Chapter 16 Review Answers

Student Textbook pages 582-583

Answers to Understanding Concepts Questions

1. Advances in technology include further development of the microscope and the development of chromosomal stains that enabled the observation of the nuclear contents and processes in cell reproduction.

2. Chromatin are long intertwined threads of DNA surrounding histone proteins. They are located in the nucleus and occur during interphase of the cell cycle. During S phase of interphase, the DNA replicates. Chromosomes are formed at the beginning (prophase) of mitosis and meiosis when the chromatin condenses by successive degrees of coiling. When the chromosomes become visible in mitosis and meiosis, they appear as two strands of identical genetic material held together by a centromere. Each strand is a chromatid. When the chromatids separate in anaphase, the single chromatid is now referred to as a chromosome.

3. The three stages of interphase are Gap or Growth 1 (G1), synthesis (S) phase, and Gap or Growth 2 (G2) phase. In G1 phase, the cell carries out rapid growth and metabolism. During S phase, the DNA is replicated to form two identical sets of genetic material in preparation for division of the nucleus. G2 phase follows S phase, and is a period in which the cell rebuilds it energy reserves and manufactures proteins and other molecules required for cell reproduction.

4. Diagram should be labelled as follows: A = replicated chromosome, B = growing spindle fibres, and C = disappearing nuclear membrane.

5. When two gametes unite and form a zygote, the haploid (n) number of chromosomes in each gamete will be doubled, forming the diploid ($2n$) number of chromosomes found in somatic cells.

6. (a) tissue renewal: mitosis

(b) growth of an embryo: mitosis

(c) production of gametes: meiosis

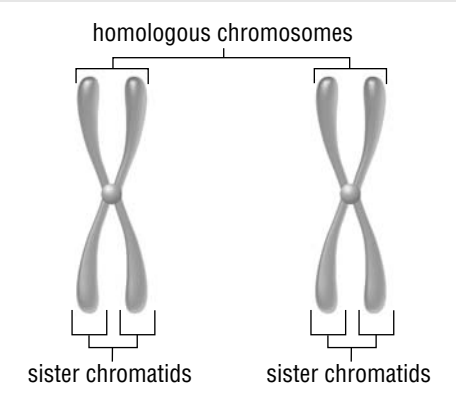
7. (a) mitosis: Root-tip cells are actively dividing and will show mitosis best.

(b) meiosis: The ovule or anther (gonad) of a flower that produce egg cells and sperm nuclei would show meiosis best.

8. The chromatin replicates during synthesis (S) phase of the cell cycle.

9. The diagram on the right shows the chromosomes in metaphase I of meiosis. During metaphase I of meiosis, the chromosomes synapse as homologous pairs. In each pair, one homologous chromosome is positioned on one side of the cell's equator, and the other homologous chromosome is positioned on the other side of the cell's equator. The diagram on the left shows the chromosomes in metaphase of mitosis.

10. (a)



(b) The tetrad arrangement of homologous chromosomes allows crossing over of segments of non-sister chromatids, resulting in genetic variability in the gametes.

11. The two cells following telophase I are haploid, in that each member of the homologous pair of chromosomes moved to an opposite pole of the cell, which then divided into two separate haploid cells.

12. Students may mention any two of the following (example organisms are given in brackets): binary fission (bacteria, and some algae and fungi), budding (yeast and hydra),

vegetative reproductions (strawberries), fragmentation (sea stars, potatoes, and most garden plants), and parthenogenesis (bees, whiptail lizard). Some students may mention asexual spore formation, which is correct, although no specific examples of organisms that form spores asexually are given in the text.

13. In mitosis, the homologous chromosomes do not form tetrads and so there is no crossing over. This is important because, as a consequence, mitosis results in the production of two genetically identical cells.

