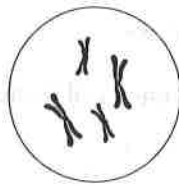


MULTIPLE-CHOICE QUESTIONS

- Which of the following does NOT occur by mitosis?
 - growth
 - production of gametes
 - repair
 - development in the embryo

The following two questions refer to the sketch below of a cell containing chromosomes.

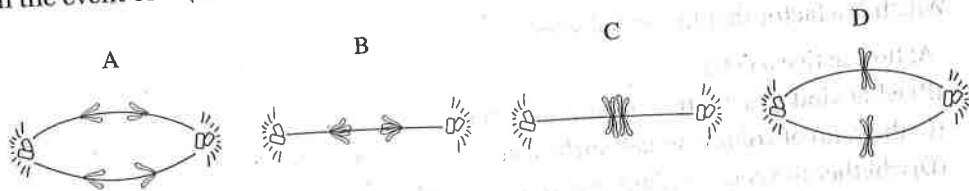


- How many chromosomes are in this cell?
 - 2
 - 4
 - 8
 - 16
- How many chromatids are in this cell?
 - 2
 - 4
 - 8
 - 16
- Which is a factor that limits cell size?
 - how active a cell is
 - what kind of activity a cell is engaged in
 - the ratio of volume to cell surface area
 - whether the cell is a plant cell or animal cell
- In which stage of the life of a cell is the nucleolus always visible?
 - anaphase
 - telophase
 - cytokinesis
 - interphase
- Which of the following cells is a giant multinucleate cell?
 - neuron
 - skeletal muscle
 - tracheids and vessels in plants
 - companion cell in plants

7. Which of the following is NOT found in plant cells?
- (A) cell plate
 - (B) actin and myosin filaments
 - (C) microtubule organizing center
 - (D) cleavage furrow
8. If a cell has 24 chromosomes at the beginning of meiosis, how many chromosomes will it have at the end of meiosis?
- (A) 6
 - (B) 12
 - (C) 24
 - (D) The number varies with the species.
9. If a cell has 24 chromosomes, how many will it have at the end of mitosis?
- (A) 6
 - (B) 12
 - (C) 24
 - (D) 48
10. All of the following are true of meiosis EXCEPT
- (A) cross-over occurs during prophase I
 - (B) there is no replication of chromosomes between meiosis I and meiosis II
 - (C) in plants, spindle fibers are attached to the centriole
 - (D) synapsis occurs during prophase I

Questions 11–13

Match the event of meiosis with the stages shown below.



11. Identify metaphase I of meiosis.
- (A) A
 - (B) B
 - (C) C
 - (D) D
12. Identify metaphase II of meiosis.
- (A) A
 - (B) B
 - (C) C
 - (D) D

13. Identify anaphase II.
- (A) A
 - (B) B
 - (C) C
 - (D) D
-
14. The synaptonemal complex forms during
- (A) anaphase I of meiosis
 - (B) prophase I of meiosis
 - (C) anaphase II of meiosis
 - (D) telophase I
15. Homologous chromosomes separate during
- (A) prophase I
 - (B) prophase II
 - (C) anaphase II
 - (D) anaphase I
16. Chiasmata are most closely related to which of the following?
- (A) crossing-over
 - (B) fertilization
 - (C) cytokinesis
 - (D) mitotic cell division
17. Which is NOT a source of genetic variation?
- (A) independent assortment of chromosomes
 - (B) cross-over
 - (C) random fertilization
 - (D) mitosis
18. Which of the following cells are permanently arrested in the G_0 phase?
- (A) bone marrow
 - (B) nerve cells
 - (C) cancer cells
 - (D) liver cells
19. Which is TRUE of the cell cycle?
- (A) The timing of cell division is controlled by cyclins and CDKs.
 - (B) A characteristic of cancer cells is density-dependent inhibition.
 - (C) The cell cycle is controlled solely by signals external to the cell.
 - (D) The cell cycle is controlled solely by internal signals.

