Unit Overview

Title of Unit: Heredity

Recommended Grade: 4th grade

Time Frame: 10 days- 42 minute classes

Unifying Theme: Patterns- Identify observable patterns in the physical characteristics of plants or groups of animals.

Integration Model: Math, History, Reading, Art

Essential Questions: How do the structures and functions of living things allow them to meet their needs?

Unit Questions:

- How do the parts of living things work together to carry out life functions?
- How does each plant or animal have different structures that serve different functions in growth, survival, and reproduction?
- Why do most living things need food, water, light, air, and a way to dispose of wastes?
- Why is energy needed for all organisms to stay alive and grow?
- How can living things be grouped based on their similarities and differences?
- How do tools make it possible to observe living things or the parts of living things that are too small to be seen with the naked eye?

PA Academic Standards addressed in this Unit:

3.1 Biological Science
3.1.B Genetics
3.1.4.B1 Describe features that are observable in both parents and their offspring.

3.3 Earth and Space Sciences
3.3.B Origin and Evolution of the Universe
3.3.4.B3 Ask questions about objects,, organisms, and events

Understand that all scientific investigations involve asking and answering questions and comparing that answer with what is already known.

Plan and conduct a simple investigation and understand that different questions require different kinds of investigations

Brief description of Unit/ Ten Day Overview:

In this ten day unit, the class will discover the features that are observable in both parents and their offspring. The students will explore how traits are inherited and also that not all traits are inherited. Students will learn how traits are controlled such as, incomplete, dominant, and recessive genes. Furthermore, students will explore how genes can combine to form specific traits.

Day 1: Trait of an Organism

Engage: Introduction to Unit and "What are inherited traits?" Discuss: Why does everyone in the classroom look different (except identical twins) from each other? Why do you look similar to your parents?

Exploration: What can you do? Students focus on inherited traits and should become more aware of three of their own inherited traits. Partners can observe these traits in each other by using mirrors. Students will record which traits (tongue rolling, thumb superiority, and handedness) and count the number of students with each variation of the trait. Stress that one inherited trait is not better or worse than its opposite trait. What other heredity traits do you think would be interesting to check? Students can suggest eye or hair color, height, and ear shape.

Evaluate: Assess Performance:

- Process Skills Checklist: Did students carefully collect, record, and interpret data regarding the incidence of the three traits in their classmates? Did students use graphs to communicate the incidence of each trait? Did they infer that the incidence of these traits is the same in the general population? Did they hypothesize that some inherited traits can be modified with effort?
- Analyze and conclude: In most classes, the majority of students will be tongue rollers, left-thumb superior, and right-handed. If the class is big enough to show a representative sample, the general population will show the same incidence. With effort, some people can change handedness. People can choose to alter some inherited tendencies, such as thumb superiority. Other traits, such as tongue rolling or eye color, are permanent and unchangeable.

Extension: Have students poll a random group of 25 people and see whether they are tongue rollers or non-rollers, left-thumb or right-thumb, and right-handed or left handed. Draw a bar graph and compare it to the one you drew of your class.

Day 2: Genes, Traits, and the Environment

Engage: Background: Human cells have 23 pairs of chromosomes. When these chromosomes are shuffled during meiosis, they can be recombined in many different ways. The number of possible combinations is 8,388,608! This large number ensures that the set of genes each parent passes on to one child is different from the set that the parents' other children receive. Identical twins are an exception; they each receive an identical set of genes.

Explanation: How do you think parents pass traits such as eye color and hair color to their children? Students may be able to link this process to the cell division they studied in Chapter 1 Reproduction. Why do you think it is useful to know what genes you have inherited from your parents? You would know what traits you might inherit, including the tendency to develop certain genetic disorders or diseases.

- Connect to the activity the previous day. How would a father pass on his ability to roll his tongue to his son? His sperm cell, carrying the dominant gene for tongue rolling, could become part of a fertilized egg (zygote), which would develop into his son. His son would then be able to roll his tongue.
- Thinking Critically: Why do you think scientists are trying to learn more about how genes affect development? Research is helping them find ways to eliminate certain heredity problems and better understand how organisms develop. Explain how two sisters can have the same shaped

eyes but different eye color. Through the shuffling and recombining of genes from both parents, the sisters can inherit eye shape from one parent but eye color from either parent.

