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Chapter 1 Introduction to Biochemistry

1) Which elements account for more than 97% of the weight of most organisms?

A) C, H, N, Mg, O, S

B) C, H, N, O, P, S

C) C, H, N

D) Fe, C, H, O, P

E) Ca^{2+}, K^{+}, Na^{+}, Mg^{2+}, Cl^{-}

Answer: B
Page Ref: Section 2

2) Proteins in biological membranes may be

A) porous.

B) attached to the membrane surface.

C) span the membrane.

D) All of the above

E) B and C only

Answer: D
Page Ref: Section 3

3) Which statement about cellulose is false?

A) It is the most abundant polysaccharide in nature.

B) Its monomers are joined by glycosidic bonds.

C) It is present in the stems of flowering plants.

D) The hydroxyl groups of neighboring cellulose molecules interact to form strong, insoluble fibers.

E) It is a branched polymer of glucose.

Answer: E
Page Ref: Section 3

4) When K_{eq} of a reaction = 1, then

A) the forward reaction is faster than the reverse reaction.

B) the reverse reaction is faster than the forward reaction.

C) the forward and reverse reaction rate constants are equal.

D) more products are formed than reactants.

E) fewer products are formed than reactants.

Answer: C
Page Ref: Section 4

5) Which statement is true about a reaction with an equilibrium constant, K_{eq}, equal to 1000?

A) The forward rate constant is 1000 times greater than the reverse rate constant.

B) The forward rate constant is 3 times greater than reverse rate constant.

C) The forward rate constant is 1000 times smaller than the reverse rate constant.

D) The forward rate constant is 3 times smaller than the reverse rate constant.

E) There is not enough information given to compare the forward and reverse rate constants.

Answer: A
Page Ref: Section 4

6) The study of the energy changes during metabolic reactions is called ________.

A) bioinformatics

B) metabodynamics

C) thermometrics

D) bioenergetics

E) biological heat dynamics

Answer: D
Page Ref: Section 4

7) A spontaneous chemical reaction always has a ________ change.

A) positive Gibb's free energy

B) negative Gibb's free energy

C) positive enthalpy

D) negative enthalpy

E) positive entropy

Answer: B
Page Ref: Section 4

8) Prokaryotes are valuable tools for biochemists because

A) *E. coli* is well–studied and typical of prokaryotes.

B) they contain as many genes as eukaryotic cells.

C) many of their chromosomes are sequenced.

D) they are not very diverse organisms.

E) All of the above

Answer: C
Page Ref: Section 6

9) Which cellular component carries out oxidation reactions, some of which produce hydrogen peroxide?

A) peroxisomes

B) mitochondria

C) chloroplasts

D) lysosomes

E) vacuoles

Answer: A
Page Ref: Section 8

10) Why is it important that the enzymes in lysosomes are more active at acidic pH than at neutral pH?

A) Since lysosomes are primarily found in the stomach acid of mammals, their pH dependence allows for maximum efficiency for the digestion of foodstuffs.

B) It prevents their diffusion out of the lysosomes.

C) It maximizes the interaction with their substrates which are always bases.

D) It prevents them from accidentally degrading the macromolecules in the cytosol.

E) It allows for regulation of their uptake by the mitochondria.

Answer: D
Page Ref: Section 8

11) Molecules from living cells cannot be synthesized outside of living cells.

Answer: FALSE
Page Ref: Section 1

12) Fermentation in the absence of cells demonstrated that metabolic processes were chemical in nature.

Answer: TRUE
Page Ref: Section 1

13) Enzymes are protein catalysts that form an intermediate with a substrate that fits into it.

Answer: TRUE
Page Ref: Section 1

14) The modified lock–and–key theory of enzyme action proposed by Emil Fischer has been completely replaced by more modern ideas of catalysis.

Answer: FALSE
Page Ref: Section 1

15) Enzymes are not as efficient as most catalysts used in organic chemistry, since they must function at body temperature.

Answer: FALSE
Page Ref: Section 1

16) Bioinformatics has permitted rapid advances in our understanding of structural macromolecules from living cells.

Answer: TRUE
Page Ref: Section 1

17) The role of DNA as the genetic material was confirmed by transforming *Streptococci* in experiments performed several years after the famous Watson and Crick description of DNA structure.

Answer: FALSE
Page Ref: Section 1

18) Crick referred to the flow of information from nucleic acid to protein as the Central Dogma.

Answer: TRUE
Page Ref: Section 1

19) Functional groups describe one or more portions of organic compounds found in living cells.

Answer: TRUE
Page Ref: Section 2

20) A phosphate ester contains a phosphate functional group.

Answer: TRUE
Page Ref: Section 2

21) Under most biological conditions, acid groups and amino groups are fully protonated.

Answer: FALSE
Page Ref: Section 2

22) Removal of water from residues of a macromolecule results in the formation of that macromolecule.

Answer: TRUE
Page Ref: Section 3

23) M_r is the mass of a molecule relative to 1/12 the mass of an atom of the most common isotope of carbon.

Answer: TRUE
Page Ref: Section 3

24) Biochemists describing the molecular weight of a protein really mean the atomic weight in grams.

Answer: FALSE
Page Ref: Section 3

25) The absolute molecular mass of macromolecules is given in daltons, where 1 dalton = 1 atomic mass unit.

Answer: TRUE
Page Ref: Section 3

26) A peptide bond is formed by the condensation of different functional groups from two amino acids.

Answer: TRUE
Page Ref: Section 3

27) The conformation of a protein enzyme determines whether it is functional or not.

Answer: TRUE
Page Ref: Section 3

28) Lysozyme is an enzyme with a cleft or depression at its active site.

Answer: TRUE
Page Ref: Section 3

29) The Haworth projection of the ring form of a monosaccharide always shows a flat plane with one edge projecting out of the page (using thicker lines).

Answer: TRUE
Page Ref: Section 3

30) Sugars with six carbons are the only ones capable of forming a ring structure as shown in a Haworth projection.

Answer: FALSE
Page Ref: Section 3

31) ATP contains both phosphoester and phosphoanhydride linkages.

Answer: TRUE
Page Ref: Section 3

32) A phosphodiester linkage in DNA contains two phosphorous atoms.

Answer: FALSE
Page Ref: Section 3

33) Lipids aggregate to form bilayers because some lipid molecules are hydrophobic and other lipid molecules are hydrophilic.

Answer: FALSE
Page Ref: Section 3

34) Thermodynamics and its laws are obeyed by living cells.

Answer: TRUE
Page Ref: Section 4

35) The tendency of a metabolic reaction to proceed is due to the free energy of both the reactants and products as well as the change in randomness of that reaction.

Answer: TRUE
Page Ref: Section 4

36) Biochemical reactions are more likely to proceed if the reaction has an increase in enthalpy ($\triangle H$) and a decrease in entropy ($\triangle S$).

Answer: FALSE
Page Ref: Section 4

37) All prokaryotic cells are about 1/10 the size of an average eukaryotic cell or smaller.

Answer: FALSE
Page Ref: Section 5

38) All cells have kept the same general patterns of metabolism, a very similar genetic code and the same monomers or residues.

Answer: TRUE
Page Ref: Section 5

39) Eukaryotes include plants, animals and bacteria.

Answer: FALSE
Page Ref: Section 5

40) The only reason phages are not considered to be cells is because they do not contain a plasma membrane.

Answer: FALSE
Page Ref: Section 6

41) Diffusion is an adequate means of distributing nutrients in prokaryotic cytoplasm because they have more surface area than volume compared to most eukaryotes.

Answer: TRUE
Page Ref: Section 7

42) Eukaryotic cells are distinguished from prokaryotes by their usually larger size, a complex cytoskeleton and membrane–bounded organelles.

Answer: TRUE
Page Ref: Section 7

43) Chloroplasts are organelles found in plants, algae and some protists and are the site of photosynthesis.

Answer: TRUE
Page Ref: Section 7

44) The endoplasmic reticulum is the major site of RNA synthesis and the site of assembly of ribosomes.

Answer: FALSE
Page Ref: Section 8

45) The nuclear envelope is a membrane that surrounds the nucleus and is continuous with the endoplasmic reticulum.

Answer: TRUE
Page Ref: Section 8

46) Ribosomes on the surface of rough endoplasmic reticulum are the site of ATP synthesis.

Answer: FALSE
Page Ref: Section 8

47) The Golgi apparatus consists of flattened, fluid–filled, membranous sacs and is responsible for chemical modification and sorting of some biomolecules.

Answer: TRUE
Page Ref: Section 8

48) Mitochondria are the main sites of energy transduction in aerobic eukaryotic cells.

Answer: TRUE
Page Ref: Section 8

49) The mitochondria and Golgi apparatus are two organelles which originated from bacteria and were incorporated into eukaryotic cells via symbiosis.

Answer: FALSE
Page Ref: Section 8

50) In an animal cell, DNA can be found only in the nucleus.

Answer: FALSE
Page Ref: Section 8

51) Actin has been shown to be one of the most evolutionarily conserved proteins. It is present in all eukaryotic cells and frequently is the most abundant protein in the cell.

Answer: TRUE
Page Ref: Section 8

52) The mitotic spindles are formed from microtubule proteins.

Answer: TRUE
Page Ref: Section 8

53) The filament fibers in the cytoskeleton are composed primarily of carbohydrate molecules.

Answer: FALSE
Page Ref: Section 8

54) The diffusion of large molecules such as enzymes is significantly slowed by the presence of the cytoskeleton.

Answer: TRUE
Page Ref: Section 8

55) In eukaryotic cells lysosomes are specialized digestive vesicles with a highly acidic interior.

Answer: TRUE
Page Ref: Section 8

56) The process of cell division that occurs in the tissues is called mitosis.

Answer: TRUE
Page Ref: Section 8

57) Photosynthesis involves capturing energy from light that is then used to drive the formation of carbohydrates from carbon dioxide and water.

Answer: TRUE
Page Ref: Section 8

58) The chemical name for ATP is alanine triphosphate.

Answer: FALSE
Page Ref: Section 8

59) Absolute zero is equal to 0 °C.

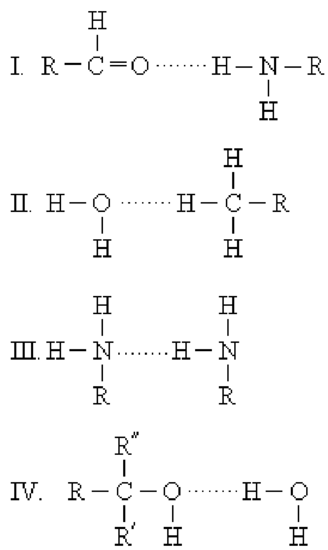
Answer: FALSE
Page Ref: Appendix

60) One Angstrom is equal to 1×10^{-10} meters.

Answer: TRUE
Page Ref: Appendix

Chapter 2 Water

1) Which is not a proper way to form a hydrogen bond? (The symbol "R" represents a general organic group. The hydrogen bonding is represented by dashed lines.)



