Web Unit Plan

Title: Where'd You Get Those Genes? *What makes me the way I am?*

Description: Have you ever wondered why you look the way you do? Student-scientists investigate the role of dominant and recessive genes while considering the impact of genetics on the world around us.

At a Glance

Grade Level: 6-8

Subject sort (for Web site index): Science

Subject(s): Science

Topics: Genetics

Higher-Order Thinking Skills: Application, Analysis, Synthesis, Evaluation

Key Learnings: Genetic Traits, Heredity

Time Needed: 2 weeks, 1 hour daily

Unit Summary

Students investigate the role of genetics in their environment, particularly how it determines their physical traits. They learn to identify dominant and recessive traits and develop an understanding of how the relationship between these traits determines genetic outcomes. Further investigation introduces the role of genetics in plants and animals. Students study the work of Gregor Mendel and learn how to predict genetic outcomes using Punnett Squares. They apply what they have learned to produce new flowers using specific genetic crosses. Students also consider the role of genetics in agriculture and take on the responsibility of a genetic engineer as they create a new food item with a positive environmental impact.

Curriculum Framing Questions

Essential Question

- What makes me the way I am?

Unit Questions

- How is our world influenced by genetics?
- How can I use data to predict outcomes?
- What is the impact of manipulating the genes of an organism?

Content Questions

- What is the relationship between phenotype, genotype, chromosomes, and genes?
- How are inherited traits passed from generation to generation?
- How do dominant and recessive traits predict genetic outcomes?

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Assessment Processes

View how a variety of student-centered assessments are used in the *Where'd You Get Those Genes* Unit Plan. These assessments help students and teachers set goals; monitor student progress; provide feedback; assess thinking, processes, performances, and products; and reflect on learning throughout the learning cycle.

Instructional Procedures

Unit Preparation

Prior to the unit, arrange for a geneticist or genetic engineer to speak with the students. This can be accomplished through a video conference or face-to-face interview. To ensure a positive and educational experience, consider the following questions prior to the classroom interview:

- What background knowledge do the students already have?
- What are the essential concepts that you want students to comprehend?
- What abstract ideas do you want the students to consider?
- What discussion points address the main objectives of the unit?
- How will you assess student learning during the interview?

Speak with the genetics expert prior to the classroom interview, clearly communicating your expectations for learning. You may also require students to prepare for the interview by brainstorming a list of potential questions they would like to ask.

Part 1: Introducing the Unit

Unit Introduction

Ask students to consider the question, *What makes me the way I am?* Divide the class into groups of 4 or 5 and instruct each student to share one characteristic, or *trait*, about themselves (for example, "athletic" or "tall"). Ask the groups to consider whether each named trait is an *inherited trait* or a *learned trait*. As a whole class, brainstorm a list of inherited vs. learned traits. Are there any traits that fit both categories?

Explain that this unit will investigate how inherited traits are passed from one generation to the next. Students will also explore how the science of genetics impacts more than just our physical appearance, applying this knowledge to plants and agriculture. Ask students to consider the ability of scientists to alter genetic outcomes. Present the unit question, *How is our world influenced by genetics?* to set them up for the culminating project and their role as responsible genetics engineers.

Throughout the unit, students will use a Collaboration Rubric to self-assess their role and contributions as a team member during group work. Distribute and discuss the rubric with students.

Gauging Student Needs

While students are in the same groups, ask them to complete the K (Know), W (Wonder), and H (How to learn) columns of their K-W-L-H Chart. Conduct a large-group discussion of the results. Introduce the following Content Questions during the discussion:

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- What are genetic traits?
- What determines our physical characteristics?
- Are genetic traits inherited or learned?
- How are genetic traits passed from one generation to the next?
- What is the relationship between genes, chromosomes, phenotype, and genotype?
- What role does genetics play in animal species, plants, and agriculture?
- How can we predict genetic outcomes?

It may be useful to write the content questions on large posters and display them around the classroom. At the end of each day, ask students to apply their new knowledge and write the answers on the posters. This can also serve as an effective review tool at the conclusion of the unit.

