# CHAPTER 12-17 PACKET O'FUN

## CHAPTER 12

1. What is the overall purpose of mitosis?

2. In what types of organism(s) does mitosis occur? What type of cell division occurs in bacteria?

3. How many cells are produced at the end of a single mitotic division?

4. How many different kinds of cells are produced at the end of a single mitotic division?

5. Six centromeres are observed in a prophase cell from another species of insect.

| | | |
|---|---|---|
| a. How many pairs of chromosomes does this organism contain? | | |
| b. For each stage of mitosis, indicate the number of centromeres you would expect to find and the number of copies of chromosomes attached to each centromere. | | |
| Stage of Mitosis | Number of centromeres visible | Number of chromosome copies attached to each centromere |
| Prophase | | |
| Anaphase | | |

6. Checkpoints in the normal cell cycle prevent cells from going through division if problems occur – for example, if the DNA is damaged.
   a. What forms do the checkpoints take? That is, how do they control whether or not cell division occurs?

   b. Cancer results from uncontrolled cell division. Explain how mutations in one or more of the checkpoints might lead to cancer.

**CHAPTER 13**

1. What is the overall purpose of meiosis?

2. In what types of organism(s) does meiosis occur?

3. Consider a single cell going through meiosis?
   a. How many cells are produced at the end of meiosis?
   b. How many chromosomes and which chromosomes does each of the daughter cells contain?

4. Six centromeres are observed in a prophase I cell from another species of insect.

| | | |
|---|---|---|
| a. How many pairs of chromosomes does this organism contain? | | |
| b. For each stage of meiosis, indicate the number of centromeres you would expect to find and the number of copies of chromosomes attached to each centromere. | | |
| Stage of meiosis | Number of centromeres visible | Number of chromosome copies attached to each centromere |
| Anaphase I | | |
| Prophase II | | |

5. What events occur during each phase of mitosis and meiosis?

| | Interphase | Prophase | Metaphase | Anaphase | Telophase & cytokinesis |
|---|---|---|---|---|---|
| Mitosis | For example:<br>*G1 – cell growth*<br>*S – DNA duplication*<br>*G2 – cell growth* | | For example:<br>*Duplicated chromosomes, each with two sister chromatids, line up independently on the metaphase plate* | | |
| Meiosis I | | | | | |

| Meiosis II | | | | | |
|---|---|---|---|---|---|

6. If the amount of DNA in a somatic cell equals X during G1 of interphase, how much DNA is present in the cell during each of the phases of mitosis and meiosis?

| *Amount of DNA in:* | Interphase | Prophase | Metaphase | Anaphase | Telophase |
|---|---|---|---|---|---|
| Mitosis | | | | | |
| Meiosis I | | | | | |
| Meiosis II | | | | | |

**CHAPTER 14**

1. Match each commonly used genetics term with its appropriate definition or example:

TERMS:

______ heterozygous

______ homozygous

______ monohybrid cross

______ autosomal

______ genotype

______ phenotype

______ gene

______ allele

______ dihybrid cross

DEFINITIONS AND EXAMPLES:

a. Blue-eyed blonde mates with brown-eyed brunette

b. BB or bb

c. not on sex chromosome

d. blue or brown eyes

e. Bb

f. locus on a chromosome that codes for a given polypeptide

g. Blonde mates with brunette

h. BB, Bb or bb

i. Males have only one for each gene on the X

2. Your individual is male/female (choose one). Females are XX and males are XY. For simplicity, assume that the individual is diploid with 2n = 6, including the sex chromosomes. On one pair of autosomes (the nonsex chromosomes), the individual is heterozygous for hair color (B = brown and dominant, b = blonde and recessive). On another pair of autosomes, the organism is heterozygous for hair structure (C = curly and dominant, c = straight and recessive). Assume further that the individual's mother was homozygous dominant for both traits and the father was homozygous recessive for both.
   a. Is your individual's hair curly or straight? Brown or black?

   b. What did the individual's mother's hair look like? What did the father's hair look like?

   c. What chromosomes and alleles were in the egg and the sperm that gave rise to your individual?

3. From a single sex cell going through meiosis, how many daughter cells are produced?

4. How many different kinds of gametes are produced from a single cell undergoing meiosis? (Assume no crossing over occurs.)

5. Your individual is heterozygous for two genes on separate pairs of homologous chromosomes. His/her genotype is CcBb. Given this information alone, how many different kinds of gametes could this individual produce? (Again assume no crossing over occurs.)

6. Compare your answer to question 5 with your answer to question 4. How do the numbers of different kinds of gametes in your answers compare? Explain any difference.

7. What aspect(s) of meiosis account(s) for Mendel's law of segregations? Mendel's law of independent assortment?

8. How many different kind of gametes can individuals with each of the following genotypes produce?
   a. AA
   b. aa
   c. Aa
   d. AaBB
   e. AaBb
   f. AaBbCC
   g. AaBbCc
   h. AaBbCcDdEeFf

9. What is the general rule for determining the number of different gametes organisms like those described in question 8 can produce.

**CHAPTER 15**

1. An organism that has the genotype AaBbCc is crossed with an organism that has the genotype AABbCc. Assume all genes are on separate sets of chromosomes (that is, they are not linked).
   a. What is the probability that any of the offspring will have the genotype AABBCC?
   b. What is the probability that any of the offspring will have the genotype AaBbcc?