A) I B) II C) III D) IV

Answer: B
Page Ref: Section 1

2) Which statement does <u>not</u> explain the polarity of water?

A) Oxygen is more electronegative than hydrogen.

B) Water molecules have a bent geometry (V–shaped).

C) The oxygen in water has sp^2 hybrid orbitals.

D) In water the hydrogen carries a partial positive charge (δ+).

Answer: C
Page Ref: Section 1

3) Which substance do you expect to be most soluble in water?

A) ammonia, NH_3 B) methane, CH_4

C) carbon dioxide, CO_2 D) nitrogen, N_2

Answer: A
Page Ref: Section 1

4) What is the maximum number of hydrogen bonds that one water molecule can have with neighboring water molecules?

A) 1 B) 2 C) 3 D) 4

Answer: D
Page Ref: Section 2

5) The abundance of water in the cells and tissues helps to minimize temperature fluctuations. This is due to what property of water?

A) density B) viscosity C) specific heat D) boiling point

Answer: C
Page Ref: Section 2

6) Compounds that ionize when dissolved in water are called ________.

A) electrolytes B) polar compounds
C) hydrophobic compounds D) amphipathic compounds

Answer: A
Page Ref: Section 3

7) Electrolytes dissolve readily in water because

A) they are held together by electrostatic forces.
B) they are hydrophobic.
C) water molecules can cluster about cations.
D) water molecules can cluster about anions.
E) water molecules can cluster about cations and anions.

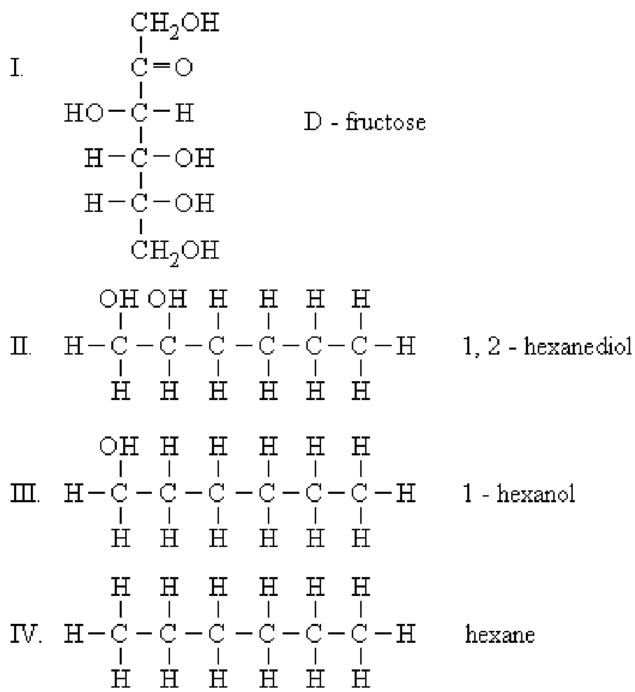
Answer: E
Page Ref: Section 3

8) A molecule or ion is said to be hydrated when it ________.

A) is neutralized by water
B) is surrounded by water molecules
C) reacts and forms a covalent bond to water
D) aggregates with other molecules or ions to form a micelle in water

Answer: B
Page Ref: Section 3

9) Which would you expect to be most soluble in water?



A) I
B) II
C) III
D) IV

Answer: A
Page Ref: Section 3

10) Solutes diffuse more slowly in cytoplasm than in water because of

A) the higher viscosity of water.

B) the higher heat of vaporization of water.

C) the presence of many crowded molecules in the cytoplasm.

D) the absence of charged molecules inside cells.

Answer: C
Page Ref: Section 3

11) The ________ pressure is the pressure required to prevent the flow of solvent through a solvent–permeable membrane that separates two solutions of different solute concentration.

A) hydrostatic
B) electromotive
C) osmotic
D) partial

Answer: C
Page Ref: Section 3

12) Which is true about the solubility of electrolytes in water?

A) They are all insoluble in water.

B) They are usually only sparingly soluble in water.

C) They often form super-saturated aqueous solutions.

D) They readily dissolve and ionize in water.

Answer: D
Page Ref: Section 3

13) What is the difference between a particle being <u>hydrated</u> versus being <u>solvated</u>?

A) A hydrated particle is surrounded by a shell of water. A solvated molecule is surrounded by a shell of solvent molecules, not necessarily water.

B) The terms hydrated and solvated mean exactly the same thing.

C) A hydrated particle has reacted with hydrogen. A solvated particle is dissolved in a solvent.

D) The word hydrated is used only when the solute is an electrolyte.

Answer: A
Page Ref: Section 3

14) The osmotic pressure of an aqueous solution depends on

A) the chemical nature of the solute.

B) the molar concentration of solute.

C) the hydrophobic effect of the solute.

D) All of the above.

E) None of the above.

Answer: B
Page Ref: Section 3

15) The osmotic pressure of a 0.010 *M* sucrose ($C_{12}H_{22}O_{11}$) solution at 25 °C is 0.24 atm. How does the osmotic pressure of a 0.010 *M* glucose ($C_6H_{12}O_6$) solution at 25 °C compare to this? Note that neither solute is volatile or ionizable.

A) The glucose solution has a lower osmotic pressure because its molar mass is lower than sucrose.

B) The glucose solution has a higher osmotic pressure because its molar mass is lower than sucrose.

C) The osmotic pressures are equal because the solutions have the same molar concentration.

D) Nothing can be said about the osmotic pressure of the glucose solution without more information.

Answer: C
Page Ref: Section 3

16) Oil and water do not form a solution due to ________.

A) the hydrophobic effect

B) the inability of oil to hydrogen bond with water

C) the nonpolarity of oil

D) All of the above (A–C)

E) A and C only

Answer: D
Page Ref: Section 4

17) Molecules that are both hydrophobic and hydrophilic are ________.

A) amphipathic B) amphoteric C) bipolar D) not possible

Answer: A
Page Ref: Section 4

18) Which molecule or ion below is amphipathic?

A) H_2NCH_2COOH (glycine) B) H_2O

C) $CH_3(CH_2)_{14}COO^-$ D) $CH_3CH_2CH_2CH_2CH_3$

Answer: C
Page Ref: Section 4

19) Which statement explains the cleaning action of soap on greasy dishes?

A) The soap changes the water–solubility of the grease so that it is easily dissolved by the water.

B) The grease is trapped inside the hydrophobic interior of micelles made of soap molecules.

C) The soap chemically breaks down the grease into smaller, more water–soluble molecules.

D) The soap hydrates the grease with its polar head groups and holds it in suspension.

Answer: B
Page Ref: Section 4

20) Some ions such as thiocyanate that are poorly solvated in water and can enhance the solubility of nonpolar compounds in water by disordering the water molecules are called ________.

A) azeotropes B) hydrophobic ions

C) zeolytes D) chaotropes

Answer: D
Page Ref: Section 4

21) Which of the following is NOT a "weak" interaction?

A) hydrogen bonds

B) van der Waals forces

C) disulfide bonds

D) ionic interactions

E) hydrophobic interactions

Answer: C
Page Ref: Section 5

22) Which of the following weak interactions is <u>not</u> an electrostatic interaction?

A) hydrogen bonds
B) charge–charge interactions
C) hydrophobic interactions
D) van der Waals forces

Answer: C
Page Ref: Section 5

23) Which of these noncovalent forces in biological systems is usually the strongest?

A) hydrogen bonds
B) London dispersion forces
C) hydrophobic interactions
D) van der Waals forces

Answer: A
Page Ref: Section 5

24) Hydrogen bonds can occur when hydrogen is covalently bonded to atoms like nitrogen and oxygen. What property of nitrogen and oxygen is important for this?

A) atomic mass
B) ionizability
C) hydrophobicity
D) electronegativity

Answer: D
Page Ref: Section 5

25) Attractions of oppositely charged functional groups of proteins are sometimes called ________.

A) salt bridges or ion pairing
B) disulfide bridges
C) London bridges
D) hydrophilic bridges

Answer: A
Page Ref: Section 5

26) Which is true about hydrogen bonding for biological molecules?

A) Hydrogen bonds are strong enough to confer structural stability, for example in DNA.

B) Hydrogen bonds are weak enough to be easily broken (weaker than covalent bonds).

C) They contribute to the water solubility of many macromolecules.

D) All of the above

Answer: D
Page Ref: Section 5

27) London dispersion forces are attractive forces that arise due to

A) infinitesimal dipoles generated by the constant random motion of electrons.

B) permanent dipoles of molecules containing covalent bonds between atoms of very different electronegativities.

C) the hydrophobic effect.

D) ion pairing between oppositely charged functional groups.

Answer: A
Page Ref: Section 5

28) The aggregation of nonpolar molecules or groups in water is thermodynamically due to the

A) increased entropy of the nonpolar molecules when they associate.

B) decreased enthalpy of the system.

C) increased entropy of the water molecules.

D) very strong van der Waals forces among the nonpolar molecules or groups.

Answer: C
Page Ref: Section 5

29) Water clustered about nonpolar molecules contribute to hydrophobic interactions because

A) Their number is minimized to increase the total entropy of water.

B) Nonpolar molecules are more highly organized than polar molecules.

C) Water molecules in the cell are more organized in the regions away from the nonpolar molecule.

D) All of the above

E) B and C

Answer: A
Page Ref: Section 5

30) The three dimensional structure of most proteins is largely determined by

A) other proteins which fold them.

B) weak noncovalent interactions.

C) denaturation.

D) hydrogen bonds.

E) All of the above

Answer: B
Page Ref: Section 5

31) The oxygen atom of water is nucleophilic because

A) it has a negative oxidation number.

B) it carries a partial positive charge.

C) it has two unshared pair of electrons.

D) it seeks electron–rich molecules.

E) All of the above

Answer: C
Page Ref: Section 6

32) Water is a nucleophile, yet it does not usually hydrolyze macromolecules in cells because

A) covalent bonds linking macromolecule subunits are stable at cell pH.

B) covalent bonds linking macromolecule subunits are stable at cell temperature.

C) the concentration of water is much too small in cells.

D) A and B

Answer: D
Page Ref: Section 6

33) Enzymes which condense subunits of macromolecules during their synthesis usually

A) transfer an acyl or carbonyl group to an electrophile.

B) exclude water from the active site.

C) contain inhibitors of hydrolases.

D) are catalyzing thermodynamically favored reactions.

E) All of the above

Answer: B
Page Ref: Section 6

34) The ion–product constant for water, K_W, is

A) 1×10^{-7} M^2. B) 1×10^{-7} M. C) 1×10^{-14} M^2. D) 1×10^{-14} M.

Answer: C
Page Ref: Section 7

35) In pure water hydronium ions are formed by ________ attack of oxygen on a proton in an adjacent water molecule.

A) ionic B) nucleophilic C) electrophilic D) covalent

Answer: B
Page Ref: Section 7

36) Pure water has a concentration of

A) 18 g/ml. B) 1 g/ml. C) 1000 g/ml. D) 55 M.

