



Biology: Genetics

High School Biology

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Idaho State Science Performance Standards:

- **LS3-HS-3.** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

Science & Engineering Practices:

- Obtaining, evaluating, and communicating information

Crosscutting Concepts:

- Cause and Effect
- Scale, Proportion, and Quantity

Idaho Math & ELA Standards:

ELA/Literacy

- **RST.9-10.1** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
- **RST.9-10.2** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Mathematics

- **ID.S.MD.1** Calculate expected values and use them to solve problems

Learning Objectives:

What will students be able to do, know, understand, etc.?

1. Know that the instructions for specifying the characteristics of the organism are carried in DNA.
2. Use a Punnett square to predict the genetic probability of offspring traits from two parents.
3. Understand that genetic disorders can both be inherited and/or influenced by lifestyle choices.
4. Evaluate their own risks of inheriting certain diseases and disorders.

Essential Question:

What's more likely to kill you: who you are related to or your lifestyle?

Guiding Questions:

What questions will constantly focus the students on the Big ideas/Critical Question within the unit in student language?

1. What diseases/illnesses/disorders are found in your family? What causes these diseases?
2. How does DNA make a living thing? How does DNA get mutated?
3. What happens when DNA is mutated?
4. Are mutations good, bad, or possibly both?
5. What is my likelihood of inheriting certain traits from my parents? Are dominant traits more common than recessive traits?
6. What is gene editing and can it be used to help remove diseases?

Misconceptions/Evolving Conceptions:

What might students commonly misunderstand about the subject? How will I directly address these?

- Students often think that inheritance of genes is simple and that most traits are determined by one gene, when in fact most traits are controlled by multiple genes. Students need to understand that often times at the high school level will simplify the inheritance pattern for traits, but it is truly a complicated process.
- Students will need to understand environmental factors can affect our DNA. To address this, I will have students brainstorm behaviors they know are bad for our health and use that to tie in DNA mutations. (smoking, drinking, not exercising, poor diet, etc.)
- Students often think the term “dominant trait” means that trait is most prevalent in society. To combat this, I will share some dominant traits that are very rare (example- Achondroplasia) and recessive traits that are extremely common (having 5-fingers).

Scaffold of Activities:

What is your lesson sequence you will use to get students to the culminating project?

These lessons are taught on a 90-minute block.

1. Frontloading/Introduction

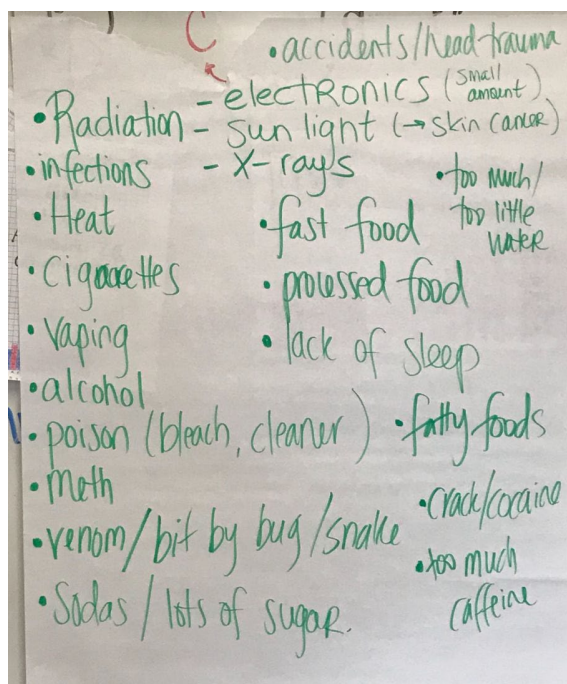
- a. Students will answer the following question, “AGREE or DISAGREE: If I get a disease in the future I’ll only have myself to blame.” Students will write their opinion and give reasons. Students will then stand and move to a side of the room to discuss their answers.
- b. Autobiographical writing in the form of 3 quick writes:
 - i. Take a moment to list any diseases/illness health issues that affect your family members (If students are adopted they can still focus on their adopted families because a big portion of this unit will be focus more in lifestyle choices and not just genetics.)
 - ii. Pick one of these health issues and explain how it affects that person’s

day-to-day life.

iii. Take a guess and explain what causes this person's health issue.

