Genetics

Module B, Anchor 3

Key Concepts:

- An individual's characteristics are determines by factors that are passed from one parental generation to the next.
- During gamete formation, the alleles for each gene segregate from each other so that each gamete carries only one allele for each gene.
- Punnett squares use mathematical probability to help predict the genotype and phenotype combinations in genetic crosses.
- The principle of independent assortment states that genes for different traits can segregate independently during the formation of gametes.
- Mendel's principles of heredity, observed through patterns of inheritance, form the basis of modern genetics.
- Some alleles are neither dominant nor recessive. Many genes exist in several different forms and are therefore said to have multiple alleles. Many traits are produced by the interaction of several genes.
- Environmental conditions can affect gene expression and influence genetically determined traits.
- The DNA that makes up genes must be capable of storing, copying, and transmitting the genetic information in a cell.
- DNA is a nucleic acid made up of nucleotides joined into long strands or chains by covalent bonds.
- DNA polymerase is an enzyme that joins individual nucleotides to produce a new strand of DNA.
- Replication in most prokaryotic cells starts from a single point and proceeds in both directions until the entire chromosome is copied.
- In eukaryotic cells, replication may begin at dozens or even hundreds of places on the DNA molecule, proceeding in both directions until each chromosome is completely copied.
- The main differences between DNA and RNA are that (1) the sugar in RNA is ribose instead of deoxyribose; (2) RNA is generally single-stranded, not double-stranded; and (3) RNA contains uracil in place of thymine.
- In transcription, segments of DNA serve as templates to produce complementary RNA molecules.
- The genetic code is read three "letters" at a time, so that each "word" is three bases long and corresponds to a single amino acid.
- Ribosomes use the sequences of RNA codons to assemble amino acids into polypeptide chains.
- The central dogma of molecular biology is that information is transferred from DNA to RNA to protein.
- Mutations are heritable changes in genetic information.
- The effects of mutations on genes vary widely. Some have little or no effect; some produce beneficial variations. Some negatively disrupt gene function.
- Mutations often produce proteins with new or altered functions that can be useful to organisms in different or changing environments.

- Human genes follow the same Mendelian patterns of inheritance as the genes of other organisms. Many human traits follow a pattern of simple dominance. The alleles of other human genes display codominant inheritance. Because the X and Y chromosomes determine sex, the genes located on them show a pattern of inheritance called sex-linkage.
- Changes in a gene's DNA sequence can change proteins by altering their amino acid sequences, which may directly affect one's phenotype.
- If nondisjunction occurs during meiosis, gametes with an abnormal number of chromosomes may result, leading to a disorder of chromosome numbers.
- Recombinant DNA technology – joining together DNA from 2 or more sources – makes it possible to change the genetic composition of living organisms.
- Transgenic organisms can be produced by the insertion of recombinant DNA into the genome of a host organism.
- Ideally, genetic modification could lead to better, less expensive, and more nutrition food as well as less harmful manufacturing processes.
- Recombinant DNA technology is advancing the prevention and treatment of disease.
- DNA fingerprinting analyzes sections of DNA that vary widely from one individual to another.

Vocabulary:

Genetics	fertilization	allele	principle of dominance
Trait	segregation	hybrid	gene
Gamete	probability	genotype	phenotype
Homozygous	heterozygous	codominance	independent assortment
Multiple allele	polygenic trait	base pairing	Incomplete dominance
Replication	DNA polymerase	nucleotides	nucleic acid
RNA	messenger RNA	ribosomal RNA	RNA polymerase
Transfer RNA	transcription	polypeptide	genetic code
Codon	anticodon	translation	gene expression
Biotechnology	PCR	genetic marker	transgenic
Recombinant DNA	clone	plasmid	gene therapy
DNA fingerprinting	genome	autosome	sex-linked gene
Sex chromosome	nondisjunction		

Basic Mendelian Genetics:

1. Different forms of a gene are called:
   - A. hybrids
   - B. dominant factors
   - C. alleles
   - D. recessive factors

2. Organisms that have two identical alleles for a particular trait are said to be:
   - A. hybrid
   - B. heterozygous
   - C. homozygous
   - D. dominant

3. What is the difference between a dominant and recessive allele?

4. State the principle of dominance. How does this explain the phenotype of heterozygous organisms?

According to this principle, under what conditions will an organism show a recessive phenotype?

5. State the principle of segregation. How does this explain how two heterozygous organisms can produce homozygous offspring?

6. State the principle of independent assortment.

7. What is a punnett square? How are punnett squares used in genetics?

8. Show the cross between two guinea pigs. One is heterozygous for black color, the other is white. Record the genotypic and phenotypic ratios of the offspring.