Answer: D
Page Ref: Section 7

37) Which statement best characterizes the distribution of charge in the hydronium ion, H_3O^+?

A) The positive charge is distributed over all of the atoms in the ion.

B) The positive charge is localized only on the oxygen atom.

C) The positive charge is distributed between the three hydrogen atoms only.

D) The positive charge is localized on only one of the hydrogen atoms.

Answer: A
Page Ref: Section 7

38) Which statement below is true about the relative lifetime of a hydrogen bond, compared to the rate of water's ionization to hydroxide ions and hydronium ions?

A) The strength of hydrogen bonding makes its dissociation much slower than the ionization of water.

B) The rate of dissociation of a hydrogen bond is the same order of magnitude as the rate of ionization of water.

C) The two rates are linked in such a way that the more the water is ionized, the stronger and longer lasting hydrogen bonding will be.

D) The lifetime of a water molecule before it is ionized is about 10^9 greater than the lifetime of a hydrogen bond.

Answer: D
Page Ref: Section 7

39) The self–ionization of water is ________.

A) a unimolecular dissociation of a single water molecule to H^+ and OH^-

B) a biomolecular reaction between two water molecules to yield H_3O^+ and OH^-

C) a result of hydrophobic interactions

D) a termolecular reaction involving the simultaneous collision of H_2O, H^+ and OH^-

Answer: B
Page Ref: Section 7

40) How does the ion–product of water, K_w, relate to the equilibrium constant, K_{eq}, for the dissociation reaction of water?

A) K_w is found by multiplying K_{eq} by the concentration of water.

B) K_w just another symbol for K_{eq} , so they are equal.

C) K_w is found by dividing K_{eq} by the ideal gas constant.

D) K_w is found by multiplying K_{eq} by the concentrations of hydronium ion and hydroxide ion.

Answer: A
Page Ref: Section 7

41) A solution containing 10^{-8} M HCl and 10^{-8} M acetic acid contains H^+ which is supplied mostly by

A) the strong acid.

B) the weak acid.

C) both the strong and the weak acids.

D) water.

E) All of the above

Answer: D
Page Ref: Section 8

42) Basic solutions form when chemicals are dissolved in water and remove

A) OH^-.

B) H^+.

C) Na^+.

D) A and B

E) A, B and C

Answer: B
Page Ref: Section 8

43) The pH of a 10^{-4} M solution of HCl is

A) 3.

B) 3.5.

C) 4.

D) 4.5.

E) greater than 4.5.

Answer: C
Page Ref: Section 8

44) Compare solution A with pH = 4 to solution B with pH = 6.

A) The concentration of hydronium ion in solution A is twice that in solution B.

B) Solution A has greater buffering capacity than solution B.

C) The concentration of hydronium ion in solution A is 100 times that in solution B.

D) The hydroxide concentrations are equal in the two solutions since pH only measures the concentration of H^+.

Answer: C
Page Ref: Section 8

45) If human blood is not maintained at close to pH = 7.4, a person can develop

A) acidosis.

B) alkalosis.

C) diabetes.

D) Both A and B

E) None of the above

Answer: D
Page Ref: Section 8

46) The Henderson–Hasselbalch equation can be used to calculate

A) the pH of a solution of an organic acid.

B) the amount of salt and acid to add to form a specific buffer.

C) the pK_a of a weak acid.

D) All of the above

E) A and C only

Answer: D
Page Ref: Section 9

47) The ratio of the concentration of a ________ over ________ describes the proportions of forms of a weak acid necessary to satisfy the Henderson–Hasselbalch equation.

A) conjugate acid; conjugate base

B) conjugate base; conjugate acid

C) proton donor; proton acceptor

D) proton acceptor; proton donor

E) B and D

Answer: E
Page Ref: Section 9

48) At the midpoint of a titration curve

A) the concentration of a conjugate base is equal to the concentration of a conjugate acid

B) the pH equals the pK_a

C) the ability of the solution to buffer is best

D) All of the above

E) A and B only

Answer: D
Page Ref: Section 9

49) Histidine contains an imidazole group which is titratable. A histidine buffer can be prepared using

A) NaOH and histidine.

B) NaOH and imidazolium ion.

C) imidazolium ion and imidazole (conjugate base).

D) HCl and imidazole.

E) All of the above

Answer: E
Page Ref: Section 9

50) The imidazolium ion has a $pK_a = 7.0$. Imidazolium buffers can be prepared for pH values of

A) 6.5 to 7.5. B) 6.1 to 7.1. C) 5.5 to 8.5. D) 6.0 to 8.0. E) 6.0 to 7.5.

Answer: D
Page Ref: Section 9

51) Since HCl is a strong acid its value of K_a is ________.

A) effectively equal to infinity

B) equal to K_w

C) zero

D) dependent on the concentration of HCl

Answer: A
Page Ref: Section 9

52) For a weak acid with a $pK_a = 6.5$, the effective buffering range is usually considered to be

A) pH 6 to pH 7.

B) pH 6.4 to pH 6.6.

C) pH 5.5 to pH 7.5.

D) dependent on the molarity of the acid.

E) B and C

Answer: C
Page Ref: Section 10

53) Blood pH is primarily regulated by

A) a protein buffer system.

B) the carbon dioxide – carbonic acid – bicarbonate buffer system.

C) the phosphate buffering system.

D) carbonic acid (H_2CO_3).

E) B and C

Answer: B
Page Ref: Section 10

54) Intracellular buffers include

A) proteins.

B) inorganic phosphate.

C) hemoglobin.

D) Both A and B

E) A, B and C

Answer: D
Page Ref: Section 10

55) pK_a values of phosphoric acid are 2.2, 7.2 and 12.7. A phosphate buffer of pH = 7.4 can be prepared using

A) $H_2PO_4^-$ and HPO_4^{2-}.

B) HPO_4^{2-} and PO_4^{3-}.

C) H_3PO_4 and HCl.

D) None of the above

Answer: A
Page Ref: Section 10

56) Acetic acid has a pK_a of 4.8. How many milliliters of 0.2 M acetic acid and 0.1 M sodium acetate are required to prepare 1 liter of 0.1 M buffer solution having a pH of 4.8?

A) 500 ml acetic acid and 500 ml sodium acetate

B) 250 ml acetic acid and 250 ml sodium acetate, then 500 ml water

C) 250 ml acetic acid and 500 ml sodium acetate, then 250 ml water

D) 500 ml acetic acid and 250 ml sodium acetate, then 250 ml water

Answer: B
Page Ref: Section 10

57) The pH of human blood is maintained at 7.4 by

A) buffering proteins.

B) carbon dioxide–carbonic acid buffer systems.

C) a bicarbonate buffer system.

D) B and C

E) A, B and C

Answer: D
Page Ref: Section 10

58) The solubility rule "like dissolves like" refers primarily to similarities in amphipathic nature between the solute and solvent.

Answer: FALSE
Page Ref: Section 1

59) The hydrogen bonding between water molecules in ice gives water an unusually low melting point compared to other molecules of similar size and molecular weight that cannot form hydrogen bonds.

Answer: FALSE
Page Ref: Section 2

60) The water solubility of alcohols with a single hydroxyl group increases as a function of molecular weight.

Answer: FALSE
Page Ref: Section 3

61) A hydrated potassium ion is surrounded by a shell of water molecules oriented primarily with their oxygen atoms toward the potassium ion.

Answer: TRUE
Page Ref: Section 3

62) In the detergent, sodium dodecyl sulfate, the sulfate groups are very hydrophobic.

Answer: FALSE
Page Ref: Section 4

63) Van der Waals forces are very strongly repulsive at short nuclear distances and very weak at long internuclear distances.

Answer: TRUE
Page Ref: Section 5

64) The combined effect of many weak noncovalent interactions can be very significant in determining factors such as three–dimensional structure for large biological molecules.

Answer: TRUE
Page Ref: Section 5

65) Water molecules that surround a less polar molecule in solution are immobile and ordered.

Answer: TRUE
Page Ref: Section 5

66) The strength of van der Waals forces between two molecules changes as the distance between them changes.

Answer: TRUE
Page Ref: Section 5

67) The attractive force between two atoms is maximized when they are separated by the sum of their van der Waals radii.

Answer: TRUE
Page Ref: Section 5

68) Salt bridges are often found on the surfaces of proteins where they are stabilized by water.

Answer: FALSE
Page Ref: Section 5

69) Hydrogen bonds in the interior of a protein or other macromolecule are stronger than those on the exterior.

Answer: FALSE
Page Ref: Section 5

70) Micelles are stabilized in water by interactions of nonpolar molecules with each other.

Answer: TRUE
Page Ref: Section 5

71) Hydrophobic interactions are sometimes called "bonds", because each one is as strong as a covalent bond.

Answer: FALSE
Page Ref: Section 5

72) Proteins dissolved in water can be hydrolyzed by nucleophilic attack from the water molecules.

Answer: TRUE
Page Ref: Section 6

73) An intermediate formed by the enzyme glutamine synthetase, gamma–glutamyl phosphate, is rapidly hydrolyzed by water if the enzyme is not around to protect it.

Answer: TRUE
Page Ref: Section 6

74) When acid is added to pure water, K_w, the ion–product constant of water, changes.

Answer: FALSE
Page Ref: Section 7

75) The equilibrium constant of water (K_{eq}) is the rate that dissociation of the molecule occurs at room temperature.

Answer: FALSE
Page Ref: Section 7

76) The H^+ (or H_3O^+) in cells is the same concentration as that of undissociated water.

Answer: FALSE
Page Ref: Section 8

77) Hyperventilation can result in alkalosis because there is excessive loss of carbon dioxide and, therefore a loss of carbonic acid.

Answer: TRUE
Page Ref: Section 8

78) Since the pK_a of acetic acid is 4.8, it can be used to prepare a buffer to maintain physiological pH.

Answer: FALSE
Page Ref: Section 9

79) The buffering capacity of a weak acid and its conjugate base is strongest when the pH = pK_a.

Answer: TRUE
Page Ref: Section 10

80) Synthetic compounds used as buffers are not as valuable for experiments as naturally occurring compounds used as buffers.

Answer: FALSE
Page Ref: Section 10

Chapter 3 Amino Acids and the Primary Structures of Proteins

1) Amino acids are named that because each one

A) is a unique carboxylic acid.

B) has a standard configuration.

C) is a carboxyl derivative of an amide acid.

D) is an amino derivative of a carboxylic acid.

Answer: D
Page Ref: Section 1

2) Amino acids found in meteorites and near stars are

A) D isomers only.

B) L isomers only.

C) Both D and L isomers.

D) not isomers.

Answer: C
Page Ref: Section 1

3) The last common ancestor of modern organisms must have used

A) both D and L amino acids.

B) D amino acids.

C) L amino acids.

D) either D or L amino acids.

Answer: C
Page Ref: Section 1

4) If the R group of an amino acid is $-CH_3$, then the name of this compound is

A) methyl amino acid.

