems with Genes**, <http://kidshealth.org/en/kids/what-is-gene.html>
- When students have finished reading the section, they should create a three column graphic organizer on a piece of paper with the **Title across the top- Changes in Genes (Mutations)**. Label one column *Beneficial*, one column *Harmful*, and the final column *Neutral*.
- Students should read the section again if necessary and add notes to the graphic organizer.
- Teacher should engage students by asking “What is a mutation?” “Are all mutations harmful?”
- Collect class responses and tell students they will explore mutations and their effects on an organism in today’s lesson.
- Show the video Genetic Diseases and Disorders (9:40).
<https://www.youtube.com/watch?v=8s4he3wLgkM&feature=youtu.be>
Stop at 4:53 today, Finish the video tomorrow
- Tell students that they can add to their graphic organizer as they are watching the video.

Explore

- Show students a Punnett square for sickle cell anemia and cystic fibrosis to introduce students to two genetic diseases that primarily affect African Americans (sickle cell anemia) and Caucasians (cystic fibrosis).



<http://www.bbc.co.uk/staticarchive/088e5fc50b3c51cfb49ebc4b6eaf203b18b93bbc.gif>



<http://userscontent2.emaze.com/images/626a5e6a-a8d7-4460-933c-ef977d04bf59/8cb41299-429b-4b0a-b84f-9591fb07b3ef.jpg>

- Have students analyze both Punnett squares.
- Ask them if they can tell you the genotype for cystic fibrosis and sickle cell anemia?
Cystic Fibrosis= ff Sickle Cell Anemia= aa
What connections are they seeing between the alleles that cause both diseases? **Both are homozygous recessive**
What does it mean to be a carrier of a disease and what does your genotype look like?
If you are a carrier of either disease you are heterozygous and your genotype is one capital and one lowercase letter (Cystic Fibrosis (Ff) Sickle Cell Anemia (Aa)
Carriers do not have the disease or disorder but can pass the disease allele to their offspring.
- Print copies of the article “Mutation Effects” from <http://www.ck12.org/book/CK-12-Biology-Concepts/section/4.10/> or allow students to use the article electronically.
- Students should highlight important information and examples of beneficial, harmful, and neutral mutations in humans and other organisms and then transfer this information to their graphic organizer.
- Allow students time to share in small groups some of the data they collected.
- Pass out the Genetic Disease/Disorder Project “**Disease Fact Collection Sheet for Research**” (attached). Students will work in teams of four. During research, students will follow a guideline for discovery of information (see **Research Guideline** attached).
- Student groups should be no more than 4. They can be assigned to groups, or can choose their own groups based on students’ interests. (NOTE: Based on the nature of the class and prior student interactions, the teacher may choose to accommodate for students needing or wishing to work independently instead of collaboratively.)
- Each group member will have a responsibility during the research phase as well as the presentation planning phase. (see attached sheet for roles)
- Hand out **Research Guideline and Research Citation sheet and Presentation Guideline** (or similar items with which students may already be familiar.) Answer any questions the students may have on expectations of their roles in the research. Explain why it is

important to cite all references.

- Students will use either “Your Genes, Your Health” or the “Genetic Disorders Library” to research a specific genetic disorder or if no electronic devices are available, they can use the Fact Sheets you have printed to collect data on a particular disease.
- Some students may have a hard time pulling out information from long reading passages. If copies are available, allow students to use highlighters to help identify key information (causes, incidence, symptoms, treatments, etc.).
- Once teams have collected the information, they can create a brochure or infographic about their specific disease or disorder. Students may create a paper copy by hand or an electronic copy and print it out.
- Explain to student groups they will present their findings to the class (and/or invited guests) during a “**Science Café**” (see Handout) event following their research time.
- Answer any questions students may have on presentation expectations before students begin.

Explain

- Revisit the concept: mutations and their effects on an organism(positive, negative, none)
- Have students raise their hands to answer the following questions based on their research of genetic disease and disorders 1) How many of your research diseases or disorders were beneficial to an organism? 2) How many of your research diseases or disorders didn’t affect the organism positively or negatively? 3) How many of your research diseases or disorders were harmful to an organism?
- This should lead to a class discussion on mutations and diseases and disorders.

Extend

- Do research to find out more about sickle cell anemia and how DNA is used to track genetic diseases.
- Students should listen to the news or read the news on the Internet or newspaper for a week and write a sentence about each story that relates to a genetic disorder.
- Students can share their articles in class as a way of gauging which genetic disorders get the most attention in the news.
- Explore how the human genome project has opened doors in the diagnosis and understanding of genetic disorders.
- Math Extension: Create pie chart that shows the percentage of people who have specific genetic disorders in the United States vs. the state of SC or county in which you live.