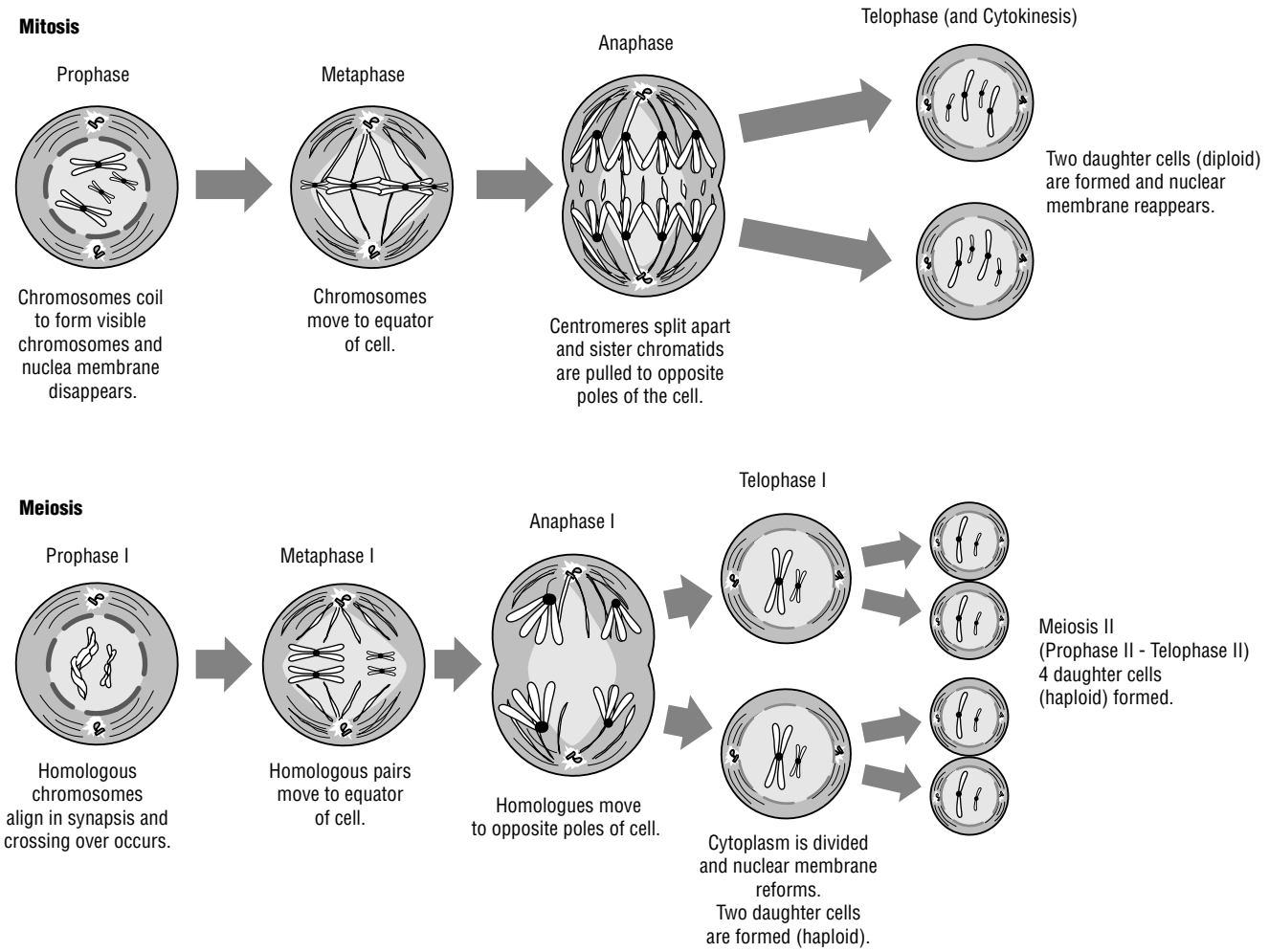
14. Use the chromosome numbers in the following table to complete the table below.