Part 2: Building Genetics Concepts

Exploring Single-Gene Human Traits

This activity introduces students to single-gene traits in humans. It reinforces the concepts of dominant/recessive genes and demonstrates how genes are passed from one generation to the next.

To begin, ask for a volunteer student to stand at the front of the room. The other students brainstorm a list of *inherited traits* that make up the volunteer's physical appearance. Write all ideas on the board.

Next, conduct a short genetics mini-lesson on single-gene traits.

Return to the list of physical traits on the board. Circle the traits that can be attributed to dominant and recessive variations of a single human gene. Then ask students to *predict* whether each circled trait exhibits the dominant phenotype or the recessive phenotype. Finally, pass out the table of Single-Gene Traits in Humans and make corrections on the board as needed.

Next, students complete the table by determining whether their own phenotype is dominant or recessive for each trait. It might be helpful to use student volunteers to demonstrate some of the traits, such as thumb crossing and tongue rolling. Distribute a piece of PTC test paper to each student for the PTC test. Students place the paper on the tip of their tongue to see if they can taste anything. The chemical tastes bitter to those who can taste it. For those who cannot taste PTC, the paper has no taste. PTC test paper is inexpensive and can be purchased from Sargent Welch (www.sargentwelch.com*), Carolina Math and Science (www.carolina.com*) or Ward's Natural Science (www.wardsci.com*).

Students should also record their genotype. Ask students to explain why a dominant phenotype could be represented by a homozygous genotype (AA) or heterozygous genotype (Aa). Scientists use a shorthand symbol (A_) to represent these two possibilities.

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Comparing Phenotypes

At this point, the classroom will naturally be buzzing with students eager to compare their findings with other classmates! Ask students, *Do you think that some genetic traits are more common in a population than others? Do you think dominant traits occur more frequently than recessive traits?*

Distribute the Comparing Phenotypes handout and ask students to predict the percentage of students in the class who share each number of phenotypes with them. They will collect data from each student and determine how many traits they have in common with their classmates. Students will represent their data visually in a bar graph and analyze their data to draw conclusions. Generate a class discussion of the results. Discussion questions may include:

- How many people in your class shared all 8 traits? Why don't these students look exactly alike?
- How many people in your class shared zero traits? Do you think it is more common to share traits with another person or more common to *not* share traits?
- Compare the actual results to your predictions. How well did you predict the number of classmates who matched your traits? Did any of the results surprise you?
- In this investigation we compared only 8 traits. But did you know that each human being has over 100,000 traits? Based on this information and the results of your investigation, do you think that there could be another person in the school who has exactly the same traits as you? What about the entire world?

Extension Activity: Connect with a classroom of similar-aged students in another region of the United States or another country. This can be accomplished through EPals (www.epals.com*) or a similar organization. Ask students, *Do you think that phenotypes vary by physical location?* Compare your classroom data from the previous activity with data from another classroom. Are the percentages of students with each phenotype similar? Where do you see the greatest differences? Why do you think that regional location may influence genetic phenotypes?

Extension Activity: Complete the Tree of Genetic Traits activity, published by the University of Utah (http://learn.genetics.utah.edu*). The students record their traits on leaf cut-outs and place their leaves on a large tree whose branches each represent a different combination of traits. When completed, the tree forms a visual representation of the frequency of trait combinations within the group.

Introducing Gregor Mendel

Prior to this activity, students should understand the relationship between chromosomes, genes, genotype, and phenotype. This activity reinforces the concept of dominant/recessive traits and introduces Mendelian genetics to explain how genotypes can be predicted.

Introduce the life and work of Gregor Mendel and his contributions to the field of genetics. The Science Channel has created a short video that introduces Mendel's experiments with peas as one of the 100 greatest scientific discoveries.