B) 2-aminopropanoic acid.

C) alanine.

D) All of the above

E) B and C

Answer: E
Page Ref: Section 1

5) Amino acids with non–ionizable side chains are zwitterions when they are ________.

A) in any solution

B) at physiological pH, pH = 7.4

C) in acidic solutions only

D) in alkaline solutions only

E) All of the above

Answer: B
Page Ref: Section 1

6) Glycine is not a stereoisomer because

A) it has no chiral carbon.

B) it does not form enantiomers.

C) it does not exist in two non–superimposable mirror–image forms.

D) All of the above

E) A and B only

Answer: D
Page Ref: Section 1

7) An amino acid with two chiral carbon atoms

A) is unstable.

B) can exist in 4 forms all of which are superimposable.

C) can form three possible stereoisomers.

D) can form four possible stereoisomers.

E) can form five possible stereoisomers.

Answer: D
Page Ref: Section 1

8) The RS system of nomenclature describes

A) amino acids not easily described by the DL system.

B) the way the R groups are arranged.

C) the chiral carbon centers of amino acids.

D) the strength of the chemical groups in amino acids.

Answer: C
Page Ref: Section 1

9) The R group of an amino acid determines if it is

A) hyrophilic or hydrophobic.

B) polar or nonpolar.

C) charged or uncharged.

D) an acid or a base.

E) All of the above

Answer: E
Page Ref: Section 1

10) Proline is distinct among the 20 commonly found amino acids because

A) it is a ring compound.

B) it is hydrophilic and ionic.

C) the nitrogen of the amino group is in a ring.

D) the carbon of the carboxyl group is in a ring.

E) it has little effect on protein structure.

Answer: C
Page Ref: Section 2

11) Tyrosine and tryptophan are less hydrophobic than phenylalanine because

A) phenylalanine has an indole group.

B) phenylalanine has no polar group in the side chain.

C) phenylalanine is a phenol.

D) tyrosine and tryptophan have smaller R groups.

E) All of the above

Answer: B
Page Ref: Section 2

12) Ultraviolet (UV) light can be used to estimate protein solution concentrations because

A) phenylalanine absorbs at 260 nm.

B) all the amino acids absorb UV light.

C) aromatic amino acids absorb at 280 nm.

D) tryptophan and tyrosine absorb at 280 nm.

E) All of the above

Answer: D
Page Ref: Section 2

13) Concentrations of some proteins <u>cannot</u> be estimated by UV spectrophotometry because they are

A) high in non–absorbing amino acids.
B) low in tryptophan and tyrosine.
C) low in protein.
D) high in aromatic amino acids.

Answer: B
Page Ref: Section 2

14) The amino acids in polypeptide chains which contain sulfur (S) are

A) cysteine, cystine, and methionine.
B) cystine.
C) methionine only.
D) cysteine only.
E) cysteine and methionine.

Answer: E
Page Ref: Section 2

15) Disulfide bridges can form in proteins ________.

A) only between cysteine residues side–by–side in the protein sequence
B) between cysteine residues that are close in three–dimensional space, but not necessarily close in the primary structure
C) between two cystine residues in proteins
D) between any two methionines or cysteines

Answer: B
Page Ref: Section 2

16) The overall shape of a protein is greatly influenced by

A) amino acid R group properties.
B) charged amino acids.
C) hydrophobic amino acids.
D) pH.
E) hydrophilic amino acids.

Answer: A
Page Ref: Section 2

17) Although the hydroxyl groups in serine and threonine are uncharged, they can react within active sites of some enzymes ________.

A) precisely because they are uncharged

B) because the hydroxyl group is polar

C) because the hydroxyl group is small and fits into the site

D) All of the above

Answer: B
Page Ref: Section 2

18) Basic amino acids are ________ (positive, negative) at pH 7 and acidic R group amino acids are ________ (positive, negative) at pH 7.

A) negative; positive

B) negative; negative

C) positive; negative

D) positive; positive

Answer: C
Page Ref: Section 2

19) An amino acid named for a plant from which it was first isolated is

A) proline.

B) methionine.

C) threonine.

D) asparagine.

Answer: D
Page Ref: Section 2

20) Arginine is the most basic of the 20 amino acids because its side chain is ________ under most cell conditions.

A) very highly charged

B) hydrophobic

C) titrated

D) protonated

E) negatively charged

Answer: D
Page Ref: Section 2

21) Cystine is likely to be isolated from proteins that are

A) high in methionine.

B) high in peptide-linked cysteine.

C) intracellular.

D) extracellular.

Answer: B
Page Ref: Section 2

22) A protein that contains more isoleucine, phenylalanine and leucine than asparagine, lysine and arginine is most likely

A) hydrophilic.
B) hydrophobic.
C) neutral.
D) low on the hydropathy index scale.

Answer: B
Page Ref: Section 2

23) A sequence of amino acids with a relatively high hydropathy is very likely to function by

A) being at the active site of an enzyme.
B) being embedded in a cell membrane.
C) making a protein soluble.
D) being on the protein surface.

Answer: B
Page Ref: Section 2

24) A polypeptide chain may have abrupt changes in direction and restriction in geometry because of the presence of

A) arginine.
B) glycine.
C) proline.
D) leucine or isoleucine.

Answer: C
Page Ref: Section 2

25) Amino acids which are not incorporated into polypeptides are converted into

A) neurotransmitters.
B) methyl donors.
C) antibiotics.
D) blood flow controllers.
E) All of the above

Answer: E
Page Ref: Section 3

26) Proteins can be modified by adding ________ to protein residues.

A) sugars and phosphate groups
B) hydroxyl and formyl groups
C) cystine
D) A and B
E) All of the above

Answer: D
Page Ref: Section 3

27) At the isoelectric pH of an amino acid which has two pK_a values the net charge is

A) 0.5. B) 1. C) 0. D) –1.

Answer: C
Page Ref: Section 3

28) Histidine has pK_a values of 1.8, 6.0 (R–group) and 9.3 . At pH 8.0, the net charge on histidine is

A) positive.
B) negative.
C) neutral (uncharged).
D) insufficient information to tell.

Answer: C
Page Ref: Section 3

29) Which amino acid is ideal for the transfer of protons within the catalytic site of enzymes due to the presence of significant amounts of both the protonated and deprotonated forms of its side chain at biological pH?

A) Lysine
B) Asparagine
C) Tyrosine
D) Cysteine
E) Histidine

Answer: E
Page Ref: Section 3

30) The pK_a's of arginine's α–Carboxyl group, α–Amino group and side chain are 1.8, 9.0 and 12.5, respectively. Calculate the isoelectric point.

A) 7.8 B) 7.2 C) 10.8 D) 5.4

Answer: C
Page Ref: Section 4

31) The pK_a's of isoleucine's α–Carboxyl group and α–Amino group are 2.3 and 9.8, respectively. Calculate the isoelectric point.

A) 2.3
B) 6.0
C) 9.8
D) The isoelectric point cannot be calculated without the pK_a value for the side chain.

Answer: B
Page Ref: Section 4

32) The pH inside cells is normally near pH 7. At pH 7 which statement is true about the charges (ionization state) of the α–Carboxyland α–Amino groups of an amino acid?

A) The α–Carboxyl group is 1– and the α–Amino group is 1+.

B) The α–Carboxyl group is 1+ and the α–Amino group is 1–.

C) The α–Carboxyl group is 1– and the α–Amino group is uncharged.

D) Both groups are uncharged (not ionized) at pH 7.

Answer: A
Page Ref: Section 4

33) Which structure below is appropriate for glycine at neutral pH?

A) H_2NCH_2COOH

B) $H_2NCH_2COO^-$

C) $^+H_3NCH_2COO^-$

D) $^+H_3NCH_2COOH$

Answer: C
Page Ref: Section 4

34) The pK_a of a certain weak acid is 4.0. Calculate the ratio of proton acceptor to proton donor at pH 7.0.

A) 1000:1

B) 20:1

C) 3:1

D) 1:1

E) The ratio cannot be calculated without knowing the structure of the weak acid.

Answer: A
Page Ref: Section 4

35) The pK_a's of the side chain group and the α–carboxyl group of glutamate are 4.1 and 2.1, respectively. Which statement accounts for this difference?

A) The side chain has more possible resonance structures.

B) The α–carboxyl group has less steric hindrance and is therefore ionized more easily.

C) The side chain is a different functional group than the α–carboxyl group.

D) The α–carboxyl group is closer to the α–amino group than the side chain is.

Answer: D
Page Ref: Section 4

36) How do the pK_a values of an ionizable side chain compare when the amino acid is free versus when it is in a polypeptide chain?

A) The pK_a of the side chain is independent of whether the amino acid is in a polypeptide chain or is free.

B) The pK_a of the side chain is always lower for the free amino acid.

C) The pK_a of the side chain may be lower or higher in a polypeptide chain due to weaker inductive effects and differences in their microenvironments.

D) The pK_a of the side chain is usually higher in a polypeptide chain due to stabilization from nearby residues in the three–dimensional structure.

Answer: C
Page Ref: Section 4

37) The isoelectric point of alanine is pH = 6.15. It is mixed with proline (pH_{COOH} = 2.0; pH_{NH2} = 10.6), and the mixture is placed in an electric field at pH 6.15. Which statement is true?

A) The two amino acids will be separated.

B) The two amino acids will not be separated.

C) Neither amino acid will move in the electric field.

D) Both amino acids will move from the origin and be separated.

Answer: A
Page Ref: Section 4

38) According to the Henderson–Hasselbalch equation, when the concentrations of proton acceptor and proton donor are the same, then

A) the carboxylic acid is totally neutralized.

B) only salt forms are present.

C) $pH = pK_a$.

D) pK_a = log[proton acceptor]/[proton donor].

Answer: C
Page Ref: Section 4

39) For the amino acid lysine, the Henderson–Hasselbalch equation can be applied to ________ ionization group(s).

A) one B) two C) three D) four

Answer: C
Page Ref: Section 4

40) The primary structure of a protein describes the ________.

A) number of each type of amino acid (percent composition)

B) linear sequence of amino acids

C) overall three–dimensional shape

D) Φ and Ψ angles for each amino acid

Answer: B
Page Ref: Section 5

41) The peptide bond is which of the following?

A) an amide bond

B) an ester bond

C) an ether bond

D) an amine bond

Answer: A
Page Ref: Section 5

42) Which amino acids are linked in phenylalanylglycine?

A) phenyline, alanine and glycine

B) phenol, alanine and glycine

C) phenylalanine and glycine

D) phenol, adenine and glycine

Answer: C
Page Ref: Section 5

43) What is the N–terminal for the pentapeptide Val–Ile–Glu–Arg–Tyr?

A) the NH_3^+ group on the side chain of Arg

B) valine

C) tyrosine

D) tryptophan

Answer: B
Page Ref: Section 5

44) What is the net charge on the tripeptide Gly–Arg–Lys at pH 7? The table below gives the pK_a's of the ionizable groups on the free amino acids.

