

Test Your Knowledge

Multiple Choice

- There are a number of differences between binary fission of a bacterium and human cell division. Which of the following is *not* one of them?
 - A bacterium has only one chromosome.
 - Human cells undergo mitosis and cytokinesis.
 - Bacteria are smaller and simpler than human cells.
 - Bacteria have to duplicate their DNA before dividing; human cells do not.
 - Human chromosomes are larger and more complex.
- You would be unlikely to see which of the following human cells dividing?
 - muscle cell
 - skin cell
 - cancer cell
 - cell from an embryo
 - intestinal lining cell
- Which of the following correctly matches a phase of the cell cycle with its description?
 - M—replication of DNA
 - S—immediately precedes cell division
 - G₂—cell division
 - G₁—immediately follows cell division
 - All of the above are correctly matched.
- Which of the following is *not* true of human somatic cells?
 - They arise by mitotic cell division.
 - They are haploid.
 - They are body cells other than eggs and sperm.
 - They are larger and more complex than bacterial cells.
 - They contain 46 chromosomes.
- In telophase of mitosis, the mitotic spindle breaks down and nuclear envelopes form. This is essentially the opposite of what happens in
 - prophase.
 - interphase.
 - metaphase.
 - S phase.
 - anaphase.
- Sister chromatids
 - cross over during prophase I of meiosis.
 - separate during the first meiotic division.
 - are produced during S phase between cell divisions.
 - cross over during prophase II of meiosis.
 - are also called homologous chromosomes.
- Which of the following is *not* a function of mitotic cell division in animals?
 - asexual reproduction
 - growth
 - repair of damaged organs
 - production of gametes
 - cell replacement
- Meiosis
 - is responsible for body growth and repair.
 - halves the number of chromosomes in cells.
 - is the process by which the body produces diploid cells.
 - follows mitosis and splits the cytoplasm in two.
 - is important in asexual reproduction.
- Crossing over is
 - important in genetic recombination.
 - what makes a cell become cancerous.
 - a key process that occurs during mitosis.
 - an important mechanism of chromosome repair.
 - what prevents cells from multiplying indefinitely in cell culture.
- Human _____ are diploid, and human _____ are haploid.
 - sex chromosomes . . . autosomes
 - autosomes . . . sex chromosomes
 - somatic cells . . . gametes
 - gametes . . . somatic cells
 - chromosomes . . . chromatids
- Which of the following does *not* lead to genetic variability?
 - random fertilization
 - crossing over during meiosis
 - division of chromosomes during anaphase of mitosis
 - orientation of chromosomes during metaphase I of meiosis
 - mutation

12. Most cells will divide if they receive the proper signal at a checkpoint in the ____ phase of the cell cycle.
 - a. M
 - b. G₁
 - c. S
 - d. G₂
 - e. cytokinesis
13. Geneticists suspect that the extra chromosome seen in Down syndrome usually comes from the egg, rather than the sperm, because
 - a. eggs are produced so rapidly that there is more chance for error.
 - b. Down syndrome is due to a dominant gene in women, a recessive gene in men.
 - c. most women inherit Down syndrome from their mothers.
 - d. eggs are produced in much larger numbers than sperm.
 - e. meiosis takes much longer in the ovary, increasing the likelihood of error.
14. Which of the following chromosomal alterations would you expect to have the most drastic consequences?
 - a. inversion
 - b. duplication
 - c. translocation
 - d. deletion
 - e. a and b are equally the most serious
15. Disorders involving unusual numbers of sex chromosomes show that "maleness" is caused by the
 - a. presence of an X chromosome.
 - b. presence of a Y chromosome.
 - c. absence of an X chromosome.
 - d. absence of a Y chromosome.
 - e. absence of an X chromosome and presence of a Y chromosome.
5. How might the genes on the sister chromatids of a certain chromosome compare with each other and with the genes on the sister chromatids of the homologous chromosome?
6. Describe three aspects of sexual reproduction that lead to the production of varied offspring.
7. Explain how an error in meiosis can cause a baby to be born with an extra or missing chromosome.
8. About one in 700 babies born in the United States possesses an extra chromosome 21, resulting in Down syndrome. Why are few individuals seen who have extra copies of other chromosomes?