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Divide the class into 6 groups and assign each group one of the websites listed below:

- Mendel's Genetics (http://anthro.palomar.edu/mendel/mendel_1.htm*)
- The Father of Genetics (http://naturalselection.0catch.com/Files/gregormendel.html*)
- Gregor Mendel's Genetics Discoveries with Peas (http://www.exploringnature.org/db/detail.php?dbID=22&detID=54*)
- Profiles: Gregor Mendel, Scientist (http://www.answers.com/topic/gregor-mendel*)
- Biology Online: Gregor Mendel (http://www.biology-online.org/dictionary/Gregor_mendel*)
- The Mendel Museum at Masaryk University (http://www.mendel-museum.com/*)

Each group will assign roles:

- The *navigator* is responsible for navigating the website and following appropriate links to access more information.
- The *reporter* is responsible for reporting important and pertinent facts from the website.
- The *illustrator* is responsible for creating quick sketches that accurately illustrate and summarize the most important facts.
- The *investigator* is responsible for asking questions that still remain after exploring the website.

Distribute The Mendel Report handout and give students ample time to complete each section. After completing the reports, pair each group of students with another group to share their findings and illustrations. This could also be accomplished as a jigsaw activity. Encourage students to seek information from other groups that may answer the questions written on their recording sheet. Have students use the Collaboration Rubric to self-assess their contributions to the group. Follow up with a class discussion about the life and contributions of Gregor Mendel.

An animated video biography of Gregor Mendel can also be used to review and wrap-up this activity.

Using Punnett Squares

Punnett squares are one tool scientists use to predict the outcome of potential crossings of two parents. This activity provides the students with the basis for understanding how traits are passed on and expressed from one generation to the next.

Review the work of Gregor Mendel and his discoveries using peas. In the same way that Mendel could predict the traits of his pea plants, explain that we can use Punnett Squares to predict traits in animals and humans.

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Conduct a short mini-lesson on Punnett Squares.

Next, students apply their knowledge of using Punnett Squares to predict future offspring in the Flower Fortunes activity (part one). Using Punnett Squares, each student horticulturist will attempt to create a unique designer flower by crossing two different colored flowers. Generate class discussion of the results.

- If one color is a dominant trait and the other color is a recessive trait, can the offspring flower produce both colors?

Data Collection and Analysis
After completing the Flower Fortunes activity, students will realize that their attempts to create a white flower with purple spots proved to be unsuccessful. Present them with the next challenge: they will receive big money if they can produce roses with light blue petals. Complete the Flower Fortunes activity (part two) in small student groups of 2-3. Using Punnett Squares, students will predict the percentage of light blue offspring when crossing co-dominant white and blue roses. Generate class discussion of the results.

- Why did your results change when the traits were co-dominant?
- What do you predict would happen if you crossed two light blue (BW) roses?

Extension Activity: Simulate the actual results of this cross using blue and white construction paper squares to represent the genes of each parent flower. Prepare 2 paper bags for each student, each bag should have 1 blue and 1 white paper square. Students pull out 2 squares (1 from each bag) and record the resulting genotype (BB, WW, or BW) 100 times. Record and analyze the data. How closely do the actual results match the Punnett Square predictions? Combine the data of the entire class to determine if the outcomes change.

Ask students to again self-assess their contributions within their group using the Collaboration Rubric.

Part 3: A Genetic Engineering Project

Students will now apply their knowledge to the field of *genetic engineering* and design a new food to solve a problem. They will begin to consider how our knowledge of genetics can be manipulated to produce desired offspring and create genetically-modified products while reflecting on the implications of this knowledge upon the greater world.

Before introducing the project, review the key genetics concepts students have just explored in a whole group discussion:

- the relationship between genotype, phenotype, chromosomes, and genes
- how genetic traits are passed from one generation to the next
- using Punnett Squares to predict genetic outcomes of single-gene traits

When it comes to food, agriculture is highly responsive to consumer demands. Genetic engineers are continually trying to create fruits and vegetables that people prefer. Using highly specialized technology, scientists can pinpoint specific genes and add, remove, or transfer this genetic material from one organism to another to

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obtain offspring with traits that are desirable for consumers. Some positive outcomes of genetic engineering:

- Better tasting food
- Foods with higher nutritional value (increased protein, minerals, or vitamins)
- Pesticide-resistant foods
- Crops and animals that grow bigger and faster
- Crop plants that can grow in little water – resistant to drought
- Crop plants that can grow in a large amount of water – resistant to flooding
- Fruits that stay fresh longer

It is also important to present the controversial side of genetic engineering. Ask your students to consider issues such as ethics, cost, benefits, and drawbacks of creating food that is genetically modified. Distribute a Discussion Rubric to establish high expectations for classroom discussion and engaged learning. Share current related news articles and open up a class discussion about potential future implications of genetic engineering. Use a Critical Thinking Rubric to help students self-assess their critical thinking skills while identifying important information, evaluating sources, and communicating an opinion during class discussion.

Becoming a Genetic Engineer

One potential of genetic engineering is the ability to combine traits from different foods to form a new plant, such as the Pluot (a mix between the plum and the apricot) or the Tangelo (a tangerine and an orange). This is called *selective breeding*. Another potential is to prevent crop destruction (for example, foods that are resistant to pesticides or drought) using *genetic engineering*. In this next activity, students will use their imagination and knowledge of genetics to create a new hypothetical food that solves a problem and has a positive environmental impact.

As a whole group, brainstorm a list of foods that could be genetically altered. Encourage your students to consider many different aspects of food, such as:

- taste
- growing conditions and locations
- texture
- size
- rate of growth
- nutritional value
- resistance to bugs or disease
- resistance to weather

Distribute the Become a Food Engineer planning sheet. Explain the concepts of selective breeding and genetic engineering. Each student will brainstorm, plan and create a new food item that addresses some concern. They will endorse and campaign for their imaginary food with a magazine advertisement. A Food Engineer Checklist will help students stay focused and assess their project components. Students can publish and share their projects on a class wiki or a classroom website. An alternative option is to create a PowerPoint* presentation.

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Part 4: Unit Wrap-Up

Revisit the K-W-L-H Charts from the beginning of the unit and ask students to complete the "L" column with information they have learned throughout the unit. Review the unit content questions as well as questions from the "W" column of the students' charts. Address any remaining questions or misconceptions.

If time and student interest permit, you can follow up or extend the unit with Designer Genes: One Size Fits All?, another unit plan from the Designing Effective Projects collection. In this unit, student genetics experts help farmers in a blight-stricken region of Mexico decide whether to use genetically engineered corn.

Prerequisite Skills

- Basic Internet and website navigation skills
- Recording and interpreting data in a bar graph
- Calculating ratio, fraction, and percentage values

Differentiated Instruction

Resource Student

- Reduce the number of concepts needed to master
- Place students in heterogeneous groups so they can receive help from peers and provide assistance to others in their area of expertise
- Establish daily routines for checking progress and setting goals

Gifted Student

- Assign an advanced student to complete an independent research project on a related topic of their choice
- Encourage effective leadership
- Provide options for creating multimedia products, such as videos or podcasts, as part of the food engineer project
- Point the student toward online resources related to the field of genetic engineering, and ask the student to draw further conclusions about the risks and benefits of genetically modified foods

English Language Learner

- When possible, make pictures available for new vocabulary
- Find books in students' first language with pictures or related ideas
- Identify relevant Web resources in the student's native language
- Place students in heterogeneous groups so they can use language in an authentic situation, get help from group members when necessary, and provide help to others in their area of expertise

Credits

This unit was designed and written by Lisa Fisher, a teacher in Wilsonville, OR.

