KEY

#10

2. Transformation involves
   a. the uptake of external genetic material, often from one bacterial strain to another.
   b. the creation of a strand of RNA from a DNA molecule.
   c. the infection of bacterial cells by phage.
   d. the type of semiconservative replication shown by DNA.
   e. the replication of DNA along the lagging strand.

3. The DNA of an organism has thymine as 20% of its bases. What percentage of its bases would be guanine?
   a. 20% c. 40% e. 80%
   b. 30% d. 60%

4. In his work with pneumonia-causing bacteria, Griffith found that
   a. DNA was the transforming agent.
   b. the pathogenic and harmless strains mated.
   c. heat-killed harmless cells could cause pneumonia when mixed with heat-killed pathogenic cells.
   d. a substance was transferred to harmless cells to transform them into pathogenic cells.
   e. a T2 phage transformed harmless cells to pathogenic cells.

5. T2 phage is grown in *E. coli* with radioactive phosphorus and then allowed to infect other *E. coli*. The culture is blended to separate the viral coats from the bacterial cells and then centrifuged. Which of the following statements best describes the expected results of such an experiment?
   a. Both viral and bacterial DNA molecules are labeled; radioactivity is found in the liquid above the pellet.
   b. Viral DNA is labeled; radioactivity is found in the pellet.
   c. Viral proteins are labeled; radioactivity is found in the liquid but not in the pellet.
   d. Both viral and bacterial proteins are labeled; radioactivity is present in both the liquid and the pellet.
   e. The virus destroyed the bacteria; no pellet is formed.

6. Watson and Crick concluded that each base could not pair with itself because
   a. there would not be room for the helix to make a full turn every 3.4 nm.
   b. the uniform width of 2 nm would not permit two purines or two pyrimidines to pair together.
   c. the bases could not be stacked 0.34 nm apart.
   d. identical bases could not hydrogen-bond together.
   e. they would be on antiparallel strands.

7. In their classic experiment, Meselson and Stahl
   a. provided evidence for the semiconservative model of DNA replication.
   b. were able to separate phage protein coats from *E. coli* by using a blender.
   c. found that DNA labeled with ^{15}N was of intermediate density.
   d. grew *E. coli* on labeled phosphorus and sulfur.
   e. found that DNA composition was species specific.

8. The joining of nucleotides in the polymerization of DNA requires energy from
   a. DNA polymerase.
   b. the hydrolysis of the terminal phosphate group of ATP.
   c. RNA nucleotides.
   d. the phosphate groups of the sugar-phosphate backbone.
   e. the hydrolysis of the pyrophosphates removed from nucleoside triphosphates.

9. The continuous elongation of a new DNA strand along one of the template strands of DNA
   a. requires the action of DNA ligase as well as polymerase.
   b. occurs because DNA ligase can only elongate in the 5′ → 3′ direction.
   c. occurs on the leading strand.
   d. occurs on the lagging strand.
   e. a, b, and c are correct.

10. Which of the following statements about DNA polymerase is *incorrect*?
    a. It forms the bonds between complementary base pairs.
    b. It is able to proofread and correct errors in base pairing.
    c. It is unable to initiate synthesis; it requires an RNA primer.
    d. It only works in the 5′ → 3′ direction.
    e. It is found in eukaryotes and prokaryotes.

11. Thymine dimers—covalent links between adjacent thymine bases in DNA—may be induced by UV light. When these dimers occur, they are repaired by
    a. excision enzymes (nucleases).
    b. DNA polymerase.
    c. ligase.
    d. primase.
    e. a, b, and c are all needed.

12. How does DNA synthesis along the lagging strand differ from that on the leading strand?
    a. Nucleotides are added to the 5′ end instead of the 3′ end.
    b. Ligase is the enzyme that polymerizes DNA on the lagging strand.
    c. An RNA primer is needed on the lagging strand but not on the leading strand.
    d. Okazaki fragments, which each grow 5′ → 3′, must be joined along the lagging strand.
    e. Helicase synthesizes Okazaki fragments, which are then joined by ligase.

