Mendelian Inheritance Lesson

Subject / Course:	High School Biology		
Topic:	Heredity		
Lesson Title:	Mendelian Inheritance and Punnett Squares		
Level:	High School	**Lesson Duration:**	45 min x2

Lesson Objectives:

1. Students will be able to use Punnett Squares to predict probability of inheritance patterns based on Mendelian Genetics on:
    a. a 2x2, single-trait Punnett Square (session 1) Monohybrid Cross
    b. a 4x4, two-trait Punnett Square (session 2) Dihybrid Cross

Summary of Tasks / Actions:

Considerations for teaching students with blindness or visual impairments:

This concept involves a great deal of information tracking in some form of note-taking, so students who are completely blind will benefit greatly from the use of manipulatives that can be placed in an organization board with clear tactile domains or areas. Students who are blind will also benefit from direct instruction using a Perkins Brailler and tactile Punnett square paper for note-taking, in addition to using a tactile manipulative model.

Additionally, when students are ready for 4x4 Punnett squares, it will almost certainly be imperative to work one-on-one with students who are blind initially to help them distribute the alleles for the traits from each parent into pairs, then show the student how to combine the father's alleles with the mother's in each box either using the tactile model or the tactile Braille paper Punnett squares.

Clarifications regarding misconceptions:

There are only a few Mendelian traits that humans inherit from their parents, while most traits are controlled by multiple genes or have multiple alleles for incomplete dominance, etc. The bell ringer questions proposed here are meant strictly to get students thinking about physical traits that they have that other people do or do not that they inherited from their parents. While teaching this lesson, it is important to clarify that, usually, a specific heritable trait in humans cannot be simplified into a Dominant and a Recessive version of the trait (I.E., eye color is not controlled by just one gene, but wet or dry earwax *is*).

Bell Ringer/Introductory Activity:

Example Questions:

1. What is your eye color? What about the eye color of your parents?
2. Are you tall or short? What about your parents? Siblings?
3. Do you have attached or detached earlobes?

Discussion Day 1:

1. Talk about what a heritable trait is: a feature of an organism that is controlled by its genetics, inherited from the organism's parents.
2. Discuss Mendelian traits and Mendelian inheritance patterns (reference back to lesson about Gregor Mendel and his pea plants). A Mendelian trait is a trait controlled by a single gene. Each gene (regardless of whether it is Mendelian or not) comes in a pair of copies or versions, one inherited from each parent, and these versions of a gene are called "alleles".
3. Dominant alleles are always expressed when present in the genetic code of an organism. Recessive alleles may be present in the genetic code, but will not be expressed when a recessive allele is paired with a dominant allele for a particular gene. A recessive allele only codes when it is paired with another recessive allele for the gene.
4. Discuss definitions of Genotypes and Phenotypes.

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5. Three possible allele combination types: homozygous dominant, homozygous recessive, heterozygous. (explain “homozygous” and “heterozygous.”)
6. Choose an example of a trait (can be a simplification of a non-Mendelian trait if that will help make a connection with the students). Work through two or three simple examples of how that trait can be inherited from parents to offspring in a 2x2 Punnett square. In each example, break down the individual steps for determining the possible inheritance patterns and their probabilities of occurrence.

Activity Day 1:

1. Have students work through additional examples of 2x2 Punnett squares, assisting as needed for setting up written or modeled squares using the tactiles manipulatives.

Discussion Day 2:

1. Review 2x2 Punnett squares briefly.
2. Introduce 4x4 Punnett squares for determining the inheritance pattern of 2 traits at the same time.
3. Show students how to group pairs of alleles from one parent so that all possible combinations of a single allele for both traits is represented on the Punnett square.
    a. Example: Father’s trait combination for wet earwax and earlobe shape are represented by **WwSs** (heterozygous wet earwax and heterozygous free hanging earlobes). The possible combinations the father could pass on to offspring would be: **WS**, **Ws**, **wS**, and **ws**.
    b. The gene combinations to be passed down can be determined using the same algorithm as used to distribute factors in mathematics, FOIL (first, outer, inner, last): First letter for each trait, outer two letters, inner two letters, last letter for each trait. This is where careful note-taking for students who are blind will become extremely important, as they will not be able to visually access the information.
4. Demonstrate how a 4x4 Punnett square can be filled out using a print model and a tactile representation. Afterward, determine the probabilities out of 16 combinations for different possible genotypes and phenotypes.

Activity Day 2:

1. Have students work through practice problems of 4x4 Punnett squares, assisting as needed for setting up written or modeled squares using the tactile manipulatives. Again, determining the parents’ possible donatable combinations is sometimes the most difficult part for students who are blind, so triage assistance as needed.

Review:

1. Go over one or two of the practice problems that the students have worked on and make sure the students are correctly filling out the Punnett square and determining the probabilities for each possible outcome for offspring.

Exit Slip:

1. What does Homozygous mean? Heterozygous?
2. If a mother and father are expecting a child, and the mother is heterozygous for a widow’s peak while the father is homozygous recessive for no widow’s peak, what are the possible genotypes and phenotypes that the child might have for this trait (include probabilities)?

Materials / Equipment:

STEIL Tactile Punnett Square 3D model manipulatives

Perkins Brailler

Tactile Punnett Square Braille paper

Monohybrid cross practice problems

Dihybrid cross practice problems

NGSS Alignment:

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HS-LS3-3 - Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. [Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.] [*Assessment Boundary: Assessment does not include Hardy-Weinberg calculations.*]

Take Home Tasks:

Assign practice problems as appropriate for students to improve mastery.