Free amino acid	pK_a of α–Carboxyl group	pK_a of α–amino group	pK_a of side chain
Glycine	2.4	9.8	---
Arginine	1.8	9.0	12.5
Lysine	2.2	9.1	10.5

A) –1

B) 0

C) +1

D) +2

Answer: D
Page Ref: Section 5

45) What is the net charge on the dipeptide Arg–Pro at pH 9.0? The table below gives the pKa's of the ionizable groups on the free amino acids.

Free amino acid	pK_a of α–Carboxyl group	pK_a of α–amino group	pK_a of side chain
Arginine	1.8	9.0	12.5
Proline	2.0	10.6	---

A) –1 B) –0.5 C) 0 D) +0.5 E) +1

Answer: D
Page Ref: Section 5

46) The ionic charges associated with a protein molecule are ________.

A) mostly contributed by the side chains of constituent amino acids

B) determined by the contribution from the α–carboxyl group, α–amino group and side chain of every amino acid in the protein

C) contributed by only the N–terminal and C–terminal residues

D) independent of the amino acid composition and depend only on pH

Answer: A
Page Ref: Section 5

47) Which substance is used to fractionate proteins based on differences in their solubility as a function of salt concentration?

A) cellophane B) sodium dodecyl sulfate

C) phenylisothiocyanate D) ammonium sulfate

Answer: D
Page Ref: Section 6

48) During the fractionation process which of the following remain in the supernatant?

A) membrane proteins

B) the less soluble impurities

C) the Target protein and other more soluble proteins

D) the remaining unbroken (whole) cells

Answer: C
Page Ref: Section 6

49) In a biochemistry laboratory a student added ammonium sulfate to a tube containing a buffered protein solution. The student then centrifuged the solution. What was the student probably trying to do?

A) change the pH of the buffer solution to solubilize all proteins

B) hydrolyze the proteins into their constituent amino acids to determine the percent composition

C) derivatize the N–terminal amino acid of all proteins

D) selectively precipitate and purify a certain protein

Answer: D
Page Ref: Section 6

50) The liquid emerging from the bottom of a chromatography column is called the ________.

A) eluate B) supernatant C) solute D) lysate

Answer: A
Page Ref: Section 6

51) Gel–filtration chromatography separates a mixture of proteins on the basis of ________.

A) charge

B) size

C) affinity for ligands in the column matrix

D) density

Answer: B
Page Ref: Section 6

52) A mixture of four proteins (X, Y, Z and N) is applied to a gel–filtration column. Given the information supplied, which will elute first?

Protein	Molecular Weight (g/mol)
X	35,000
Y	26,000
Z	146,000
N	26,000

A) Z

B) Y and N elute together

C) X

D) cannot answer without information about the isoelectric point

Answer: A
Page Ref: Section 6

53) Which is used as the basis of separation of proteins by affinity chromatography?

A) The net charge and pI of the protein at the pH of the column.

B) The protein's molecular weight.

C) The protein's density.

D) The selective binding of the protein to a ligand on the column matrix.

Answer: D
Page Ref: Section 6

54) A mixture of two proteins with the same pI and molecular weights (MW) of 10,000 and 15,000 daltons, respectively, are applied to a gel filtration column. What happens during elution?

A) Both elute together.

B) The one with MW of 10,000 elutes first.

C) The one with MW of 15,000 elutes first.

D) More information is needed about the specificity of the column matrix to tell what happens.

Answer: C
Page Ref: Section 6

55) What is the purpose of SDS in SDS–PAGE?

A) to selectively bind the target protein

B) to maintain buffer pH in the gel

C) to cause the separation to be on the basis of molecular weight only

D) to initiate polymerization of acrylamide to form a gel

Answer: C
Page Ref: Section 6

56) Which technique is used less for protein purification and more for the determination of molecular weights?

A) affinity chromatography

B) SDS–PAGE

C) gel filtration

D) ion exchange chromatography

Answer: B
Page Ref: Section 6

57) Even though mass spectrometry has been in use for over a hundred years, it had only limited use with proteins until the 1980's because

A) not many proteins had been discovered and purified before the 1980's.

B) it was not possible to disperse charged proteins into a gaseous stream of particles.

C) many proteins are difficult or impossible to crystallize.

D) proteins decompose too quickly into their component amino acids.

Answer: B
Page Ref: Section 7

58) In which technique is a protein solution a pumped through a metal needle at high voltage to create tiny droplets that are analyzed for their mass/charge ratio?

A) electrospray mass spectrometry

B) MALDI–TOF

C) aerosol microscopy

D) Millikan analysis

E) SDS–PAGE

Answer: A
Page Ref: Section 7

59) Which technique is most sensitive and accurate for the determination of a protein's molecular weight?

A) SDS–PAGE

B) Gel filtration chromatography

C) mass spectrometry

D) X–ray crystallography

E) osmotic pressure

Answer: C
Page Ref: Section 7

60) Which is used to hydrolyze the peptide bonds of a protein to yield free amino acids?

A) PITC B) SDS C) CNBr D) HCl

Answer: D
Page Ref: Section 8

61) Which will react with amino acids to yield derivatives that can be detected by monitoring the absorbance at 254 nm?

A) PITC B) SDS C) CNBr D) HCl

Answer: A
Page Ref: Section 8

62) The distribution of amino acids in a protein often cannot be determined precisely by acid hydrolysis. Why?

A) The side chains of asparagine and glutamine are also hydrolyzed.

B) The amine groups on lysine and arginine neutralize much of the acid.

C) The side chain of phenylalanine is almost totally destroyed by acid hydrolysis.

D) All of the above

Answer: A
Page Ref: Section 8

63) What is the purpose of treating a protein with 2–mercaptoethanol?

A) to hydrolyze the protein into its amino acids

B) to cleave the disulfide bonds

C) to derivatize any free sulfhydryl groups to prevent them from reforming disulfide bonds

D) to derivatize the N–terminal amino acid during the Edman degradation

Answer: B
Page Ref: Section 9

64) An octapeptide was determined to have the following amino acid composition:
Lys (2), Phe (2), Gly (1), His (1), Leu (1), Met (1). The native peptide was run through one cycle of the Edman degradation and the PTH–leucine derivative was identified by HPLC. When the native peptide was exposed to cyanogen bromide (CNBr), a heptapeptide and free glycine were recovered. Incubation of the native protein with trypsin gave a tetrapeptide, a tripeptide, and free lysine. The peptides were separated and each run through one cycle of the Edman degradation. The tetrapeptide yielded the PTH–leucine derivative, and the tripeptide yielded the PTH–phenylalanine derivative. Incubation of the native protein with pepsin produced a dipeptide and two tripeptides. The amino acid composition of the tripeptides (not the order) were determined to be (Phe, Gly, Met) and (Phe, Lys, Lys). What is the sequence of the octapeptide?

<u>Specificities of Proteases</u>

BrCN	cuts at the C–terminal side of Met
Trypsin	cuts at the C–terminal side of Lys or Arg
Pepsin	cuts at the N–terminal side of Phe, Trp or Tyr

A) Leu–His–Phe–Lys–Lys–Phe–Met–Gly

B) Gly–Met–Phe–Lys–Lys–Phe–His–Leu

C) Met–Leu–Phe–Lys–Phe–Gly–Lys–His

D) Leu–His–Lys–Lys–Phe–Phe–Gly–Met

E) His–Phe–Leu–Lys–Lys–Phe–Met–Gly

Answer: A
Page Ref: Section 10

65) What information can be gained by comparing the sequences of proteins that have the same or similar function in different species?

A) to determine evolutionary relationships and relatedness of species

B) to determine sequences that are conserved among species since they are likely to be important to the function and stability of the proteins

C) to locate highly variable residues which contribute little to the structure and function of the protein

D) All of the above

Answer: D
Page Ref: Section 11

66) All 20 common amino acids have an amino group and a carboxyl group bonded to the same carbon atom.

Answer: TRUE
Page Ref: Section 1

67) All 20 common amino acids exist in nature equally as both the D and L stereoisomers.

Answer: FALSE
Page Ref: Section 1

68) All amino acids have mirror–image pairs designated D and L.

Answer: FALSE
Page Ref: Section 1

69) Uncharged R groups of amino acids are not polar.

Answer: FALSE
Page Ref: Section 2

70) Ultraviolet (UV) light can be used to estimate concentrations of proteins in solutions because tryptophan and tyrosine absorb light at a wavelength of 280 nm.

Answer: TRUE
Page Ref: Section 2

71) Asparagine and glutamine are both amides of aspartic acid and because they have uncharged sidechains are often found on the interior of proteins.

Answer: FALSE
Page Ref: Section 2

72) The hydropathy of amino acids can help determine the folding of protein chains.

Answer: TRUE
Page Ref: Section 2

73) Amino acids and amino acid derivatives can be used to modify proteins.

Answer: FALSE
Page Ref: Section 3

74) The isoelectric point of amino acids is the average of the values pK_{COOH} + pK_{NH2}.

Answer: FALSE
Page Ref: Section 4

75) Amino acids are neutral at the isoelectric pH.

Answer: TRUE
Page Ref: Section 4

76) In gel electrophoresis the molecules with the highest molecular weight migrate the farthest from the starting wells.

Answer: FALSE
Page Ref: Section 6

77) Cation-exchange resins have negatively charged groups covalently attached to the column matrix.

Answer: TRUE
Page Ref: Section 6

78) Affinity chromatography can be used to save many purification steps compared to other techniques due to its high specificity for the target protein.

Answer: TRUE
Page Ref: Section 6

79) Most proteins contain an approximately equal amount of each of the standard amino acids.

Answer: FALSE
Page Ref: Section 6

80) Most purification procedures for proteins are carried out at room temperature.

Answer: FALSE
Page Ref: Section 6

81) The purpose of adding ammonium sulfate to a solution containing proteins is to cause fractionation by precipitating the less soluble proteins.

Answer: TRUE
Page Ref: Section 6

82) The liquid that emerges from the bottom of a chromatographic column is called the supernatant.

Answer: FALSE
Page Ref: Section 6

83) The twenty standard amino acids are the only amino acids found in living organisms.

Answer: FALSE
Page Ref: Section 7

84) Iodoacetate is used to acetylate sulfhydryl groups to prevent their oxidation to disulfides.

Answer: TRUE
Page Ref: Section 8

85) Proteins are treated with substances such as 2–mercaptoethanol to remove disulfide bonds before being sequenced because the disulfide bonds will interfere with the sequencing procedure.

Answer: TRUE
Page Ref: Section 9

Match the following to their functions.

86) Regulates mammalian metabolism.
Page Ref: Section 3

87) Methyl donor in metabolism
Page Ref: Section 3

88) 21st amino acid in many species
Page Ref: Section 3

89) First amino acid in newly synthesized bacterial proteins.
Page Ref: Section 3

90) Neurotransmitter
Page Ref: Section 3

91) Controls the constriction of certain blood vessels.
Page Ref: Section 3

A) epinephrine (adrenaline)

B) g–aminobutyrate

C) Histamine

D) selenocysteine

E) N–formylmethionine

F) S–adenosylmethionine

86) A	87) F	88) D	89) E	90) B	91) C

Chapter 4 Proteins: Three–Dimensional Structure and Function

1) Which pair represents different conformations?