8. Which of the following is *not* involved in the formation of a eukaryotic transcription initiation complex?
   a. TATA box
   b. transcription factors
   c. snRNA
   d. RNA polymerase II
   e. promoter

9. Which of the following is *true* of RNA processing?
   a. Exons are excised before the mRNA is translated.
   b. The RNA transcript that leaves the nucleus may be much longer than the original transcript.
   c. Assemblies of protein and snRNPs, called spliceosomes, may catalyze splicing.
   d. Large quantities of rRNA are assembled into ribosomes.
   e. Signal peptides are added to the 5′ end of the transcript.

10. All of the following are transcribed from DNA *except*
   a. exons.
   b. introns.
   c. tRNA.
   d. 3′ and 5′ UTRs.
   e. promoter.

11. What might introns have to do with the evolution of new proteins?
   a. The excised introns are transcribed and translated as new proteins by themselves.
   b. Introns are more likely to accumulate mutations than exons, and these mutations then result in the production of novel proteins.
   c. Introns that are self-excising may also function as hydrolytic enzymes for other processes.
   d. Introns provide more area where crossing over may occur (without interfering with the coding sequences) and thus increase the probability of exon shuffling between alleles.
   e. Introns often correspond to domains in proteins that fold independently and have specific functions. Switching domains between nonallelic genes could produce novel proteins.

12. A ribozyme is
   a. an exception to the one gene–one RNA molecule axiom.
   b. an enzyme that adds the 5′ cap and poly-A tail to mRNA.
   c. an example of rearrangement of protein domains caused by RNA splicing.
   d. an RNA molecule that functions as an enzyme.
   e. an enzyme that produces both small and large ribosomal subunits.

13. Which of the following would *not* be found in a bacterial cell?
   a. mRNA
   b. rRNA
   c. snRNA
   d. RNA polymerase
   e. simultaneous transcription and translation

14. Which of the following is transcribed and then translated to form a protein product?
   a. a gene for tRNA
   b. an intron
   c. a gene for a transcription factor
   d. 5′ and 3′ UTRs
   e. a gene for rRNA

15. Transfer RNA
   a. translocates a growing polypeptide destined for export to the endoplasmic reticulum.
   b. binds to its specific amino acid in the active site of an aminoacyl-tRNA synthetase.
   c. has catalytic activity and is thus a ribozyme.
   d. is translated from mRNA.
   e. is produced in the nucleolus.

16. Place the following events in the synthesis of a polypeptide in the proper order.
   1. A peptide bond forms.
   2. An aminoacyl tRNA matches its anticodon to the codon in the A site.
   3. A tRNA translocates from the A site to the P site, and an unattached tRNA exits from the E site.
   4. The large subunit attaches to the small subunit, with the initiator tRNA in the P site.
   5. A small subunit binds to an mRNA and an initiator tRNA.

   a. 4-5-3-2-1
   b. 4-5-2-1-3
   c. 5-4-3-2-1
   d. 5-4-1-2-3
   e. 5-4-2-1-3

17. Translocation in the process of translation involves
   a. the hydrolysis of GTP.
   b. movement of the tRNA in the A site to the P site.
   c. movement along the mRNA a distance of one triplet.
   d. the release of the unattached tRNA from the E site.
   e. all of the above.

18. Which of the following type of molecule catalyzes the formation of a peptide bond?
   a. RNA polymerase
   b. tRNA
   c. mRNA
   d. aminoacyl-tRNA synthetase
   e. proteinase

Test Your Knowledge

MULTIPLE CHOICE: *Choose the one best answer.*

1. Inducible enzymes
   a. are usually involved in anabolic pathways.
   b. are produced when a small molecule inactivates the repressor protein.
   c. are produced when an activator molecule enhances the attachment of RNA polymerase to the operator.
   d. are regulated by inherently inactive repressor molecules.
   e. are regulated almost entirely by feedback inhibition.

2. In *E. coli*, tryptophan switches off the *trp* operon by
   a. inactivating the repressor protein.
   b. inactivating the gene for the first enzyme in the pathway (feedback inhibition).
   c. binding to the repressor and increasing the latter's affinity for the operator.
   d. binding to the operator.
   e. binding to the promoter.

3. In the control of gene expression in bacteria, a regulatory gene
   a. has its own promoter.
   b. is transcribed continuously.
   c. is not contained in the operon it controls.
   d. codes for repressor proteins.
   e. is or does all of the above.

4. A mutation that renders nonfunctional the product of a regulatory gene for a repressible operon would result in
   a. continuous transcription of the genes of the operon.
   b. complete blocking of the attachment of RNA polymerase to the promoter.
   c. irreversible binding of the repressor to the operator.
   d. no difference in transcription rate when an activator protein was present.
   e. negative control of transcription.