- Drawing conclusions: Why do identical twins look so much alike? They developed from the same fertilized egg (zygote), so they have exactly the same genes. Why do you think some identical twins have different personalities and interests? They are influenced by their environment.
- Making Comparisons: What factors might prevent someone who has inherited musical ability from becoming a musician? Not being exposed to music would make it impossible for the person to become a good musician. A hearing impairment might make becoming a musician difficult. Many environmental factors could interfere with the development of musical talent. Identical twins have the same genetic information. Yet one twin can be taller than the other. Explain how this can happen. Environmental conditions, such as good diet or exposure to harmful conditions, can cause one twin to either grow more than the other or grow less than the other.

Expansion: Science, Technology, and Society: Dinosaur Genes

- What to do: Tell students that a group of scientists believe they found dinosaur DNA in ancient bones unearthed from a Utah coal mine. Scientists have also been trying to obtain dinosaur DNA from insects that became trapped in clear, hard amber millions of years ago. Amber is the source of dinosaur DNA in the fictional book and movie *Jurassic Park*. Have students share what they recall about DNA if they have seen the movie or read the book?
- What's the Result? Ask students what they would like to find out if they were studying dinosaur DNA. Encourage them to draw pictures or write a description of what they would hope to find. Allow time for them to share their work with their classmates.

Day 3:

Evaluate: Students might enjoy working in groups of three to four to create puzzles. Tell each group to cut a piece of heavy paper into eight to ten puzzle pieces. On each piece, they should write an inherited trait, such as eye color or blood type. Groups can then exchange puzzles and try putting them together. Discuss how the pieces represent the genes that work together to determine a person's traits.

- Close the investigation: Answer the investigation wrap up questions.
- Challenge- Organize students into small groups and ask them to work together to answer this question: If a tomato plant were growing poorly, how could you determine whether the problem was environmental or heredity? Students might suggest examining another plant growing near the first to see whether it is growing poorly, looking for signs of insect pests, or trying to transplant the plant to a different environment.
- Following up- Baseline Assessment- look again at which traits students thought were inherited and which traits might be due to environmental conditions. Invite students to make any changes in the class chart based on what they learned in the investigation. Clarify any misunderstandings. Reteaching- Ask students, working in pairs, to diagram the relationships among cells, chromosomes, genes, and DNA. Label all four structures. Combine pairs into groups of six and ask them to compare their drawings and present the clearest one to the class.

Day 4: How are Traits Inherited?

Engage: Discuss why some children look more like one parent than the other?

Exploration: Scrambled Genes Students focus on the ways that genes combine and should recognize the vast number of possible gene combinations. Students will use disks divided into two groups- mother and father. The four disks will represent genes for four different traits. Each side of the disk will be marked with a different gene either recessive or dominant of a certain trait. With three circles drawn on a sheet of paper, label these sperm cell, egg cell, and zygote. For the female, shake the cup with the disks for the female parent and empty in the egg cell. Write down the traits that appear. Repeat this process for the male. Record the combination of genes for the zygote.

Evaluate: Assess Performance:

- Process Skills Checklist- Did students make and use models successfully? Were they able to match the disks in the zygote to learn how pairs of genes can be combined? Did students record their data accurately? Did students recognize the small probability of predicting specific combinations of genes?
- Analyze and conclude (questions in lab) - Meiosis is the process by which a set of chromosomes is separated into sex cells. Fertilization is the process in which the chromosomes from mother and father are combined in the zygote. They would be siblings. They might vary in a number of traits represented by the combinations of disks.
- Explain to students that meiosis is Greek for less. What becomes less during meiosis? The number of chromosomes. Why must sex cells have less chromosomes? In sexual reproduction, two cells come together to start a new organism. The sex cells must have fewer chromosomes so the new cell has the normal number.

Day 5: Inheriting Traits

Explain: Students focus on ways that dominant and recessive genes can combine and should understand how dominant and recessive genes control inherited traits. Review what students found when they flipped the disks.

- Why is the dominant trait more common in this activity? It is more common because the dominant gene masks the recessive gene, so the dominant trait shows up when either one or two dominant genes are present. The recessive trait only shows up if two recessive genes are present. (In reality, a dominant gene may have lower frequency in a population than a corresponding recessive gene. Thus, a recessive trait, such as type O blood, can be more common than a dominant trait, such as type A blood.)

