Lesson Title: Heredity
Foundation 7: Science Content Knowledge & Inquiry Skills
Science Grade 10: Biology

Arkansas Biology Science Curriculum Framework
Heredity and *Evolution*—Biology **Standard 4: Students shall demonstrate an understanding of *heredity.*** Students shall demonstrate and apply knowledge of the characteristics and processes of science using appropriate safety procedures, equipment, and technology.
HE.4.B.3—Use the *laws* of probability and *Punnett squares* to predict *genotypic* and *phenotypic*
English Language Arts Common Core State Standards **Science and Technical Subjects : Grades 9-10**
RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions
RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10.*
RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically
NGSS Essential Characteristics of Science and Engineering Focus: 1. Asking questions (for science) and defining problems (for engineering) 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations (for science) and designing solutions (for engineering) 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information

Materials

- *Discovering Science Through Inquiry: Living Organisms*
  Dominant and Recessive Traits Inquiry Card (one copy per student and one display copy)
- 4 coins (showing heads and tails)
- TI 83 Plus/TI-84 Calculators
- *Class Trait Investigation* (one copy per student)
- markers
- Heredity Lesson PowerPoint™ presentation
- *Punnett Square* Student Project Card
- *Punnett Square Data Collection* sheet
- *Punnett Square Rubric for Scoring* sheet

Background Information

Characteristics that cannot be learned are known as inherited traits and are passed from parents to their offspring through a mechanism known as DNA. All living organisms inherit traits from their parents. Besides inheriting unique characteristics, like hair color or size, parents pass on traits that are shared by all members of their species. These traits are adaptations that have become genetic and are often crucial for survival. Some particularly useful adaptations include camouflage, hibernation, regeneration of limbs or tissue, and even specialized limbs for moving in specific situations. (*From Discovering Science through Inquiry: Living Organisms Heredity Science Inquiry Card)*

Essential Questions

Where do individual traits come from? How are traits passed from one generation to the next? How is the Punnett Square used to help scientists explain inheritance? Why is sample size important in his process?

Lesson Objectives

Students will be able to do the following:

1. Define heredity
2. Review basics of the role of DNA in heredity
3. Describe how traits are passed from parents to their offspring
4. Distinguish between an acquired characteristic and an inherited characteristic
5. Calculate and predict the probability of genotypic and phenotypic ratios using a Punnett Square

Phase One: Engage the Learner

Introduce a topic or question in a way that challenges or intrigues students. The goal is to capture their attention. Ask what students already know or would like to know about the topic. These activities mentally engage students with an event or question. Engagement activities capture students' interest and help them to make connections with what they know and can do. The teacher provides an orientation to the unit and assesses students' prior understanding of the concepts addressed in the unit.

In this section, students participate in a discussion about heredity and learn about traits and how they can be classified. Students perform a small investigation to gain knowledge about how dominant and recessive traits are expressed in their own classroom. The students will be given a list of characteristics and will determine which are dominant and recessive traits.

Procedures

1. Display the Dominant and Recessive Traits Inquiry Card hiding the dominant and recessive trait heading at the top. Tell students that this card shows different traits that occur among the humans. Explain that a trait is a feature that can distinguish one person or thing from another.

2. Tell students that the card shows two forms of each inherited characteristic/traits (dominant and recessive). Briefly explain to students that the dominant trait is usually occurs more frequently than the recessive trait in population sample. Tell students that we all express dominant or recessive characteristics for each trait listed on this chart. Based on probability, there should be more of the dominant trait expressed in a population sample than a recessive trait.
3. Tell students that today they are going to conduct an investigation to determine which traits shown on the card occur more frequently in the population by collecting data from the class and using it as a population sample. First the students will form a hypothesis
4. Display the chart below on the SmartBoard/whiteboard. Explain to students that the traits shown on the Dominant and Recessive Traits Inquiry Card are recorded in the first column of the chart.
5. Tell the class they are going to hypothesize which traits are recessive or dominant. Have students jot down their hypothesis on a sticky note.
6. Quickly poll the class, using a show of hands, to determine which trait the majority of students hypothesized is the dominant trait and the recessive trait. For example, tell students, "Raise your hands if you hypothesized that ear lobes attached is the dominant trait. Raise your hands if you hypothesized that ear lobes detached is the dominant trait. If 20 out of 30 students believe ear lobes attached is dominant, then for the class predictions chart record Ear lobes attached as dominant and ear lobes detached as recessive for the class predictions. Keep this chart displayed to reference later in the lesson.