5. The control of gene expression is more complex in eukaryotic cells because
   a. DNA is associated with protein.
   b. gene expression differentiates specialized cells.
   c. the chromosomes are linear and more numerous.
   d. operons are controlled by more than one promoter region.
   e. inhibitory or activating molecules may help regulate transcription.

6. DNA methylation of cytosine residues
   a. initiates the acetylation of histones.
   b. may be a mechanism of epigenic inheritance when methylation patterns are repeated in daughter cells.
   c. occurs in the promoter region and enhances binding of RNA polymerase.
   d. is a signal for proteasomes to degrade a protein.
   e. may be related to the transformation of proto-oncogenes to oncogenes.

7. Which of the following is *not* true of enhancers?
   a. They may be located thousands of nucleotides upstream from the genes they affect.
   b. When bound with activators, they interact with the promoter region and other transcription factors to produce an initiation complex.
   c. They may complex with steroid-activated receptor proteins, which selectively activate specific genes.
   d. They may coordinate the transcription of enzymes involved in the same metabolic pathway when they contain the same combination of control elements.
   e. Each gene may have several enhancers, and each enhancer may be associated with and regulate several genes.

8. Which of the following is *not* an example of the control of gene expression after transcription?
   a. mRNA stored in the cytoplasm needing activation of translation initiation factors
   b. the length of time mRNA lasts before it is degraded
   c. rRNA genes amplified in multiple copies in the genome
   d. alternative RNA splicing before mRNA leaves the nucleus
   e. splicing or modification of a polypeptide

9. A eukaryotic gene typically has all of the following associated with it *except*
   a. a promoter.
   b. an operator.
   c. enhancers.
   d. introns and exons.
   e. control elements.

10. Which of the following would you expect to find as part of a receptor protein that binds with a steroid hormone?
    a. a TATA box
    b. a domain that binds to DNA and protein-binding domains
    c. an activated operator region that allows attachment of RNA polymerase
    d. an enhancer sequence located at some distance upstream or downstream from the promoter
    e. transmembrane domains that facilitate the protein's localization in a plasma membrane

CH 18

11. Proteasomes are
    a. complexes of proteins that excise introns.
    b. single-stranded RNA molecules complexed with proteins that block translation of or degrade mRNA.
    c. small, positively charged proteins that form the core of nucleosomes.
    d. enormous protein complexes that degrade proteins marked with ubiquitin.
    e. complexes of transcription factors whose protein-protein interactions are required for enhancing gene transcription.

12. Which of the following statements explains why a larger portion of the DNA in a eukaryotic cell is transcribed than would be predicted by the number of proteins made by the cell?
    a. Multiple enhancer regions are being transcribed to amplify the transcription of protein-coding genes.
    b. Much of this non-protein-coding RNA functions to regulate the translation or degradation of mRNAs.
    c. Many of these transcriptions produce double-stranded siRNAs that regulate the transcription of other genes.
    d. The additional DNA that is transcribed represents introns that are excised from the primary transcript in the production of mRNA.
    e. These transcriptions are of noncoding "junk" DNA that is a remnant of mutated protein-coding segments, and the transcripts are degraded by nuclear enzymes.

13. Which of the following is *not* descriptive of small ncRNAs?
    a. They are thought to have facilitated the evolution of morphological complexity.
    b. The inhibition of gene expression by RNA was first observed experimentally and called RNA interference (RNAi).
    c. The newly discovered piRNAs induce heterochromatin formation, and evidence indicates that they are the most recent ncRNA to have evolved.
    d. The regulatory functions of ncRNAs include effects on both transcription and translation.
    e. They are often found in "transcription factories" within an interphase nucleus, where they loosen loops of chromatin and enhance transcription of genes on multiple chromosomes.

14. Which of the following descriptions is *not* part of the process by which miRNA regulates gene expression?
    a. A long miRNA transcript folds on itself, forming loops called hairpins.
    b. An enzyme cuts the hairpins, and dicer trims the ends.
    c. One strand is degraded, and the remaining RNA strand associates with proteins.
    d. If the miRNA and an mRNA molecule are complementary all along their length, the miRNA is degraded and translation proceeds.
    e. If the match between the miRNA and an mRNA is less complete, then translation is blocked.