2. Week 1: DNA

- a. Day 1: Priming Activity (See section above)
- b. Day 2: Explore structure of DNA, introduce vocabulary (nucleotide, base pairing). Students color a DNA molecule from the [Biology Coloring Book](#) by Robert D Griffin. See [Introduction to Genetics lesson plan](#) and [Genetics Vocabulary lesson plan](#)
- c. Day 3: Review "synthesis" step of cell cycle to help students understand importance of DNA replication. Students will jigsaw a reading about DNA replication. They will group up and then explain steps to classmates, by the end getting the full picture. We will watch [videos demonstrating](#) the process. Class will end with students brainstorming this question, "What happens if a step goes wrong?".
- d. Day 4: Begin class with brainstorm behaviors "we know are bad for our health." I will record all answers on chart paper. As a class we will read an [article about vaping](#) and links to possible DNA mutations it can cause to cells in the mouth. Students will follow AVID reading strategies to mark the text. Following the article students will perform an activity ([DNA Replication with paper clips](#) from Schoolwires) that reviews DNA replication and introduces how a DNA mutation occurs. This helps students develop a mental and physical model of the structure of DNA, how it replicates, and gives them a window to view mutations. Students will answer lab questions throughout the activity. At the end of the day we will revisit our chart emphasizing that most of these behaviors can mutate DNA overtime and cause problems. If time students will watch a [video clip about beneficial mutations](#) in the human population.
- e. Day 5: Students will do a short reading and answer questions about other types of DNA mutations and explore visual examples to get more practice identifying types of DNA mutations. Students will be guided into the next critical question "How does DNA make a living thing?". Students will be shown a [short clip that introduces Protein Synthesis](#).



3. Week 2: Protein Synthesis

- a. Day 1: Remind students of the next critical question "How does DNA make a living us human and impact our health?". Introduce proteins and protein synthesis. Share a list of key proteins that have vital roles in our bodies

(example- hemoglobin). Share with students that Protein Synthesis is the process of turning DNA into RNA to make a protein. Students will begin by reading about protein synthesis and identifying the differences between DNA and RNA.

- b. Day 2: Explore the first step of protein synthesis, transcription. Read about this process mark text, watch [Transcription video](#), label picture, and write summary about transcription. Practice transcription, turning DNA into mRNA. Remind students about mutations and our chart of behaviors that can mutate DNA. Have them do a problem where they mutate the DNA during transcription process.
 - c. Day 3: Explore the second step of protein synthesis, translation. Read this section in the packet, mark text, watch [Translation video](#), label picture, and write summary about translation. Practice translation, turning mRNA into tRNA, and building amino acids. Remind students about mutations and our chart of behaviors that can mutate DNA. Have them do a problem where they mutate the RNA during the translation process.
 - d. Day 4: Students will spend the class period acting out protein synthesis. They will travel to the nucleus (poster on the board with a DNA sequences) and perform transcription. They will then travel to ribosomes (stations at their desk) to build their protein. Students will perform this sequence again but this time with a environmental choice that has mutated their DNA (UV rays, smoking, etc.) by the end the students will have a very messed up protein and I will tie this back into the disease process by saying something like your cell is now cancerous.
4. Week 3: Genetics
- a. Day 1: Students will revisit the list of diseases/illnesses they created for their families. They will make some guesses as to the cause of the disease. If many people are affected it could be genetic. If it is a special circumstance, affecting only one person, could it be environmental? To start the genetics portion of this unit, students will be given pictures of my family. They will lay them out in a pedigree type chart and identify any genes they see running through the family. We will use this lesson to introduce vocabulary like gene, allele, dominant, recessive, genotype, phenotype, homozygous, and heterozygous. As each word is defined and examples are given, the students will apply the vocabulary to the teacher's family tree. If time students can start to explore their own family's pedigree and track a physical trait through the family.
 - b. Day 2: This day will focus on principles of mendelian genetics. Students will learn how to use a Punnett square to determine the probability of offspring inheriting certain traits from parents. Students will work through various Punnett Square problems.
 - c. Day 3: Students will partake in a "stay and stray" activity I created. First, they will "stay" at their desks [and read about one particular human gene](#). They will fill in a graphic organizer about that gene. As part of the graphic organizer they will need to write one Punnett square problem using the trait they read about. After the whole class has read and written about the trait, we will do a quick whip around sharing information about the trait. When that is done, students will "stray" to 3 or 4 classmates where they will work through the Punnett square problems they