20. A cell that passes the restriction point will most likely

- (A) stop dividing
- (B) divide
- (C) show density-dependent inhibition
- (D) die

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- (A) stop dividing
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 - (C) show density-dependent inhibition
 - (D) die

Answers to Multiple-Choice Questions

1. **(B)** The production of gametes, sperm, and eggs occurs by meiosis, where the chromosome number gets cut in half.
2. **(B)** There are 4 replicated chromosomes in this cell but 8 chromatids. The number of chromosomes is determined by the number of centromeres, 1 per chromosome.
3. **(C)** See #2.
4. **(C)** Two important factors limit cell size and promote cell division: ratio of the volume of a cell to the surface area and capacity of the nucleus.
5. **(D)** Most of the life of the cell is spent in interphase when the chromosomes are threadlike and not visible under a light microscope. When the cell divides, chromosomes must be condensed. When supercoiled or condensed, chromosomes appear like the Xs and Ys we commonly see them as. The nucleolus is not a real structure but threadlike chromosomes organized in a way that form a sphere.
6. **(B)** The skeletal muscle cell is a giant cell with many nuclei. At some time in its evolutionary history, it apparently underwent mitosis many times (which accounts for the many nuclei) without undergoing cytokinesis (which accounts for its large size).
7. **(D)** A cleavage furrow is a shallow groove in the cell surface in animal cells where cytokinesis is taking place. The cell plate is seen in dividing plant cells. The middle lamella is a layer between two adjacent plant cells.
8. **(B)** Meiosis cuts the chromosome number in half, from $2n$ to n . This occurs so that after fertilization, when two gametes fuse, the embryo will have the correct chromosome number, $2n$.
9. **(C)** The cells that result from mitotic cell division have the same number of chromosomes as the parent cell.
10. **(C)** Plants do not have centrioles, they have only microtubule organizing centers.
11. **(C)** During metaphase I of meiosis, homologous pairs line up on the metaphase plate in double file.
12. **(D)** During metaphase II of meiosis, single chromosomes line up on the metaphase plate in preparation for division. During meiosis II, sister chromatids separate.
13. **(A)** During anaphase II, sister chromatids are separating.
14. **(B)** The synaptonemal complex forms during prophase I and holds the two replicated chromosomes tightly together as a bivalent or tetrad so that crossing-over can occur without error.

15. **(D)** Homologous chromosomes separate during anaphase I of meiosis.
16. **(A)** Chiasmata are the microscopically visible regions of homologous chromatids where crossing-over has occurred.
17. **(D)** The daughter cells resulting from mitotic cell division are genetically identical to each other and to the mother cell. Sources of variation are independent assortment of chromosomes, crossover, random fertilization, and recombinant chromosomes.
18. **(B)** A cell arrested in the G_0 phase is not dividing. Most human body cells are not actively dividing. Highly specialized cells such as nerve and muscle cells never divide. Liver cells can be induced to divide when damaged, and human skin and bone marrow cells are always dividing. Also, cancer cells are always rapidly dividing.
19. **(A)** The timing of the cell cycle responds to external and internal cues and to fluctuations in levels of cyclins and cyclin-dependent kinases (CDKs). Normal cells stop dividing when crowded. This phenomenon is called contact inhibition or density-dependent inhibition. Cancer cells are characterized by uncontrolled growth.
20. **(B)** In mammalian cells, the G_1 checkpoint is known as the restriction point. If the cell receives the go-ahead signal at the G_1 checkpoint, it will usually complete the cycle and divide. In contrast, if the cell is not stimulated to pass the restriction point, it will switch into a nondividing mode known as G_0 .

FREE-RESPONSE QUESTION

Directions: Answer all questions. You must answer the question in essay—not outline—form. You may use labeled diagrams to supplement your essay, but diagrams alone are *not* sufficient. Before you start to write, read each question carefully so that you understand what the question is asking.

An organism is heterozygous at two gene loci on different chromosomes.



- a. Explain how these alleles are transmitted by the process of mitosis to daughter cells.
- b. Explain how these alleles are distributed to gametes by the process of meiosis.
- c. Explain how the behavior of these two pairs of chromosomes during meiosis provides the physical basis for two of Mendel's laws of heredity.