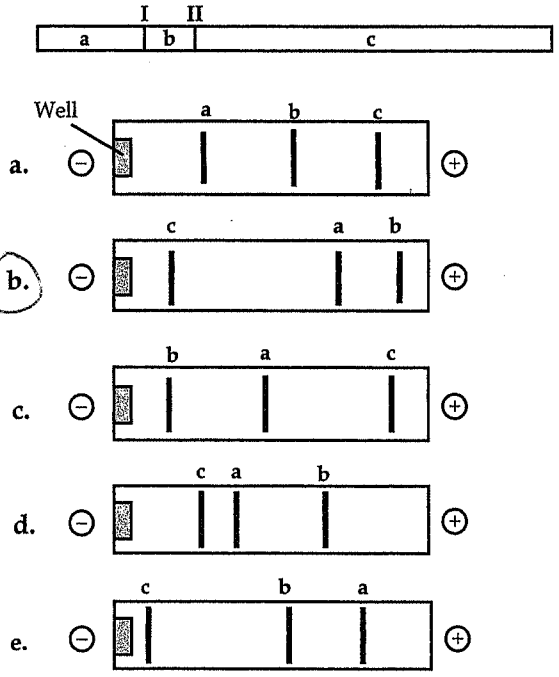
15. Cytoplasmic determinants are
    a. unevenly distributed cytoplasmic components of an unfertilized egg.
    b. often involved in transcriptional regulation.
    c. usually separated in the first few mitotic divisions following fertilization.
    d. maternal contributions that help to direct the initial stages of development.
    e. all of the above.

16. Pattern formation in animals is based on
    a. positional information a cell receives from gradients of morphogens.
    b. the induction of cells by the nurse cells in the mother's ovary.
    c. the packing of chromatin in the nucleus.
    d. the differentiation of cells that then migrate together to form tissues and organs.
    e. the first few mitotic divisions.

17. What would be the fate of a *Drosophila* larva that inherits two copies of a mutant *bicoid* gene (one mutant allele from each heterozygous parent)?
    a. It develops two heads, one at each end of the larva.
    b. It develops two tails, one at each end of the larva.
    c. It develops normally but, if female, produces mutant larvae that have two tail regions.
    d. It develops into an adult with legs growing out of its head.
    e. It receives no *bicoid* mRNA from the nurse cells of its mother.

18. In the following hypothetical embryo, a high concentration of a morphogen called morpho is needed to activate gene *P*; gene *Q* is active at or above medium concentrations of morpho; and gene *R* is expressed so long as any quantity of morpho is present. A different morphogen, called phogen, activates gene *S* and inactivates gene *Q* when at medium to high concentrations. If morpho and phogen are diffusing from their sites of production at the opposite ends of the embryo, which genes will be expressed in region 2 of this embryo? (Assume a gradient of morphogen concentrations in the three

6. The following segment of DNA has restriction sites I and II, which create restriction fragments a, b, and c. Which of the following gels produced by electrophoresis would represent the separation and identity of these fragments?



7. Which of the following processes or procedures does *not* involve any nucleic acid hybridization?
   a. separation of fragments by gel electrophoresis
   b. Southern blotting
   c. polymerase chain reaction
   d. DNA profiling
   e. DNA microarray assay

8. Which of the following statements is *not* true of restriction sites?
   a. Modification by methylation of bases within them prevents restriction of bacterial DNA.
   b. They are usually symmetrical sequences of four to eight nucleotides.
   c. They signal the attachment of RNA polymerase.
   d. Each is cut by a specific restriction enzyme.
   e. Cutting one in the middle of a functional and identifiable gene is used to screen clones that have taken up foreign DNA.

9. Which of the following statements describes a difficulty in getting prokaryotic cells to express eukaryotic genes?
   a. The signals that control gene expression are different, and prokaryotic promoter regions must be added to the vector.
   b. The genetic code differs because prokaryotes substitute the base uracil for thymine.
   c. Prokaryotic cells cannot transcribe introns because their genes do not have them.
   d. The ribosomes of prokaryotes are not large enough to handle long eukaryotic genes.
   e. The RNA splicing enzymes of bacteria work differently from those of eukaryotes.

