Population Genetics: Genetic Drift, Natural Selection, and Mutation.

Courtney Cage and Jeff Larson
Grade: 6th – 8th

Interdisciplinary

OBJECTIVE, BACKGROUND INFORMATION, & REFERENCES

The scientific objective of this lesson is to provide students with a basic understanding of population genetics including genetic drift, natural selection, and mutation.

An understanding of mitosis, meiosis, Mendelian genetics, and Punett squares is necessary. The students must also have working knowledge for terms such as heterozygous, homozygous, recessive trait, dominant trait, allele, chromosome, DNA, progeny, phenotype, and genotype.

References: http://en.wikipedia.org/wiki/Population_genetics; http://www.millerandlevine.com/km/evol/Moths/moths.html; http://www.intute.ac.uk/biologicalsciences/.

VOCABULARY, MATERIALS, PREPARATION, SAFETY

Vocabulary: Mitosis: The identical division of a parent cell into two daughter cells. Meiosis: The creation of four haploid non-identical daughter cells from a single diploid parental cell. Meiosis results in the creation of gamete cells. Heterozygous: Two alleles for the same gene are different. Homozygous: Two alleles for the same gene are the same. Recessive allele: the allele for a specific trait produces little or no phenotypic effect when occurring with a dominant allele. Dominant allele: An allele that expresses its phenotypic effect when paired with a recessive allele. Allele: an alternative form of a gene. Diploid organisms have 2 alleles for a given gene. Chromosome: An organized structure of DNA and protein found within cells. DNA: Deoxyribonucleic acid, this is the hereditary material in most living things. Progeny: the offspring that results from a genetic cross. Phenotype: The observable characteristic or trait of an organism. Genotype: The specific allele make-up of an organism.

Materials: The lesson plan will utilize glass jars, marbles, miniature white boards and a 4-faced dice.

Students will already be familiar with basic genetic terms and background information. During the integrative mathematical portion of the lesson, students will gain an understanding of probability, ratios, and percentages.

This lesson plan does not pose any risk to the students. General safety rules will be followed.

5 E'S

Describe how each of the 5 E's will be accomplished:

[Engage]

Start with a quick mention of the goal of the lesson: The goal of this lesson is to demonstrate population genetics with and without stressors.

Each table will receive 2 jars. One is full of ½ red and ½ blue marbles. The students will perform a random selection of marbles to obtain 2nd generation progeny. These marbles will be placed into the second jar. The students will be asked to observe the F1 generation and asked if the F1 generation is the same as the P generation. The concept of genetic drift will be discussed.

Next, the marbles will all go back to the first jar. A new F1 generation will be created by selecting for blue marbles only, not red. This simulates what happens when a specific trait is solely selected for, as often happens in breeding situations. Once complete, the students will be asked to compare this selected F1 generation with the P generation. Also, does this look the same as the randomly selected F1 generation? Loss of genetic variation will be discussed regarding the selected F1 generation, along with an introduction to inbreeding.

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[Explore]

Now that the students have had a visual aid to understand genetic drift and loss of genetic variation, the idea of pedigrees and inbreeding will be explored. The students will be presented with a genetic pedigree that exemplifies inbreeding and loss of genetic variation. Specifically, inbreeding in canines will be utilized, and a pedigree that demonstrates increasing percentages of hip dysplasia in inbred dogs will be shown. Once they understand how a pedigree works, they will be introduced to an example of "The sire and 3 dames" pedigree. In this example, the 3 dames will have different alleles, while the sire remains the same. The students will generate an F1 and F2 progeny, and they will determine the ratio of dogs with and without hip dysplasia. Once complete, they will find that the ratio of hip dysplasia increases with each generation of inbred progeny.

[Explain]

A short discussion of genetic drift and loss of genetic variation will take place. Then, there will be an introduction to natural selection.

[Elaborate]

Elaboration of their knowledge will be accomplished by asking the students to incorporate a natural selector into the creation of their F1 progeny. In this example, the blue marbles will be selected against using a 4-faced dice. Thus, whenever a blue marble is selected, the students will throw the 4-faced dice to see if that marble will "live" to reproduce. If the dice lands on 1, then the marble will not be added to the F1 progeny. However, if the dice lands on 2, 3, or 4, then the marble will survive to reproduce. In this example, the blue marble has a 75% chance of survival. Again, the students will be asked to compare these findings with those they previously found when looking at genetic drift and loss of genetic variation. Other questions that may be asked include: What happens to the 2^{nd} generation population, how many red compared to blue marbles are there, and what will the F2 generation look like? A discussion of the peppered moth will be included to provide a real-world example of natural selection during the industrial revolution.

[Evaluate]

During this portion, another explanatory segment will take place to clarify what mutations are. Then, in order to evaluate the students learning, the students will be asked to evaluate what would happen if one blue marble mutated to become more reproductively successful than the red marbles. What would eventually happen to the population of marbles?