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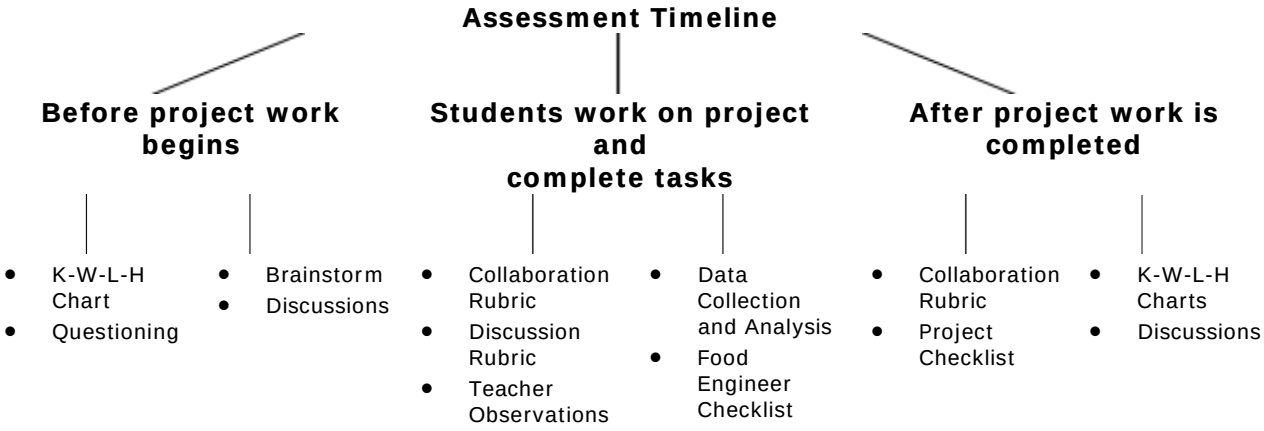
THINGS YOU NEED

Assessment Plan



Assessment Summary

Students will be assessed with a mix of self-assessment and teacher feedback. Teachers use questioning, discussions, and observation throughout the unit to assess students' understanding of the Curriculum-Framing Questions as well as other important questions about genetics and the impact of genetic engineering. The teacher and students use the K-W-L-H Chart at the beginning of the unit to determine students' prior knowledge about genetics and heredity, and again at the end of the unit to document what students have learned. The Comparing Phenotypes handout assesses each student's ability to collect, record, display, and analyze data while drawing conclusions regarding the occurrence of genetic traits in the classroom. When navigating the Internet to learn about Mendelian genetics, the Collaboration Rubric guides students in their role as a member of a collaborative team. Students use the Discussion Rubric to self-assess their discussion skills while considering the positive and negative impacts of genetic engineering. A Critical Thinking Rubric supports students as they form opinions about the benefits and drawbacks of genetic engineering. As students create their own genetically modified foods and prepare marketing materials, they refer to the Food Engineer Checklist to guide their work.

Content Standards and Objectives

Targeted Content Standards and Benchmarks

Oregon Science Standards

- 7.1L.2 Distinguish between inherited and learned traits, explain how inherited traits are passed from generation to generation, and describe the relationships among phenotype, genotype, chromosomes, and genes.
- 7.3S.2 Organize, display, and analyze relevant data, construct an evidence-based explanation of the results of an investigation, and communicate the conclusions including possible sources of error.
- 7.4D.1 Define a problem that addresses a need and identify constraints that may be related to possible solutions.

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- 7.4D.3 Explain how new scientific knowledge can be used to develop new technologies and how new technologies can be used to generate new scientific knowledge.

21st Century Skills Standards

Students will:

- Assume shared responsibility for collaborative work, and value the individual contributions made by each team member
- Utilize multiple media and technologies, and know how to judge their effectiveness as well as assess their impact

Objectives

Students will be able to:

- Explain the relationship between phenotype, genotype, chromosomes, and genes
- Interpret data and apply conclusions to the occurrence of genetic phenotypes in the classroom and other cultures
- Demonstrate how inherited traits are passed from generation to generation
- Use effective Internet search strategies to gather information about historical figures
- Predict genetic outcomes using dominant and recessive traits
- Analyze the effect of genetic engineering on the field of agriculture
- Collaborate with peers to share information and resources and to accomplish tasks