Frequency of Occurrence for Dominant and Recessive Trait Among ____Period Students		
Characteristic	**Hypothesis of Dominant and Recessive Traits** (Number of Students)	**Number of Students with Each Trait**
Characteristic 1: Ear lobes attached/ Ear lobes detached	**Dominant:** **Recessive:**	**Dominant:** **Recessive:**
Characteristic 2: Widow's Peak/ No widow's Peak	**Dominant:** **Recessive:**	**Dominant:** **Recessive:**
Characteristic 3: Straight Thumb/ Hyperflexible Thumb	**Dominant:** **Recessive:**	**Dominant:** **Recessive:**

7. Tell students that they will collect a data sample from the students in their class to confirm or disconfirm their hypotheses about which traits are dominant and which are recessive.
8. Divide your class into three groups. Assign each group one trait. Then pass out the chart handout based on the group's assigned trait. Groups will report back their subset of data to be recorded on a whole class chart.
9. Model how to observe the assigned traits and how to record it in a sample chart. Place 3–4 minutes on a digital timer preferably the projector screen to keep students on task and limit unnecessary loss of time.

10. Once the timer has sounded, gather the class back together. Ask each group, which trait is the dominant trait or the trait that occurred more frequently in the population sample? Then ask which trait is the recessive trait or the trait that occurred less frequently in the population sample? Ask groups to share the actual data for each. Record this data in the whole-class chart.

11. The statistics should show the following traits as dominant and recessive:
    a. Characteristic 1: Detached earlobes, dominant trait and attached earlobes, recessive trait
    b. Characteristic 2: Widow's peak, dominant trait and no widow's peak, recessive trait.
    c. Characteristic #3, straight thumb, dominant trait and hyperflexible thumb, recessive trait.
12. Display the original inquiry card with the dominant and recessive trait headings at the top to determine if the class investigation is actually true according to the inquiry card.

Phase Two: Explore the Concept

Students encounter hands-on experiences in which they explore the concept further. They receive little explanation and few terms at this point, because they are to define the problem or phenomenon in their own words. The purpose at this stage of the model is for students to acquire a common set of experiences from which they can draw upon to make sense of the concept. Students must spend significant time during this stage of the model talking about their experiences, both to articulate their own understanding and to understand another's viewpoint.

In this section, students will use the graphing calculator to create a simulation of a Punnett square to illustrate the predicted outcomes for crossing the long/short beak trait of two heterozygous birds.

Procedures

1. Divide students into small groups of 3−5.
2. Follow steps 1-4 on the lesson plan for Punnett Square, from *TechTools for TI Graphing Calculators*, Challenging Projects (pages 88-91).
3. Have students complete steps 1−6 on the Punnett Square Project Card. As students complete the steps on the project card, students should record their results and responses for only sections I−III on the Punnett Square Data Collection Sheet (pg. 91).
4. *Special Note:* Section IV on the Punnett Square Data Collection Sheet will be completed in the Elaborate section of the lesson. Students will present their Punnett Square Simulations to the class in the Evaluate section of the lesson.
5. Each individual student is responsible for submitting a completed Punnett Square Data Collection Sheet to be assessed at the end of the lesson.