Chromosome Numbers of Some Common Organisms

Organism	Diploid body cell (2*n*)
fruit fly	8
garden pea	14
leopard frog	26
pine tree	24

Cell type and phase	Number of chromosomes	State of chromatin or chromosomes (duplicated or unduplicated)
fruit fly germ cell after telophase I of meiosis	4	duplicated
garden pea germ cell after telophase II of meiosis	7	unduplicated
leopard frog somatic cell in interphase	26	Unduplicated, if not a germinal cell
pine tree gametophyte cell in prophase of mitosis	12	duplicated

15. The top diagram in this question refers to mitosis and the bottom diagram shows meiosis. They should be labelled as shown below:



Answers to Applying Concepts Questions

16. An embryo in the first four weeks of development is more likely to be seriously affected by the same exposure to radiation than a 10-year-old child because the embryo is still actively developing tissues, whereas the 10-year old child is still growing, but has many more mature cells than the embryo.

17. (a) Students may suggest that G1 will be shortened, as this is typically the longest phase in the cell cycle. Others may suggest that none of the phases will be shortened, as all are essential for cell division. Accept any reasonable, well-explained answer.

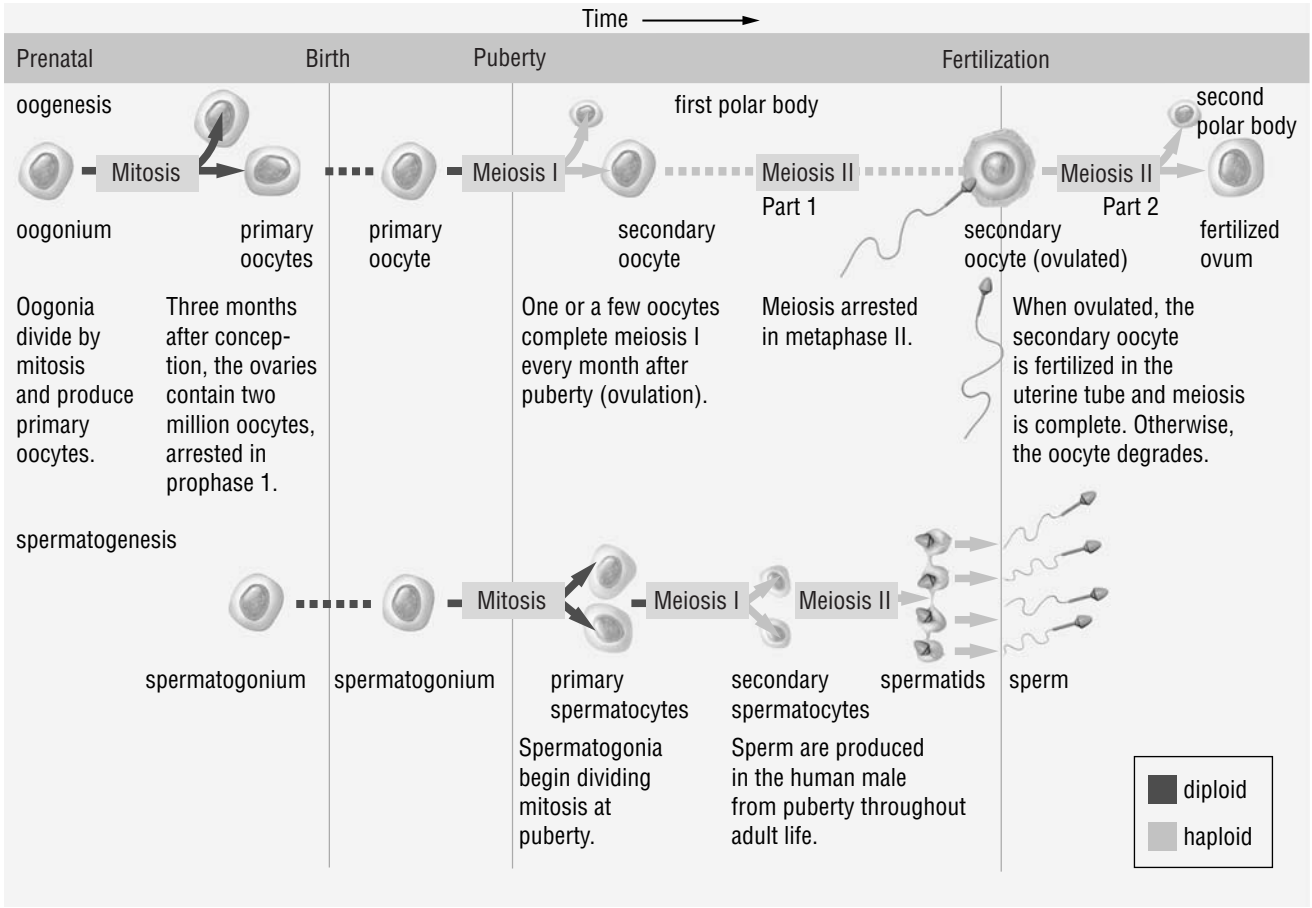
(b) Materials needed to examine the cell cycle of cancerous tissue include: biopsy of skin cancer, biopsy of non cancerous (normal) skin cells, microscope, cell and nuclear stains, microscope slides, reference book that shows cancerous skin cells and immature cells. Students should prepare several stained slides of cancerous and normal cells. Examination of cancerous skin cells should show a larger number of undifferentiated cells and cells in mitosis than in normal skin cells.