10. Complementary DNA does not create as complete a library of genes as the shotgun approach because
   a. it has eliminated introns from the genes.
   b. a cell produces mRNA for only a small portion of its genes.
   c. the shotgun approach produces more restriction fragments.
   d. cDNA is not as easily integrated into plasmids.
   e. reverse transcriptase cannot transcribe introns.

Use the following choices to answer questions 11–14.
   a. restriction enzyme
   b. reverse transcriptase
   c. DNA ligase
   d. DNA polymerase
   e. RNA polymerase

11. Which is the last enzyme involved in making recombinant plasmids?

12. Which is the first enzyme used in the production of cDNA?

13. Which enzyme is used in the polymerase chain reaction?

14. Which is the first enzyme used in the production of RFLPs?

15. You are attempting to introduce a gene that imparts resistance to larval moths in bean plants. Which of the following vectors are you most likely to use?
   a. phage DNA
   b. *E. coli* plasmid
   c. Ti plasmid
   d. yeast plasmid
   e. bacterial artificial chromosome

16. STRs (short tandem repeats) are a valuable tool for
   a. DNA microarray assays.
   b. infecting plant cells with recombinant DNA.
   c. acting as probes in Southern blots.
   d. genetic profiling.
   e. PCR to produce multiple copies of a DNA segment.

Ch 19

Test Your Knowledge

MULTIPLE CHOICE: *Choose the one best answer.*

1. The study of viruses has provided information on all of the following topics *except*
   a. the molecular biology of all organisms.
   b. the sexual replicative cycles of viruses.
   c. new techniques for manipulating genes.
   d. the causes of diseases.
   e. the role of mutation in the relationship between host and virus.

2. Beijerinck concluded that the cause of tobacco mosaic disease was not a filterable toxin because
   a. the infectious agent could not be cultivated on nutrient media.
   b. a plant sprayed with filtered sap would develop the disease.
   c. the infectious agent could be crystallized.
   d. the infectious agent replicated and could be passed on from a plant infected with filtered sap.
   e. the filtered sap was infectious even though microbes could not be found in it.

3. Viral genomes may be any of the following *except*
   a. single-stranded DNA.
   b. double-stranded RNA.
   c. misfolded infectious proteins.
   d. a linear single-stranded RNA molecule.
   e. a circular double-stranded DNA molecule.

4. The reverse transcriptase carried by retroviruses
   a. uses viral RNA as a template for making complementary RNA strands.
   b. protects viral DNA from degradation by restriction enzymes.
   c. destroys the host cell DNA.
   d. translates RNA into proteins.
   e. uses viral RNA as a template for DNA synthesis.

5. Virus particles are formed from capsid proteins and nucleic acid molecules
   a. by spontaneous self-assembly.
   b. at the direction of viral enzymes.
   c. using host cell enzymes.
   d. using ATP stored in the tail piece.
   e. by both b and d.

6. A virus has a base ratio of (A + G)/(U + C) = 1. What type of virus is this?
   a. a single-stranded DNA virus
   b. a single-stranded RNA virus
   c. a double-stranded DNA virus
   d. a double-stranded RNA virus
   e. a retrovirus

