1. Which of the following is NOT a direct function of mitosis in humans?
   A) growth
   B) production of 4 haploid gametes from a single diploid parent cell
   C) repair of damaged tissues
   D) development of organs
   E) production of 2 diploid daughter cells from a single diploid parent cell

2. Which of the following is FALSE about the roles played by checkpoints in the regulation of the cell cycle?
   A) Cell density and anchorage are among the properties of a cell that are monitored by checkpoints
   B) Checkpoints can prevent a sick or damaged cell from dividing
   C) By default, checkpoints are closed; cells do not progress past a checkpoint unless the right signals are present
   D) A checkpoint within M phase prevents division from occurring until chromosomes are properly organized in the cell
   E) Checkpoints act to speed up the cell cycle by making it more efficient

3. How do the daughter cells at the end of mitosis and cytokinesis compare with their parent cell when it was in G₁ of the cell cycle?
   A) The daughter cells have the same number of chromosomes and the same amount of DNA.
   B) The daughter cells have the same number of chromosomes and half the amount of DNA.
   C) The daughter cells have the same number of chromosomes and twice the amount of DNA.
   D) The daughter cells have half the amount of cytoplasm and half the amount of DNA.
   E) The daughter cells have half the number of chromosomes and half the amount of DNA.

4. When do sister chromatids separate and move to opposite poles of the cell?
   A) metaphase
   B) prometaphase
   C) telophase
   D) anaphase
   E) prophase
5. If cells in the process of dividing are subjected to spinfinadine, a drug that interferes with the attachment of the spindle apparatus to centromeres, which stage of mitosis will be arrested?
   A) interphase
   B) anaphase
   C) metaphase
   D) prophase
   E) prometaphase

6. A cell containing 46 chromatids at metaphase of mitosis would, at its completion, produce two nuclei each containing how many chromosomes?
   A) 12
   B) 16
   C) 23
   D) 46
   E) 92

7. If a cell has 4 chromosomes at metaphase of mitosis, how many chromosomes will it have during anaphase?
   A) 1
   B) 2
   C) 4
   D) 8
   E) 16

8. Cytokinesis usually, but not always, follows mitosis. If a cell completed mitosis but not cytokinesis, the result would be a cell with
   A) a single large nucleus.
   B) two nuclei.
   C) two abnormally small nuclei.
   D) high concentrations of actin and myosin.
   E) two nuclei but with half the amount of DNA.

9. During which phases of the cell cycle are chromosomes composed of two chromatids?
   A) from interphase through anaphase
   B) from G₁ of interphase through metaphase
   C) from G₂ of interphase through metaphase
   D) from metaphase through telophase
   E) from anaphase through telophase

10. Chromosomes first become visible (condense) during which phase of mitosis?
    A) anaphase
    B) telophase
    C) prophase
    D) metaphase
    E) prometaphase
11. The formation of a cell plate is beginning across the middle of a cell and nuclei are re-forming at opposite ends of the cell. What kind of cell is this?
   A) a plant cell in metaphase
   B) a plant cell undergoing cytokinesis
   C) an animal cell in metaphase
   D) an animal cell in telophase
   E) an animal cell undergoing cytokinesis

12. Red blood cells are in which phase?
   A) G₀
   B) G₁
   C) S
   D) G₂
   E) M

13. Which number in the figure above represents the point in the cell cycle during which the chromosomes are replicated?
   A) I
   B) II
   C) III
   D) IV
   E) V

14. In the figure above, mitosis is represented by which number?
   A) I
   B) II
   C) III
   D) IV
   E) V

15. G₁ is represented by which number(s)?
   A) III
   B) IV
   C) V
   D) I and V
   E) II and IV
16. DNA is replicated in this phase of the cell cycle:
   A) G₀
   B) G₁
   C) S
   D) G₂
   E) M

17. Why do many cancer patients undergoing chemotherapy lose their hair?
   A) The cancerous cells take up too much of the body’s energy, leaving none available for hair growth
   B) Most types of cancer start in the hair follicles
   C) Chemotherapy treatments block the synthesis of keratin, the primary protein component of hair
   D) Chemotherapy treatments disrupt meiosis
   E) Chemotherapy treatments stop cell division, and hair follicles require high rates of cell division

18. A triploid cell contains three sets of chromosomes. If an organism’s diploid number is 12, then a cell from this organism that is triploid would be expected to have which of the following?
   A) 18 chromosomes in 3 sets of 6
   B) 36 chromosomes in 3 sets of 12
   B) 18 chromosomes in 6 1/2 pairs
   C) 18 chromosomes, each with three chromatids
   D) 12 chromosome pairs and 12 unique chromosomes

19. After cytokinesis I of meiosis, the chromosomal makeup of each daughter cell is
   A) haploid, and the chromosomes are each composed of a single chromatid.
   B) haploid, and the chromosomes are each composed of two chromatids.
   C) diploid, and the chromosomes are each composed of a single chromatid.
   D) diploid, and the chromosomes are each composed of two chromatids.
   E) tetraploid, and the chromosomes are each composed of two chromatids.

