Solution Manual for Genetics A Conceptual Approach 6th Edition by Pierce

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Chapter 2

Think-Pair-Share questions for the chapter opening story:

- In the blind men's riddle, two blind men must sort out 10 pairs of socks so that each man gets exactly five pairs of different colored socks. In the analogy, is it important that the men are blind? In a cell, what does the blindness represent?

  Possible Answers: The analogy depends on the men being blind. If they could see they could distinguish the socks by color and easily sort the socks so that each man got two socks of each color. While theoretically it might be possible for cells to evolve some mechanism by which they distinguish each pair of chromosomes and by this discrimination ensure that one chromosome of each pair ends up in a resulting cell, cells have not evolved such a mechanism. Through the process of mitosis, each chromosome replicates and the two replicated copies (analogous to the two socks of a pair) get pulled in opposite directions and end up in separate cells. The cells don't have a mechanism to see the different types of chromosomes and ensure at the end that each daughter cell gets exactly one copy of each pair—this is what the blindness represents.

Section 2.2

1. A chromosome consists of two sister chromatids. Does the genetic information on the two sister chromatids come from only one parent or from both parents? Explain your reasoning.

   Possible Answers: This questions is designed to help address the difference between sister chromatids and homologous chromosomes, a common point of confusion for many students. For the most part, the genetic information on the two sister chromosomes comes from the same parent, because the sister chromatids are produced by replication and are exact copies of the genetic information originally present on a single chromosome, which comes from one parent. However, crossing over can produce information from two different parents on the same chromosome. One chromosome of a homologous pair comes from one parent and the other homolog comes from the other parent. When crossing over takes place, information is exchanged between nonsister chromatids—chromatids from different but homologous chromosomes. So, after crossing over, the information on one chromatid may contain information from the other homolog (which comes from the other parent).

2. Are homologous pairs of chromosome present in mitosis? Explain your reasoning.

   Possible Answers: This question addresses a common misconception among students who often assume that homologous pairs of chromosomes exist in meiosis but not in mitosis. Homologous pairs of chromosomes are present in mitosis. However, they don't pair up in mitosis like they do in meiosis, and sister chromatids of each chromosome separate independently.

3. A cell has eight chromosomes in metaphase II of meiosis. How many chromosomes and DNA molecules will be present per cell in this same organism at the following stages?

   a. Prophase of mitosis

   b. Metaphase I of meiosis

   c. Anaphase of mitosis

   c. Anaphase II of meiosis

d. Anaphase I of meiosis

e. After cytokinesis that follows mitosis

f. After cytokinesis that follows meiosis II.

Possible Answers: This question requires that students think through the different steps of mitosis and meiosis and fully understand what is happening in each stage.

	Number of Chromosomes	**Number of DNA Molecules**
a. Prophase of mitosis	16	32
b. Metaphase I of meiosis	16	32
c. Anaphase of mitosis	32	32
c. Anaphase II of meiosis	16	16
d. Anaphase I of meiosis	16	32
e. After cytokinesis that follows mitosis	16	16
f. After cytokinesis that follows meiosis II	8	8

Section 2.3

4. What is the difference between sister chromatids and homologous chromosomes?

Possible Answers: Students often are confused and have misconceptions about the difference between sister chromatids and homologous chromosomes. Sister chromatids are identical copies (unless crossing over takes place) of the same original chromosome. Homologous chromosomes are different chromosomes, containing information for the same traits (homologous information) but not the same genetic information. One homolog comes from one parent; the other homolog comes from the other parent.

5. List as many similarities and differences in mitosis and meiosis as you can. Which differences do you think are most important and why?

Possible Answers:

Similarities

- Both involve chromosome and cell division.
- Both are preceded by DNA replication.
- Both use spindle fibers to separate chromosomes.
- Both have a stage where sister chromatids separate.

Differences

- Meiosis normally involves two cell divisions; mitosis usually has only a single cell division.
- Chromosome reduction occurs in meiosis but not in mitosis.
- Resulting daughter cells are genetically different in meiosis but not in mitosis.
- Crossing over occurs in meiosis but does not normally take place in mitosis.
- Random assortment of chromosomes occurs in anaphase I of meiosis but does not occur in anaphase of mitosis.
- In metaphase I of meiosis, pairs of homologous chromosomes line up; in metaphase of mitosis (and metaphase II of meiosis) individual chromosomes line up.
- In anaphase I of meiosis, homologous chromosomes separate; in anaphase of mitosis (and anaphase II of meiosis) sister chromatids separate.

6. Describe how and where each of the following terms applies to mitosis and/or meiosis: (1) replication; (2) pairing; and (3) separation.

Possible Answers:

Replication, pairing, and separation are key events that take place in mitosis and meiosis.

Replication: In mitosis and meiosis, DNA replication takes place during S phase preceding nuclear division.

Pairing: Homologous chromosomes pair up in meiosis, but no pairing of homologous chromosomes takes place in mitosis. However, the sister chromatids of each chromosome are paired in both mitosis and meiosis.

Separation: In mitosis, sister chromatids separate in anaphase. In meiosis, homologous chromosomes separate in anaphase I and sister chromatids separate in anaphase II.

7. Do you know of any genetic diseases or disorders that result from errors in mitosis or meiosis? How do errors in mitosis or meiosis bring about these diseases?

   Possible Answers: There are many chromosome abnormalities that result from errors in mitosis and/or meiosis, including Down syndrome (resulting from an extra copy of chromosome 21) and Turner syndrome (resulting from a single X chromosome). Many cancers have abnormal chromosomes that result from errors in mitosis (see Chapter 23). Errors in mitosis and/or meiosis often result in abnormal separation of chromosomes, so that cells end up with too many or too few chromosomes.