Section 16.3 Review Answers

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1. The process of meiosis produces haploid gametes from diploid parent cells as is necessary for sexual reproduction. Meiosis also contributes to genetic variation by producing many genetically different gametes. Variation in gametes results from crossing over, in which non-sister chromatids exchange chromosome sections during prophase I. Also in metaphase I, homologous chromosomes assort independently, which allows for different combinations of parental chromosomes in the gametes.

2. Meiosis occurs in spermatogonial cells in the testes in males, and in the oogonial cells in the ovaries of females.

3. At the end of meiosis II, four haploid cells have been formed from the original parent cell.

4. Assuming that no crossing over occurs, a diploid organism with four pairs of chromosomes can produce 2^4 (16) genetically distinct gametes.

5. In prophase I of meiosis, the chromosomes exchange portions of the non-sister chromatids in the process known as crossing over, as shown in the image. Crossing over is significant because it results in the production of many genetically different gametes by an organism, which contributes to genetic variation in the species.

6. (a) Nondisjunction occurs when chromosomes or chromatids do not separate and move to the poles of the cell in anaphase of meiosis I or II. This results in gametes with an extra chromosome or a missing chromosome. Crossing over is a process that occurs during prophase I of meiosis, in which chromosomes exchange of portions of non-sister chromatids.

(b) A primary oocyte is the first functional egg cell formed by mitosis from oogonial cells in the ovaries. The primary oocyte then undergoes meiosis I to produce a secondary oocyte, the second functional egg cell. The secondary oocyte fully completes meiosis II upon fertilization.

(c) Spermatids are four haploid cells formed after meiosis II in spermatogenesis. The spermatids differentiate into sperm cells by passing through a series of developmental stages. The nucleus and certain enzymes are organized into a "head" region. The midsection holds many mitochondria that provide energy for the sperm. A long tail-like flagellum provides locomotion.

(d) Oocytes are functional egg cells that are formed via mitosis and meiosis in oogenesis. During these divisions, other egg cells are formed, known as polar bodies, which have much less cytoplasm than the oocytes. This occurs because the division of the cytoplasm between the oocyte and the polar body is unequal (known as asymmetrical cytokinesis). The oocyte requires nutrients found in the cytoplasm to sustain it following fertilization and during its long journey in the Fallopian tube to the uterus, where it again receives nutrients. Polar bodies are non-functional and soon degenerate.

7. (a) metaphase (mitosis): In metaphase of mitosis, 23 pairs of homologous chromosomes occur as linked sister chromatids (92 chromatids in total). (Note: Of these 23 pairs of chromosomes, males actually have two

nonhomologous sex chromosomes, the X chromosome and the Y chromosome.)

(b) metaphase I (meiosis): In metaphase I of meiosis, twenty-three pairs of homologous chromosomes are arranged in pairs. Each homologous chromosome contains 2 linked sister chromatids, and is part of a tetrad of four chromatids.

(c) metaphase II (meiosis): In metaphase II of meiosis, each cell contains twenty-three chromosomes, one member of the earlier homologous chromosome pairs. Each chromosome consists of a pair of linked sister chromatids.

8. No, identical twins cannot be different sexes. Identical twins are born if a single zygote, during its first two weeks of embryonic development, divides into two separate bodies. Because the sex of the zygote is already determined upon fertilization, each twin must be the same sex.

9. In metaphase I of meiosis, the chromosome tetrads align at the cell equator. The feature of this alignment that contributes to genetic diversity is independent assortment.

10. A drawing or descriptive answer should reflect understanding that nondisjunction occurs in either anaphase I or anaphase II, in which an X chromosome fails to move to the pole of the cell, resulting in an oocyte or spermatid without an X chromosome.