Lesson Outline for Teaching

Lesson 1: Mendel and His Peas

A. Early Ideas about Heredity

1. Heredity is the passing of traits from parents to offspring.
2. In the 1850s, Gregor Mendel, an Austrian monk, performed experiments that helped answer questions about how traits are inherited.
3. Genetics is the study of how traits pass from parents to offspring.

B. Mendel's Experimental Methods

1. Pea plants were ideal for genetic studies because they reproduce quickly; they have easily observed traits; and the experimenter can control which pairs of plants reproduce.
2. Mendel controlled which plants pollinated other plants.
   a. When a(n) true-breeding plant self-pollinates, it always produces offspring with traits that match the parent.
   b. By cross-pollinating plants himself, Mendel was able to select which plants pollinated other plants.
3. With each cross-pollination Mendel did, he recorded the traits that appeared in the offspring.

C. Mendel's Results

1. Mendel's crosses between true-breeding plants with purple flowers produced plants with only purple flowers. Crosses between true-breeding plants with white flowers produced plants with only white flowers.
2. Crosses between true-breeding plants with purple flowers and true-breeding plants with white flowers produced plants with only purple flowers.
3. The first–generation purple-flowering plants are called hybrid plants.
4. When Mendel cross-pollinated two hybrid plants, the trait that had disappeared in the first generation always reappeared in the second generation.
5. Mendel analyzed the data from many experiments on seven different traits. He always noted a 3:1 ratio; for example, purple flowers grew from hybrid crosses three times more often than white flowers.

D. Mendel's Conclusions

1. After analyzing the results of his experiments, Mendel concluded that two factors control each trait.
2. Mendel also proposed that, when organisms reproduce, each reproductive cell—sperm or egg—contributes one factor for each trait.
3. A genetic factor that blocks another genetic factor is dominant.

4. A genetic factor that is blocked by the presence of a dominant factor is called recessive.

5. For the second generation, Mendel cross-pollinated two hybrids with purple flowers. About 75 percent of the second-generation plants had purple flowers. These plants had at least one dominant factor. Twenty-five percent of the second-generation plants had white flowers. These plants had the same two recessive factors.

Discussion Question

What is the difference between self-pollination and cross-pollination?

Self-pollination occurs when pollen from one plant lands on the pistil of a flower on the same plant. Cross-pollination occurs when pollen from one plant reaches the pistil of a flower on a different plant.

Lesson Outline for Teaching

Lesson 2: Understanding Inheritance

A. What controls traits?

1. Inside each cell is a nucleus that contains threadlike structures called chromosomes.
2. Mendel's factors are parts of chromosomes, and each cell in offspring contains chromosomes from both parents.
3. A(n) gene is a section on a chromosome that has genetic information for one trait.
4. The different forms of a gene are called alleles.
5. Geneticists refer to how a trait appears, or is expressed, as the trait's phenotype.
6. The two alleles that control the phenotype of a trait are called the trait's genotype.
   a. In genetics, uppercase letters represent dominant alleles, and lowercase letters represent recessive alleles.
   b. When two alleles of a gene are the same, its genotype is homozygous.
   c. If two alleles of a gene are different, its genotype is heterozygous.

B. Modeling Inheritance

1. In a situation based on chance, such as flipping a coin, the chance of getting an outcome can be represented by a(n) ratio such as 50:50, or 1:1.
2. A(n) Punnett square is a model that is used to predict possible genotypes and phenotypes of offspring.
   a. To create a Punnett square, you need to know the genotype of both parents.
   b. If you count large numbers of offspring from a particular cross, the overall ratio will be close to the ratio predicted by a Punnett square.
3. A(n) pedigree is a diagram that shows phenotypes of genetically related family members. It also gives clues about their genotypes.

C. Complex Patterns of Inheritance

1. Alleles show incomplete dominance when the offspring's phenotype is a blend of the parents' phenotypes.
2. Alleles show codominance when both alleles can be observed in a phenotype.
3. Unlike the genes in Mendel's pea plants, some genes have multiple alleles.
4. ABO blood type is a trait that is determined by multiple alleles.
5. Polygenic inheritance occurs when multiple genes determine the phenotype of a trait.
6. Human eye color is an example of polygenic inheritance.

Lesson Outline continued

D. Genes and the Environment

1. Genes are not the only factors that can affect phenotypes. An organism's environment can also affect its phenotype.
2. The flower color of one type of hydrangea is determined by the soil in which the hydrangea grows.
3. Healthy choices can affect a person's phenotype.

Discussion Question

How can environment affect an organism's phenotype; for example, flower color in hydrangeas?

The soil in which the hydrangea grows affects the flower color. Acidic soil produces blue flowers; basic, or alkaline, soil produces pink flowers.

Lesson Outline for Teaching

Lesson 3: DNA and Genetics

A. The Structure of DNA

1. Genes provide directions for a cell to assemble molecules that express traits such as eye color or seed shape.
2. Chromosomes are made of proteins and deoxyribonucleic acid, or DNA, which is an organism's genetic material.
3. Strands of DNA in a chromosome are tightly coiled like a telephone cord.
4. The work of several scientists revealed that DNA is shaped like a twisted ladder, or a(n) double helix.
5. DNA is made of nucleotides, which are molecules made of a nitrogen base, a sugar, and a phosphate group.
6. There are four nitrogen bases—adenine (A), cytosine (C), thymine (T), and guanine (G).
7. Replication copies a DNA molecule to make another DNA molecule. It produces two identical strands of DNA.

B. Making Proteins

1. The DNA of each cell carries a complete set of genes that provides instructions for making all the proteins a cell requires.
2. Segments of DNA that are not parts of genes are often called junk DNA.
3. Ribonucleic acid, or RNA, is a type of nucleic acid that carries the code for making proteins from the nucleus to the cytoplasm.
   a. Like DNA, RNA is made of nucleotides.
   b. Unlike DNA, RNA is single-stranded and has the sugar ribose. It has the nitrogenous base uracil instead of thymine.
4. The process of making mRNA from DNA is transcription.
5. The three types of RNA are transfer RNA, ribosomal RNA, and messenger RNA.
6. The process of making a protein from RNA is called translation.
7. The order of the nitrogen bases in mRNA determines the order of the amino acids in a protein.
8. Each series of three nitrogen bases on mRNA is called a(n) codon.
   a. Most codons code for amino acids.
   b. One of the codons codes for an amino acid that is at the beginning of a protein. This codon signals that translation should start. Three of the codons do not code for any amino acid. Instead, they code for the end of the protein.

C. Mutations

1. A change in the nucleotide sequence of a gene is a(n) mutation.
2. Mutations can be triggered by exposure to X-rays, ultraviolet light, radioactive materials, and some kinds of chemicals.
3. Types of DNA mutations include deletion mutations, insertion mutations, and substitution mutations.
4. Each type of mutation changes the sequence of nitrogen base pairs, which can cause a gene to code for a different protein than a normal gene.
5. Because mutations can change proteins, they can change traits.
6. Mutations can have negative effects, positive effects, or no effect on traits.

Discussion Question

How is RNA different from DNA?

RNA has a single strand, whereas DNA has two strands. RNA has the nitrogen base uracil instead of thymine and the sugar ribose instead of deoxyribose.