

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 1) Which of the following organelles is specialized for lipid and steroid synthesis? 1) _____
- A) lysosomes
 - B) mitochondria
 - C) peroxisomes
 - D) rough endoplasmic reticulum
 - E) smooth endoplasmic reticulum

Answer: E

- Explanation: A)
B)
C)
D)
E)

- 2) Post-transcriptional processing adds a(n) _____ to the 5' end of the mRNA molecule. 2) _____
- A) CAP B) poly C tail C) poly A tail D) intron E) exon

Answer: A

- Explanation: A)
B)
C)
D)
E)

- 3) During transcription, _____. 3) _____
- A) RNA is synthesized from DNA in the nucleus
 - B) protein is synthesized from RNA in the nucleus
 - C) DNA is synthesized from DNA in the nucleus
 - D) RNA is synthesized from DNA in the cytoplasm
 - E) protein is synthesized from RNA in the cytoplasm

Answer: A

- Explanation: A)
B)
C)
D)
E)

4) _____ is composed of nucleotide polymers with the phosphate of one nucleotide bound to the ribose sugar of another.

4) _____

- A) Ribonucleic acid
- B) Deoxyribonucleic acid
- C) Flavin adenine dinucleotide
- D) Adenosine diphosphate
- E) Guanosine monophosphate

Answer: A

Explanation: A)
B)
C)
D)
E)

5) Which of the following molecules will dissolve readily in water?

5) _____

- A) triglyceride
- B) NaCl
- C) C₆H₁₄
- D) fatty acid
- E) cholesterol

Answer: B

Explanation: A)
B)
C)
D)
E)

6) Continuous with the outer portion of the nuclear pore, this membrane-bound structure functions in the synthesis of secretory proteins, integral membrane proteins, or proteins bound for other organelles.

6) _____

- A) lysosome
- B) nucleolus
- C) smooth endoplasmic reticulum
- D) rough endoplasmic reticulum
- E) mitochondria

Answer: D

Explanation: A)
B)
C)
D)
E)

7) Which of the following properties is true for both DNA and RNA? 7) _____
A) follows the law of complementary base pairing
B) double-stranded
C) contains the base uracil
D) contains the base thymine
E) contains the sugar deoxyribose

Answer: A

Explanation: A)
B)
C)
D)
E)

8) _____ are proteins attached to intermediate filaments in regions where cells are exposed to mechanical stresses. 8) _____
A) Connexins B) Tubulins C) Occludins D) Dyneins E) Cadherins

Answer: E

Explanation: A)
B)
C)
D)
E)

9) Which of the following is NOT a possible destination for proteins synthesized on ribosomes free in the cytosol? 9) _____
A) peroxisome
B) remains in cytosol
C) nucleus
D) secreted from the cell
E) mitochondrion

Answer: D

Explanation: A)
B)
C)
D)
E)

10) _____ are molecules whose general structure includes a carboxyl group, an amine group, a hydrogen molecule, and a residual group. 10) _____
A) Carbohydrates
B) Lipids
C) Amino acids
D) Proteins
E) Nucleotides

Answer: C

Explanation: A)
B)
C)
D)
E)

11) During translation, _____ is synthesized in the _____.

11) _____

- A) DNA : nucleus
- B) RNA : nucleus
- C) protein : cytoplasm
- D) protein : nucleus
- E) RNA : cytoplasm

Answer: C

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

12) What causes DNA to uncoil during transcription?

12) _____

- A) binding of RNA polymerase to the promoter sequence
- B) binding of helicase to the DNA
- C) binding of tRNA to the initiator codon
- D) binding of DNA polymerase to the leader sequence
- E) binding of ubiquitin to the DNA

Answer: A

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

13) Which of the following components of the plasma membrane forms ion channels?

13) _____

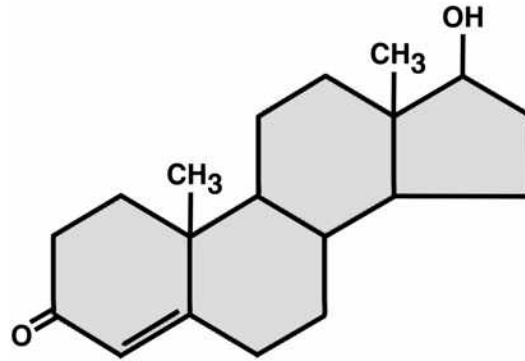
- A) integral membrane proteins
- B) carbohydrates
- C) peripheral membrane proteins
- D) phospholipids
- E) cholesterol

Answer: A

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

14) Based on the following figure, what type of molecule is this?

14) _____



- A) steroid
- B) phospholipid
- C) fatty acid
- D) amino acid
- E) nucleotide

Answer: A

Explanation: A)
B)
C)
D)
E)

15) _____ are membrane-bound organelles that contain enzymes like catalase, which catalyzes the breakdown of H₂O₂ to H₂O and O₂.

15) _____

- A) Ribosomes
- B) Vaults
- C) Peroxisomes
- D) Lysosomes
- E) Mitochondria

Answer: C

Explanation: A)
B)
C)
D)
E)

16) The _____ is the site of ribosomal RNA production.

16) _____

- A) lysosome
- B) nucleus
- C) nucleolus
- D) mitochondria
- E) cytosol

Answer: C

Explanation: A)
B)
C)
D)
E)

17) Which of the following molecules is a polymer?

17) _____

- A) both protein and nucleic acid
- B) protein, nucleic acid, and glycogen
- C) protein only
- D) nucleic acid only
- E) glycogen only

Answer: B

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

18) Which of the following is found in DNA but not RNA?

18) _____

- A) both adenine and thymine
- B) adenine only
- C) thymine only
- D) deoxyribose only
- E) both thymine and deoxyribose

Answer: E

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

19) What organelle synthesizes most of the ATP used by cells?

19) _____

- A) Golgi apparatus
- B) lysosomes
- C) peroxisomes
- D) mitochondria
- E) ribosomes

Answer: D

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

20) Secondary protein structure is the result of _____.

20) _____

- A) van der Waals forces
- B) hydrogen bonds
- C) covalent bonds
- D) ionic bonds
- E) all of the above

Answer: B

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

21) _____ are molecules composed of a glycerol and three fatty acids.

21) _____

- A) Phospholipids
- B) Saturated fatty acids
- C) Steroids
- D) Triglycerides
- E) Eicosanoids

Answer: D

Explanation: A)
B)
C)
D)
E)

22) _____ are proteins that form channels between cells, allowing ions and small molecules to diffuse directly from one cell to the other.

22) _____

- A) Connexins
- B) Cadherins
- C) Occludins
- D) Tubulins
- E) Dyneins

Answer: A

Explanation: A)
B)
C)
D)
E)

23) During what phase of cell division do two new nuclear envelopes begin to redevelop?

23) _____

- A) telophase
- B) metaphase
- C) interphase
- D) anaphase
- E) prophase

Answer: A

Explanation: A)
B)
C)
D)
E)

24) During what phase of the cell cycle does cellular replication of DNA occur?

24) _____

- A) S
- B) mitosis
- C) G₁
- D) G₂
- E) G₀

Answer: A

Explanation: A)
B)
C)
D)
E)

25) Which of the following statements about the genetic code is true?

25) _____

- A) A single codon may code for more than one amino acid.
- B) The tRNA anticodon is complementary to the mRNA codon, and therefore is ALWAYS identical to the DNA triplet word.
- C) A single gene contains only those nucleotides that code for a single protein.
- D) The promoter sequence is found on the antisense strand of DNA.
- E) Termination codons do not code for amino acids.

Answer: E

Explanation: A)
B)
C)
D)
E)

26) What functions as a marker to direct proteins to proteasomes that degrade proteins?

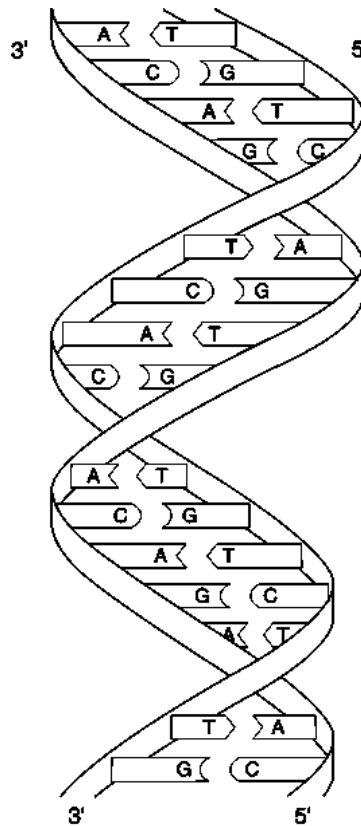
26) _____

- A) The A site
- B) AUG
- C) Ubiquitin
- D) Protease
- E) Polymerase

Answer: C

Explanation: A)
B)
C)
D)
E)

Figure 2.1



Using Figure 2.1, answer the following questions:

- 27) In Figure 2.1, _____ between phosphate and carbohydrate of the nucleotides hold the backbone of the DNA strands together. 27) _____
- A) disulfide bridges
 - B) hydrogen bonds
 - C) van der Waals forces
 - D) ionic bonds
 - E) covalent bonds

Answer: E

Explanation: A)
B)
C)
D)
E)

28) _____ act(s) as the precursor to steroid molecules, many of which function as hormones.

28) _____

- A) Saturated fatty acids
- B) Cholesterol
- C) Unsaturated fatty acids
- D) Eicosanoids
- E) Phospholipids

Answer: B

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

29) Which of the organelles contains its own DNA?

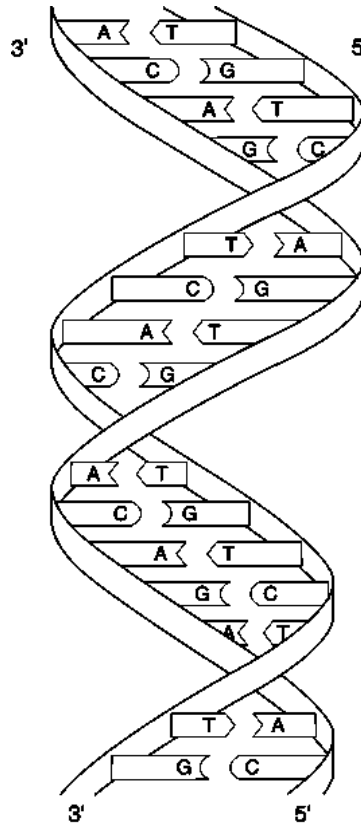
29) _____

- A) mitochondria
- B) smooth endoplasmic reticulum
- C) rough endoplasmic reticulum
- D) lysosomes
- E) Golgi apparatus

Answer: A

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

Figure 2.1



Using Figure 2.1, answer the following questions:

- 30) Based upon the number of nucleotides, how many amino acids will be formed from the DNA strand shown in Figure 2.1? 30) _____
- A) 7 B) 3 C) 5 D) 2 E) 50

Answer: C

Explanation: A)
B)
C)
D)
E)

- 31) The protein _____ is responsible for generating force as microtubular proteins slide past one another. 31) _____
- A) tubulin B) dynein C) actin D) myosin E) keratin

Answer: B

Explanation: A)
B)
C)
D)
E)

32) The _____ is the site where lipids, triglycerides, and steroids are synthesized, as well as where calcium is stored within the cell. 32) _____

- A) smooth endoplasmic reticulum
- B) nucleolus
- C) rough endoplasmic reticulum
- D) mitochondria
- E) lysosome

Answer: A

Explanation: A)
B)
C)
D)
E)

33) Which of the following is an INCORRECT description of the function of the organelle? 33) _____

- A) Breakdown of phagocytosed debris occurs in the peroxisomes.
- B) Calcium is stored in the smooth endoplasmic reticulum.
- C) ATP synthesis occurs in the mitochondria.
- D) Peptide hormone synthesis occurs in the rough endoplasmic reticulum.
- E) Packaging of secretory products into vesicles occurs in the Golgi apparatus.