Apply the Concepts

Multiple Choice

1. In certain fungi and algae, cells undergo mitosis repeatedly without subsequently undergoing cytokinesis. What would result from this?
 - a. a decrease in chromosome number
 - b. inability to duplicate DNA
 - c. division of the organism into many cells, most lacking nuclei
 - d. large cells containing many nuclei
 - e. a rapid rate of sexual reproduction
2. A human bone marrow cell, in prophase of mitosis, contains 46 chromosomes. How many chromatids does it contain altogether?
 - a. 46
 - b. 92
 - c. 23
 - d. 23 or 46, depending on when during prophase you look
 - e. 46 or 92, depending on when during prophase you look
3. Which of the following is the most significant difference between mitosis and meiosis?
 - a. Chromosomes are duplicated before mitosis.
 - b. Meiosis is not followed by cytokinesis.
 - c. Homologous pairs of chromosomes are split up in meiosis.
 - d. A spindle formed of microtubules moves the chromosomes in mitosis.
 - e. Crossing over occurs in mitosis.

Essay

1. Explain why, strictly speaking, the phrase "like begets like" applies only to asexual reproduction.
2. Briefly describe mitosis and cytokinesis and state their functions.
3. Describe how cancer cells differ from normal body cells.
4. Compare mitosis and meiosis. What are their functions? Which produces haploid cells? Diploid cells? What kinds of cells undergo mi-

4. If there are 22 chromosomes in the nucleus of a toad skin cell, a toad egg would contain ____ chromosomes.
 - a. 22
 - b. 44
 - c. 11
 - d. 33
 - e. 88
5. Which of the following carry the same genetic information?
 - a. sister chromatids
 - b. X and Y chromosomes
 - c. all autosomes
 - d. homologous chromosomes
 - e. all haploid cells
6. A cell biologist carefully measured the quantity of DNA in grasshopper cells growing in cell culture. Cells examined during the G_2 phase of the cell cycle contained 200 units of DNA. What would be the amount of DNA in one of the grasshopper daughter cells seen in telophase of mitosis?
 - a. 50 units
 - b. 100 units
 - c. between 50 and 100 units
 - d. 200 units
 - e. 400 units
7. What would be the quantity of DNA in one of the grasshopper cells (question 6) produced by telophase II of meiosis?
 - a. 50 units
 - b. 100 units
 - c. between 50 and 100 units
 - d. 200 units
 - e. 400 units
8. The two chromosomes of a homologous pair
 - a. carry identical genetic information at corresponding locations.
 - b. carry information for the same characteristics at different locations.
 - c. carry identical genetic information at different locations.
 - d. carry information for the same characteristics at corresponding locations.
 - e. Any of the above is possible.
9. A picture of a dividing pigeon cell taken through a microscope shows that the cell contains seven chromosomes, each consisting of two chromatids. This picture must have been taken during
 - a. metaphase of mitosis.
 - b. prophase I of meiosis.
 - c. telophase II of meiosis.
 - d. prophase II of meiosis.
 - e. telophase of mitosis.
10. A culture of mouse cells is treated with a chemical that interferes with the activity of microfilaments. Which of the following will probably be affected the most?
 - a. mitosis
 - b. chromosome duplication
 - c. pairing of homologous chromosomes
 - d. cytokinesis
 - e. joining of sister chromatids at the centromere
11. A zoologist examined an intestine cell from a crayfish and counted 200 chromosomes, each consisting of two chromatids, at prophase I of mitosis. What would he expect to see in each of the four cells at telophase II of meiosis if he looked in the crayfish ovary?
 - a. 50 chromosomes, each consisting of two chromatids
 - b. 50 chromosomes, each consisting of one chromatid
 - c. 100 chromosomes, each consisting of two chromatids
 - d. 100 chromosomes, each consisting of one chromatid
 - e. 200 chromosomes, each consisting of one chromatid
12. One chromosome of a homologous pair carries the genes *J* and *K*. The other chromosome of the pair carries the genes *j* and *k* at corresponding loci. Crossing over results in exchange of chromosome segments and production of gametes with new combinations of genes. A "recombinant"-type gamete resulting from this crossover might contain
 - a. genes *J* and *K*.
 - b. genes *j* and *K*.
 - c. genes *J* and *j*.
 - d. genes *j* and *k*.
 - e. genes *K* and *k*.