A) *cis*–1,2–dichloroethene and *trans*–1,2–dichloroethene

B) L–glycine and D–glycine

C) eclipsed ethane and staggered ethane

D) pentane and 2–methylbutane

Answer: C
Page Ref: Introduction

2) A change from one conformation of a molecule to another involves ________.

A) rotation about bonds only

B) breaking and reforming of covalent bonds

C) inversion about a center of symmetry

D) Any of the above

Answer: A
Page Ref: Introduction

3) The ________ is the single shape a protein adopts under physiological conditions.

A) minimal configuration

B) native conformation

C) primary structure

D) most stable enantiomer

Answer: B
Page Ref: Introduction

4) Structural proteins that typically assemble into large cables or threads to provide mechanical support to cells or organisms are classified as ________ proteins.

A) fibrous

B) enzyme

C) globular

D) β–strand

Answer: A
Page Ref: Introduction

5) To what level of structure do α–helices belong?

A) primary

B) secondary

C) tertiary

D) quaternary

Answer: B
Page Ref: Section 1

6) What does it mean to say a protein is oligomeric?

A) *In vivo* it establishes an equilibrium between two or more active conformations.

B) It has more than fifty amino acids.

C) The active protein involves the association of two or more polypeptide chains.

D) The protein has multiple α–helices.

Answer: C
Page Ref: Section 1

7) Computers are used to advance the understanding of three dimensional protein structure by

A) determining the specific sequence of amino acids.

B) finding repeating subunit patterns.

C) calculating atomic positions from X–ray diffraction patterns.

D) collimating X–ray beams.

Answer: C
Page Ref: Section 2

8) Which technique is commonly used to determine the three–dimensional conformation of a protein?

A) isoelectric focusing

B) the Edman degradation

C) SDS–PAGE

D) X–ray crystallography

Answer: D
Page Ref: Section 2

9) ________ received a Nobel Prize in 1964 for determining the structure of vitamin B_{12}. He/she also solved the structure of penicillin in 1947 and developed many techniques used in the study of large proteins.

A) Max Perutz

B) Linus Pauling

C) Rosalind Franklin

D) Dorothy Crowfoot

Answer: D
Page Ref: Section 2

10) ________ is a technique used to analyze the macromolecular structure of proteins in solution.

A) X–ray crystallography

B) SDS–PAGE

C) Affinity chromatography

D) NMR

Answer: D
Page Ref: Section 2

11) NMR is often used for the determination of the ________ of proteins.

A) molecular weight

B) isoelectric point

C) tertiary structure

D) pK_a

Answer: C
Page Ref: Section 2

12) Which is evidence that structures for proteins determined by X–ray crystallography represent the structures in solution?

A) Their similarity to structures determined by NMR.

B) The protein crystals are soluble in water.

C) The proteins must align in a regular pattern to form a crystal.

D) Only one conformation is ever possible for a protein so it is irrelevant whether the protein is in a crystal or in solution.

Answer: A
Page Ref: Section 2

13) Which statement is <u>not</u> true about the peptide bond?

A) The peptide bond has partial double–bond character.

B) The peptide bond is longer than the typical carbon–nitrogen bond.

C) Rotation is restricted about the peptide bond.

D) The carbonyl oxygen and the amide hydrogen are most often in a *trans* configuration with respect to one another.

Answer: B
Page Ref: Section 2

14) In peptide bonds, the bonds between

A) C and N are shorter than typical C–N bonds.

B) C and N are longer than typical C–N bonds.

C) C and O are longer than typical C=O bonds.

D) C and O are shorter than typical C=O bonds.

E) Both A and C

Answer: E
Page Ref: Section 3

15) Nearly all peptide bonds are in the *trans* configuration because

A) *cis* peptide bonds are weaker.

B) *trans* peptide bonds are stronger.

C) *cis* peptide bonds prevent R groups from interacting.

D) *trans* peptide bonds minimize steric hindrance of R groups.

Answer: D
Page Ref: Section 3

16) Which represents the backbone of a protein?

Note: R = amino acid side chain
N = nitrogen
C_α = alpha carbon
C = carbonyl carbon

A) $R_1R_2R_3R_4R_5$

B) repeating units of N–C

C) repeating units of N–C_α–C

D) repeating units of C_α–C

Answer: C
Page Ref: Section 3

17) What is true about the rotation about bonds in a protein backbone?

A) The rotation is free about all bonds in the backbone, except for the bond between the nitrogen and the alpha carbon in proline residues.

B) The bond between the carbonyl carbon and nitrogen is restricted. Other bonds are free to rotate depending only on steric hindrance or the presence of proline residues.

C) All bonds in the backbone have restricted rotation and partial double–bond character.

D) The rotation is free only about the peptide bond. The other bonds are restricted by steric hindrance and the presence of proline residues.

Answer: B
Page Ref: Section 3

18) The conformation of the backbone of a polypeptide is described completely by the angle(s) of rotation about which bond(s)?

A) the peptide bond only

B) N–C_α only

C) N–C_α, C_α–C and C–N bonds

D) N–C_α and C_α–C bonds only

Answer: D
Page Ref: Section 3

19) What feature does a Ramachandran plot display?

A) allowed angles of phi and psi for a polypeptide backbone

B) preferred amino acids in an α-helix

C) the hydropathy of amino acids

D) the variation of pH versus volume of base added during titration to determine the pK_a

Answer: A
Page Ref: Section 3

20) Ramachandran determined the "allowed" values of the phi and psi angles primarily by considering ________.

A) pK_a values of the amino acids
B) the hydropathy of amino acids
C) steric hindrance
D) hydrogen bonding effects

Answer: C
Page Ref: Section 3

21) The distance along a helix axis for one complete turn is called the ________.

A) axial distance
B) rise
C) screw length
D) pitch

Answer: D
Page Ref: Section 4

22) Which was a major scientific accomplishment by Linus Pauling?

A) Determined the α-helix structure in keratin.

B) Discovered β-strands and described their assembly into sheets.

C) Determined the three-dimensional structure of hemoglobin and myoglobin.

D) Determined the structure of penicillin.

Answer: A
Page Ref: Section 4

23) An ideal α-helix has a pitch of 0.54 nm and a rise of 0.15 nm. What is the length along the helix axis for a segment of an ideal α-helix that contains 30 amino acids?

A) 200 nm
B) 4.50 nm
C) 16.20 nm
D) 55.5 nm

Answer: B
Page Ref: Section 4

24) How many complete turns are there in an ideal α-helix that contains 15 amino acids and has a pitch of 0.54 nm and a rise of 0.15 nm?

A) 1
B) 4
C) 8
D) 59

Answer: B
Page Ref: Section 4

25) Proline is not often found in a-helices of proteins because it

A) has a small, uncharged side chain.

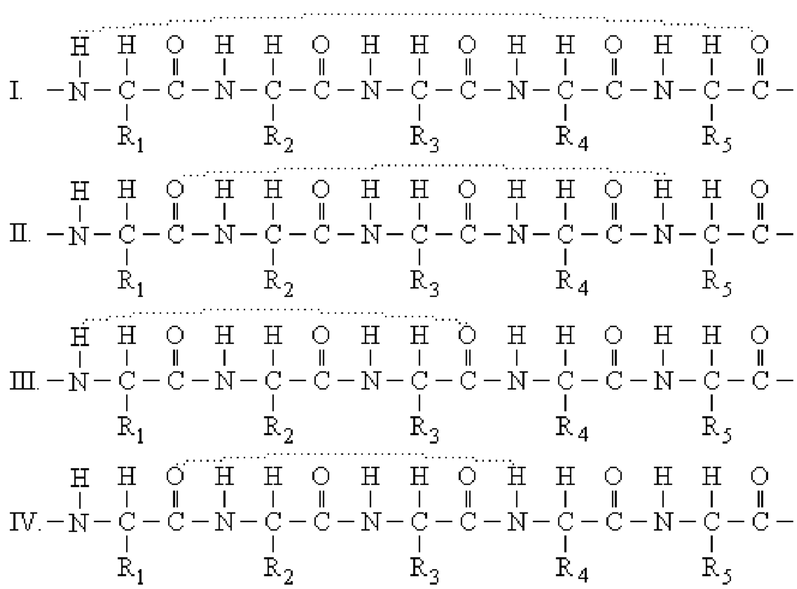
B) has a very bulky side chain.

C) lacks a hydrogen atom on its amide nitrogen.

D) interacts with adjacent amino acids.

Answer: C
Page Ref: Section 4

26) Which structure below indicates the proper hydrogen-bonding pattern between amino acids in an α-helix? (Dashed lines represent the hydrogen bonds.)



A) I B) II C) III D) IV

Answer: B
Page Ref: Section 4

27) Which statement is <u>not</u> true about an α-helix?

A) It is usually right-handed.

B) It is a type of secondary structure.

C) It frequently contains proline residues.

D) It is stabilized by hydrogen bonding.

Answer: C
Page Ref: Section 4

28) Which is true about the side chains of residues in an α–helix?

A) They extend above or below the pleats.

B) They extend radially outward from the helix axis.

C) They point toward the center of the helix.

D) They hydrogen bond extensively with each other.

Answer: B
Page Ref: Section 4

29) What would you expect about the formation of an α–helix for a segment of a protein chain that contains lysine approximately every fourth residue with all other residues being mostly hydrophobic?

A) Helix formation would be favored at low pH.

B) Helix formation would be favored at high pH.

C) Helix formation would be favored at neutral pH.

D) Helix formation would never occur regardless of pH.

Answer: B
Page Ref: Section 4

30) A helical wheel can be used to show

A) the pitch of a helix structure.

B) the amphipathic nature of a helix.

C) DNA binding.

D) pleated sheets.

Answer: B
Page Ref: Section 4

31) Which is not true about β–sheets?

A) The side–chains of all amino acids point to the same side of the sheet.

B) The polypeptide chains in the sheet are nearly fully extended.

C) The range of allowed phi and psi angles is broader than for those in the α–helix.

D) In antiparallel sheets the hydrogen bonds between adjacent strands are nearly perpendicular to the backbones of the strands.

Answer: A
Page Ref: Section 5

32) A b sandwich forms when

A) two hydrophobic sides of b–sheets interact.

B) two hydrophilic sides of b–sheets interact.

C) an a–helix separates two b–sheets.

D) two amphipathic a–helices interact.

Answer: A
Page Ref: Section 5

33) Supersecondary structures that contain recognizable combinations of α–helices, β–strands and loops (e.g. the Greek Key) are called ________.

A) domains

B) folds

C) homologous regions

D) motifs

Answer: D
Page Ref: Section 7

34) How many monomers are there in an oligomeric protein designated $\alpha\beta_2\gamma_2$?