2. Consider the cross AaBbCcddEe x AABBccDDEe. What is the probability that any offspring will have the genotype AaBBCcDdEE?

3. In fruit flies (*Drosophilia melanogaster*) the most common eye color is red. A mutation of the gene for eye color produces white eyes. The gene is located on the X chromosome.
   a. What is the probability that a heterozygous red-eyed female fruit fly mated with a white-eyed male will produce any white-eyed offspring?

   b. What is the probability that the mating in part a will produce any white-eyed females?

   c. What is the probability that this mating will produce any white-eyed males?

4. A heterozygous brown-eyed human female who is a carrier of color blindness marries a blue-eyed male who is not color-blind. Color blindness is a sex-linked trait. Assume that eye color is an autosomal trait and that brown is dominant over blue. What is the probability that any of the offspring produced have the traits listed?
   a. Brown eyes

   b. Blue eyes

   c. Color blindness

   d. Color-blind males

   e. Brown-eyed, color-blind males

   f. Blue-eyed, color-blind females

   g. What is the probability that any of the males will be color-blind?

   h. Why do males show sex-linked traits more often than females?

5. Three new traits have been discovered in a population of Drosophilia:
    - Tapping ( a behavioral mutant in which the fly taps one foot constantly)
    - Single stripe (a pigmentation change that leads to a long stripe down the fly's back)
    - Angular (causes angular bends in bristles that are normally straight)

The positions of the three genes on the chromosomes are unknown. Given two pure breeding (homozygous) lines and using an initial cross of normal, normal, normal females with tapping, single stripe, angular males, describe the appropriate genetic experiments needed to establish whether any of these traits are caused by genes that are:

Linked on the same chromosome or unlinked

**CHAPTER 16**

1. In the early to mid-1900s, there was considerable debate about whether protein or DNA was the hereditary material. For what reasons did many researchers assume that protein was the genetic material?

2. Watson and Crick were the first to correctly describe the structure of DNA. What evidence did they use to do this? How did they use this evidence to put together or propose the structure of DNA?

3. Some researchers estimate that the mutation rate for any given gene (or its DNA) in certain strains of bacteria is about $10^{-8}$. This means that one error or mutation in a given gene is introduced for every 100-million cell divisions.
   a. What can cause mistakes in replication?

   b. How are such mistakes normally corrected?

**CHAPTER 17**

1. How does intron removal occur? Your explanation should contain definitions or descriptions of the following terms and structures:

| | |
|---|---|
| pre-mRNA | exons |
| RNA splicing | spliceosome |
| introns | |

2. If 20% of the DNA in a guinea pig cell is adenine, what percentage is cytosine? Explain your answer.

3. A number of different types of RNA exist in prokaryotic and eukaryotic cells. List the three main types of RNA involved in transcription and translation. Answer the questions to complete the chart.

| a. Types of RNA | b. Where are they produced? | c. Where and how do they function in cells? |
|---|---|---|
| | | |
| | | |
| | | |

4. Given your understanding of transcription and translation, fill in the blanks below and indicate the 5' and 3' ends of each nucleotide sequence. Again, assume no RNA processing occurs.

Nontemplate strand of DNA: 5' A T G T A T G C C A A T G C A 3'

Template strand of DNA: _' T _ _ _ _ _ _ _ _ _ _ _ _ _ _ _'

mRNA: _' A _ _ _ _ U _ _ _ _ _ _ _ _ _ _'

Anticodons on complementary Trna: _' _ _ _/ _ _ _ /_ _ _ /_ _ _/ _ _ _ _'

5. Scientists struggled to understand how four bases could code for 20 different amino acids. If one base coded for one amino acid, the cell could produce only four different kinds of amino acids ($4^1$) If two bases coded for each amino acid, there would be four possible choices (of nucleotides) for the first base and four possible choices for the second base. This would produce $4^2$ or 16 possible amino acids.
   a. What is the maximum number of *three-letter codons* that can be produced using only four different nucleotide bases in DNA?

b. How many different codons could be produced if the codons were four bases long?

6. Now that the complete genetic code has been determined, you can use the strand of DNA shown here and the codon chart in the book to answer the next questions.

Original template strand of DNA: 3' TAC GCA AGC AAT ACC GAC GAA 5'

a. If this DNA strand produces an mRNA, what is the sequence of the mRNA?

b. For what sequence of amino acids does this mRNA code? (Assume no introns.)

c. The chart lists 5 point mutations that may occur in the original strand of DNA. What happens to the amino acid sequence or protein produced as a result of each mutation? (Note: Position 1 refers to the first base at the 3' end of the transcribed strand.)

| **Mutation** | **Effect on amino acid sequence** |
|---|---|
| Substitution of T for G at position 8 | |
| Addition of T between positions 8 and 9 | |
| Substitution of T for C at position 18 | |
| Deletion of C at position 18 | |
| Which of the mutations produces the greatest change in the amino acid sequence of the polypeptide coded for by this 21 base pair gene? | |

7. Why do dentists and physicians cover patients with lead aprons when they take mouth or other X-rays?