Lesson adapted from

- Exploring Genetics. Across the Middle School. Science and Math Curricula. Dr. Jeffrey Batten. Carol Cutler White, Editor. 2nd Edition. July 2014. (n.d.). Retrieved April 25, 2017, from <http://www.greenomes.org/> (“Genetic Disorders Mini Research Project-Science Activity 8)
- K-8 Science Lessons. (2010, August). Retrieved April 25, 2017, from <http://www.s2temsc.org/k-8-science-lessons.html> (Science S3 Seventh Grade 7-4.3 Lesson B)

Genetic Disorders Mini-Research Project

- Disease or Disorder Name: _____
- What is _____?
- Does the mutation causing this disease or disorder have beneficial, harmful, or neutral effects on the organism?
- How do you get this disease or disorder?
- How is the disease or disorder spread?
- What are the signs & symptoms of this disease or disorder?
- How is this disease or disorder diagnosed?
- How can you prevent this disease or disorder?
- How do you treat this disease or disorder?
- Can this disease or disorder be influenced by environmental factors?
- Does this disease or disorder affect one group of people more than another?
- What percentage of people in United States have this disease or disorder? If the same percentage of our student body had this disease or disorder, approximately how many people would that be?
- Include at least one picture of your disease.
- List references you used and references for more information.

Adapted from: Exploring Genetics. Across the Middle School. Science and Math Curricula. Dr. Jeffrey Batten. Carol Cutler White, Editor. 2nd Edition. July 2014. (n.d.). Retrieved April 25, 2017, from <http://www.greenomes.org/> ("Genetic Disorders Mini Research Project-Science Activity 8)

Group Member Responsibilities

Researcher: All members will serve as researchers. Research should come from a variety of sources. ***Each source should be cited on the Research Citation Sheet.***

Summarizer: This group member is responsible for guiding other group members to find the most fascinating facts to include in the presentation. (See *Finding Fascinating Facts* sheet)

Time Manager: This group member should guide the group in developing a timetable for when tasks should be completed and the group member responsible for that task.

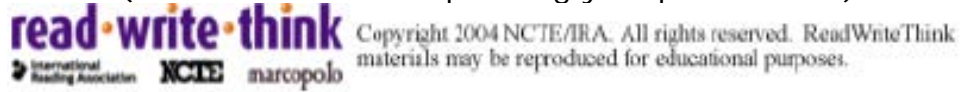
Presentation Planner: This group member should guide the group in deciding what type of presentation to present and what information should be included to inform the audience of the answer to the Focus Question. (See *Presentation Guidelines*)

Materials Manager: This group member will develop a list of materials needed for the presentation. This group member is responsible for gathering the materials and then returning them to the proper places.

Source: K-8 Science Lessons. (2010, August). Retrieved April 25, 2017, from <http://www.s2temsc.org/k-8-science-lessons.html> (Science S3 Seventh Grade 7-4.3 Lesson B)

Presentation guidelines

(Use this rubric when planning your presentation)



http://www.readwritethink.org/files/resources/lesson_images/lesson416/OralRubric.pdf

TRAIT	4	3	2	1
NONVERBAL SKILLS				
EYE CONTACT	Holds attention of entire audience with the use of direct eye contact, seldom looking at notes.	Consistent use of direct eye contact with audience, but still returns to notes.	Displayed minimal eye contact with audience, while reading mostly from the notes.	No eye contact with audience, as entire report is read from notes.
BODY LANGUAGE	Movements seem fluid and help the audience visualize.	Made movements or gestures that enhances articulation.	Very little movement or descriptive gestures.	No movement or descriptive gestures.
POISE	Student displays relaxed, self-confident nature about self, with no mistakes.	Makes minor mistakes, but quickly recovers from them; displays little or no tension.	Displays mild tension; has trouble recovering from mistakes.	Tension and nervousness is obvious; has trouble recovering from mistakes.
VERBAL SKILLS				
ENTHUSIASM	Demonstrates a strong, positive feeling about topic during entire presentation.	Occasionally shows positive feelings about topic.	Shows some negativity toward topic presented.	Shows no interest in topic presented.
ELOCUTION	Student uses a clear voice and correct, precise pronunciation of terms so that all audience members can hear presentation.	Student's voice is clear. Student pronounces most words correctly. Most audience members can hear presentation.	Student's voice is low. Student incorrectly pronounces terms. Audience members have difficulty hearing presentation.	Student mumbles, incorrectly pronounces terms, and speaks too quietly for a majority of students to hear.
CONTENT				
SUBJECT KNOWLEDGE	Student demonstrates full knowledge by answering all class questions with explanations and elaboration.	Student is at ease with expected answers to all questions, without elaboration.	Student is uncomfortable with information and is able to answer only rudimentary questions.	Student does not have grasp of information; student cannot answer questions about subject.
ORGANIZATION	Student presents information in logical, interesting sequence which audience can follow.	Student presents information in logical sequence which audience can follow.	Audience has difficulty following presentation because student jumps around.	Audience cannot understand presentation because there is no sequence of information.
MECHANICS	Presentation has no misspellings or grammatical errors.	Presentation has no more than two misspellings and/or grammatical errors.	Presentation has three misspellings and/or grammatical errors.	Student's presentation has four or more spelling and/or grammatical errors.