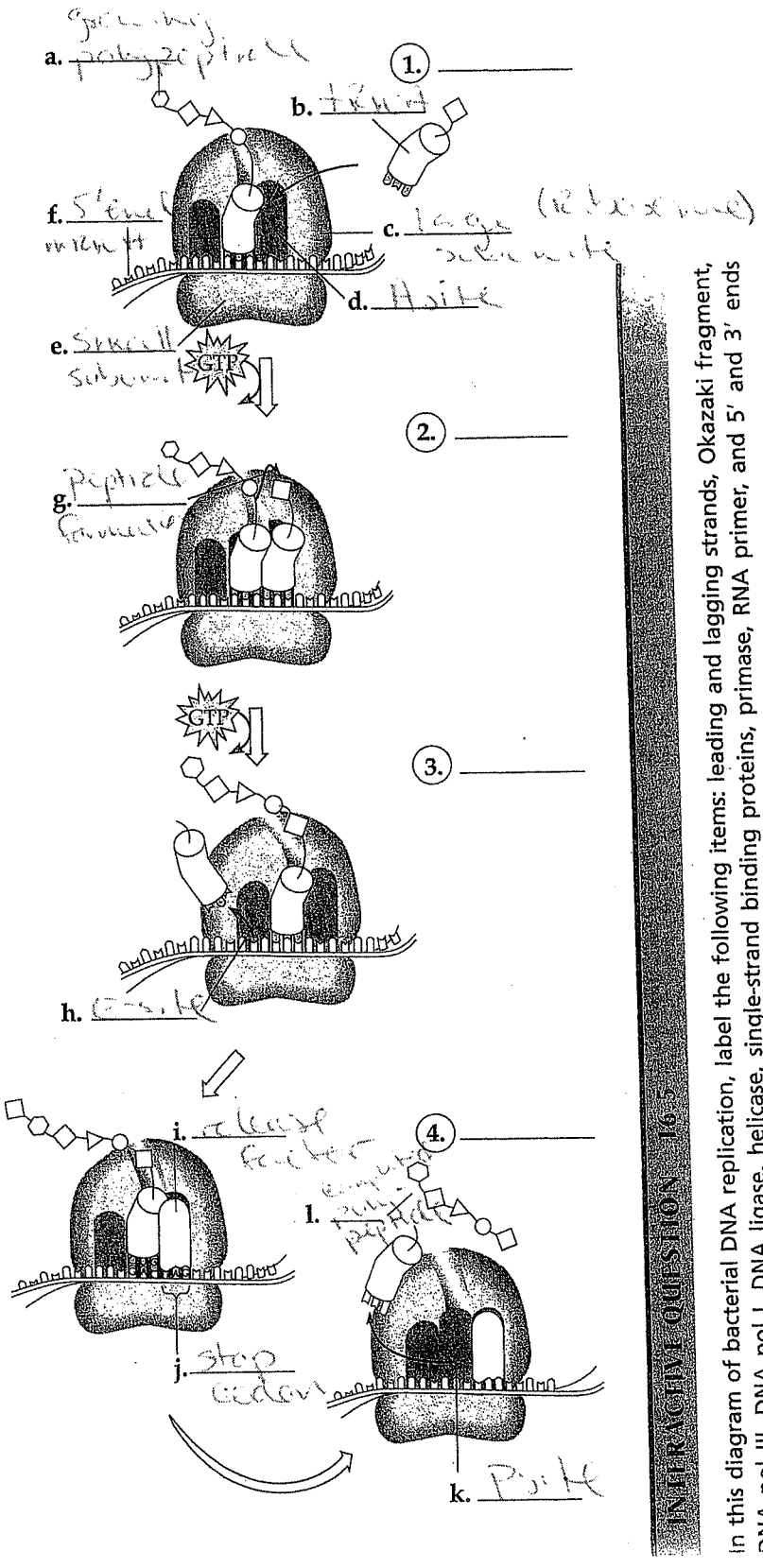
7. Vertical transmission of a plant virus involves
   a. movement of viral particles through plasmodesmata.
   b. inheritance of an infection from a parent.
   c. a bacteriophage transmitting viral particles.
   d. insects carrying viral particles between plants.
   e. the transfer of filtered sap.

8. Bacteria defend against viral infection
   a. with antibiotics they produce.
   b. with restriction enzymes that chop up foreign DNA.
   c. through thetransfer of R plasmids.
   d. with reverse transcriptase.
   e. through the incorporation of viral DNA into the bacterial chromosome.

9. Drugs that are effective in treating viral infections
   a. induce the body to produce antibodies.
   b. inhibit the action of viral ribosomes.
   c. interfere with the synthesis of viral nucleic acid.
   d. change the cell-recognition sites on the host cell.
   e. are vaccines that stimulate the immune system to create immunity.

10. Which of the following is true of prions?
    a. They are emerging viruses.
    b. They are fast-acting infectious agents.
    c. They probably evolved from transposons.
    d. They are infectious proteins that may convert brain proteins into misfolded forms.
    e. They may be transferred between animals by sexual contact.

11. An RNA viral genome may be replicated by
    a. DNA polymerase from the host.
    b. RNA polymerase coded by viral genes and carried in the viral capsid.
    c. reverse transcriptase that synthesizes RNA.
    d. RNA polymerase from the host.
    e. restriction enzymes from the host.



INTERACTIVE QUESTION 16.5

In this diagram of bacterial DNA replication, label the following items: leading and lagging strands, Okazaki fragment, DNA pol III, DNA pol I, DNA ligase, helicase, single-strand binding proteins, primase, RNA primer, and 5′ and 3′ ends of parental DNA.