20. A cell divides to produce two daughter cells that are genetically different.
   A) The statement is true for mitosis only.
   B) The statement is true for meiosis I only.
   C) The statement is true for meiosis II only.
   D) The statement is true for mitosis and meiosis I.
   E) The statement is true for mitosis and meiosis II.

21. Homologous chromosomes pair up and crossing over occurs.
   A) The statement is true for mitosis only.
   B) The statement is true for meiosis I only.
   C) The statement is true for meiosis II only.
   D) The statement is true for mitosis and meiosis I.
   E) The statement is true for mitosis and meiosis II.
22. Sister chromatids are separated from each other.
   A) The statement is true for mitosis only.
   B) The statement is true for meiosis I only.
   C) The statement is true for meiosis II only.
   D) The statement is true for mitosis and meiosis I.
   E) The statement is true for mitosis and meiosis II.

23. If an organism is diploid, what is the maximum possible number of alleles for a given gene that this organism can have?
   A) It depends on the number of alleles that exist for the gene
   B) It depends on the number of chromosomes the organism has
   C) 1
   D) 2
   E) 4

24. A male frog has two copies of Chromosome 12. One copy carries a green eye allele and the other carries an orange eye allele. Which of the following sperm types will he produce?
   A) Only green gene sperm
   B) Only orange gene sperm
   C) 1/2 green and 1/2 orange gene sperm
   D) 3/4 green and 1/4 orange gene sperm
   E) An indeterminate frequency of green and orange gene eggs

25. Independent assortment of chromosomes is a result of
   A) the random and independent way in which each pair of homologous chromosomes lines up at the metaphase plate during meiosis I.
   B) the random nature of the fertilization of ova by sperm.
   C) the random distribution of the sister chromatids to the two daughter cells during anaphase II.
   D) the relatively small number of genes shared by the X and Y chromosomes.
   E) All of the above

26. A cross between homozygous purple-flowered and homozygous white-flowered pea plants results in offspring with purple flowers. This demonstrates
   A) dominance
   B) true-breeding.
   C) a dihybrid cross.
   D) the blending model of genetics.
   E) the mistakes made by Mendel.
27. Two birds mate, resulting in offspring with a 3:1 ratio for a particular trait. This suggests
A) that the parents were true-breeding for different traits.
B) a test cross.
C) that each offspring has the same alleles.
D) that a blending of traits has occurred.
E) that the parents were both heterozygous.

28. A sexually reproducing animal has two independently assorting genes, one for nose shape
(N) and one for body length (B). Its genotype is NnBb. Which of the following gametes
could be produced by this organism?
A) Bn
B) Nn
C) BbNn
D) B
E) nn

29. It was important that Mendel examined not just the F\(_1\) generation in his breeding
experiments, but the F\(_2\) generation as well, because
A) many of the F\(_1\) offspring died.
B) the dominant phenotypes were visible in the F\(_2\) generation, but not in the F\(_1\)
C) parental traits that were not observed in the F\(_1\) reappeared in the F\(_2\).
D) he obtained very few F\(_1\) offspring, making statistical analysis difficult.
E) analysis of the F\(_1\) offspring would have allowed him to discover the law of
independent assortment, but not determine dominance.

30. When crossing an organism that is homozygous dominant for a single trait with a
heterozygote, what is the chance of producing an offspring with the homozygous
recessive phenotype?
A) 0%
B) 25%
C) 50%
D) 75%
E) 100%

31. Black fur in mice (B) is dominant to white fur (b). Long tails (L) are dominant to short
tails (l). What fraction of the progeny of the cross BbLl × BBll will have black fur and
long tails?
A) 1/16
B) 3/16
C) 3/8
D) 1/2
E) 9/16
In a particular plant, leaf color is controlled by gene locus $D$. Plants with at least one allele $D$ have dark green leaves, and plants with the homozygous recessive $dd$ genotype have light green leaves. A true-breeding dark-leaved plant is crossed with a light-leaved one, and the $F_1$ offspring are crossed. The predicted outcome of the $F_2$ is diagrammed in the Punnett square shown in Figure 14.1, where 1, 2, 3, and 4 represent the genotypes corresponding to each box within the square.

