***Brock Biology of Microorganisms, 14e* (Madigan et al.)**
Chapter 4 Molecular Biology

Multiple Choice Questions

1) The functional unit of genetic information is the
A) nucleotide.
B) gene.
C) chromosome.
D) protein.
Chapter Section: 4.1

3) DNA-binding proteins interact predominantly within which portion of a double-stranded DNA helix?
A) major groove
B) minor groove
C) 3' end
D) supercoil
Chapter Section: 4.2

4) AT-rich DNA will denature/melt
A) at a higher temperature than GC-rich DNA.
B) at a lower temperature than GC-rich DNA.
C) usually at the same temperature as GC-rich DNA, with some minor variations.
D) in accordance with the animal or plant from which it was taken.
Chapter Section: 4.2

5) Supercoiling is important for DNA structure, because
A) it holds together the antiparallel strands of DNA in the double helix.
B) it provides energy for transcription.
C) it condenses the DNA so that it can fit inside the cell.
D) it prevents RNA from pairing with DNA in the double helix.
Chapter Section: 4.2

6) Many pharmaceutical drugs specifically inhibit transcription in *Bacteria* but not *Archaea* or *Eukarya*. Why would drugs that inhibit transcription only affect *Bacteria* and not *Archaea* even though they are both prokaryotes?
A) *Archaea* and *Eukarya* have very similar ribosomes that are different than bacterial ribosomes.
B) *Bacteria* lack a nucleus.
C) *Archaea* lack operons.
D) *Archaea* and *Eukarya* have very similar RNA polymerases that are different than bacterial RNA polymerases.
Chapter Section: 4.9

7) How are plasmids different than chromosomes?
A) Plasmids are always small, linear pieces of DNA.
B) Plasmids are composed of single-stranded DNA.

C) Plasmids contain genes that are NOT essential for cellular growth and replication.
D) Plasmids carry unimportant genes that are of little significance for the ecology and metabolism of an organism.
Chapter Section: 4.3

8) Genes that encoded for polymerases, gyrases, ribosomal proteins, and other proteins essential to replication, transcription, and translation are present on
A) chromosomes.
B) plasmids.
C) chromosomes and plasmids.
D) neither chromosomes nor plasmids.
Chapter Section: 4.3

9) DNA replication always proceeds in only one direction because the _____ of the incoming nucleotide is attached to the free _____ of the growing DNA strand.
A) 5'-phosphate / 3'-hydroxyl
B) 3'-phosphate / 5'-hydroxyl
C) 5'-deoxyribose / 3'-base
D) 3'-base / 5'-deoxyribose
Chapter Section: 4.4

10) Which of the following is formed on the lagging strand during DNA synthesis?
A) DNA secondary structures
B) Okazaki fragments
C) RNA polymerase
D) replisomes
Bloom's Taxonomy: Comprehension
Chapter Section: 4.6

11) The template for RNA polymerase is _____, and the new RNA chain is _____ to the template.
A) an independent RNA segment / parallel and identical
B) DNA / antiparallel and complementary
C) an independent RNA segment / antiparallel and complementary
D) DNA / parallel and identical
Chapter Section: 4.7

12) In the process of transcription, promoters are specific sequences of _____ that are recognized by _____.
A) DNA / DNA polymerase
B) RNA / DNA polymerase
C) DNA / sigma factors
D) RNA / ribosomes
Chapter Section: 4.7

13) An example of correct nucleotide pairing is
A) T and U.

B) G and U.
C) A and T.
D) C and U.
Chapter Section: 4.3

14) Stop codons are also called _____ codons.
A) nonsense
B) release factor
C) degeneracy
D) conversion
Chapter Section: 4.11

15) Transfer RNA molecules
A) function to transfer ribonucleotides to RNA polymerase during transcription.
B) function to transfer the correct amino acids to the ribosome during translation.
C) contain codons that bind to ribosomes during translation.
D) are only present in the nucleus or eukaryotes.
Chapter Section: 4.12

16) In all cells, genes are composed of
A) nucleic acids.
B) mRNA.
C) proteins.
D) chaperones.
Chapter Section: 4.1

17) Which of the following is an example of one codon?
A) CATT
B) GCCATT
C) CAG
D) CCGUAA
Chapter Section: 4.11