- wrote.
- d. Day 4: Review genetics vocabulary by playing a Kahoot. Then students will review Punnett squares by doing a BRAIN vs HAND activity. Students pair up and one student is the brain, this student verbally works through the problem telling the hand all the steps needed to complete the problem. The hand physically does the work and writes what the brain says down. If at any time the two don't agree they discuss. Students switch off several times being the brain and the hand. At the end of class sex-linked inheritance is introduced and we work through some problems.
 - e. Day 5: Students are introduced to codominance and incomplete dominance. Definitions are written, examples are explained, and students create their own illustration for each. Students work through more Punnett square problems. (*In all Punnett square problems, throughout the unit, I try to focus on as many human traits as possible and relate the work, when possible, to the diseases my students focused on in their initial writing.*)
 - f. Day 6: Students begin culminating project. Students are first shown the teachers example of the mini-book. I use an example from my own family (ALS) and show the students how I worked through the pages of the book to learn more about the disease of ALS and help me to determine my risk of getting it. Students are given their own [Disease Research Mini-Book](#) and then asked to think about one disease that affects their family and make this the focus of their book. Students are responsible for the following tasks: a short "dedication" explaining why the students selected their particular disease and explain how it affects their family. They will research the cause (focusing on genetics and/or environment). This [video](#) is helpful in helping students understand how genes and environment both play a role in our health. They will also explain symptoms/treatments, they will build a pedigree showing the prevalence of the disease in their family, they will research any chromosomal mutations tied to the disease (if any), and finally they will write an evaluation explaining if they should be concerned about getting this disease in the future and what steps they can do to prevent the illness (if anything). Students will be encouraged to use the following websites to guide their research:
 - i. [Chromosome Map - Genes and Disease](#)
 - ii. mayoclinic.org
 - iii. [A - Health Conditions](#)
 - iv. [Bipolar Disorder Candidate Genes: CSHL DNA Learning Center](#)
 - g. Day 7: Research day. Check in with students and help them work through areas they are stuck on.
 - h. Day 8: Small group Presentation. Because the assignment can be about very personal information, I asked students to write 3-4 names of classmates they would be comfortable sharing their mini-books with. After sorting through these requests (most students were fine sharing with anyone in class) I also divided groups so that each group had diseases that were caused by environmental/lifestyle choices, genetics, and a combination of each. Students took turns going around and sharing the information they learned during the research process. After each member shared, the group would fill in a graphic organizer deciding if the disease had a

genetic cause, environmental cause, or a combination. Students also took notes on the cause of the disease and ways to prevent the illness. As we finished up the activity we can back together as a group and share the final results of each group, most groups discovered that the majority of the diseases they researched had both a genetic and environmental/lifestyle component.

- i. Day 9: Students reviewed all topics on genetics and took a Genetics Test. The test included the same essential questions we started with, just slightly modified, “What concerns you more about your health and your future: your lifestyle or the genes you inherit from your family?”

Ongoing Formative Assessments:

Every class ends with an “end of day question” that is aligned to the lesson objective. I read every student's answer before they leave and assess it on a 5-point scale. Every class period starts with a “bell work question” that is either a review question from the day before or a primer to help me determine prior knowledge of that day's lesson. We always go over the bell work question and this helps me correct misconceptions. Some questions that could be included in these Bell Work Questions and End of Day Questions are “How does something you learned today apply to your life?” and “Why are we doing what we are doing?” What did we figure out today and what was our evidence?”

Also, during the unit, students will have a graphic organizer that will circle back on throughout the unit that will have three columns: 1. “I used to think. . .” 2. “But now I know. . .” 3. “I know this because. . .”

Summative Assessment/Culminating Project:

After researching one particular disease that impacts their families, students will create a mini portfolio in the form of a mini-book. The mini-book will contain a short “dedication” explaining why the students selected their particular disease and explain how it affects their family. They will research the cause (focusing on genetics and/or environment), they will explain symptoms/treatments, they will build a pedigree showing the prevalence of the disease in their family, they will research DNA/chromosomal mutations tied to the disease (if any), and finally they will write an evaluation explaining if they should be concerned about getting this disease in the future and what steps they can take to prevent the illness (if anything).