Phase Three: Explain the concept and define terms

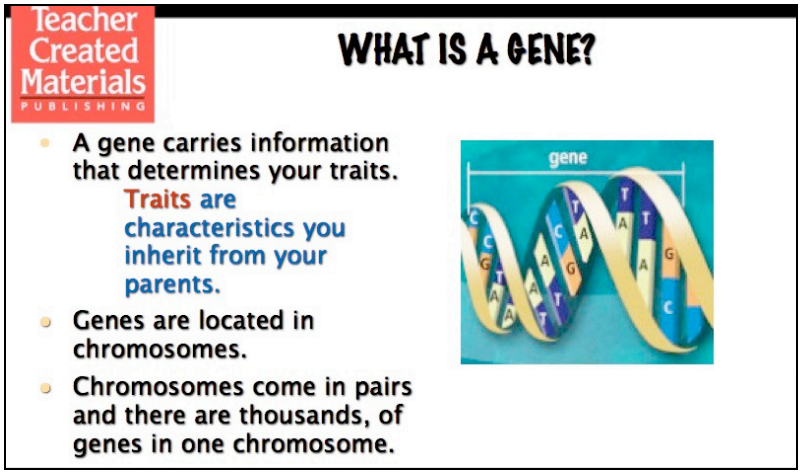
Only after students have explored the concept are the students provided with the scientific explanation and terms for what they are studying. The teacher may present the concepts via lecture, demonstration, reading, or multimedia (video, computer-based). Students then use the terms to describe what they have experienced, and they begin to examine mentally how this explanation fits with what they already know.

In this section, students learn how to use the Punnett square. Students continue to practice using the Punnett square in problems presented by the teacher. In addition, students learn basic

vocabulary and take T style notes on how scientists calculate the probability of genes being passed from one generation to the next.

Procedures

1. Have students write two-column notes by folding their papers in half vertically (or hotdog style) and drawing a line down the middle of their papers. Instruct students that the PowerPoint™ presentation will present questions on slides that they are to write on the left side of their papers (left column). Answers to those questions are on the same slide and they are to write them on the right side of their papers (right column).



For example, using the slide above a student's notes might include the following on each side:
Question: (left side of paper): What is a gene?
Answer: (right side of paper): genes carry information; located in chromosomes

2. Walk around the room and make observations of students' notes to ensure everyone is on task. During practice problems, provide assistance to students that may need it or partner them with classmates.
3. Informally assess students' answers to questions to check for understanding during this phase.

Phase Four: Elaborate the Concept

Students elaborate on their understanding of the concept. They are given opportunities to apply the concept in unique situations, or they are given related ideas to explore and explain using the information and experiences they have accumulated so far. Interaction between the students is essential during the elaboration stage. By discussing their ideas with others, students can construct a deeper understanding of the concepts.

In this section, students will apply their knowledge of Punnett squares to create a simulation for another animal using the graphing calculator.

Procedures

1. Tell students that they are going to create a simulation of a Punnett square for another animal using the graphing calculator.
2. Have students work in the same groups they were assigned to during the Explore section of the lesson to finish the Punnett Square project from *TechTools for TI Graphing Calculators*.
3. Have students in small group complete part IV on the Punnett Square Data Collection Sheet (pg. 91).

Phase Five: Evaluate students' Understanding of Concept

The final stage of the model has a dual purpose. It is designed for the students to continue to elaborate on their understanding and to evaluate what they know now and what they have yet to figure out. Evaluation of student understanding should take place throughout all phases of the instructional model. The evaluate stage, however, is when the teacher determines the extent to which students have developed a meaningful understanding of the concept.

In this section, students examine the Essential Question of the lesson and reflect on their learning. Students also take the Heredity Assessment.

Procedures

1. Have small groups present their Punnett square simulations to the class.
2. Conclude the lesson by with a discussion of the essential questions below. Have students respond to each of these questions by discussing them with a partner during Mix-Freeze-Share.
3. To structure the activity, have the students stand up and move around the classroom to "mix" with each other while music is played. When the music stops, have students step towards the person closest to them to form a pair or a trio. Pose the first question to the group. Students should discuss the question with their partner(s). Repeat the process for each essential question. Debrief the questions with the whole group.
    a. Where do individual traits come from?
    b. How are traits passed from one generation to the next?
    c. How is the Punnett Square used to help scientists explain inheritance?
    d. Why is sample size important in his process?

Assessment

- Have groups evaluate themselves and their group on the completion of the Punnett Square graphing calculator project using the Punnett Square Rubric (pg. 92).
- Use the rubric evaluate each individual student's project.