18) In all cells a gene encodes for
A) a protein (via mRNA).
B) a tRNA.
C) an rRNA.
D) a protein, tRNA, or rRNA depending on the specific gene.
Chapter Section: 4.13

19) Which of the following is NOT correct regarding DNA and RNA synthesis?
A) The overall direction of chain growth is from the 5' to 3' end.
B) Both processes require an RNA primer to begin.
C) The template strand is antiparallel to the newly synthesized strand.
D) DNA is the template for both DNA and RNA synthesis.
Chapter Section: 4.7

20) Termination of RNA synthesis is ultimately determined by
A) exhaustion of RNA polymerase activity.
B) special protein factors.
C) terminases.
D) specific nucleotide sequences on the template strand.
Answer: D
Bloom's Taxonomy: Knowledge
Chapter Section: 4.8

21) The flow of biological information begins with
A) DNA replication.
B) RNA transcription.
C) mRNA translation.
D) transcriptional regulation.
Chapter Section: 4.1

22) DNA participates in protein synthesis through
A) cyclic messengers.
B) direct pairing with amino acids.
C) an RNA intermediate.
D) protein folding.
Chapter Section: 4.1

23) The two strands of the DNA double helix are held together by
A) 5' to 3' attraction.
B) hydrogen bonds between nucleotide bases.
C) codons.
D) peptide bonds between nucleotide bases.
Chapter Section: 4.1

24) In *Bacteria*, a chromosome can be distinguished from a plasmid, because a chromosome is a genetic element that
A) is circular.
B) is linear.
C) encodes for essential functional genes.
D) replicates via a bidirectional fork.
Chapter Section: 4.3

25) Transposable elements are
A) segments of DNA that move from one site to another.
B) transcribed genes.
C) segments of RNA that are involved in transposing DNA into proteins.
D) proteins that aid in the secretion of enzymes out of the cell.
Chapter Section: 4.3

26) In complementary base pairing of DNA, adenine pairs with _____ (or _____ in RNA)

and cytosine always pairs with _____.
A) guanine / uracil / thymine
B) uracil / thymine / guanine
C) thymine / guanine / uracil
D) thymine / uracil / guanine
Chapter Section: 4.2

27) The function of the DNA polymerase is to catalyze
A) the addition of deoxynucleotides.
B) the formation of RNA primers.
C) the addition of ribonucleotides.
D) hydrogen bonding between complementary base pairs.
Chapter Section: 4.4

28) DNA replication is started with a(n) _____, which, in most cases, *in vivo* is a short stretch of _____.
A) promoter / DNA
B) mRNA / RNA
C) primer / RNA
D) ribosome-binding sequence / DNA
Chapter Section: 4.4

29) The function of RNA polymerase is to
A) catalyze the formation of phosphodiester bonds between deoxyribonucleotids.
B) catalyze the formation of phosphodiester bonds between ribonucleotides.
C) cleave mRNA to remove introns.
D) activate tRNAs.
Chapter Section: 4.7

30) Polycistronic transcription units are common in
A) *Archaea.*
B) *Bacteria.*
C) *Eukarya.*
D) both *Archaea* and *Bacteria.*
Chapter Section: 4.9

31) An operon is a useful genetic element, because it
A) encourages the binding of RNA polymerase.
B) allows coordinated expression of multiple related genes in prokaryotes.
C) translates DNA sequence into amino acid sequence.
D) encourages the binding of ribosomes in the correct location.
Chapter Section: 4.4

32) Plasmids often encode for proteins
A) involved in translation.
B) required for cellular growth.
C) that confer resistance to antibiotics.

