CHAPTER 6
DNA REPLICATION, REPAIR, AND RECOMBINATION

DNA Replication

6-1 The process of DNA replication requires that each of the parental DNA strands be used as a _____ to produce a duplicate of the opposing strand.

(a) catalyst
(b) competitor
(c) template
(d) copy

6-2 DNA replication is considered semiconservative because _____.

(a) after many rounds of DNA replication, the original DNA double helix is still intact
(b) each daughter DNA molecule consists of two new strands copied from the parent DNA molecule
(c) each daughter DNA molecule consists of one strand from the parent DNA molecule and one new strand
(d) new DNA strands must be copied from a DNA template

6-3 The classic experiments conducted by Meselson and Stahl demonstrated that DNA replication is accomplished by employing a _____ mechanism.

(a) continuous
(b) semiconservative
(c) dispersive
(d) conservative

6-4 If the genome of the bacterium *E. coli* requires about 20 minutes to replicate itself, how can the genome of the fruit fly *Drosophila* be replicated in only 3 minutes?

(a) The *Drosophila* genome is smaller than the *E. coli* genome.
(b) Eucaryotic DNA polymerase synthesizes DNA at a much faster rate than procaryotic DNA polymerase.
(c) The nuclear membrane keeps the *Drosophila* DNA concentrated in one place in the cell, which increases the rate of polymerization.
(d) *Drosophila* DNA contains more origins of replication than *E. coli* DNA.

6-5 Meselson and Stahl grew cells in media that contained different isotopes of nitrogen (^{15}N and ^{14}N) so that the DNA molecules produced from these different isotopes could be distinguished by mass.

A. Explain how "light" DNA was separated from "heavy" DNA in the Meselson and Stahl experiments.
B. Describe the three existing models for DNA replication when these studies were begun, and explain how one of them was ruled out definitively by the experiment you described for part A.
C. What experimental result eliminated the dispersive model of DNA replication?

6-6 Indicate whether the following statements are true or false. If a statement is false, explain why it is false.
A. When DNA is being replicated inside a cell, local heating occurs, allowing the two strands to separate.
B. DNA replication orgins are typically rich in G-C base pairs.
C. Meselson and Stahl ruled out the dispersive model for DNA replication.
D. DNA replication is a bidirectional process that is initiated at multiple locations along chromosomes in eucaryotic cells.

6-7 Answer the following questions about DNA replication.
A. On a DNA strand that is being synthesized, which end is growing—the 3′ end, the 5′ end, or both ends? Explain your answer.
B. On a DNA strand that is being used as a template, where is the copying occurring relative to the replication origin—3′ of the origin, 5′, or both?

6-8 How does the total number of replication origins in bacterial cells compare with the number of origins in human cells?
(a) 1 versus 100
(b) 5 versus 500
(c) 10 versus 1000
(d) 1 versus 10,000

6-9 The chromatin structure in eucaryotic cells is much more complicated than that observed in procaryotic cells. This is thought to be the reason that DNA replication occurs much faster in procaryotes. How much faster is it?
(a) 2×
(b) 5×
(c) 10×
(d) 100×

6-10 DNA polymerase catalyzes the joining of a nucleotide to a growing DNA strand. What prevents this enzyme from catalyzing the reverse reaction?
(a) hydrolysis of PP_i to $P_i + P_i$
(b) release of PP_i from the nucleotide
(c) hybridization of the new strand to the template
(d) loss of ATP as an energy source

6-11 Figure Q6-11 shows a replication bubble.

Figure Q6-11

A. On the figure, indicate where the origin of replication was located (use O).
B. Label the leading-strand template and the lagging-strand template of the right-hand fork [R] as X and Y, respectively.
C. Indicate by arrows the direction in which the newly made DNA strands (indicated by dark lines) were synthesized.
D. Number the Okazaki fragments on each strand 1, 2, and 3 in the order in which they were synthesized.
E. Indicate where the most recent DNA synthesis has occurred (use S).
F. Indicate the direction of movement of the replication forks with arrows.

6-12 Which of the following statements about the newly synthesized strand of a human chromosome is *true*?

(a) It was synthesized from a single origin solely by continuous DNA synthesis.
(b) It was synthesized from a single origin by a mixture of continuous and discontinuous DNA synthesis.
(c) It was synthesized from multiple origins solely by discontinuous DNA synthesis.
(d) It was synthesized from multiple origins by a mixture of continuous and discontinuous DNA synthesis.

6-13 You have discovered an "Exo⁻" mutant form of DNA polymerase in which the 3′-to-5′ exonuclease function has been destroyed but the ability to join nucleotides together is unchanged. Which of the following properties do you expect the mutant polymerase to have?

(a) It will polymerize in both the 5′-to-3′ direction and the 3′-to-5′ direction.
(b) It will polymerize more slowly than the normal Exo⁻ polymerase.
(c) It will fall off the template more frequently than the normal Exo⁻ polymerase.
(d) It will be more likely to generate mismatched base pairs.

6-14 A molecule of bacterial DNA introduced into a yeast cell is imported into the nucleus but fails to replicate the yeast DNA. Where do you think the block to replication arises? Choose the protein or protein complex below that is most probably responsible for the failure to replicate bacterial DNA. Give an explanation for your answer.

(a) primase
(b) helicase
(c) DNA polymerase
(d) initiator proteins