18. If a chromosome synapses with a nonhomologous chromosome during meiosis, it is doubtful that the gamete, or the zygote, or the embryo will survive with the resulting chromosomal abnormality.

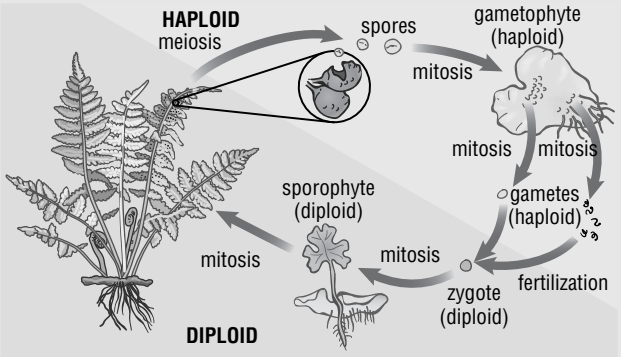
19.

20. Ignoring crossing over, but allowing for multiple pairings of homologous chromosomes, the number of different gametes a human germ cell could produce would be 2^{23} (8 388 608). Ignoring crossing over, the probability that a couple's second child will be genetically identical to their first child is 1 in 8 388 608.

21. Students may draw a sketch of the life cycle of a fern, moss, or conifer. Diagrams should be similar to those shown on the next page. While some students may mention *Cniardia*, technically speaking, the term "alternation of generations" refers to the alternation of diploid and haploid generations, a strategy found only in



plants. *Cniardia* alternates between asexually-reproducing and sexually-reproducing phases, but all forms of the organism remain diploid.



Three important features of this life cycle that students should mention include the following: one generation in the life cycle is haploid and one is diploid; the diploid organism produces spores via meiosis, which are haploid, that divide via mitosis to form a haploid gametophyte; the haploid gametophyte divides via mitosis to produce haploid gametes, and undergoes fertilization to form a diploid zygote, which divides mitotically to form a diploid sporophyte organism.

22. The table below outlines possible student answers identifying the advantages and disadvantages of asexual reproduction:

Advantage	Disadvantage
Because the daughter organism does not fully separate from the parent until it is capable of independent survival, asexual reproduction may increase chances of survival in a hostile environment.	Because offspring are genetically identical to the parent, there is little genetic variation. As a result, offspring may be unable to adapt to a changing environment. Similarly, competition among siblings may be greater because they are identical in their needs.
Does not require the presence of a second organism.	Because pairing of homologous chromosomes and crossing over does not occur, there are fewer opportunities to replace or repair damaged chromosomes.
Carried out with less time and energy. Therefore, may help organisms take advantage of favourable environmental conditions.	