32. Which of the boxes marked 1-4 correspond to plants with dark leaves?
   A) 1 only
   B) 1 and 2
   C) 4 only
   D) 1, 2, and 3
   E) All boxes

33. Which of the boxes correspond to plants with a homozygous genotype?
   A) 1
   B) 1 and 4
   C) 1, 2, and 3
   D) 2 and 3
   E) All boxes

34. In certain dogs, long legs are dominant to short. If a heterozygous dog mates with a homozygous short-legged dog, what is the probability that the offspring will be short?
   A) 1
   B) 1/2
   C) 1/4
   D) 1/6
   E) 0

35. A woman has three sons. The chance that her next child will be a daughter is
   A) 1.
   B) 0.
   C) 1/4.
   D) 1/2.
   E) 3/4.
36. Males are more often affected by sex-linked traits than females because
   A) males only have one X chromosome
   B) X chromosomes in males generally have more mutations than X chromosomes in females.
   C) mutations on the Y chromosome often worsen the effects of X-linked mutations.
   D) male hormones such as testosterone often alter the effects of mutations on the X chromosome.
   E) female hormones such as estrogen often compensate for the effects of mutations on the X.

37. Red-green color blindness is an x-linked recessive trait in humans. Two people with normal color vision have a color-blind son. What are the genotypes of the parents?
   A) $X^bX^b$ and $X^bY$
   B) $X^BX^B$ and $X^bY$
   C) $X^bX^b$ and $X^B Y$
   D) $X^B X^B$ and $X^B Y$
   E) $X^B X^B$ and $X^B Y$

38. Dependent assortment:
   A) Occurs when genes are located on different chromosomes.
   B) Occurs when genes are located close together on the same chromosome.
   C) Results in a 3:1 ratio of offspring when conducting a dihybrid cross.
   D) A and C.
   E) B and C.

39. Cytosine makes up 22% of the nucleotides in a sample of DNA from an organism. Approximately what percentage of the nucleotides in this sample will be thymine?
   A) 11
   B) 22
   C) 28
   D) 44
   E) It cannot be determined from the information provided.

40. What kind of chemical bond is found between paired nitrogenous bases of the DNA double helix?
   A) ionic
   B) polar covalent
   C) nonpolar covalent
   D) phosphate
   E) hydrogen
41. What is meant by the description "antiparallel" regarding the strands that make up DNA?
   A) One strand is positively charged and the other is negatively charged.
   B) One strand contains only nitrogenous bases and the other contains only phosphates.
   C) The twisting nature of DNA creates nonparallel strands.
   D) The 5' to 3' direction of one strand runs counter to the 5' to 3' direction of the other strand.
   E) Base pairings create unequal spacing between the two DNA strands.

42. Which enzyme unzips the DNA double helix in preparation for DNA replication?
   A) helicase
   B) primase
   C) single-strand binding proteins
   D) DNA ligase
   E) DNA polymerase

43. What determines the nucleotide sequence of the newly synthesized strand during DNA replication?
   A) the particular DNA polymerase catalyzing the reaction
   B) the relative amounts of the four nucleotides in the cell
   C) the nucleotide sequence of the template strand
   D) the primase used in the reaction
   E) the arrangement of histones in the sugar phosphate backbone

44. The leading and the lagging strands differ in that
   A) the leading strand is built continuously, whereas the lagging strand is built in short fragments that are ultimately stitched together.
   B) the leading strand is built by adding nucleotides to the 3' end of the growing strand, and the lagging strand is built by adding nucleotides to the 5' end.
   C) the lagging strand is built continuously, whereas the leading strand is built in short fragments that are ultimately stitched together.
   D) the leading strand is synthesized at twice the rate of the lagging strand.

45. Which of the following keeps the two strands of DNA separated after they have been unzipped?
   A) helicase
   B) single-strand binding proteins
   C) ligase
   D) DNA polymerase
   E) primase

46. A new DNA strand is built only in the 5' to 3' direction because
   A) DNA polymerase begins adding nucleotides to the 5' end of the template.
   B) the polarity of DNA prevents addition of nucleotides at the 3' end.
   C) DNA polymerase can only add nucleotides to the 5' end of the new strand.
   D) DNA polymerase can only add nucleotides to the free 3' end.
47. A template DNA strand reads 3’ AACGTTATAG 5’. What is the sequence of the newly-synthesized, complementary strand to this template?
   A) 3’ TTGCAATATC 5’
   B) 3’ GATATTGCAA 5’
   C) 5’ GATATTGCAA 5’
   D) 5’ TTGCAATATC 3’
   E) 5’ CCATGGCGCT 3’

48. Which of the following separates molecules by size using an electrical charge?
   A) PCR
   B) DNA sequencing
   C) DNA ligase
   D) gel electrophoresis
   E) DNA polymerase

49. If you start with one DNA molecule, how many molecules will you have after 3 cycles of PCR?
   A) 1
   B) 2
   C) 4
   D) 6
   E) 8

50. Which of the following is FALSE about DNA polymerases?
   A) They require a primer to begin synthesis
   B) They unwind DNA before they start synthesis
   C) They require free nucleotides to synthesize a DNA molecule
   D) They require a single-stranded DNA template to synthesize a DNA molecule
   E) They only synthesize in the 5’ to 3’ direction