Answer: A

Explanation: A)
B)
C)
D)
E)

34) _____ are membrane-bound organelles containing enzymes that degrade cellular and extracellular debris. 34) _____

- A) Vaults
- B) Lysosomes
- C) Ribosomes
- D) Mitochondria
- E) Peroxisomes

Answer: B

Explanation: A)
B)
C)
D)
E)

35) _____ are molecules that form the core structure of cell membranes and micelles. 35) _____

- A) Saturated fatty acids
- B) Steroids
- C) Eicosanoids
- D) Triglycerides
- E) Phospholipids

Answer: E

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

36) Which of the following is NOT a function of the initiation factors associated with translation of protein from mRNA? 36) _____

- A) They bind to the CAP group at the 5' end.
- B) They align the first tRNA with the P site on a ribosome.
- C) They form a complex with small ribosomal subunits.
- D) They trigger binding of the small ribosomal subunit to AUG.
- E) They form a complex with charged tRNA.

Answer: B

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

37) Which of the following protects mRNA from degradation in the cytosol? 37) _____

- A) poly A tail B) exons C) RNA CAP D) introns E) ubiquitin

Answer: A

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

38) Which of the following is NOT found in plasma membranes? 38) _____

- A) phospholipids
- B) cholesterol
- C) carbohydrates
- D) proteins
- E) eicosanoids

Answer: E

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

39) Which of the following is NOT a monosaccharide?

39) _____

- A) glucose
- B) deoxyribose
- C) lactose
- D) fructose
- E) galactose

Answer: C

Explanation: A)
B)
C)
D)
E)

40) RNA polymerase binds to a _____ to initiate the process of _____.

40) _____

- A) gene : translation
- B) triplet : translation
- C) leader sequence : transcription
- D) leader sequence : translation
- E) promoter sequence : transcription

Answer: E

Explanation: A)
B)
C)
D)
E)

41) The strand of DNA that gets transcribed to mRNA is called the _____.

41) _____

- A) sense strand
- B) exon strand
- C) promoter sequence
- D) ribophorin
- E) intron strand

Answer: A

Explanation: A)
B)
C)
D)
E)

42) Formation of peptide bonds occurs by _____ reactions between a(n) _____ and a(n) _____.

42) _____

- A) hydrolysis : amino acid : amino acid
- B) hydrolysis : fatty acid : glycerol
- C) condensation : fatty acid : glycerol
- D) oxidation : glucose : glucose
- E) condensation : amino acid : amino acid

Answer: E

Explanation: A)
B)
C)
D)
E)

43) Glycogen _____. 43) _____
A) forms the regulatory molecules known as enzymes
B) is an important storage polysaccharide found in animal tissues
C) contains the genetic information found in cells
D) serves as a structural component of human cells
E) helps to protect vital organs from damage

Answer: B

Explanation: A)
B)
C)
D)
E)

44) Which of the following is NOT a function of nucleotides? 44) _____
A) Nucleotides are necessary for expression of the genetic code.
B) Nucleotides provide electrons to the electron transport chain.
C) Nucleotides provide substrates for the citric acid cycle.
D) Nucleotides store the genetic code.
E) Nucleotides provide most of the energy for cellular processes.

Answer: C

Explanation: A)
B)
C)
D)
E)

45) Intercellular communication can occur through the binding of a chemical released from one cell to a specific _____ on another cell. 45) _____
A) clathrin-coated vesicle
B) nucleus
C) organelle
D) receptor
E) phagosome

Answer: D

Explanation: A)
B)
C)
D)
E)

46) Which of the following statements about the genetic code is FALSE? 46) _____
A) There is one initiator codon that codes for an amino acid.
B) There are 3 termination codons that do not code for amino acids.
C) Each amino acid is coded for by only one codon.
D) mRNA is read 3 bases at a time, which are called codons.
E) Each codon is specific for only one amino acid.

Answer: C

Explanation: A)
B)
C)
D)
E)

47) Which of the following filaments is found in cilia and flagella? 47) _____
A) microfilaments and microtubules
B) microfilaments and intermediate filaments
C) microfilaments only
D) microtubules only
E) intermediate filaments only

Answer: D

Explanation: A)
B)
C)
D)
E)

48) The initiator codon is composed of the sequence _____. 48) _____
A) CCC B) CCG C) UUG D) AUG E) AAC

Answer: D

Explanation: A)
B)
C)
D)
E)

49) _____ are proteins that fuse adjacent cells together to form a nearly impermeable barrier. 49) _____
A) Tubulins B) Cadherins C) Connexins D) Syneins E) Occludins

Answer: E

Explanation: A)
B)
C)
D)
E)

50) Which of the following is an example of a fibrous protein? 50) _____
A) insulin
B) growth hormone
C) collagen
D) Na⁺/K⁺ pumps
E) hemoglobin

Answer: C

Explanation: A)
B)
C)
D)
E)

51) Which of the following is an INCORRECT association between a molecule and its chemical property? 51) _____

- A) monosaccharide : hydrophilic
- B) fatty acid : amphipathic
- C) DNA : polymer of nucleotides
- D) ATP : nucleotide
- E) steroid : derived from cholesterol

Answer: B

Explanation: A)
B)
C)
D)
E)

52) Which of the following is NOT a base in RNA? 52) _____

- A) thymine
- B) uracil
- C) cytosine
- D) adenine
- E) guanine

Answer: A

Explanation: A)
B)
C)
D)
E)

53) Each of the following statements concerning hydrogen bonds is true except one. Identify the exception. 53) _____

- A) Hydrogen bonds can occur within a single molecule.
- B) Hydrogen bonds are strong attractive forces between hydrogen atoms and negatively charged atoms.
- C) Hydrogen bonds can form between neighboring molecules.
- D) Hydrogen bonds are responsible for many of the unique properties of water.
- E) Hydrogen bonds are important forces for tertiary structure of proteins.

Answer: B

Explanation: A)
B)
C)
D)
E)

54) Which of the following molecule types is NOT a polymer? 54) _____

- A) fatty acid
- B) glycogen
- C) protein
- D) DNA
- E) RNA

Answer: A

Explanation: A)
B)
C)
D)
E)

55) Glycogen is an example of a _____.

55) _____

- A) nucleic acid
- B) nucleotide
- C) steroid
- D) fatty acid
- E) polysaccharide

Answer: E

Explanation: A)
B)
C)
D)
E)

56) The layer of carbohydrates on the external surface of a cell is called what?

56) _____

- A) glycogen
- B) inclusion
- C) desmosome
- D) glycocalyx
- E) glycolipid

Answer: D

Explanation: A)
B)
C)
D)
E)

57) Which of the following molecules is a disaccharide?

57) _____

- A) lactose
- B) glucose
- C) glycogen
- D) fructose
- E) galactose

Answer: A

Explanation: A)
B)
C)
D)
E)

58) Which cytoskeletal proteins provide the structural support for microvilli?

58) _____

- A) centrioles
- B) microtubules
- C) microfilaments
- D) tight junctions
- E) intermediate filaments

Answer: C

Explanation: A)
B)
C)
D)
E)

59) What type of junction would you expect to find most commonly in the intestinal tract, where exchange across epithelium is common?

59) _____

- A) tight junctions
- B) I junctions
- C) loose junctions
- D) desmosomes
- E) gap junctions

Answer: A

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

60) Which of the following statements about ribosomes is FALSE?

60) _____

- A) Ribosomes contain protein.
- B) Ribosomes can be located in the Golgi apparatus.
- C) Ribosomes contain ribosomal RNA.
- D) Ribosomes are the site of protein synthesis.
- E) Ribosomes can be located free in the cytosol.

Answer: B

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

61) What is special about the P site of a ribosome?

61) _____

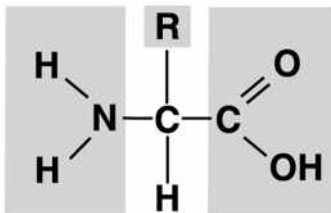
- A) It has the binding site for mRNA.
- B) It holds the tRNA with the next amino acid to be added to the polypeptide chain.
- C) It contains the enzyme that catalyzes formation of a peptide bond.
- D) It causes the ribosome to attach to the endoplasmic reticulum.
- E) It holds the tRNA with the most recent amino acid that has been added to the polypeptide chain.

Answer: E

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

62) What type of molecule is shown below?

62) _____



- A) steroid
- B) amino acid
- C) protein
- D) carbohydrate
- E) nucleotide

Answer: B

Explanation: A)
B)
C)
D)
E)

63) What is the base sequence of the tRNA molecule that recognizes the complementary mRNA molecule?

63) _____

- A) P site
- B) anticodon
- C) codon
- D) A site
- E) initiator codon

Answer: B

Explanation: A)
B)
C)
D)
E)

64) A codon is _____.

64) _____

- A) a series of three nucleotides found in mRNA that codes for an amino acid
- B) a membrane-bound protein that binds hormones
- C) a monosaccharide linked to a disaccharide
- D) a phosphate group attached to a base
- E) the sequence of amino acids within a protein

Answer: A

Explanation: A)
B)
C)
D)
E)

65) Which of the following is NOT a property of smooth endoplasmic reticulum?

65) _____

- A) in liver cells, it contains detoxifying enzymes
- B) contains the enzyme catalase
- C) stores calcium
- D) forms transport vesicles to move proteins to the Golgi apparatus
- E) steroid hormone synthesis

Answer: B

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

66) Where is the genetic code stored?

66) _____

- A) Golgi apparatus
- B) cytoplasm
- C) brain
- D) nucleus
- E) heart

Answer: D

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

67) Each amino acid differs from others in the _____.

