ANSWERS TO EXERCISES

1. chromosomes
2. binary fission
3. homologous
4. meiosis
   gametes
5. interphase
6. mitosis
   cytokinesis
7. Asexual
   sexual
8. Meiosis
9. crossing over
   chiasmata
   genetic
   recombination
10. false, identical
11. false, one
12. false, diploid
13. false, S
14. false, cytokinesis
15. true
16. false, meiosis I
17. false, anaphase II
18. true
19. false, does not
    replicate
20. true
21. mitosis
22. mitosis
23. meiosis
24. meiosis
25. mitosis
26. meiosis
27. mitosis
28. both
29. both
30. mitosis
31. meiosis
32. both
33. mitosis
34. neither
35. meiosis
36. b
37. d
38. c
39. a
40. c
41. telophase
42. metaphase
43. prophase
44. anaphase
45. anaphase
46. telophase
47. prophase
48. anaphase
49. prophase
50. telophase
51. f
52. a
53. c
54. g
55. a
56. g
57. b
58. a
59. d
60. d
61. b
62. b
63. b
64. e
65. d
66. c
67. d
68. e
69. b
70. If the cells are dividing randomly in the culture dish, you can relate the percentage of time the cells spend in each phase of the cell cycle with the percentage of cells observed at each stage of the cell cycle. For instance, if cells spend 50% of the time in interphase, you would expect to find about half of the actively dividing cells in interphase at any particular time. So, if you saw 1121 cells and 34 ($34 \div 1121 = 3.0\%$) were in prophase, 11 (1.0%) were in metaphase, 45 (4.0%) were in anaphase, 23 (2.1%) were in telophase, and 1008 (89.9%) were in interphase, the percentages would indicate the relative amounts of time the cells spend in each phase of the cell cycle. If the average time for a complete mitotic division is known for the cells growing in the culture, these percentages could be used to determine the amounts of time cells spend in each phase. For instance, if it takes 24 hours (1140 minutes) for a complete cell cycle, these cells spend about 34 minutes (3% of 1140) in prophase, 11 minutes in metaphase, 46 minutes in anaphase, 24 minutes in telophase, and 1025 minutes in interphase.
71. One effect might be a reduction in genetic variation in human populations as fewer types of people produce more and more copies of themselves. There is a danger of eugenic manipulation of human traits, since those with "superior" traits might be cloned and those with "inferior" traits might be prohibited from being cloned (or even from reproducing at all). Another effect might be a skewing of sex ratios as more and more males are cloned and fewer and fewer females, especially in countries like China where males are considered more "valuable" to society than females. A much higher male sex ratio could, in turn, lead to other societal changes such as legalized prostitution.
72. Since cancer cells characteristically reproduce rapidly, chemicals that differentially attack actively dividing cells kill cancer cells. Also, chromosomes in their condensed condition during cell division are more vulnerable to damage from radiation treatment, often leading to cell death, so that radiation is quite effective against cancer cells. Unfortunately, these cancer treatments will also target rapidly and constantly dividing normal body cells as well. So, during cancer treatment, hair cells and cells lining the gastrointestinal tract also die off, since they are normally rapidly dividing.

73. The three elements leading to genetically diverse offspring are: (1) crossing over occurs early in meiosis, allowing homologous chromosomes to exchange genes and produce new combinations of genes; (2) the independent assortment of paired homologous maternally-derived and paternally-derived chromosomes, each with many different versions of the genes they carry, produce many different combinations of chromosomes in the sex cells produced by meiosis; and (3) since fertilizations are random combinations from among the variety of eggs and sperm available, this further increases the genetic variation among offspring.

74. Since cancer occurs as the result of uncontrolled cell division, gaining knowledge of the mechanisms controlling cell division might provide a way to control the abnormal growth. In addition, the aging process is also affected by cell division. As organisms age, the rate of replacement of worn out cells decreases. Being able to control cell division and differentiation so that needed cell types could be produced might be a way to counteract the aging process.

75. Homologous chromosomes share several properties, including similar lengths, similar positions of the centromere, similar types and locations of genes, and the ability to pair with each other during meiosis. A cell is diploid when both members of each homologous pair of chromosomes are present. Haploid cells contain one chromosome of each homologous pair of chromosomes.

76. If we think of the amount of DNA in the chromosomes, at G_1 of interphase there are 100 units of DNA in the unreplicated chromosomes. By the end of interphase, the chromosomes have replicated, so that during prophase I, there would be 200 units of DNA in the pairs of replicated chromosomes. As a result of the first meiotic division, the pairs of replicated chromosomes move away from each other and into separate cells, so that during prophase II, there would be 100 units of DNA in the single replicated chromosomes. During the second meiotic division, the centromeres holding the sister chromatids of the replicated chromosomes together divide, so that the sister chromatids become unreplicated chromosomes as they move towards opposite poles, so that the sperm cells produced would each have 50 units of DNA in their single unreplicated chromosomes.

77. According to W. Richardson and L. Dale, human males are XY and females are XX, and fruit fly males are XY and females are XX. According to J. Bell of Cal State Univ., Chico, honey bee males are haploid with one X and females are diploid with XX (in bees, if a queen lays a fertilized egg, it develops into a diploid XX female, but if the queen lays an unfertilized egg, it develops into a haploid X male). And, according to S. Carr, bird sex determination is the opposite of humans; XY is female (sometimes, the sex chromosomes are called WZ in birds), and XX (ZZ) is male.

78. According to reports from Discovery.com, the New Mexico Whiptail is an all-female species that is actually a mixture of two other species, the Western Whiptail, which lives in the desert, and the Little Striped Whiptail, a denizen of grasslands. Most products of crossbreeding, such as the mule, are sterile. But the New Mexico Whiptail, as well as several other all-female species of whiptail lizard, does reproduce, and all of its offspring are female. Moreover, it reproduces by parthenogenesis — its haploid eggs require no fertilization, and its offspring are exact and complete genetic duplicates of the mother. Scientists understand only partially how this reproductive mode developed, and it raises many questions. One of the most intriguing is how this cloning affects the lizard's ability to adapt to environmental changes. Since there is no genetic variation except that which occurs through mutation, the New Mexico Whiptail cannot evolve as other species do.

79. According to G. Schuett et. al. and D. Blanchard, automictic parthenogenesis occurs when an egg with the X (also called the Z) chromosome fuses with a polar body also with an X (Z) chromosome to form a male offspring (XX = ZZ) without any sperm involved. These parthenogenetic rattlesnake and turkey offspring are diploid, whereas parthenogenetic whiptails are haploid.