D) involved in DNA replication.
Chapter Section: 4.3

33) The codon on the _____ matches with the anticodon on the _____ to direct the addition of the correct amino acid to the growing polypeptide chain.
A) mRNA / tRNA
B) tRNA / mRNA
C) DNA / mRNA
D) tRNA / rRNA
Chapter Section: 4.12

34) The structure and function of a protein are determined by its _____ sequence.
A) nucleotide
B) amino acid
C) ribonucleotide
D) translocation
Chapter Section: 4.10

35) Transcription in eukaryotes occurs in the
A) RNA polymerase.
B) endoplasmic reticulum.
C) cytoplasm.
D) nucleus.
Chapter Section: 4.9

36) During DNA replication Okazaki fragments are linked together by_____, an enzyme that creates phosphodiester bonds between nicked fragments of DNA.
A) exopolymerase
B) DNA gyrase
C) topoisomerase
D) DNA ligase
Chapter Section: 4.6

37) Each adenine-thymine base pair has _____ hydrogen bonds, while each guanine-cytosine base pair has _____ hydrogen bonds.
A) two / one
B) two / three
C) four / three
D) three / two
Chapter Section: 4.1

38) In DNA replication there are leading and lagging strands, because
A) DNA replication is conservative and a completely new DNA molecule must be made.
B) DNA replication is semiconservative and each strand is copied simultaneously in opposite directions.
C) the strands of DNA are parallel and are copied in the same direction simultaneously.
D) one strand of DNA is copied faster than the other.

Chapter Section: 4.6

True/False Questions

1) Most prokaryotic genomes are double-stranded circular DNA.
Chapter Section: 4.2

2) In nature, the predominant form of DNA is supercoiled in a negative direction.
Chapter Section: 4.2

3) Genes found on plasmids DO NOT impact metabolism or cellular structures.
Chapter Section: 4.3

4) The genetic material in a virus is technically called a plasmid.
Chapter Section: 4.3

5) DNA replication is bidirectional in prokaryotes with circular chromosomes.
Chapter Section: 4.6

6) RNA acts at both the genetic and the functional levels.
Chapter Section: 4.13

7) RNA is incapable of forming secondary structure.
Chapter Section: 4.12

8) The formation of new DNA does NOT require energy.
Chapter Section: 4.4

9) rRNA has an enzymatic role in all stages of protein synthesis.
Chapter Section: 4.13

10) Throughout the living world, the genetic code is generally universal; however, there are slight variations.
Chapter Section: 4.11

11) DNA replication involves the synthesis of an RNA primer on one strand of the DNA.
Chapter Section: 4.6

Essay Questions

1) You isolate a piece of DNA from a microorganism you cultivated from your teeth. The piece of DNA is 94 kbp is size and is circular. You sequence it and discover that it contains genes for capsule formation, pili, and antibiotic resistance, as well as an origin of replication. What is this piece of DNA and how is it related to the other genetic elements found in prokaryotic cells?
Chapter Section: 4.3

2) The following is the sequence of bases in the sense strand of a DNA segment and contains the

beginning of a gene.

DNA 3' A T A T T A C C A G G C A T G G A C C C C C G G G 5'

Based on this sequence, write the sequence of the anti-sense DNA strand and the mRNA. Label the 5' and 3' ends in your predicted sequences. The start codon in this organism is AUG. Indicate where the start codon is in your sequence. Why is the start codon important? Why does there have to be a specific start codon?
Chapter Section: 4.6

3) What is the basic flow of genetic information in all cellular life? Include in your answer a diagram that illustrates the relationships between the basic components and steps in the flow of genetic information.
Chapter Section: 4.1

4) Explain the difference between transcription and translation and how the processes differ in bacteria and eukaryotes.
Chapter Section: 4.9

5) Explain the concept of semiconservative replication and how simultaneous copying of both strands of DNA is accomplished in prokaryotic cells.
Chapter Section: 4.6

6) Some essential genes and DNA sequences in cells DO NOT encode for proteins but are still essential for cellular growth and replication. Give two examples of a gene or sequence of which this is true and explain why it is essential for growth or replication.
Chapter Section: 4.13

7) Explain the role of sigma factors in RNA synthesis in *Bacteria*.
Chapter Section: 4.8

8) Explain the process of RNA transcription using the terms *upstream*, *Pribnow box*, and *consensus sequence*.
Chapter Section: 4.8

9) Explain how *Escherichia coli* can grow with a doubling time of 20 minutes when chromosome replication takes 40 minutes.
Chapter Section: 4.4

10) Speculate why the half-life of mRNA is short, while the half-lives of rRNA and tRNA are long.
Chapter Section: 4.12

11) Explain why GC-rich DNA requires a higher temperature to denture or melt than AT-rich DNA and hypothesize as to why the GC content of chromosomes in microorganisms from different environments varies widely.
Chapter Section: 4.2