67) _____

- A) size of the amino group
- B) number of carboxyl groups
- C) characteristic of the R group
- D) number of peptide bonds in the molecule
- E) number of central carbon atoms

Answer: C

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

68) What organelle packages and directs proteins to their proper destination?

68) _____

- A) smooth endoplasmic reticulum
- B) Golgi apparatus
- C) ribosomes
- D) lysosomes
- E) rough endoplasmic reticulum

Answer: B

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

69) What are Okazaki fragments?

69) _____

- A) termination codons
- B) proteins that target other cell proteins for degradation
- C) initiation factors
- D) sections of RNA prior to splicing
- E) sections of DNA formed during replication

Answer: E

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

70) In the liver, detoxifying enzymes are localized in what organelle?

70) _____

- A) lysosomes
- B) mitochondria
- C) peroxisomes
- D) smooth endoplasmic reticulum
- E) Golgi apparatus

Answer: D

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

71) Post-transcriptional processing adds a(n) _____ to the 3' end of the mRNA molecule.

71) _____

- A) poly A tail
- B) CAP
- C) exon
- D) poly C tail
- E) intron

Answer: A

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

72) The amphipathic property of phospholipids can be described as _____.

72) _____

- A) a polar region that dissolves in water and a nonpolar region that faces away from water
- B) a single polar region that is miscible in aqueous solution
- C) a single nonpolar region that is not miscible in aqueous solution
- D) a nonpolar region that dissolves in water and a polar region that face one another
- E) a nonpolar region facing the outside and a polar region facing the inside of a cell

Answer: A

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

73) Hydrogen bonding between the amino hydrogen of one amino acid and the carboxyl oxygen of another is responsible for which of the following? 73) _____

- A) Twisting the DNA into a helical structure.
- B) Primary protein structure.
- C) Holding the two strands of DNA together by the Law of Complementary Base Pairing.
- D) Secondary protein structure.
- E) Tertiary protein structure.

Answer: D

Explanation: A)
B)
C)
D)
E)

74) The _____ structure of a protein is created by hydrogen bonds between the hydrogen atom on the amine group and the oxygen atom on the carboxyl group. 74) _____

- A) quaternary
- B) primary
- C) quintary
- D) secondary
- E) tertiary

Answer: D

Explanation: A)
B)
C)
D)
E)

75) Protein enters the Golgi apparatus _____. 75) _____

- A) from a transport vesicle that enters the trans face of the Golgi apparatus
- B) from a transport vesicle that enters the cis face of the Golgi apparatus
- C) through a diffusive process
- D) directly from the smooth endoplasmic reticulum
- E) after leaving the rough endoplasmic reticulum

Answer: B

Explanation: A)
B)
C)
D)
E)

76) Which of the following is NOT an amphipathic molecule?

76) _____

- A) phospholipid
- B) glycolipid
- C) glucose
- D) integral membrane protein
- E) connexon

Answer: C

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

77) The leader sequence of a protein that has just been translated functions to _____.

77) _____

- A) keep the protein in the cytosol
- B) end translation of a protein
- C) stimulate translation of a protein
- D) determine the destination of the protein
- E) initiate degradation of an incomplete protein

Answer: D

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

78) Where does RNA polymerase bind to initiate transcription?

78) _____

- A) initiation factor
- B) hormone response element
- C) promoter sequence
- D) P subunit of the ribosome
- E) leader sequence

Answer: C

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

79) What organelle packages proteins into secretory vesicles?

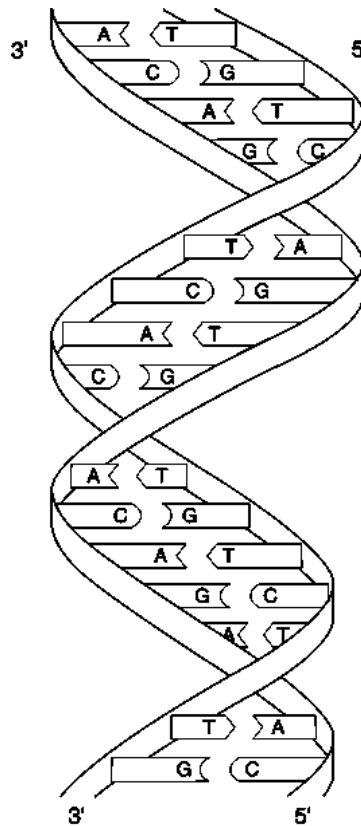
79) _____

- A) Golgi apparatus
- B) rough endoplasmic reticulum
- C) lysosomes
- D) peroxisomes
- E) smooth endoplasmic reticulum

Answer: A

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

Figure 2.1



Using Figure 2.1, answer the following questions:

80) In Figure 2.1, _____ between complementary bases hold the two strands of DNA together.

80) _____

- A) disulfide bridges
- B) hydrogen bonds
- C) van der Waals forces
- D) covalent bonds
- E) ionic bonds

Answer: B

Explanation: A)
B)
C)
D)
E)

81) What is/are the beadlike structure(s) of chromosomes within the nucleus between periods of cell division? 81) _____

- A) Chromophore
- B) Histones
- C) Promoter
- D) Chromatid
- E) Chromatin

Answer: E

Explanation: A)
B)
C)
D)
E)

82) In some cases, signals originating within one cell can diffuse directly to a neighboring cell through _____ 82) _____

- A) occludins
- B) desmosomes
- C) tight junctions
- D) gap junctions
- E) cadherins

Answer: D

Explanation: A)
B)
C)
D)
E)

83) Alpha-helices and β -pleated sheets are examples of _____ structure of a protein. 83) _____

- A) tertiary
- B) primary
- C) pentanary
- D) secondary
- E) quaternary

Answer: D

Explanation: A)
B)
C)
D)
E)

84) The process whereby a complementary mRNA is produced from a DNA template is called _____ 84) _____

- A) transcytosis
- B) transoperon
- C) translation
- D) transcription
- E) post-translational modification

Answer: D

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

85) Following is a list of steps for initiating translation. Put them in the correct order. 85) _____

1. Binding of initiator tRNA to mRNA
2. Binding of large ribosomal subunit to mRNA
3. Binding of small ribosomal subunit to mRNA
4. Binding of tRNA with 2nd amino acid to the A site
5. Formation of covalent bond between methionine and second amino acid

- A) 1, 3, 2, 4, 5 B) 3, 1, 2, 4, 5 C) 1, 2, 3, 4, 5 D) 2, 3, 1, 4, 5 E) 3, 2, 1, 4, 5

Answer: B

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

86) _____ are molecules that contain primarily carbons and hydrogens linked together by nonpolar covalent bonds. 86) _____

- A) Polysaccharides
- B) Proteins
- C) Carbohydrates
- D) Lipids
- E) Nucleotides

Answer: D

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

87) During what phase of the cell cycle is the cell carrying out its normal activity and NOT involved directly in cell division? 87) _____

- A) mitosis B) G₀ C) G₂ D) S E) G₁

Answer: B

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

88) What links sister chromatids together?

88) _____

- A) histones
- B) chromatins
- C) actins
- D) dyneins
- E) centromeres

Answer: E

Explanation: A)
B)
C)
D)
E)

89) _____ are modified fatty acids that function in intercellular communication and include prostaglandins and thromboxanes.

89) _____

- A) Phospholipids
- B) Saturated fatty acids
- C) Eicosanoids
- D) Steroids
- E) Triglycerides

Answer: C

Explanation: A)
B)
C)
D)
E)

90) What enzyme catalyzes the reaction whereby nucleotides are added to the polynucleotide chain during replication?

90) _____

- A) chromatin
- B) histone
- C) RNA polymerase
- D) helicase
- E) DNA polymerase

Answer: E

Explanation: A)
B)
C)
D)
E)

91) During what phase of the cell cycle does rapid protein synthesis occur as the cell grows to double its size.

91) _____

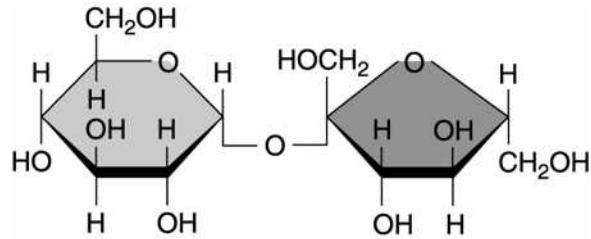
- A) G₁
- B) G₂
- C) mitosis
- D) S
- E) G₀

Answer: B

Explanation: A)
B)
C)
D)
E)

92) What type of molecule is shown in the accompanying figure?

92) _____



- A) fatty acid
- B) disaccharide
- C) amino acid
- D) monosaccharide
- E) phospholipid

Answer: B

Explanation: A)
B)
C)
D)
E)

93) The _____ structure of a protein is formed between residual groups of the amino acid backbone by a number of different chemical interactions, dependent upon the nature of the residual groups interacting.

93) _____

- A) quaternary
- B) secondary
- C) quintary
- D) primary
- E) tertiary

Answer: E

Explanation: A)
B)
C)
D)
E)

94) Which of the following does NOT describe a part of post-transcriptional processing?

94) _____

- A) splicing of nucleic acid fragments
- B) addition of a poly A tail at the 3' end
- C) removal of the introns from the strand
- D) capping of the 5' end
- E) formation of bonds between a phosphate group and a sugar

Answer: E

Explanation: A)
B)
C)
D)
E)

95) Where inside a cell is glycogen stored?

95) _____

- A) mitochondria
- B) smooth endoplasmic reticulum
- C) lysosomes
- D) cytosol
- E) Golgi apparatus

Answer: D

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

96) Keratin is an example of which type of cytoskeletal protein?

96) _____

- A) microfilaments
- B) tight junctions
- C) intermediate filaments
- D) microtubules
- E) centrioles

Answer: C

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

97) When proteins are synthesized by ribosomes on the rough endoplasmic reticulum, where does the translation begin?

97) _____

- A) nucleus
- B) cytosol
- C) rough endoplasmic reticulum
- D) Golgi apparatus
- E) smooth endoplasmic reticulum

Answer: B

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

98) The initiator codon, that originates transcription, codes for the amino acid _____.

98) _____

- A) tyrosine
- B) methionine
- C) arginine
- D) leucine
- E) proline

Answer: B

- Explanation:
- A)
 - B)
 - C)
 - D)
 - E)

99) Ubiquitin tags proteins for what purpose? 99) _____
A) mark for degradation by proteasomes
B) protect from degradation by proteasomes
C) for the protein to be secreted by exocytosis
D) for synthesis to continue on the rough endoplasmic reticulum
E) for the protein to enter the nucleus and alter transcription

Answer: A

Explanation: A)
B)
C)
D)
E)

100) _____ are molecules that are composed of one or more phosphate groups, a 5-carbon sugar, and a nitrogenous base. 100) _____
A) Phospholipids
B) Nucleotides
C) Amino acids
D) Glycoproteins
E) Lipids

Answer: B

Explanation: A)
B)
C)
D)
E)

101) Where are triglycerides synthesized? 101) _____
A) mitochondria
B) smooth endoplasmic reticulum
C) rough endoplasmic reticulum
D) Golgi apparatus
E) cytosol

Answer: B

Explanation: A)
B)
C)
D)
E)

102) Which of the following statements is true?