Evaluate: Assess Performance-

- Process Skills Checklist- Did students carefully collect and record data on the combinations of dominant and recessive genes? Were students able to hypothesize that if both parents pass on recessive genes for blue eyes, their child would have blue eyes?
- Analyze and Conclude- Any zygote with at least one “A” carries a dominant gene; any zygote with at least one “a” carries a recessive gene. Zygotes with one or two dominant genes will be brown-eyed. Only those with two recessive genes will be blue-eyed. Each parent must carry a recessive gene (a) for blue eyes. If both parents pass on a recessive gene to the child, the child will be blue-eyed (aa).

Expansion: Research the number of left-handed people versus the number of right-handed people in a population. Find out if hand preference is determined by a single pair of genes or by a combination of genes. Share your results with your classmates.

Day 6:

Exploration: All in the Family Students focus on how dominant and recessive genes are passed from generation to generation and should understand how different combinations of dominant and recessive genes produce attached and free earlobes. Have student create a pedigree chart for their family or an imaginary family. Students will be tracking free and attached earlobes. Point out that scientists use symbols to distinguish between the dominant and recessive forms of a gene in a pedigree chart: the dominant gene is written with an upper case letter and the recessive form is written in the lower case of the same letter.

Evaluate: Assess Performance-

- Process Skills Checklist- Did students accurately collect and record data? Did they observe patterns in the way ear lobe shapes are inherited? Were students able to hypothesize that free ear lobes are produced by a dominant gene and attached ear lobes are produced by recessive genes?
- Analyze and conclude- Parents with attached ear lobes each carry two recessive genes for attached lobes. They could not pass on any genes for free ear lobes to their children, so none of their children could have free ear lobes. Parents with free ear lobes must carry at least one dominant gene. If either or both parents pass on a dominant gene to a child, the child will have free ear lobes. However, if each parent also has a recessive gene, and if both pass them on to the child, the child will have attached ear lobes. Attached ear lobes are inherited as two recessive genes. Free ear lobes are inherited as one or two dominant genes. They can be attached or free, but each parent must carry a recessive gene for attached ear lobes.

Day 7:

Explanation: Laws of Heredity
Background:

- Gregor Mendel investigated seven characteristics common to two forms of pea plants in his quest to understand the laws of heredity. In addition to plant height, he studied seed shape, seed color, flower position, flower color, pod shape, and pod color.
- Mendel summarized his findings in three laws, or principles: 1) during the formation of sex cells, paired factors are separated so that a sperm or egg cell contains only one of the two possible factors; 2) each factor is inherited independently of any other; and 3) each inherited characteristic is determined by the interaction of two factors, one from each parent, and the expression of one factor of each pair is dominant over the other. He published his work in 1866.

Guide the Discussion:

- Connect to the activities- Which part of Mendel's process was like combining the disks? When Mendel hand-pollinated the plants, he was combining the two sets of genes. How were results of Mendel's experiments with the height of pea plants similar to the pedigree chart for ear lobes? Both show the presence of dominant and recessive genes and traits in several generations.
- Making Inferences- Why was it important that Mendel used thousands of plants? A large sample size allowed Mendel to apply the laws of probability to make deductions about how inherited traits passed on. How did carrying his experiments through several generations affect Mendel's findings? By observing inheritance through several generations, Mendel was able to recognize that dominant and recessive genes (factors) existed and how they interacted.

- Identifying and Solving Problems- How could you determine whether a tall pea plant carried a recessive gene for shortness? You could cross the tall plant with a short one. If some offspring were short, the tall plant had to carry a recessive gene for shortness. Mendel also discovered that if a parent plant with only smooth seeds and a parent with only wrinkled seeds were crossed, only smooth seeds were produced. Is a smooth shape or a wrinkled shape dominant? How do you know? A smooth shape is dominant. In the offspring, the dominant gene for the smooth shape masked the recessive gene for the wrinkled shape.
- Thinking Critically- How would Mendel's results have changed if the traits he selected to examine blended in pea plants instead of remaining distinct? He might not have discovered the concept of dominant and recessive traits.
- Thinking about the Data- What other human characteristics can you think of besides skin color that appears to be the result of the blending of several genes? People's height and blood type are characteristics that are determined by the interaction of several genes, as is the color of animals' fur and some flowers.

Evaluate: Students can work in groups of three or four. Let each group choose a plant or animal trait, real or imaginary, which has a dominant form and a recessive form. Ask them to create a chart that shows how this is passed from one generation to the next. Provide time for groups to share their charts and receive feedback from classmates.