A) 2

B) 3

C) 4

D) 5

E) not given

Answer: D
Page Ref: Section 8

35) The principle forces holding subunits of an oligomeric protein to each other are ________.

A) peptide bonds

B) hydrophobic interactions

C) covalent bonds

D) disulfide bonds

Answer: B
Page Ref: Section 8

36) Which factor does <u>not</u> help to explain why many proteins exhibit quaternary structure?

A) Oligomers are usually more stable than the free monomers.

B) Active sites can be formed when the protein chains associate.

C) The subunits always are able to maintain the same three–dimensional structure whether they are associated into an oligomer or not.

D) Increased efficiency by the sharing of the same subunit with the same function among different proteins.

Answer: C
Page Ref: Section 8

37) Protein subunits in a multisubunit protein are held to each other primarily by

A) covalent bonds.

B) hydrophobic interactions exclusively.

C) both strong and weak interactions.

D) hydrophobic and other weak interactions.

E) All of the above

Answer: D
Page Ref: Section 8

38) A tetrameric protein contains

A) four different subunits.

B) four identical subunits.

C) three subunits and one prosthetic group.

D) A or B only

E) A, B or C

Answer: D
Page Ref: Section 8

39) A protein has a molecular weight of 5600 daltons; its subunits are about 1960 daltons. There are ________ protein chains per oligomer.

A) 4

B) 3

C) 2

D) 1

E) Cannot determine from the information given

Answer: B
Page Ref: Section 8

40) Which is not an example of an oligomeric protein?

A) cytochrome *c*

B) potassium channel protein

C) MS2 capsid protein

D) hemoglogin

E) bacterial photosynthetic reaction center

Answer: A
Page Ref: Section 8

41) ________ is used to estimate the molecular weight of oligomeric proteins, while ________ is used to determine molecular weight of each chain.

A) Melting point; SDS–gel electrophoresis

B) SDS–gel electrophoresis; gel–filtration chromatography

C) Acrylamide gel electrophoresis; isoelectric focusing

D) Gel–filtration chromatography; SDS–gel electrophoresis

E) SDS–gel electrophoresis; NMR

Answer: D
Page Ref: Section 8

42) Many proteins have multiple subunits because

A) an active site is shared by different subunits.

B) they are more stable and flexible in movement.

C) different combinations can perform different functions.

D) All of the above

E) A and C above

Answer: D
Page Ref: Section 8

43) Protein folding can be followed in the laboratory by measuring

A) viscosity.

B) electrophoretic mobility and gel filtration.

C) UV absorption and light rotation.

D) A, B, and C above

E) A and C above

Answer: E
Page Ref: Section 9

44) Which statement is true about disulfide bonds and protein folding?

A) Disulfide bonds have no influence on protein folding since they only form after the protein adopts its native conformation.

B) Proteins occasionally adopt nonnative conformations and form improper disulfide bonds that can be reversed by the enzyme protein disulfide isomerase.

C) The folding of the native conformation is influenced more strongly by the formation of disulfide bonds than by the primary structure of a protein.

D) If a protein forms an improper disulfide bond it is irreversibly inactivated and must be targeted by the cell for degradation.

Answer: B
Page Ref: Section 9

45) The T_m of a protein is temperature at which it

A) is completely denatured.
B) liquifies.
C) is half denatured.
D) resists denaturation.

Answer: C
Page Ref: Section 9

46) Proteins with high T_m values are generally stable at

A) room temperature (21 °C).
B) 50 ° to 60 °C.
C) temperatures below 50 °C.
D) temperatures above 60 °C.
E) All of the above

Answer: D
Page Ref: Section 9

47) Which demonstrates that the primary structure of a protein determines its tertiary structure?

A) How the disulfide bonds hold it in the correct shape.
B) Proteins can refold even when the amino acid sequence is changed.
C) Proteins refold when the amino acid sequence is the same as in the native conformation.
D) Chaotropic agents cannot denature the native conformation.
E) All of the above

Answer: C
Page Ref: Section 9

48) Proteins segments which fold first can promote the folding of other sections of the protein into the native conformation by a process known as

A) renaturation.
B) stabilization.
C) hydrophobic interaction.
D) disulfide bridge formation.
E) cooperativity.

Answer: E
Page Ref: Section 10

49) In addition to self assembly, some proteins fold with the help of

A) energy stabilizers.

B) weak chemical interactions.

C) other proteins.

D) low entropy pickets.

E) All of the above

Answer: C
Page Ref: Section 10

50) Chaperones are proteins which

A) renature and denatured proteins.

B) help cells repair damage due to heat shock.

C) assist protein self assembly.

D) use ATP to fold proteins.

E) All of the above

Answer: E
Page Ref: Section 10

51) Hemoglobin is

A) a tetramer of 4 myoglobin proteins.

B) a tetramer of four globin chains and one heme prosthetic group.

C) a dimer of subunits each with two distinct protein chains (alpha and beta).

D) a dimer of subunits each with two myoglobin proteins.

E) an erythrocyte.

Answer: C
Page Ref: Section 12

52) Hydrophobic amino acid sequences in myoglobin are responsible for

A) covalent bonding to the heme prosthetic group.

B) the folding of the polypeptide chain.

C) the irreversible binding of oxygen.

D) A and B above

Answer: B
Page Ref: Section 12

53) The main property of myoglobin and hemoglobin that makes them an efficient system for oxygen delivery from lungs to muscles is

A) hydrophobicity.

B) different binding affinities for oxygen.

C) movement of the protein shapes.

D) cooperativity.

E) All of the above

Answer: B
Page Ref: Section 12

54) A hyperbolic binding curve differs from a sigmoidal binding curve in that the hyperbolic curve

A) has a single equilibrium constant for oxygen binding.

B) binds more oxygen after the initial proteins first bind oxygen.

C) shows cooperativity.

D) binds up to four molecules of oxygen.

E) All of the above

Answer: A
Page Ref: Section 12

55) Cooperative binding of oxygen by hemoglobin

A) is induced by hemoglobin.

B) is a result of different affinities for oxygen by each subunit protein.

C) is induced by oxygenation.

D) is a result of interaction with myoglobin.

Answer: C
Page Ref: Section 13

56) Which statement is false about the heme group?

A) When oxygen binds to heme, the iron ion is oxidized from Fe^{2+} to Fe^{3+}.

B) If exposed to air, a free heme group (not associated with hemoglobin) is readily oxidized converting Fe^{2+} to Fe^{3+} and can no longer bind oxygen.

C) The heme group is tightly, but non–covalently, held in myoglobin molecule.

D) The chemical structure of the heme groups in myoglobin and hemoglobin are identical.

Answer: A
Page Ref: Section 13

57) Conditions in the tissues which enhance the delivery of oxygen by hemoglobin are the presence of

A) carbon dioxide.

B) 2,3 BPG.

C) protons.

D) All of the above

E) A and B above

Answer: D
Page Ref: Section 13

58) Antibodies bind antigens at

A) light chains.

B) heavy chains.

C) hypervariable regions.

D) glycoprotein regions.

E) All of the above

Answer: C
Page Ref: Section 14

59) Antibodies are suitable for diagnostic tests because

A) they can be made radioactive.

B) they can be readily purified.

C) they are found in very small quantities.

D) they bind very specifically to antigens.

E) they are found everywhere.

Answer: D
Page Ref: Section 14

60) All proteins possess primary, secondary, tertiary and quaternary structure.

Answer: FALSE
Page Ref: Section 1

61) β-strands are a type of secondary structure.

Answer: TRUE
Page Ref: Section 1

62) Water can easily penetrate and even pass through the interior of a folded protein.

Answer: FALSE
Page Ref: Section 2

63) Proline exists in the *cis* configuration more frequently than any other amino acid.

Answer: TRUE
Page Ref: Section 3

64) All amino acids can readily interconvert between the *cis* and *trans* forms by rotation about the peptide bond.

Answer: FALSE
Page Ref: Section 3

65) α–helices easily form on the surface of water–soluble proteins due to the stabilizing effect of hydrogen bonding with water.

Answer: FALSE
Page Ref: Section 4

66) Proline is the least common amino acid in α–helices due to its inability to fully participate in intrahelical hydrogen bonding.

Answer: TRUE
Page Ref: Section 4

67) A <u>fold</u> in a protein is a combination of secondary structures that form the core of a protein domain.

Answer: TRUE
Page Ref: Section 7

68) Homologous proteins can be identified not only by sequencing, but also by comparing similarities in tertiary structure.

Answer: TRUE
Page Ref: Section 7

69) In oligomeric proteins all the subunits are always identical.

Answer: FALSE
Page Ref: Section 8

70) The subunits of a multisubunit proteins are always identical.

Answer: FALSE
Page Ref: Section 8

71) Proteins often consist of multiple subunits so that they may have different functions under different conditions.

Answer: TRUE
Page Ref: Section 8

72) The amount of energy required to denature a protein is often small.

Answer: TRUE
Page Ref: Section 9

73) Once denatured, proteins cannot be renatured or restored to the native state.

Answer: FALSE
Page Ref: Section 9

74) Chaotropic agents denature by disrupting stabilizing hydrophobic interactions, while detergents denature by penetrating and disrupting hydrophilic interactions.

Answer: FALSE
Page Ref: Section 9

75) Disulfide bond formation between two cysteine residues appropriately located in a polypeptide chain drives protein folding into the proper configuration.

Answer: FALSE
Page Ref: Section 9

76) The native structures of proteins are more stable than non–native conformations; they occupy a low–energy well when folded.

Answer: TRUE
Page Ref: Section 10

77) Using simple computer algorithms biochemists can easily predict the tertiary structure of a protein from its sequence.

Answer: FALSE
Page Ref: Section 10

78) The association of hydrophobic side chains in the interior of proteins helps to stabilize helices and pleated sheet domains.

Answer: TRUE
Page Ref: Section 10

79) Chaperones are proteins which prevent incorrect folding of proteins as well as preventing some proteins from aggregating.

Answer: TRUE
Page Ref: Section 10

80) Heat shock proteins are those stable at higher temperatures.

Answer: FALSE
Page Ref: Section 10

81) Ascorbic acid is necessary for the formation of hydroxyproline and hydroxylysine residues before they are incorporated into the collagen protein molecule.

Answer: FALSE
Page Ref: Section 11

82) The porphyrin prosthetic group is held into the interior of globin molecules by covalent bonds to specific amino acid residues.

Answer: FALSE
Page Ref: Section 12

83) The hydrophobic crevice of globin prevents complete electron transfer to the oxygen so that the electron returns to the iron atom when oxygen dissociates.

Answer: TRUE
Page Ref: Section 12

84) Myoglobin has a greater affinity for oxygen than hemoglobin.

Answer: TRUE
Page Ref: Section 12

85) Cooperative binding and allosterism of hemoglobin allow oxygen to be unloaded at low partial pressures of oxygen in the tissues.

Answer: TRUE
Page Ref: Section 13

86) The Bohr effect describes the effect of pH on hemoglobin's ability to bind oxygen. Oxygen binds more tightly at low pH and less tightly at higher pH values.