102) _____

- A) The Golgi apparatus contains the enzyme catalase to break down the hydrogen peroxide it produces when degrading oxygen-derived wastes.
- B) Ribosomes are composed of protein and lipid.
- C) The compositions of the intracellular fluid and extracellular fluid are identical due to the free movement of molecules across the cell membrane.
- D) Proteins to be secreted from the cell are synthesized in the mitochondrial matrix.
- E) The nuclear envelope is continuous with the membrane of the endoplasmic reticulum.

Answer: E

Explanation: A)
B)
C)
D)
E)

103) What is the portion of DNA that codes for a particular protein called?

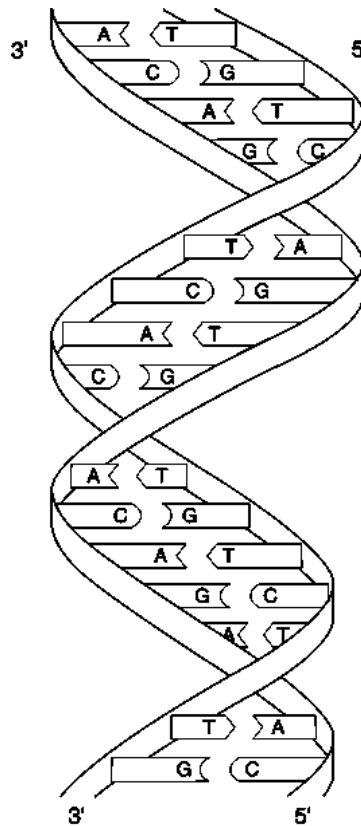
103) _____

- A) codon
- B) triplet
- C) gene
- D) promoter sequence
- E) nucleotide

Answer: C

Explanation: A)
B)
C)
D)
E)

Figure 2.1



Using Figure 2.1, answer the following questions:

- 104) Which of the following nucleotide sequences accurately reflects the mRNA that would be produced from the double-stranded DNA pictured in Figure 2.1? 104) _____
- A) ACAGAGUGACAGAAC
 - B) GTTCTGTCACCTCTGT
 - C) TGTCTCACTGTCTTG
 - D) ACAGAGTGACAGAAC
 - E) UGUCUCACUGUCUUG

Answer: E

Explanation: A)
B)
C)
D)
E)

105) The promoter sequence of the gene is recognized by _____ , which initiates transcription. 105) _____
A) tRNA polymerase
B) RNA polymerase
C) DNA polymerase
D) methioninase
E) helicase

Answer: B

Explanation: A)
B)
C)
D)
E)

106) During what phase of cell division do chromosomes align along the midline? 106) _____
A) prophase
B) interphase
C) telophase
D) metaphase
E) anaphase

Answer: D

Explanation: A)
B)
C)
D)
E)

107) Which of the following is NOT an integral membrane protein? 107) _____
A) channels for ion diffusion across membranes
B) occludins
C) carrier proteins for mediated transport
D) connexons
E) actin

Answer: E

Explanation: A)
B)
C)
D)
E)

108) _____ is a polysaccharide found in animal cells, whereas _____ is a polysaccharide found in plants that can be degraded by humans. 108) _____
A) Galactose : starch
B) Lactose : starch
C) Galactose : cellulose
D) Glycogen : cellulose
E) Glycogen : starch

Answer: E

Explanation: A)
B)
C)
D)
E)

- 109) What strand of mRNA would be transcribed from the following strand of DNA: AATG? 109) _____
A) UUAC B) GGUA C) TTAC D) TTUC E) UUGT
- Answer: A
Explanation: A)
 B)
 C)
 D)
 E)
- 110) Which microtubular proteins are responsible for the distribution of chromosomes during cell division? 110) _____
A) spindle fibers
B) keratin
C) actin
D) myosin
E) tubulin
- Answer: A
Explanation: A)
 B)
 C)
 D)
 E)
- 111) Which of the following chemical groups are necessary components of a nucleotide? 111) _____
A) peptide, phosphate, and carbohydrate
B) carbohydrate, phosphate, and peptide
C) phosphate, carbohydrate, and base
D) carbohydrate, base, and peptide
E) phosphate, peptide, and base
- Answer: C
Explanation: A)
 B)
 C)
 D)
 E)
- 112) Which of the following is NOT a phase of mitosis? 112) _____
A) telophase
B) metaphase
C) prophase
D) anaphase
E) meiosis
- Answer: E
Explanation: A)
 B)
 C)
 D)
 E)

113) Which of the following processes is NOT a post-translational modification that occurs in the endoplasmic reticulum or Golgi apparatus to make proteins functional? 113) _____

- A) the addition of carbohydrates
- B) the addition of lipids
- C) the addition of more amino acids
- D) the removal of the leader sequence
- E) the cleavage of excess amino acids

Answer: C

Explanation: A)
B)
C)
D)
E)

114) Based upon the triplet nature of a codon and the presence of four possible bases, how many possible amino acids might be coded for by mRNA? 114) _____

- A) 32
- B) 64
- C) 128
- D) 8
- E) 16

Answer: B

Explanation: A)
B)
C)
D)
E)

115) Lipophobic molecules that are to be released by cells are stored in membrane-bound structures called _____. 115) _____

- A) inclusions
- B) the endoplasmic reticulum
- C) excretory vesicles
- D) secretory vesicles
- E) the Golgi apparatus

Answer: D

Explanation: A)
B)
C)
D)
E)

116) Which of the following INCORRECTLY describes a polymer? 116) _____

- A) DNA is a polymer of nucleotides.
- B) ATP is a polymer of phosphates.
- C) Starch is a polymer of glucose.
- D) A protein is a polymer of amino acids.
- E) Glycogen is a polymer of glucose.

Answer: B

Explanation: A)
B)
C)
D)
E)

- 117) A mRNA codon is complementary to the DNA _____. 117) _____
- A) gene
 - B) anticodon
 - C) leader sequence
 - D) triplet
 - E) promoter sequence
- Answer: D
- Explanation: A)
B)
C)
D)
E)
- 118) Which of the following is NOT a function of the cytoskeleton? 118) _____
- A) mechanical support
 - B) suspension of organelles
 - C) cellular movement
 - D) contraction
 - E) cellular metabolism
- Answer: E
- Explanation: A)
B)
C)
D)
E)
- 119) The presence of _____ chemical groups makes carbohydrates _____. 119) _____
- A) amino : polar
 - B) hydroxyl : polar
 - C) amino : acidic
 - D) hydroxyl : nonpolar
 - E) carboxyl : polar and acidic
- Answer: B
- Explanation: A)
B)
C)
D)
E)
- 120) During replication, which strand of the new DNA is synthesized from the 5' to 3' strand of original DNA? 120) _____
- A) beginning strand
 - B) leading strand
 - C) trailing strand
 - D) lagging strand
 - E) ending strand
- Answer: B
- Explanation: A)
B)
C)
D)
E)

121) Which of the following is an amphipathic molecule?

121) _____

- A) integral membrane protein
- B) peripheral membrane protein
- C) triglyceride
- D) glycogen
- E) glucose

Answer: A

Explanation: A)
B)
C)
D)
E)

122) The presence of _____ in the plasma membrane can increase the fluidity of the membrane.

122) _____

- A) phospholipids
- B) glycoproteins
- C) cholesterol
- D) integral membrane proteins
- E) peripheral membrane proteins

Answer: C

Explanation: A)
B)
C)
D)
E)

123) A fatty acid that contains three double bonds in its carbon chain is said to be _____.

123) _____

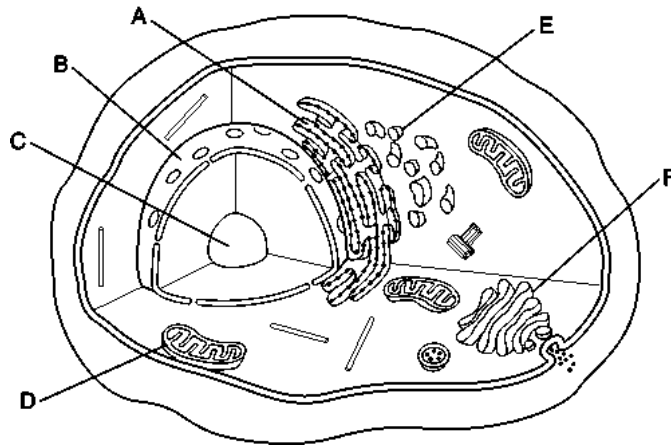
- A) hypersaturated
- B) polyunsaturated
- C) saturated
- D) polysaturated
- E) monounsaturated

Answer: B

Explanation: A)
B)
C)
D)
E)

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

Figure 2.2



Using Figure 2.2, answer the following questions:

124) Identify the organelle referred to as D in the picture of the cell above and give the function of that organelle. 124) _____

Answer: mitochondria—membrane-bound organelle that contains the enzymes of the Krebs cycle and the electron transport chain and is, therefore, involved in the production of cellular energy in the form of ATP

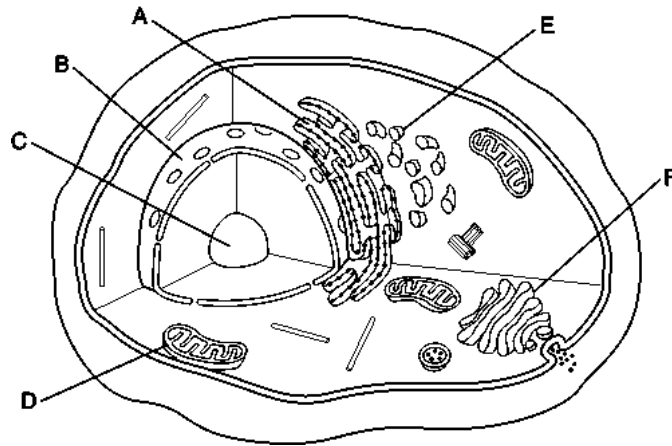
Explanation:

125) What spherical structures are involved in the transport of nonpolar molecules through the aqueous environment and are composed of a phospholipid monolayer? 125) _____

Answer: micelles

Explanation:

Figure 2.2

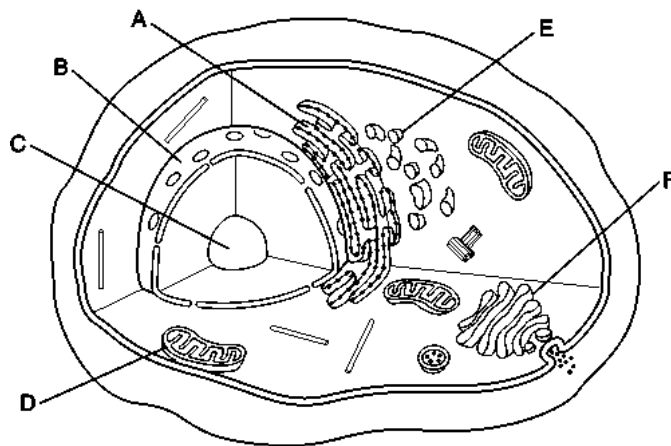


Using Figure 2.2, answer the following questions:

- 126) Identify the organelle referred to as E in the picture of the cell above and give the function of that organelle. 126) _____
 Answer: smooth endoplasmic reticulum—site of lipid synthesis and storage of calcium
 Explanation:
- 127) Components of the electron transport chain are found in what region of a mitochondrion? 127) _____
 Answer: inner mitochondrial membrane
 Explanation:
- 128) Within the nucleus, chromosomes are coiled around these proteins. 128) _____
 Answer: histones
 Explanation:
- 129) What organelle contains catalase? 129) _____
 Answer: peroxisomes
 Explanation:
- 130) Myosin is a type of (microfilament / intermediate filament / microtubule). 130) _____
 Answer: intermediate filament
 Explanation:
- 131) What structural component of mRNA functions to stabilize mRNA, thereby preventing its degradation in the cytoplasm? 131) _____
 Answer: poly A tail
 Explanation:
- 132) Name the two five-carbon sugar molecules that are found in nucleotides. 132) _____
 Answer: ribose, deoxyribose
 Explanation:
- 133) What structure separates the nucleus from the cytosol? 133) _____
 Answer: nuclear envelope
 Explanation:

- 134) Fatty acids are a major component of _____, which are our storage form of lipids and _____, which form the basic structure of cell membranes. 134) _____
 Answer: triglycerides : phospholipids
 Explanation:
- 135) Proteins tagged with the polypeptide _____ are targeted for degradation by a protein complex called a _____. 135) _____
 Answer: ubiquitin : proteasome
 Explanation:
- 136) Molecules that are to be released from the cell can be stored in _____ vesicles. 136) _____
 Answer: secretory
 Explanation:
- 137) Describe the makeup of a triglyceride. 137) _____
 Answer: a glycerol with 3 fatty acids attached
 Explanation:
- 138) Name the two sites on the ribosome where tRNA will bind. 138) _____
 Answer: A and P sites
 Explanation:
- 139) The CAP region of mRNA is necessary for (initiation / termination) of translation. 139) _____
 Answer: initiation
 Explanation:

Figure 2.2



Using Figure 2.2, answer the following questions:

- 140) Identify the organelle referred to as B in the picture of the cell above and give the function of that organelle. 140) _____
 Answer: nucleus—contains the cell's DNA
 Explanation:

141) This enzyme is involved in producing the exact copy of DNA required for cell replication. 141) _____

Answer: DNA polymerase

Explanation:

142) Name the three components of a nucleotide. 142) _____

Answer: 5-carbon carbohydrate, phosphate, base (purine or pyrimidine)

Explanation:

143) Through what structure in the nuclear envelope can mRNA pass through to get into the cytosol? 143) _____

Answer: nuclear pore

Explanation:

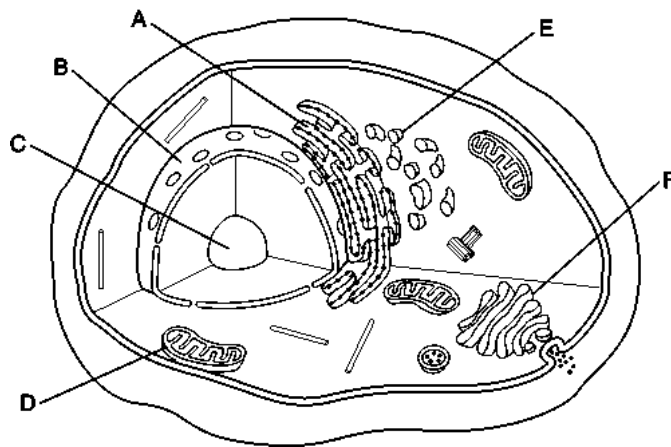
144) Name the five bases found in nucleic acids, and state whether each is a purine or a pyrimidine. 144) _____

Answer: Pyrimidines = cytosine, thymine, and uracil

Purines = adenine and guanosine

Explanation:

Figure 2.2



Using Figure 2.2, answer the following questions:

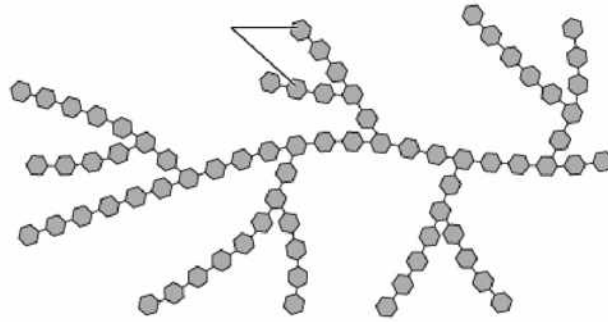
145) Identify the organelle referred to as A in the picture of the cell above and give the function of that organelle. 145) _____

Answer: rough endoplasmic reticulum—synthesis of proteins to be packaged into vesicles

Explanation:

146) What molecule is shown in the figure below?

146) _____



Answer: glycogen

Explanation:

147) What two structural characteristics of proteins are formed by hydrogen bonds between the carboxyl O and the amino H of amino acids within the same protein?

147) _____

Answer: α -helices : β -pleated sheets

Explanation:

148) What are masses in the cytosol of cells that contain glycogen called?

148) _____

Answer: inclusions

Explanation:

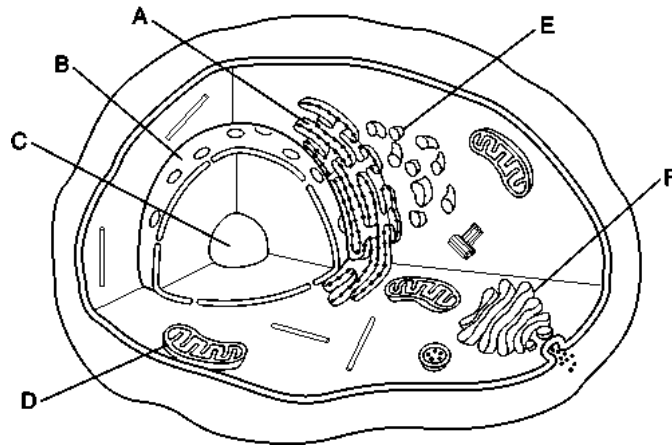
149) What type of integral membrane protein spans the membrane repeatedly, thereby allowing portions of the protein to face the cytosol while other portions of the protein face the extracellular fluid?

149) _____

Answer: transmembrane protein

Explanation:

Figure 2.2



Using Figure 2.2, answer the following questions:

150) Identify the organelle referred to as F in the picture of the cell above and give the function of that organelle. 150) _____

Answer: Golgi apparatus—processes peptides produced within the rough endoplasmic reticulum, packages them in vesicles, and directs them to their ultimate location

Explanation:

151) List the five phases of mitosis. 151) _____

Answer: prophase, prometaphase, metaphase, anaphase, telophase

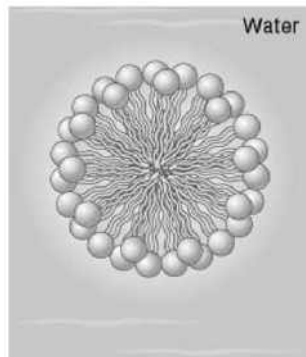
Explanation:

152) What is the innermost chamber of a mitochondrion called? 152) _____

Answer: mitochondrial matrix

Explanation:

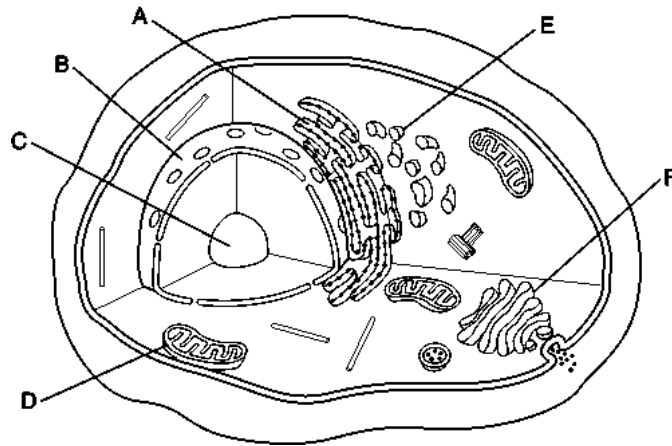
153) Identify the structure below. What type of molecule makes up this structure? 153) _____



Answer: Structure is a micelle. It is composed of phospholipids.

Explanation:

Figure 2.2



Using Figure 2.2, answer the following questions:

154) Identify the organelle referred to as C in the picture of the cell above and give the function of that organelle. 154) _____

Answer: nucleolus—site within the nucleus for the synthesis of rRNA

Explanation:

155) The membrane of the rough endoplasmic reticulum is continuous with what other membrane(s)? 155) _____

Answer: smooth endoplasmic reticulum and nuclear envelope

Explanation:

156) What two types of molecules make up ribosomes? 156) _____

Answer: rRNA : proteins

Explanation:

157) Certain epithelial cells have a decided polarity where the _____ membrane faces the lumen of a hollow tube, whereas the _____ membrane faces the extracellular fluid. 157) _____

Answer: apical : basolateral

Explanation:

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

158) Thymine is a pyrimidine. 158) _____

Answer: True False

Explanation:

159) Movement between cells in an epithelium is called transepithelial transport. 159) _____

Answer: True False

Explanation:

160) The innermost compartment of a mitochondrion is called the matrix. 160) _____

Answer: True False

Explanation:

- 161) The Golgi apparatus sorts and packages proteins into vesicles targeted for their final destination. 161) _____
Answer: True False
Explanation:
- 162) Every adenine nucleotide of DNA will be transcribed into a thymine on the mRNA. 162) _____
Answer: True False
Explanation:
- 163) The exon is cut from the original mRNA sequence, leaving the intron as the portion of mRNA that leaves the nucleus to be translated into a protein. 163) _____
Answer: True False
Explanation:
- 164) Cyclic nucleotides form ring structures due to the covalent bonding between an oxygen of the phosphate group and a carbon of the carbohydrate. 164) _____
Answer: True False
Explanation:
- 165) Microtubules are dynamic structures in that they may form and disassemble repeatedly in a cell. 165) _____
Answer: True False
Explanation:
- 166) The mitotic spindle forms from the centrosome during cell division. 166) _____
Answer: True False
Explanation:
- 167) The semiconservative nature of the replication of DNA means that a new strand is coupled to an old strand. 167) _____
Answer: True False
Explanation:
- 168) The anticodon is complementary to the triplet coding for a particular amino acid. 168) _____
Answer: True False
Explanation:
- 169) The hormone insulin is a peptide hormone consisting of two polypeptides held together by disulfide bridges. 169) _____
Answer: True False
Explanation:
- 170) The mRNA codon UUU codes for the amino acid phenylalanine. Therefore, no other codon can code for phenylalanine. 170) _____
Answer: True False
Explanation:
- 171) Disulfide bridges contribute to the tertiary structure of proteins by covalent bonds between the sulfhydryl groups on two cysteine amino acids. 171) _____
Answer: True False
Explanation:

- 172) Anabolism describes the breakdown of large molecules to smaller molecules. 172) _____
Answer: True False
Explanation:
- 173) Cholesterol is the precursor molecule for all steroids in the body. 173) _____
Answer: True False
Explanation:
- 174) Helicase catalyzes the uncoiling of DNA during transcription. 174) _____
Answer: True False
Explanation:
- 175) Glycoproteins have a glycogen molecule covalently bound to a protein. 175) _____
Answer: True False
Explanation:
- 176) When insulin is first translated by ribosomes, the initial inactive polypeptide that is formed is called preinsulin. 176) _____
Answer: True False
Explanation:
- 177) Each strand of mRNA is translated by one ribosome at a time. 177) _____
Answer: True False
Explanation:
- 178) Vaults direct the development of the mitotic spindle during cell division. 178) _____
Answer: True False
Explanation:
- 179) Proteases break peptide bonds. 179) _____
Answer: True False
Explanation:
- 180) The cytoskeleton suspends the organelles within the cytoplasm. 180) _____
Answer: True False
Explanation:
- 181) Inclusions are intracellular stores of glycogen or triglycerides. 181) _____
Answer: True False
Explanation:
- 182) Bonding between Okazaki fragments forms the lagging strand of DNA. 182) _____
Answer: True False
Explanation:
- 183) Sucrose is a disaccharide composed of a glucose and a lactose molecule. 183) _____
Answer: True False
Explanation:

184) Guanine and cytosine are held together by two hydrogen bonds.

184) _____

Answer: True False

Explanation:

MATCHING. Choose the item in column 2 that best matches each item in column 1.

Match the following descriptions with the correct junction type.

185) Intermediate filaments penetrate the membranes between two cells at the site of protein plaques forming strong linkage between the two cells. A) desmosomes

185) _____

Answer: A

Match the following junctional proteins with the correct junction type.

186) Occludins. A) tight junctions

186) _____

Answer: A

Match the following descriptions with the correct junction type.

187) These junctions are found in epithelial tissue where they prevent paracellular movement of molecules. A) tight junctions

187) _____

Answer: A

Match the following junctional proteins with the correct junction type.

188) Cadherins. A) desmosomes

188) _____

Answer: A

Match the following descriptions with the correct organelle.

189) Proteins are packaged into transport vesicles. A) smooth endoplasmic reticulum

189) _____

Answer: A

Match the following descriptions to the correct level of protein structure.

190) Formed by chemical interactions between R groups within the same polypeptide chain. A) tertiary

190) _____

Answer: A

Match the following descriptions with the correct organelle.

191) Lipids are synthesized here. A) smooth endoplasmic reticulum

191) _____

Answer: A

Match the following descriptions with the correct junction type.

192) These junctions allow the passage of small molecules and ions from the cytosol of one cell to that of a neighboring cell. A) gap junctions

192) _____

Answer: A

Match the following descriptions with the correct organelle.

193) Endocytotic vesicles fuse with this organelle.

Answer: A

A) lysosomes

193) _____

B) mitochondria

194) Most ATP in cells is produced here.

Answer: B

194) _____

Match the following junctional proteins with the correct junction type.

195) Connexons.

Answer: A

A) gap junctions

195) _____

Match the following descriptions with the correct organelle.

196) The enzyme catalase is located here.

Answer: A

A) peroxisomes

196) _____

Match the following descriptions to the correct level of protein structure.

197) The sequence and number of amino acids in the polypeptide chain.

Answer: B

A) secondary

197) _____

B) primary

198) Formed by hydrogen bonds between the amino hydrogen and carboxyl oxygen of amino acids within the same polypeptide chain.

Answer: A

198) _____

Match the following descriptions with the correct organelle.

199) Proteins are packaged into secretory vesicles.

Answer: A

A) Golgi apparatus

199) _____

Match the following descriptions to the correct level of protein structure.

200) Applies to proteins containing more than one polypeptide chain.

Answer: A

A) quaternary

200) _____

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

201) Define and describe the structure of proteins, including the forces that determine the three-dimensional structure of these molecules.

Answer: Proteins are chains of amino acids bound by peptide bonds formed by the condensation reaction of the amine group on one amino acid with the carboxyl group on the other amino acid. The difference between peptides and proteins is the number of amino acids; peptides are composed of less than 50 amino acids, whereas proteins have more than 50. Once formed, there are many chemical interactions involved in the creation of this three-dimensional structure that can be described at different levels. *Primary* structure refers to the sequence of amino acids that comprise a particular peptide or protein. *Secondary* structure involves the folding of that primary structure, produced by hydrogen bonds between amine groups with the oxygen on the carboxyl group of another amino acid. This forms proteins into α -helices and β -pleated sheets. *Tertiary* structure is formed by the interaction between residual groups (R groups) on particular amino acids. Hydrogen bonds can form between polar R groups. Ionic bonds can form between ionized or charged R groups. Van der Waals forces are an electrical attraction between the electron of one molecule with the neutron of another, whereas covalent bonds can form disulfide bridges between sulfhydryl groups on cysteine residues. *Quaternary* structure exists only in proteins with more than one polypeptide chain, like hemoglobin, which contains four separate polypeptide chains.

202) List the membranous organelles that are present within the cell and describe their function.

Answer: The endoplasmic reticulum is composed of two structures that are smooth and rough in character. The rough portion contains ribosomes that are involved in the translation of proteins. Those proteins can be secreted from the cell (hormones), incorporated into the cell membrane (receptors and ion channels), or incorporated into lysosomes. The smooth portion of the endoplasmic reticulum is the site of lipid synthesis and the storage of calcium. The Golgi apparatus is closely associated with the endoplasmic reticulum, processing molecules that were synthesized in the endoplasmic reticulum and packaging them into vesicles for delivery to their site of action. Mitochondria are structures that contain both an inner and outer membrane. The innermost compartment contains the enzymes of the Krebs cycle. The inner membrane contains the components of the electron transport chain. The lysosome is a membrane-bound vesicle that contains lytic enzymes, which can degrade debris (intra or extracellular). Old organelles can be degraded in this manner. Peroxisomes are vesicles, usually smaller than lysosomes, which contain enzymes that degrade amino acids and fatty acids. A byproduct of this degradation is hydrogen peroxide, which is toxic to cells. However, they also contain catalase, an enzyme that degrades hydrogen peroxide.

203) All of the organelles present within a cell are not bound by membranes. Describe the non-membrane-bound organelles that are found in cells.

Answer: Ribosomes are dense granules composed of rRNA and protein, some of which are associated with the rough endoplasmic reticulum. These structures play an important role in protein synthesis. The ribosomes that are free within the cytosol synthesize proteins that remain in the cytosol, or can enter the mitochondria, the nucleus, or the peroxisome. Proteins synthesized within the rough endoplasmic reticulum will cross the membrane (be secreted) or become associated with membranes, such as a plasma membrane or an organelle. The other non-membranous structures of the cell are vaults. These recently discovered organelles are barrel-shaped and three times larger than ribosomes, but their function is not yet clearly understood. They may be involved in the transport of molecules between the nucleus and cytoplasm. They have received considerable attention of late for their role in the development of resistance to chemotherapies.

204) In general, describe the process whereby mRNA that has exited the nucleus is used to synthesize a functional protein.

Answer: mRNA is read in triplets, from the initiator codon (AUG), which codes for the amino acid methionine, to a termination codon. Translation is started by initiation factors that bind to the CAP group on the mRNA, while other factors form a complex with small ribosomal subunits and a charged tRNA (containing an amino acid). The tRNA with an anticodon will bind to the codon on the mRNA by the Law of Complementary Base Pairs. The large ribosomal subunit then binds, causing initiation factors to dissociate, thereby aligning the first tRNA with the P site of the ribosome. A second charged tRNA with the appropriate anticodon will attach itself to the A site on the ribosome. An enzyme within the ribosome then catalyzes the formation of a peptide bond between amino acids, and the first tRNA will be released from the amino acid. The ribosome will then move three bases down to the next codon. As the first tRNA leaves the P site, the second tRNA will move from the A to the P site. Then, a new charged tRNA will bind to the A site; the tRNA with the anticodon that matches the mRNA. This process will continue until the termination codon is reached. The leader sequence will determine whether the protein will remain in the cytosol or attach to the endoplasmic reticulum. Post-translational modification is required in order to make the protein functional, and this process can occur anywhere from the rough endoplasmic reticulum to the Golgi apparatus. The leader sequence must first be cleaved as well as any other excess amino acids that are present on the protein. Thereafter, other molecules can be added to proteins, like carbohydrates (glycoprotein), or lipids (lipoproteins), in order to make the protein functional.

205) Describe the three types of proteins that comprise the cytoskeleton.

Answer: Microfilaments are the smallest of the cytoskeletal proteins. The functions of microfilaments, such as actin, include contraction, amoeboidlike movement of cells, and separation of the cytoplasm during cell division. Other microfilaments provide the structural support for the microvilli of cells within the small intestines and hair cells of the cochlea. Intermediate filaments tend to be stronger and more stable than microfilaments, and include proteins like keratin (located in the skin) and myosin. The largest of the cytoskeletal proteins are microtubules, which are composed of proteins called tubulin. Microtubules form the spindle fibers that are involved in the distribution of chromosomes during cell division. Microtubules are also the primary component of cilia and flagella—hair-like protrusions involved in motility. Cilia are composed of ten microtubules connected by the protein dynein that generate the force necessary to cause the microtubules to slide past one another, thereby moving the cilia. Flagella are similar in structure, except they are longer than cilia.

206) In order for tissues to maintain their structure and function, there must be some way for cells to adhere to their neighbors. Describe the adhesion proteins that function in coupling one cell to the next.

