MENDELIAN GENETICS

SSS: SC.H.1.4.2, SC.F.2.4.1, SC.F.2.4.2, SC.F.2.4.3

INTRODUCTION

Mendelian genetics so named after the Austrian monk and naturalist Gregor Mendel is the basis of all genetic research and discoveries. Though Mendel knew nothing of DNA, chromosomes, mitosis, or meiosis, he was able to show that something was going on inside the "black box" of genetics. Mendel's discoveries set the foundation for understanding inheritance patterns of single genes and ultimately a better understanding of multifactorial inheritance patterns commonly studied in Biotechnology.

STUDENT LEARNING OBJECTIVES

1. Students will be able to solve a monohybrid cross
2. Students will be able to develop and solve their own dihybrid cross

MATERIALS

Teaching Aids

Lecture Presentation: **Mendelian Genetics** (PowerPoint)
Plastic cups for Monohybrid cross demonstration
Handouts

- Mendelian Genetics WS1 - Monohybrid Cross
- Mendelian Genetics WS2 - Dihybrid Cross

PROCEDURES

Agenda

- Quick Write: Who is Mendel and why is he famous?
- Form groups and complete WS2+WS3
- Tomorrow's Topic: Chromosomes and Inheritance

Lecture

Introduction (5 min): Students pull out a sheet of paper and write about Gregor Mendel. Not all students will have heard of Mendel, and fewer will remember anything about his accomplishments. Students should be made aware that his discoveries set the stage for scientist to unravel the mysteries of pedigrees, and genetic.

Hook (5 min): Students often ask why Mendelian genetics is so important. After all, wasn't Mendel just counting pea plants, and since he didn't know anything about DNA or chromosomes wasn't he just wasting time. To answer the first question, tell the story about the Amish families and how this tragedy might have been avoided had someone used simple Mendelian genetics.

> **[***In 2004, researchers discovered a gene that causes a form of sudden infant death syndrome (SIDS) that had caused the death of 21 infants from nine Amish families in central Pennsylvania. The gene in question was found to be "recessive," one that in its normal form actually helps regulate fetal development. The point is that even a simple monohybrid cross such as the one Mendel used for his pea*

experiments would have revealed the "deadly" genes expected path into the future generations of the Amish].

To answer the second question "wasn't he just wasting his time," explain to the students that some of the greatest discoveries in science came from solving the "black box" problems. It's usually the stuff we can't see that leads to the greatest discoveries.

Body

Part 1 (10 min)**:** Using the PowerPoint presentation as a guide, talk about Mendel and his pea plant experiments, rules of probability, and the Punnett Square.

Cups Demonstration (10 min)**:** Ask students to define the bold-faced words as you encounter them during this demonstration. The cups are used to demonstrate the mechanics of a **Monohybrid cross**. Explain that you must first cross the **Parental Generation (P)** as occurs during **fertilization** of sperm and egg.

(1) Stack six tall cloudy cups (dominant female) and six small clear cups (recessive male) side by side on the counter. Explain that each stack of cups represents a parent and for simplicity each parent has a single **chromosome** containing a single **gene** for body size.

(2) Now separate each stack into two groups of three cups. Explain that one group represents the paternal chromosome 1 and the other represents the maternal chromosome 1. The gene for body size is found on both maternal and paternal chromosome 1 and the **alleles** are said to be **homozygous.**

(3) Each stack of three cups should be arranged to construct the **Punnett Square** with the **dominant** alleles on the top and the **recessive** alleles on the side.

(4) To simulate fertilization, combine (stack) one cup from top row and one cup from side row, place cups inside the Punnet Square. Repeat this process until all four squares have been filled. Cups can be combined in several ways, but I suggest following the conventional pattern of 0:0, 1:0, 0:1, 1:1. Where in "a:b " a = cup from top row; b = cup from bottom row.

(5) The four groups of cups represent the **First Filial Generation (F1)** offspring and each are said to be **heterozygous** since each contains two alleles for body size (one small and one large). F1 offspring share identical **phenotypes** and **genotypes**. Push the cups aside for now.

Part 2 (2 min)**:** Return to the PowerPoint presentation and show the illustration of the monohybrid cross.

Cups (3 min)**:** Return to the cups. Explain that you will be crossing two F1 offspring and ask the students, "How does this relate to the Amish story, and how was this problem avoided in the parental cross." [Here we're crossing siblings, so if any recessive genetic disorder is present in their genotype it will have a 25% chance of being expressed.

(6) Each F1 offspring is now considered a parent. Build the Punnet Square as you did before, except this time each parent has a dominant group and a

recessive group of three cups. The four groups of cups represent the **Second Filial Generation (F2)** offspring, except this time phenotypes following a **3:1** ratio and genotypes following a **1:2:1** ratio.

Part 3 (10 min)**:** Each student will get a copy of the Mendelian Genetics WS1 (Monohybrid Cross) to solve and put in their journals. Students should follow instructions on the worksheet for building the monohybrid cross and completing the Punnett Squares.

Part 4 (10 min)**:** Return to PowerPoint presentation and discuss Mendel's first law, the **Law of Segregation**. Ask the students, "What's a law, and why isn't it called the theory of segregation?" Discuss Mendel's second law, the **Law of Independent Assortment** and using a **Dihybrid** cross. Finally, there are patterns of inheritance that Mendel didn't know about, such as, **incomplete dominance** and **codominance**.

Wrap-up (10 min) Return to powerpoint and review major points. Discuss the purpose of Exercise 1 and what students need to do.

Exercise 1. Develop and solve a dihybrid cross.

Students will form groups of two or three. Each group will get a copy of the Mendelian Genetics WS2.

Part 1 (5 min)**:** Develop the dihybrid cross. Each group should work together to decide on the organism they will breed, a single physical feature of that organism, two characteristics of that feature, the dominant and recessive forms of each characteristic, and symbols for each of those forms.

Part 2 (15 min)**:** Solve the dihybrid cross. Students will use the information from part 1 to solve a dihybrid cross between two heterozygous individuals.

ASSESSMENT

Objective 1: Using WS1, students will solve a monohybrid cross and use the two Punnett Squares to determine the results of crossing two homozygous individuals and two heterozygous individuals.

Objective 2: Using WS2, students will work together in groups to decide on the organism, feature, genes, alleles, and symbols to use to develop and solve a dihybrid cross and complete a Punnett Square.

REFERENCES

Athro Limited

http://www.athro.com/evo/gen/punnett.html