23. (a) Understanding the insect's life cycle could help control the insect population by enabling the development of control mechanisms. For example, if the insect reproduced asexually, there would be little genetic variation among offspring and they would be less likely to adapt to pesticide use over time. If the insects reproduce sexually, introducing sterile insects of the same species into the environment may reduce the number of organisms over time, as fertile insects mate with sterile ones. Collecting, sterilizing, and releasing the insects would similarly result in infertile egg production. Determining the point of the lifecycle (e.g., larvae, pupa, or adult) where the insect is most vulnerable, and then planning a course of action to reduce the insect's numbers is also a viable strategy.

(b) No, asexual reproduction would not prevent migration to other orchards. It would only ensure that the offspring are genetically identical to the parent organism.

(c) Cover each tree with insect netting for flying insects or use some other form of barrier, such as insect tape, for crawling insects.

Answers to Making Connections Questions

24. (a) Mitosis occurs more frequently in a 5-year-old than in a 40-year-old human because the 5- year-old has a higher rate of growth and mitosis, as he or she is actively producing new tissues in his or her development to maturity. The 40 year old is past maturity and the number of cell divisions occurring is declining.

(b) Sample suggestions may include the following: research the number of cell divisions different types of tissues are capable of as they age; research which factors cause tissues to wear out over time; determine if genetic changes that occur from exposure to environmental factors increase cell aging; determine if stem cells are programmed to die after a certain number of cell divisions. This research could be applied to help prevent age-related cosmetic tissue degeneration, disease, and mental deterioration.

25. The script for the students' 15-minute play should include the props that they would use, as well as directions for how they would position the students during each phase of mitosis. For example, a belt or skipping rope could represent the centromere. The students themselves would be the chromatids. Longer ropes could represent the cell membrane and the nuclear membrane. The students should also put this play into context. For example, a student has cut his or her finger and the play will look at how the skin repairs itself by cell division. The script may also include diagrams (a storyboard) of how students will be positioned. Remind your students that the script should not focus on the terminology associated with mitosis, but on the process itself.

26. At this point in the program, students will not be aware of how geneticists use crossing over and recombinants to map chromosomes. This topic is discussed in Chapter 17. As such, accept any well-reasoned argument as to how genes may be mapped. Students may recognize that while crossing over occurs at random points between homologous chromosomes, this is less likely to occur near centromeres and, most importantly, when genes are located in close proximity to each other along a chromosome. The less distance there is between two genes, the less likely it is that a crossover will occur. Scientists use this information to map the relative positions of genes on chromosomes. This question works well when assigned to gifted students.

27. Organisms that can reproduce sexually and asexually often reproduce asexually when nutrients or other favourable environmental factors are present, and sexually when conditions become less favourable (when genetic variation is beneficial). As such, an experiment could be designed to determine the effects of two environmental factors such as temperature (warm or cold), moisture levels (moist or dry), or perhaps the availability of a specific food nutrient on insect reproduction. By studying several populations of the same insect, it is possible to determine the optimum range of each environmental condition for asexual and sexual reproduction. This can be done by counting the number of eggs produced, eggs that hatch, and/or offspring that become fertile adults under different conditions. Once baseline data is obtained for the optimum environmental conditions for both forms of reproduction, this could be the control for testing the effects of different environmental conditions that are consistent with the insect's habitat. Experiments should include a procedure, materials list, hypothesis, list of variables (controlled, manipulated, and responding), and a method of assessing the results. Two different environmental factors should be tested.

28. For artificial chromosomes to behave appropriately during cell division, they would have to be able to replicate prior to mitosis so that genetic material is available for the creation of two daughter cells. They must also be able to condense during prophase. The chromosomes would also need to have centromeres to which spindle fibres could attach, allowing them to assemble at the equator of the cell during metaphase and be pulled to opposite poles during anaphase.