Answer: Tight junctions are composed of integral membrane proteins called occludins that fuse neighboring cells, creating an impermeable barrier. Because of this barrier, most polar solutes must pass through the cell itself by transepithelial transport, rather than by moving between cells (paracellular transport). These tight junctions are commonly found between epithelial cells that line hollow organs in order to maintain separation between fluid compartments. The extent to which fluid compartments are separated is determined by the expression of occludin proteins. Desmosomes are strong filamentous junctions that provide the structural support for cell attachment. Proteins called cadherins are involved in creating these connections between cells. Gap junctions are protein channels formed by connexin proteins. Gap junctions allow for communication between neighboring cells. Molecules, some relatively large (cAMP), can diffuse from one cell to the next when these channels are open.

207) Describe the structure and function of nucleotides and nucleic acids.

Answer: Nucleotides are composed of one or more phosphate groups, a five-carbon sugar (ribose or deoxyribose), and a nitrogenous base. The nitrogenous bases in nucleotides can be from one of two classes: purines (a double carbon-nitrogen ring for adenine and guanine) or pyrimidines (a single carbon-nitrogen ring for cytosine, thymine, and uracil). Nucleotides can function in the exchange of cellular energy in molecules like adenosine triphosphate (ATP), nicotinamide adenine dinucleotide (NAD⁺) and flavin adenine dinucleotide (FAD). Cyclic nucleotides function as intracellular second messengers, like cyclic guanosine monophosphate (cGMP) and cyclic adenine monophosphate (cAMP). Nucleotide polymers function in the storage of genetic information, like deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). The polymeric strands of DNA and RNA are identified by the 3' and 5' end, with the 3' being the carboxyl end (from the carbohydrate) and the 5' end containing the phosphate group. The Law of Complementary Base Pairing ensures that double-stranded DNA will have matching information on both strands. Cytosine is always paired with guanine, whereas adenine is always paired with thymine. In RNA, the thymine is replaced with uracil. DNA stores the genetic code whereas RNA is necessary for expression of the code.

208) The membrane of a cell is an important structure that isolates the cell's cytosol from the external environment. The components of membranes are important determinants of their function. What are the components of a membrane and how do those components function?

Answer: Cell membranes are composed of phospholipids, cholesterol, integral proteins, peripheral proteins, and carbohydrates. Phospholipids are the major constituent of membranes. They are amphipathic molecules with polar (hydrophilic) and nonpolar (hydrophobic) regions. The phospholipids form a bilayer with the hydrophilic region exposed to the outside and inside of the cell, and the nonpolar region associated with itself within the core of the phospholipid bilayer. As a consequence, the membrane is a fluid structure with no strong bonds between its components. Cholesterol can also be present within the membrane, which acts to interfere with hydrophobic interactions within the membrane, thereby increasing membrane fluidity. Integral membrane proteins are intimately associated with the membrane and cannot be easily removed. Many are transmembrane proteins whose amino acid chain passes through the lipid bilayer multiple times. These transmembrane proteins can function as ion channels and transporters to move ions across the membrane. Other integral membrane proteins are located on the cytosolic or interstitial side of the membrane. Peripheral membrane proteins are more loosely associated with the membranes and, therefore, can be easily removed. Most are located on the cytosolic side of the membrane and can be associated with the cytoskeleton. Carbohydrates are located on the extracellular side of the membrane and can act as a protective layer (glycocalyx) or be involved in cell recognition.

209) Describe the process of gene transcription, including how that process is regulated.

Answer: The section of DNA that contains a gene is identified by the promoter that is upstream from the gene. There is a specific promoter sequence that is recognized by an RNA polymerase causing that enzyme to bind and uncoil the DNA. Free nucleotides align with the sense strand of DNA based upon the Law of Complementary Base Pairing. The RNA polymerase will catalyze the formation of bonds between the free nucleotides, thereby forming a single-stranded mRNA. As it is being synthesized, segments of the mRNA called *introns* are spliced from the mRNA strand until all that is left are the *exons*, which are joined together. A CAP is added to the 5' end, which is necessary for the initiation of translation. At the same time, many adenine molecules (the poly A tail) are added to the other end (the 3' region) of the mRNA molecule, protecting the mRNA from degradation once it is in the cytosol. The regulation of mRNA concentration in the cytosol can occur through a number of mechanisms. The mRNA can be bound to a protein, thereby inactivating that mRNA. In addition, both stability and synthesis rates of mRNA are an important determinant of the amount of mRNA coding for a particular protein that is present. This process of transcription can be regulated by DNA binding proteins, whose binding to the promoter region of the gene can either enhance or inhibit binding of the RNA polymerase to the gene, thereby altering expression of the gene.

210) Carbohydrates and lipids are important biomolecules that store energy for the body to use later. Describe the structures and properties of carbohydrates and lipids, including the different forms of these biomolecules that are present within the body.

Answer: Carbohydrates have the general structure of $C_nH_{2n}O_n$. They are polar molecules that readily dissolve in water. They are described based on their size as mono, di, and polysaccharides. Monosaccharides are simple sugars composed of six carbons, including glucose, fructose, and galactose, or five carbons, as with ribose and deoxyribose. Disaccharides are combinations of simple sugars covalently bound together, as with sucrose (glucose and fructose) and lactose (glucose and galactose). Polysaccharides are formed by many simple sugars bound together covalently, including glycogen and starch.

Lipids are a diverse group of molecules primarily containing carbons and hydrogens bound by nonpolar covalent bonds. Some contain oxygen, while others contain phosphate groups that polarize the molecule. Triglycerides are a form of lipid typically referred to as a fat composed of one glycerol with three fatty acids bound to it. Fatty acids are long carbon chain molecules with a carboxyl group at the end. Saturated fatty acids have no double bonds between the carbons, whereas unsaturated fatty acids have at least one (monounsaturated) or more (polyunsaturated) double bonds between carbons on the fatty acid. Triglycerides and fatty acids are both nonpolar and do not readily dissolve in water. Phospholipids are similar to triglycerides except one of the fatty acids attached to glycerol is replaced with a phosphate group. Therefore, the molecule is amphipathic with a polar (phosphate) and nonpolar (fatty acids) region. Eicosanoids are fatty acid derivatives that function in cellular communication. Finally, steroids are produced from the precursor cholesterol and act as hormones to communicate between cells.

Answer Key
Testname: C2

- 1) E
- 2) A
- 3) A
- 4) A
- 5) B
- 6) D
- 7) A
- 8) E
- 9) D
- 10) C
- 11) C
- 12) A
- 13) A
- 14) A
- 15) C
- 16) C
- 17) B
- 18) E
- 19) D
- 20) B
- 21) D
- 22) A
- 23) A
- 24) A
- 25) E
- 26) C
- 27) E
- 28) B
- 29) A
- 30) C
- 31) B
- 32) A
- 33) A
- 34) B
- 35) E
- 36) B
- 37) A
- 38) E
- 39) C
- 40) E
- 41) A
- 42) E
- 43) B
- 44) C
- 45) D
- 46) C
- 47) D
- 48) D
- 49) E
- 50) C

Answer Key
Testname: C2

- 51) B
- 52) A
- 53) B
- 54) A
- 55) E
- 56) D
- 57) A
- 58) C
- 59) A
- 60) B
- 61) E
- 62) B
- 63) B
- 64) A
- 65) B
- 66) D
- 67) C
- 68) B
- 69) E
- 70) D
- 71) A
- 72) A
- 73) D
- 74) D
- 75) B
- 76) C
- 77) D
- 78) C
- 79) A
- 80) B
- 81) E
- 82) D
- 83) D
- 84) D
- 85) B
- 86) D
- 87) B
- 88) E
- 89) C
- 90) E
- 91) B
- 92) B
- 93) E
- 94) E
- 95) D
- 96) C
- 97) B
- 98) B
- 99) A
- 100) B

Answer Key

Testname: C2

- 101) B
- 102) E
- 103) C
- 104) E
- 105) B
- 106) D
- 107) E
- 108) E
- 109) A
- 110) A
- 111) C
- 112) E
- 113) C
- 114) B
- 115) D
- 116) B
- 117) D
- 118) E
- 119) B
- 120) B
- 121) A
- 122) C
- 123) B
- 124) mitochondria—membrane-bound organelle that contains the enzymes of the Krebs cycle and the electron transport chain and is, therefore, involved in the production of cellular energy in the form of ATP
- 125) micelles
- 126) smooth endoplasmic reticulum—site of lipid synthesis and storage of calcium
- 127) inner mitochondrial membrane
- 128) histones
- 129) peroxisomes
- 130) intermediate filament
- 131) poly A tail
- 132) ribose, deoxyribose
- 133) nuclear envelope
- 134) triglycerides : phospholipids
- 135) ubiquitin : proteasome
- 136) secretory
- 137) a glycerol with 3 fatty acids attached
- 138) A and P sites
- 139) initiation
- 140) nucleus—contains the cell's DNA
- 141) DNA polymerase
- 142) 5-carbon carbohydrate, phosphate, base (purine or pyrimidine)
- 143) nuclear pore
- 144) Pyrimidines = cytosine, thymine, and uracil
Purines = adenine and guanosine
- 145) rough endoplasmic reticulum—synthesis of proteins to be packaged into vesicles
- 146) glycogen
- 147) α -helices : β -pleated sheets
- 148) inclusions

Answer Key

Testname: C2

- 149) transmembrane protein
- 150) Golgi apparatus—processes peptides produced within the rough endoplasmic reticulum, packages them in vesicles, and directs them to their ultimate location
- 151) prophase, prometaphase, metaphase, anaphase, telophase
- 152) mitochondrial matrix
- 153) Structure is a micelle. It is composed of phospholipids.
- 154) nucleolus—site within the nucleus for the synthesis of rRNA
- 155) smooth endoplasmic reticulum and nuclear envelope
- 156) rRNA : proteins
- 157) apical : basolateral
- 158) TRUE
- 159) FALSE
- 160) TRUE
- 161) TRUE
- 162) FALSE
- 163) FALSE
- 164) TRUE
- 165) TRUE
- 166) FALSE
- 167) TRUE
- 168) FALSE
- 169) TRUE
- 170) FALSE
- 171) TRUE
- 172) FALSE
- 173) TRUE
- 174) FALSE
- 175) FALSE
- 176) FALSE
- 177) FALSE
- 178) FALSE
- 179) TRUE
- 180) TRUE
- 181) TRUE
- 182) TRUE
- 183) FALSE
- 184) FALSE
- 185) A
- 186) A
- 187) A
- 188) A
- 189) A
- 190) A
- 191) A
- 192) A
- 193) A
- 194) B
- 195) A
- 196) A
- 197) B

Answer Key

Testname: C2

198) A

199) A

200) A

201) Proteins are chains of amino acids bound by peptide bonds formed by the condensation reaction of the amine group on one amino acid with the carboxyl group on the other amino acid. The difference between peptides and proteins is the number of amino acids; peptides are composed of less than 50 amino acids, whereas proteins have more than 50. Once formed, there are many chemical interactions involved in the creation of this three-dimensional structure that can be described at different levels. *Primary* structure refers to the sequence of amino acids that comprise a particular peptide or protein. *Secondary* structure involves the folding of that primary structure, produced by hydrogen bonds between amine groups with the oxygen on the carboxyl group of another amino acid. This forms proteins into α -helices and β -pleated sheets. *Tertiary* structure is formed by the interaction between residual groups (R groups) on particular amino acids. Hydrogen bonds can form between polar R groups. Ionic bonds can form between ionized or charged R groups. Van der Waals forces are an electrical attraction between the electron of one molecule with the neutron of another, whereas covalent bonds can form disulfide bridges between sulfhydryl groups on cysteine residues. *Quaternary* structure exists only in proteins with more than one polypeptide chain, like hemoglobin, which contains four separate polypeptide chains.