Other Patterns of Inheritance:

1. Compare and contrast codominance, incomplete dominance, and complete dominance.

2. Compare and contrast multiple alleles and polygenic traits.

3. Why do multiple alleles and polygenic traits produce many different phenotypes for a trait?

4. Can a trait show more than one inheritance pattern?

5. You would like to determine if a plant shows codominance or incomplete dominance. What type of cross would you perform and why? Explain how you would know whether the gene involved showed co- or incomplete dominance.

6. What is the relationship between genes and the environment?

DNA Structure:

1. Thoroughly describe the structure of a DNA molecule.

2. What are the base pairing rules? If the percentage of adenine in a sample goes up 5 %, what will happen to the percentage of thymine? What will happen to the percentage of guanine?

3. What are the three roles of DNA? Explain how the structure of DNA aids in each role.

4. What happens when a piece of DNA is missing?
    A. Genetic information is stored
    B. Genetic information is transmitted
    C. Genetic information is lost
    D. Genetic information is copied

DNA Replication:

1. Thoroughly describe the process of DNA replication.

2. Compare and contrast DNA replication in prokaryotes and eukaryotes.

3. What is base pairing and how is it involved in DNA replication?

4. When a DNA molecule is replicated, how do the new molecules compare to the original molecule? How does replication ensure that this occurs?

Transcription:

1. Thoroughly describe the process of transcription.

2. What is made during transcription?

3. Why is transcription necessary for protein synthesis?

4. Suppose you start with a DNA strand ACCGTCACG. Use the rules of base pairing to determine the complementary RNA strand.

5. Compare and contrast DNA and RNA structure. How does the different structure of RNA relate to its different function in cells?

6. Compare and contrast DNA replication and transcription.

7. Describe the process of RNA editing.

Protein Synthesis:

1. List the three types of RNA. Describe the role of each in protein synthesis.

2. What is made during protein synthesis?

3. What are codons and anticodons? How do they work together during protein synthesis?

4. Thoroughly describe the process of protein synthesis.

5. Explain why controlling the proteins in an organism controls the organism's characteristics.

6. What is the correct sequence of transfer of genetic information in most organisms?
    A. RNA, DNA, protein
    B. DNA, RNA protein
    C. protein, DNA, RNA
    D. RNA, protein, DNA

7. What are the roles of endoplasmic reticulum and ribosomes in protein synthesis?

8. Does protein synthesis occur in all organisms?

Mutation:

1. What is a mutation?

2. What are some causes of mutation?

3. List and describe the types of gene mutations.

4. What types of gene mutations are most severe? Why?

5. List and describe the types of chromosome mutations.

6. How does the repetitive nature of the genetic code help to reduce the damage done by mutations?

7. One difference between a gene mutation and a chromosomal mutation is
   A. A gene mutation affects the DNA of more genes than a chromosomal mutation.
   B. A gene mutation can involve as insertion or deletion, but cannot involve a frameshift
   C. A chromosomal mutation can affect the number of chromosomes in a cell
   D. A chromosomal mutation is more likely to be passed on to offspring or daughter cells

8. Most mutations
   A. have no effect on the organism
   B. are beneficial
   C. are harmful
   D. are fatal

Human Heredity:

1. A normal human zygote contains
   A. 23 chromosomes
   B. 46 chromosomes
   C. 44 chromosomes
   D. XYY chromosomes

2. What is a nondisjunction? How does a nondisjunction cause chromosome disorders?

3. What is the difference between autosomes and sex chromosomes?

4. What are sex-linked traits? How are they inherited differently between males and females?

5. Which of the following forms a Barr body:
    A. one of the Y chromosomes in a male cell
    B. one of the X chromosomes in a male cell
    C. one of the X chromosomes in a female cell
    D. both of the X chromosomes in a female cell

Genetic Engineering:

1. Organisms that contain genes from other organisms are called
    A. transgenic
    B. mutagenic
    C. donors
    D. clones

2. Describe what happens during a polymerase chain reaction. What is the use of PCR?

3. Explain what genetic markers are and describe how scientists use them.

4. What are transgenic organisms? What are the potential benefits of transgenic organisms? Concerns?

5. How can genetic engineering impact human health?

6. Describe the uses of DNA fingerprinting.

7. A gene that makes it possible to distinguish a bacterium that has been transformed from one that has not is:

A. a resistance gene
B. an antibiotic
C. a genetic marker
D. a clone

8. Explain what a DNA probe is and describe how it could be used to identify a person who has an allele for a genetic disorder.