

1) When a DNA molecule is described as replicating bidirectionally, that means that it has two:

- A) chains.
- B) independently replicating segment.
- C) origins.
- D) replication forks.
- E) termination points.

2) An Okazaki fragment is a:

- A) fragment of DNA resulting from endonuclease action.
- B) fragment of RNA that is a subunit of the 30S ribosome.
- C) piece of DNA that is synthesized in the 3' → 5' direction.
- D) segment of DNA that is an intermediate in the synthesis of the lagging strand.
- E) segment of mRNA synthesized by RNA polymerase.

3) The proofreading function of DNA polymerase involves all of the following except:

- A) a 3' → 5' exonuclease.
- B) base pairing.
- C) detection of mismatched base pairs.
- D) phosphodiester bond hydrolysis.
- E) reversal of the polymerization reaction.

4) The 5' → 3' exonuclease activity of E. coli DNA polymerase I is involved in:

- A) formation of a nick at the DNA replication origin.
- B) formation of Okazaki fragments.
- C) proofreading of the replication process.
- D) removal of RNA primers by nick translation.
- E) sealing of nicks by ligase action.

5) In contrast to bacteria, eukaryotic chromosomes need multiple DNA replication origins because:

- A) eukaryotic chromosomes cannot usually replicate bidirectionally.
- B) eukaryotic genomes are not usually circular, like the bacterial chromosome is.
- C) the processivity of the eukaryotic DNA polymerase is much less than the bacterial enzyme.
- D) their replication rate is much slower, and it would take too long with only a single origin per chromosome.
- E) they have a variety of DNA polymerases for different purposes, and need a corresponding variety of replication origins.

6) The Ames test is used to:

- A) detect bacterial viruses.
- B) determine the rate of DNA replication.
- C) examine the potency of antibiotics.
- D) measure the mutagenic effects of various chemical compounds.
- E) quantify the damaging effects of UV light on DNA molecules.

7) Which of these enzymes is not directly involved in methyl-directed mismatch repair in *E. coli*?

- A) DNA glycosylase
- B) DNA helicase II
- C) DNA ligase
- D) DNA polymerase III
- E) Exonuclease I

8) The role of the Dam methylase is to:

- A) add a methyl group to uracil, converting it to thymine.
- B) modify the template strand for recognition by repair systems.
- C) remove a methyl group from thymine.
- D) remove a mismatched nucleotide from the template strand.
- E) replace a mismatched nucleotide with the correct one.

9) When bacterial DNA replication introduces a mismatch in a double-stranded DNA, the methyl-directed repair system:

- A) cannot distinguish the template strand from the newly replicated strand.
- B) changes both the template strand and the newly replicated strand.
- C) corrects the DNA strand that is methylated.
- D) corrects the mismatch by changing the newly replicated strand.
- E) corrects the mismatch by changing the template strand.

10) In base-excision repair, the first enzyme to act is:

- A) AP endonuclease.
- B) Dam methylase.
- C) DNA glycosylase.
- D) DNA ligase.
- E) DNA polymerase.

11) The DNA below is replicated from left to right. Label the templates for leading strand and lagging strand synthesis.

(5')ACTTCGGATCGTTAAGCCGCTTTCTGT(3')
(3')TGAAGCCTAGCAATTCCGGCGAAAGACA(5')

12) All known DNA polymerases catalyze synthesis only in the 5' → 3' direction. Nevertheless, during semiconservative DNA replication in the cell, they are able to catalyze the synthesis of both daughter chains, which would appear to require synthesis in the 3' → 5' direction. Explain the process that occurs in the cell that allows for synthesis of both daughter chains by DNA polymerase.

13) What is an Okazaki fragment? What enzyme(s) is (are) required for its formation in *E. coli*?

14) A suitable substrate for DNA polymerase is shown below. Label the primer and template, and indicate which end of each strand must be 3' or 5'.



To observe DNA synthesis on this substrate *in vitro*, what additional reaction components must be added?

15) DNA replication in *E. coli* begins at a site in the DNA called the (a) _____. At the replication fork the (b) _____ strand is synthesized continuously while the (c) _____ strand is synthesized discontinuously. On the strand synthesized discontinuously, the short pieces are called (d) _____ fragments. An RNA primer for each of the fragments is synthesized by an enzyme called (e) _____, and this RNA primer is removed after the fragment is synthesized by the enzyme (f) _____, using its (g) _____ activity. The nicks left behind in this process are sealed by the enzyme (h) _____.

16) All known DNA polymerases can only elongate a preexisting DNA chain (i.e., require a primer), but cannot initiate a new DNA chain. Nevertheless, during semiconservative DNA replication in the cell, entirely new daughter DNA chains are synthesized. Explain the process that occurs in the cell that allows for the synthesis of daughter chains by DNA polymerase.

17) Match the damage type or repair step at the left with a related enzyme at right. Only one answer will be the most direct for each.

- | | |
|-----------------------------------|---|
| ___ cytosine deamination | (a) hypoxanthine-N-glycosylase |
| ___ base loss | (b) AP endonuclease |
| ___ adenine deamination | (c) mutH protein |
| ___ binds to GATC sequences | (d) DNA polymerase I |
| ___ binds to mismatch in DNA | (e) uracil N-glycosylase |
| ___ DNA synthesis in gaps | (f) mutS-mutL complex |
| ___ seals nicks | (g) ABC excinuclease |
| ___ O ₆ -methylguanine | (h) DNA photolyase |
| ___ direct chemical reversal | (i) O ₆ -methylguanine methyltransferase |
| ___ of pyrimidine dimer formation | (j) DNA ligase |
| ___ double-strand break | (k) λ integrase |
| ___ excision of a lesion- | (l) RecA protein |
| ___ containing oligonucleotide | (m) restriction endonuclease |

18) Briefly explain the difference between base-excision repair and nucleotide-excision repair.

19) What distinguishes the simple from the complex class of bacterial transposon?