13. Humans have 23 pairs of chromosomes, while our closest relatives, chimpanzees, have 24. Chromosome studies indicate that at some point early in human evolution, two chromosomes simultaneously broke into a large portion and a small portion. The large parts combined to form a large chromosome, and the small parts combined to form a much smaller chromosome, which was subsequently lost. This important chromosomal change could best be described as
 - a. nondisjunction followed by deletion.
 - b. translocation followed by deletion.
 - c. duplication followed by deletion.
 - d. translocation followed by inversion.
 - e. nondisjunction followed by inversion.
14. It would be most difficult to spot which of the following by looking at a karyotype?
 - a. an extra chromosome
 - b. part of a chromosome duplicated
 - c. a missing chromosome
 - d. part of a chromosome inverted
 - e. a translocation

Essay

1. Recall how chemotherapy slows the growth of cancerous tumors. Common side effects of chemotherapy are hair loss, nausea, and loss of appetite. Why do you think that chemotherapy has some of its strongest side effects on the skin and lining of the digestive tract?
2. Most of the grasshopper somatic cells examined by the cell biologist in Multiple Choice questions 6 and 7 above contained either 100 or 200 units of DNA. Some of the interphase cells, however, contained between 100 and 200 units. Explain what was happening in these cells.
3. A slide of dividing cells in an onion root tip (Figure 8.11A in the text) is a "snapshot" in time. Each cell is stopped at the particular point in its cell cycle when the slide was made. A biology student examined such a slide under a microscope. Out of 100 cells she caught in the act of dividing, 38 were in prophase, 15 in prometaphase, 8 in metaphase, 10 in anaphase, and 29 in telophase. Assuming that the cells are growing and dividing independently, what do these data tell you about the phases of mitosis in onion cells?
4. A white blood cell from a female golden retriever was found to contain a total of 78 chromosomes. How many different kinds (sizes and shapes) of chromosomes would you expect to find in the cell? Why?
5. The somatic cells of a mosquito contain three pairs of chromosomes—two large ones, two medium-sized ones, and two small ones. One large chromosome bears the *A* gene; its homologue bears the *a* gene. One medium-sized chromosome bears the *B* gene; its homologue bears the *b* gene. One small chromosome bears the *C* gene; its homologue bears the *c* gene. Sketch cells at metaphase I of meiosis in the ovary of the mosquito, showing the different alignments of chromosomes that are possible. Then show how these lead to different combinations of genes in the gametes. How many different combinations are possible in the eggs? In the sperm of a male mosquito with the same genes, how many different gene combinations are possible? If the male and female mate and her eggs are fertilized with his sperm, how many different combinations are possible in the zygotes?
6. One chromosome of a homologous pair carries genes *Q* and *R*. Its homologue carries genes *q* and *r*. Show how crossing over during meiosis could produce gametes with new combinations of genes. What combinations of genes occur in parental-type gametes? In recombinant-type gametes?
7. Which of the following abnormalities in sex chromosomes would result in a predominantly male phenotype? A predominantly female phenotype? Explain why. XXXX, XXY, XYYY, X, XYYY