Technology and Resources

Internet Resources

Websites

- Genetic Science Learning Center, University of Utah
  http://learn.genetics.utah.edu/*
  A comprehensive site with interactive exhibits and links to classroom genetics activities and lesson plans.
- Oracle ThinkQuest: Discovering Genetics
  http://library.thinkquest.org/03oct/00737/*
  This ThinkQuest includes lesson plans and a comprehensive student quiz.
- Exploring Nature Educational Resource: Genetics
  http://www.exploringnature.org/db/detail_index.php?dbID=22&dbType=2t*
  A kid-friendly site with simple explanations and diagrams.
- Exploring Nature Educational Resource: Punnett's Square Activity
  http://www.exploringnature.org/db/detail.php?dbID=22&detID=2290*
  A kid-friendly explanation of Mendel and his contributions to genetics.
- Kids DO Science: Probability and Genetics
  http://www.uga.edu/srel/kidsdoscience/kidsdoscience-genetics.htm*
  Genetics activities for kids; includes templates, posters, and lesson plans.

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- Tiki's Guide to Genetic Engineering
  http://tiki.oneworld.net/genetics/home.html*
  A kid-friendly site that explores the issue of genetic engineering through Tiki the Penguin.
- Single Gene Traits in Humans
  http://employees.csbsju.edu/SSAUPE/biol115/genetics_single_gene.htm*
  A table of single-gene traits in humans.
- Single Gene Traits in Humans
  http://www.uga.edu/srel/kidsdoscience/genetics/human-trait-poster.pdf*
  A poster of dominant/recessive single-gene traits in humans.
- Mendel's Genetics
  http://anthro.palomar.edu/mendel/mendel_1.htm*
  Describes Mendel's work with pea plants and includes word pronunciation sound links.
- The Father of Genetics
  http://naturalselection.0catch.com/Files/gregormendel.html*
  A biography of Gregor Mendel.
- Gregor Mendel's Genetics Discoveries with Peas
  http://www.exploringnature.org/db/detail.php?dbID=22&detID=54*
  A kid-friendly explanation of Mendel's experiments with peas.
- Profiles: Gregor Mendel, Scientist
  http://www.answers.com/topic/gregor-mendel*
  A biography of Gregor Mendel.
- Biology Online: Gregor Mendel
  http://www.biology-online.org/dictionary/Gregor_mendel*
  A short biography of Gregor Mendel with links to Mendelian traits and inheritance.
- The Mendel Museum at Masaryk University
  http://www.mendel-museum.com/*
  An online exhibit dedicated to the life and work of Gregor Mendel.

Interactive Online Activities

- Gizmos: Mouse Genetics (one trait)
  http://www.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID=449*
  Breed pure mice with known genotypes that exhibit specific fur colors, and learn how traits are passed on via dominant and recessive genes. Punnett Squares are used to predict results.
- Gizmos: Mouse Genetics (two traits)
  http://www.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID=382*
  Breed pure mice with known genotypes that exhibit specific fur and eye colors, and learn how traits are passed on via dominant and recessive genes. Punnett Squares are used to predict results.

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- Gizmos: Chicken Genetics
  http://www.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID=453*
  Breed pure chickens with known genotypes that exhibit specific feather colors and learn how traits are passed on via co-dominant genes. Punnett Squares are used to predict results.
- Gizmos: Evolution Mutation and Selection
  http://www.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID=554*
  Observe genetic evolution in a fictional population of bugs and see natural selection taking place. Explores the inheritance of color according to Mendel's laws and probability.
- Gizmos: Natural Selection
  http://www.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID=447*
  Capture moths on a tree surface and watch the moth populations change, illustrating the effects of natural selection.

Web Videos

- The Science Channel Videos: 100 Greatest Discoveries: Genetics
  http://science.discovery.com/videos/100-greatest-discoveries-shorts-genetics.html*
  A brief video illustrating the discovery of genetics and the historical importance of Gregor Mendel.
- WatchKnow: Gregor Mendel
  http://www.watchknow.org/Video.aspx?VideoID=25039*
  A short video biography of Gregor Mendel.

Technology—Hardware

- Computers with an Internet connection for research
- Projection system for sharing research and showing video clips
- Videoconferencing equipment for conducting expert interview

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