202) The endoplasmic reticulum is composed of two structures that are smooth and rough in character. The rough portion contains ribosomes that are involved in the translation of proteins. Those proteins can be secreted from the cell (hormones), incorporated into the cell membrane (receptors and ion channels), or incorporated into lysosomes. The smooth portion of the endoplasmic reticulum is the site of lipid synthesis and the storage of calcium. The Golgi apparatus is closely associated with the endoplasmic reticulum, processing molecules that were synthesized in the endoplasmic reticulum and packaging them into vesicles for delivery to their site of action. Mitochondria are structures that contain both an inner and outer membrane. The innermost compartment contains the enzymes of the Krebs cycle. The inner membrane contains the components of the electron transport chain. The lysosome is a membrane-bound vesicle that contains lytic enzymes, which can degrade debris (intra or extracellular). Old organelles can be degraded in this manner. Peroxisomes are vesicles, usually smaller than lysosomes, which contain enzymes that degrade amino acids and fatty acids. A byproduct of this degradation is hydrogen peroxide, which is toxic to cells. However, they also contain catalase, an enzyme that degrades hydrogen peroxide.

203) Ribosomes are dense granules composed of rRNA and protein, some of which are associated with the rough endoplasmic reticulum. These structures play an important role in protein synthesis. The ribosomes that are free within the cytosol synthesize proteins that remain in the cytosol, or can enter the mitochondria, the nucleus, or the peroxisome. Proteins synthesized within the rough endoplasmic reticulum will cross the membrane (be secreted) or become associated with membranes, such as a plasma membrane or an organelle. The other non-membranous structures of the cell are vaults. These recently discovered organelles are barrel-shaped and three times larger than ribosomes, but their function is not yet clearly understood. They may be involved in the transport of molecules between the nucleus and cytoplasm. They have received considerable attention of late for their role in the development of resistance to chemotherapies.

Answer Key

Testname: C2

- 204) mRNA is read in triplets, from the initiator codon (AUG), which codes for the amino acid methionine, to a termination codon. Translation is started by initiation factors that bind to the CAP group on the mRNA, while other factors form a complex with small ribosomal subunits and a charged tRNA (containing an amino acid). The tRNA with an anticodon will bind to the codon on the mRNA by the Law of Complementary Base Pairs. The large ribosomal subunit then binds, causing initiation factors to dissociate, thereby aligning the first tRNA with the P site of the ribosome. A second charged tRNA with the appropriate anticodon will attach itself to the A site on the ribosome. An enzyme within the ribosome then catalyzes the formation of a peptide bond between amino acids, and the first tRNA will be released from the amino acid. The ribosome will then move three bases down to the next codon. As the first tRNA leaves the P site, the second tRNA will move from the A to the P site. Then, a new charged tRNA will bind to the A site; the tRNA with the anticodon that matches the mRNA. This process will continue until the termination codon is reached. The leader sequence will determine whether the protein will remain in the cytosol or attach to the endoplasmic reticulum. Post-translational modification is required in order to make the protein functional, and this process can occur anywhere from the rough endoplasmic reticulum to the Golgi apparatus. The leader sequence must first be cleaved as well as any other excess amino acids that are present on the protein. Thereafter, other molecules can be added to proteins, like carbohydrates (glycoprotein), or lipids (lipoproteins), in order to make the protein functional.
- 205) Microfilaments are the smallest of the cytoskeletal proteins. The functions of microfilaments, such as actin, include contraction, amoeboidlike movement of cells, and separation of the cytoplasm during cell division. Other microfilaments provide the structural support for the microvilli of cells within the small intestines and hair cells of the cochlea. Intermediate filaments tend to be stronger and more stable than microfilaments, and include proteins like keratin (located in the skin) and myosin. The largest of the cytoskeletal proteins are microtubules, which are composed of proteins called tubulin. Microtubules form the spindle fibers that are involved in the distribution of chromosomes during cell division. Microtubules are also the primary component of cilia and flagella—hair-like protrusions involved in motility. Cilia are composed of ten microtubules connected by the protein dynein that generate the force necessary to cause the microtubules to slide past one another, thereby moving the cilia. Flagella are similar in structure, except they are longer than cilia.
- 206) Tight junctions are composed of integral membrane proteins called occludins that fuse neighboring cells, creating an impermeable barrier. Because of this barrier, most polar solutes must pass through the cell itself by transepithelial transport, rather than by moving between cells (paracellular transport). These tight junctions are commonly found between epithelial cells that line hollow organs in order to maintain separation between fluid compartments. The extent to which fluid compartments are separated is determined by the expression of occludin proteins. Desmosomes are strong filamentous junctions that provide the structural support for cell attachment. Proteins called cadherins are involved in creating these connections between cells. Gap junctions are protein channels formed by connexin proteins. Gap junctions allow for communication between neighboring cells. Molecules, some relatively large (cAMP), can diffuse from one cell to the next when these channels are open.
- 207) Nucleotides are composed of one or more phosphate groups, a five-carbon sugar (ribose or deoxyribose), and a nitrogenous base. The nitrogenous bases in nucleotides can be from one of two classes: purines (a double carbon-nitrogen ring for adenine and guanine) or pyrimidines (a single carbon-nitrogen ring for cytosine, thymine, and uracil). Nucleotides can function in the exchange of cellular energy in molecules like adenosine triphosphate (ATP), nicotinamide adenine dinucleotide (NAD⁺) and flavin adenine dinucleotide (FAD). Cyclic nucleotides function as intracellular second messengers, like cyclic guanosine monophosphate (cGMP) and cyclic adenine monophosphate (cAMP). Nucleotide polymers function in the storage of genetic information, like deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). The polymeric strands of DNA and RNA are identified by the 3' and 5' end, with the 3' being the carboxyl end (from the carbohydrate) and the 5' end containing the phosphate group. The Law of Complementary Base Pairing ensures that double-stranded DNA will have matching information on both strands. Cytosine is always paired with guanine, whereas adenine is always paired with thymine. In RNA, the thymine is replaced with uracil. DNA stores the genetic code whereas RNA is necessary for expression of the code.

Answer Key

Testname: C2

- 208) Cell membranes are composed of phospholipids, cholesterol, integral proteins, peripheral proteins, and carbohydrates. Phospholipids are the major constituent of membranes. They are amphipathic molecules with polar (hydrophilic) and nonpolar (hydrophobic) regions. The phospholipids form a bilayer with the hydrophilic region exposed to the outside and inside of the cell, and the nonpolar region associated with itself within the core of the phospholipid bilayer. As a consequence, the membrane is a fluid structure with no strong bonds between its components. Cholesterol can also be present within the membrane, which acts to interfere with hydrophobic interactions within the membrane, thereby increasing membrane fluidity. Integral membrane proteins are intimately associated with the membrane and cannot be easily removed. Many are transmembrane proteins whose amino acid chain passes through the lipid bilayer multiple times. These transmembrane proteins can function as ion channels and transporters to move ions across the membrane. Other integral membrane proteins are located on the cytosolic or interstitial side of the membrane. Peripheral membrane proteins are more loosely associated with the membranes and, therefore, can be easily removed. Most are located on the cytosolic side of the membrane and can be associated with the cytoskeleton. Carbohydrates are located on the extracellular side of the membrane and can act as a protective layer (glycocalyx) or be involved in cell recognition.
- 209) The section of DNA that contains a gene is identified by the promoter that is upstream from the gene. There is a specific promoter sequence that is recognized by an RNA polymerase causing that enzyme to bind and uncoil the DNA. Free nucleotides align with the sense strand of DNA based upon the Law of Complementary Base Pairing. The RNA polymerase will catalyze the formation of bonds between the free nucleotides, thereby forming a single-stranded mRNA. As it is being synthesized, segments of the mRNA called *introns* are spliced from the mRNA strand until all that is left are the *exons*, which are joined together. A CAP is added to the 5' end, which is necessary for the initiation of translation. At the same time, many adenine molecules (the poly A tail) are added to the other end (the 3' region) of the mRNA molecule, protecting the mRNA from degradation once it is in the cytosol. The regulation of mRNA concentration in the cytosol can occur through a number of mechanisms. The mRNA can be bound to a protein, thereby inactivating that mRNA. In addition, both stability and synthesis rates of mRNA are an important determinant of the amount of mRNA coding for a particular protein that is present. This process of transcription can be regulated by DNA binding proteins, whose binding to the promoter region of the gene can either enhance or inhibit binding of the RNA polymerase to the gene, thereby altering expression of the gene.
- 210) Carbohydrates have the general structure of $C_nH_{2n}O_n$. They are polar molecules that readily dissolve in water. They are described based on their size as mono, di, and polysaccharides. Monosaccharides are simple sugars composed of six carbons, including glucose, fructose, and galactose, or five carbons, as with ribose and deoxyribose. Disaccharides are combinations of simple sugars covalently bound together, as with sucrose (glucose and fructose) and lactose (glucose and galactose). Polysaccharides are formed by many simple sugars bound together covalently, including glycogen and starch.

Lipids are a diverse group of molecules primarily containing carbons and hydrogens bound by nonpolar covalent bonds. Some contain oxygen, while others contain phosphate groups that polarize the molecule. Triglycerides are a form of lipid typically referred to as a fat composed of one glycerol with three fatty acids bound to it. Fatty acids are long carbon chain molecules with a carboxyl group at the end. Saturated fatty acids have no double bonds between the carbons, whereas unsaturated fatty acids have at least one (monounsaturated) or more (polyunsaturated) double bonds between carbons on the fatty acid. Triglycerides and fatty acids are both nonpolar and do not readily dissolve in water. Phospholipids are similar to triglycerides except one of the fatty acids attached to glycerol is replaced with a phosphate group. Therefore, the molecule is amphipathic with a polar (phosphate) and nonpolar (fatty acids) region. Eicosanoids are fatty acid derivatives that function in cellular communication. Finally, steroids are produced from the precursor cholesterol and act as hormones to communicate between cells.