Research Citation Sheet

Fill out one citation per source used

Source (Check one): Book ___ Magazine ___ Encyclopedia _____
Author's Last Name _____ Author's First Name _____
Title of publication _____
Title of article (if found in a magazine or encyclopedia) _____
Date of Publication _____ Place of Publication _____ Publisher _____
Volume of magazine or encyclopedia _____
Page number (s): _____

Source: Website _____
Author's Last Name _____ Author's First Name _____ (if available)
Title of Website _____ Title of page _____
Company or organization who posted the webpage _____
Web address (URL): _____
Date the information was retrieved: _____

Book example: Allen, Thomas B. *Vanishing Wildlife of North America*. Washington, D.C.: National Geographic Society, 1974.

Encyclopedia example: Tobias, Richard. "Thurber, James." *Encyclopedia Americana*. 1991 ed.

Website example: Levy, Steven. "Great Minds, Great Ideas." *Newsweek* 27 May 2002. 10 June 2002 <<http://www.msnbc.com/news/754336.asp>>

Finding Fascinating Facts

When you are preparing a research topic to present to others through writing or in a presentation, you want to find factual information that is interesting. If you find something that you think is a "fascinating fact", then others will think so too!

How to begin:

- Choose a topic for research. What is the big question you want to answer?
- Choose your best resources. Try to find a good mixture of books, articles, and possibly the Internet.
- What do you already know about the topic? This information could be included.
- Continue to ask questions before, during, and after reading. Use your notebook to record your notes and other questions you may have.
- After reading, determine what is really important. What do you want to let others know about your topic? What are the "fascinating facts?"
- RECORD BIBLIOGRAPHIC INFORMATION! What if we want to find that information ourselves?

Source: K-8 Science Lessons. (2010, August). Retrieved April 25, 2017, from <http://www.s2temsc.org/k-8-science-lessons.html> (Science S3 Seventh Grade 7-4.3 Lesson B)

Infographics

Information graphics or infographics are visual representations of information, data or knowledge. These graphics are used where complex information needs to be explained quickly and clearly, such as in signs, maps, journalism, technical writing, and education.

“Constructing visual representation of information is not mere translation of what can be read to what can be seen. It entails filtering the information, establishing relationships, discerning patterns and representing them in a manner that enables a consumer of that information construct meaningful knowledge.” VENKATESH RAJAMANICKAM, 2005

What is an Infographic?

An infographic is an artistic representation of data and information which uses different elements such as:

- Graphs
- Pictures
- Diagrams
- Narrative
- Timelines
- Checklists

Why use infographics?

- To transmit or communicate a message.
- To present large amounts of information in a compact and easy to understand way.
- To reveal the data. Discovering cause-effect relations, knowing what’s happening.

How to implement the strategy:

1. The student (or group) needs to have a clear idea of the data they want to visualize.
2. Students should then organize the data.
3. Next, create a design for the visualization.
4. Students may use a free online infographic creator, presentation software such as powerpoint or prezi, or simply using chart paper to create their infographic.

Additional Resources:

- <http://www.instantshift.com/2009/06/07/infographic-designs-overview-examples-and-best-practices/>
- <http://notes.fundersandfounders.com/post/90355203872/33-ways-visualize-ideas>
- <https://www.youtube.com/watch?v=AiVKfNeRbPQ>

- https://web.archive.org/web/20130903171731/http://www.informationdesign.org/downloads/Infographic_Handout.pdf

Setting up a Science Café for Student Presentations

- What is a science café?
 - A Science Café is a live event based on the European Café Scientifique where lively public conversations about science occur. It is typically held in a casual location. Usually a scientist will present on a topic of interest, in plain language, with dialogue and discussion occurring following the presentation. There are two main phases: the initial presentation and the group discussion. There are many Science Cafes in the United States. For more information visit: www.sciencecafes.org
 - An example of a Teen Science Café in New Mexico can be found here: <http://cafenm.org/>
 - In a school, the setting can be in a classroom, media center, or auditorium depending on the number of guests. However, the atmosphere should remain as casual as possible.

- Who to invite?
 - For the classroom, parents, other classes and/or other guests such as local scientists may be invited.

- What should student presenters know prior to the presentation?
 - Students should have been given ample time to research the topic they will be presenting. The presentation can take many forms: using a video clip or photos, presentation software, posters, readings from articles, etc. They should be able to answer questions from the audience following the presentation.

This strategy comes from:

K-8 Science Lessons. (2010, August). Retrieved April 25, 2017, from <http://www.s2temsc.org/k-8-science-lessons.html> (Science S3 Seventh Grade 7-4.3 Lesson B)