Day 8: Punnett Squares

Engage: Discussion- explain that in all Punnett squares, capital letters are used for dominant genes and small letters for recessive genes. What are the eye colors of the mother and father in this example (both have brown eyes, since both have a dominant B gene). What do the boxes inside the squares represent? (Most students will say that the boxes stand for offspring). Emphasize that the boxes do not really show offspring but the possibilities for this trait in the offspring of this set of parents. Go through the sequence with students, emphasizing the notion of the possibility at each step. Judging from the possibilities shown in the completed Punnett square, what color would you predict the eyes of a child of these parents would be? (Brown, because three out of four boxes show brown.)

Exploration: Divide the class into four groups. Assign each group one of the following pairs of traits: brown eyes (dominant), blue eyes (recessive), no dimples (recessive), dimples (dominant), curly hair (dominant), and straight hair (recessive). Ask each group to make a Punnett square showing possible combinations with these traits. To make the squares they should use pictures from magazines. The pictures should be labeled with gene combinations and traits. Each group should make at least three squares showing different parental combinations. Encourage group members to divide tasks evenly among themselves.

Exploration: How Sex is Determined- Have students look at the Punnett square on this page. Ask them to identify the gene possibilities from the female parent (XX) and male parent (XY). Then ask students to examine the expected gene combinations of the offspring. What are the chances of the parents having a boy or girl? Equal
Explain to students that Henry XVIII of England divorced or beheaded his wives because they failed to bear him a son. Some gave him daughters, but he blamed his wives for no sons. What assumptions did Henry XVIII make about who determined the sex of children? (He thought women determined a child's sex). Was his assumption correct? (No, a woman has two X chromosomes. A man has an X chromosome and Y chromosome. Only a man can contribute the Y chromosome to produce a boy.)

Day 9:

Exploration
Divide the class into five or six groups. Have each group learn about and present a report on new genetic technologies, such as genetic engineering, recombinant DNA, cloning, plant breeding, and birth defects. Assign roles such as researcher, writer, illustrator, reporter, and facilitator.

Day 10:

Explanation: Designer Genes
Discussion Starter- Why might scientists want to change or replace genes? Students may answer that changing genes could help to prevent passing on an illness or might help an organism's growth and development.
Have students present short presentations.

Evaluate:

- Connecting to the Activities- If a dominant gene were spliced into an egg cell that was then fertilized, would the offspring show that trait? Explain your answer. Yes, the gene would be passed on to the zygote along with other genes in the sperm and egg cells.
- Assess Understanding- Invite students to work in small groups to list three areas they think should be open to genetic engineering and three that should not.
- Investigation Wrap-Up- Offspring receive genes in pairs, one from the mother and one from the father. If one or both genes are dominant, the dominant trait will be expressed in the offspring. If both genes are recessive, the recessive trait will be expressed in the offspring. He crossed purebred tall plants with purebred short ones and he hand-pollinated plants to be sure one parent was tall and one was short. All four sections in the square should show the Tt combination. A blue eyed person carries two recessive genes. Therefore, parents with blue eyes do not have the dominant genes for brown eyes to pass on to their offspring.
- Challenge- Ask students to work with partners to create a chart showing the possible offspring of two short pea plants. Have them describe the height of each possible type of offspring.
- Following up-
    - Baseline assessment- Return to the class list of reasons why some children look more like one parent than the other. Ask students which of the reasons were accurate, and guide the class to revise reasons that were incorrect. Guide students to include dominant and recessive genes in the discussion.
    - Reteaching- Assist students in constructing a concept web based on the phrase "inherited traits". Use the Web Activity Support Master to reteach. Students might suggest words and phrases such as controlled by dominant genes, can be influenced by environmental conditions, or produced by two recessive genes.

Students should take the chapter test. Also, to assess performance students should construct a pedigree chart for an imaginary family for a specific hereditary trait and explain how that trait is transmitted through the generations.

Annotated Bibliography:

"Chapter 2: Heredity". Discovery Works Teaching Guide Unit D: Continuity of Life. Houghton Mifflin Science. Boston: 2003, 28-47.

This teacher's edition contains lesson plans to teach heredity. It contains newer and more interactive lessons to explore heredity.

"Chapter 4: Heredity". Science Teacher's Edition 6. Addison- Wesley Publishing Company. New York: 1989, 84-105.

This is a teacher's edition book to teach different science units, including heredity. This includes slightly older information and more historical information about heredity.