Answer: FALSE
Page Ref: Section 13

87) At high carbon dioxide concentrations the carbamates of hemoglobin can be formed. The carbamates of oxyhemoglobin are less stable than those of deoxyhemoglobin.

Answer: TRUE
Page Ref: Section 13

88) Part of immunoglobulin molecules can be changed in order to bind to a variety of antigens while the amino acid sequence of another part does not change.

Answer: TRUE
Page Ref: Section 14

Match each level of organization with a description.

89) Primary structure
Page Ref: Section 1

90) Secondary structure
Page Ref: Section 1

91) Tertiary structure
Page Ref: Section 1

92) Quaternary structure
Page Ref: Section 1

A) Overall shape of a protein

B) Repeated pattern of folding

C) Multiple subunits are present

D) Specific order of amino acids

89) D 90) B 91) A 92) C

Match the protein organization most associated with the term(s) listed below:

93) Subunits
Page Ref: Section 8

94) Cystine
Page Ref: Section 8

95) Hydrogen bonds between carbonyl and amino groups
Page Ref: Section 8

96) Peptide bonds
Page Ref: Section 8

A) Tertiary

B) Secondary

C) Primary

D) Quaternary

93) D 94) A 95) B 96) C

For each term select the description that best describes its contribution to the structure of collagen.

97) Allysine
Page Ref: Section 11

98) Proline
Page Ref: Section 11

99) Glycine
Page Ref: Section 11

100) Vitamin C
Page Ref: Section 11

101) Hydroxyproline
Page Ref: Section 11

A) Has H bonds which help stabilize the protein

B) Makes the protein rigid

C) Required for hydroxylation

D) Forms covalent cross links

E) Allows tightly wound helix formation

97) D 98) B 99) E 100) C 101) A

Chapter 5 Properties of Enzymes

1) Which of the following statements is FALSE?

   A) Enzymes make reactions 10^3 to 10^{20} times faster.

   B) Enzymes lower the amount of energy needed for a reaction.

   C) Enzymes are chemically unchanged during the actual catalytic process.

   D) Enzymes speed up the attainment of a reaction equilibrium.

   E) Enzymes are proteins.

Answer: C
Page Ref: Introduction

2) Which of the following statements is FALSE?

   A) The word enzyme is from a Greek word meaning "in yeast."

   B) Enzymes are always made of protein.

   C) The first enzyme was crystallized in 1926.

   D) Enzymes can couple two different reactions.

Answer: B
Page Ref: Introduction

3) Unlike typical catalyzed reactions in organic chemistry enzyme reactions are

   A) usually stereospecific.

   B) reaction specific.

   C) essentially 100% efficient.

   D) modulated to change activity levels.

   E) All of the above

Answer: E
Page Ref: Introduction

4) The hydrophobic cleft in globular proteins which bind substrate molecules is called the ________.

   A) substrate pocket

   B) modulator site

   C) active site

   D) activity site

   E) oligomeric site

Answer: C
Page Ref: Introduction

5) Most of the known enzymes are ________.

A) oxidoreductases

B) transferases

C) hydrolases

D) lyases

E) isomerases

Answer: C
Page Ref: Section 1

6) An enzyme that catalyzes conversions of L–sugars to D–sugars is called a/an ________.

A) lyase

B) hydrolase

C) synthetase

D) synthase

E) isomerase

Answer: E
Page Ref: Section 1

7) Oxidases, peroxidases, oxygenases or reductases are all

A) lyases.

B) synthases.

C) synthetases.

D) oxidoreductases.

E) hydrolases.

Answer: D
Page Ref: Section 1

8) In a first order chemical reaction, the velocity of the reaction is proportional to the ________, while in a zero order reaction, the velocity of the reaction is proportional to the ________.

A) amount of enzyme; concentration of substrate

B) concentration of substrate; amount of enzyme

C) concentration of substrate; speed of the reaction

D) speed of the reaction; concentration of substrate

Answer: B
Page Ref: Sec tion 2

9) The main difference between chemical and enzyme kinetics is that

A) enzyme reactions are altered by pH.

B) enzyme reactions depend on the concentration of the substrate.

C) enzyme reactions depend on the concentration of the enzyme and its recycling.

D) the rate constant for the formation of products is k_2.

Answer: C
Page Ref: Section 2

10) When two different substrates react to form two different products, the rate constants for each separate substrate can be determined by

A) varying one substrate at a time, keeping the other in excess.

B) varying both substrates and measuring the appearance of the two products.

C) limiting one substrate and varying the other.

D) keeping both substrate concentrations high and detecting one product at a time.

Answer: A
Page Ref: Section 2

11) When there are two substrates in a reaction, the reaction is said to be second order if ________.

A) the reaction is first order with respect to each substrate concentration

B) the maximum rate is independent of either substrate's concentration

C) the substrate concentrations are equal

D) it proceeds at twice the rate upon double the concentrations of both substrates

Answer: A
Page Ref: Section 2

12) The non–enzymatic hydrolysis of sucrose into glucose and fructose is an example of a pseudo first–order reaction because

A) no enzymes are involved.

B) water has no role in the reaction.

C) water is of such high concentration as to be considered constant.

D) water is present at concentrations proportional to the sucrose.

Answer: C
Page Ref: Section 2

13) In an enzyme reaction involving one enzyme and one substrate, the rate of the reaction depends on

A) substrate concentration.

B) enzyme concentration.

C) both substrate and enzyme concentrations.

D) the enzyme concentration at first and the substrate concentration later on.

Answer: C
Page Ref: Section 2

14) At the beginning of an enzyme–catalyzed reaction the ________ is negligible.

A) formation of ES
B) formation of E + P
C) conversion of ES to E + S
D) disappearance of ES

Answer: B
Page Ref: Section 2

15) The concentrations of enzymes are determined by using pseudo first–order conditions in which

A) S concentration is kept the same and the rate is measured.

B) E concentration is kept the same and the rate is measured.

C) S concentration is constant, E concentration varied and the rate is measured.

D) E concentration is constant, S concentration varied and the rate is measured.

E) All of the above

Answer: C
Page Ref: Section 2

16) The initial velocity of an enzyme reaction (v_0) describes

A) the concentration of the enzyme at maximal velocity.

B) the concentration of substrate at maximal velocity.

C) the concentration of both at the start of the reaction.

D) the rate of the reaction at when the substrate and enzyme are first mixed.

Answer: D
Page Ref: Section 2

17) When varying the substrate concentration at a fixed concentration of enzyme it is observed that at low concentrations of substrate the reaction is ________,while at high concentrations of substrate the reaction is ________.

A) maximal; initial

B) initial; maximal

C) second order; first order

D) first order; second order

E) first order; zero order

Answer: E
Page Ref: Section 2

18) Which enzyme below is fastest?

A) kinase, $k_{cat} = 10^3$

B) papain, $k_{cat} = 10$

C) carboxypeptidase, $k_{cat} = 10^2$

D) catalase, $k_{cat} = 10^7$

Answer: D
Page Ref: Section 3

19) The Michaelis constant, K_m, is equal to the ________.

A) maximum velocity that any given enzyme reaction can achieve

B) substrate concentration which gives the best enzyme assay for an enzyme reaction

C) substrate concentration when the rate is equal to half its maximal value

D) maximum velocity divided by two

Answer: C
Page Ref: Section 3

20) The assumptions made in calculating the Michaelis–Menten Equation include

A) that the formation and decomposition of ES is the same for a period of time.

B) that the concentration of the substrate is much greater than the concentration of E.

C) that the value of k_{-2} can be ignored.

D) A, B and C

E) A and B only

Answer: D
Page Ref: Section 3

21) The expression: $V_{max} = k_2[E]_{total}$ applies to

A) zero order kinetics of an enzyme–catalyzed reaction.

B) first order kinetics of an enzyme–catalyzed reaction.

C) second order kinetics of an enzyme–catalyzed reaction.

D) only the initial part (near time = zero) of an enzyme–catalyzed reaction.

Answer: A
Page Ref: Section 3

22) The time that is required for an enzyme to convert one substrate molecule into one product molecule is

A) K_m. B) k_{cat}. C) $1/K_m$. D) $1/k_{cat}$.

Answer: D
Page Ref: Section 3

23) The (lower, higher) the value of K_m, the (less, more) tightly the enzyme is bound to the substrate.

A) lower, less

B) lower, more

C) higher, less

D) higher, more

E) B and C

Answer: E
Page Ref: Section 3

24) The catalytic proficiency of an enzyme is the ________.

A) turnover number

B) K_m/[E]

C) rate constant with the enzyme divided by the rate constant without the enzyme

D) rate constant with the enzyme times the rate constant without the enzyme

Answer: C
Page Ref: Section 4

25) The ratio of $k_{\text{cat}}/K_{\text{m}}$ for each of two different substrates present in equal concentrations in an enzyme reaction will measure enzyme affinity because

A) the rates of P formation are given by the values found for each substrate.

B) the rates of P formation are the same for each substrate.

C) it is an indication of the formation of ES for each substrate.

D) All of the above

Answer: A
Page Ref: Section 4

26) The enymatic rate constant (k_{cat}/K_m) of orotidine 5'–phosphate decarboxylase is 6 x 10^7 $M^{-1}s^{-1}$ and the nonenzymatic rate constant (k_n) is 3 x 10^{-16} s^{-1}. What is the value of the enzyme's catalytic proficiency?

A) 2 x 10^{23} M^{-1}

B) 5 x 10^{-24} M

C) 12 x 10^{-9} $M^{-1}s^{-2}$

D) 8.3 x 10^7 Ms^2

E) Cannot calculate the proficiency without knowing the value of V_{max}.

Answer: A
Page Ref: Section 4

27) It is difficult to determine either K_{m} or V_{max} from a graph of velocity vs. substrate concentration because

A) too much substrate is required to determine them.

B) the graph is sigmoidal.

C) an asymptotic value must be determined from the graph.

D) the points on the graph are often not spread out on the hyperbola.

Answer: C
Page Ref: Section 5

28) The reason to rewrite the Michaelis–Menten equation (such as the Lineweaver–Burk plot) is to

A) visualize reactions better.

B) form enzyme kinetic data as a hyperbolic curve.

C) calculate catalytic proficiency.

D) calculate V_{max} and K_{m}.

Answer: D
Page Ref: Section 5

29) In the Lineweaver–Burk plot of an enzyme reaction, the K_m is given by the ________.

A) x–intercept
B) y–intercept
C) negative reciprocal of the x–intercept
D) reciprocal of the y–intercept

Answer: C
Page Ref: Section 5

30) The Lineweaver–Burk plot and other linear transformation of the Michaelis–Menten curve of kinetics are valuable for

A) determination of K_m.
B) determination of V_{max}.
C) determination of k_{cat}.
D) determination of types of enzyme inhibition.
E) All of the above

Answer: E
Page Ref: Section 5

31) The K_m values for enzyme reactions such as A + B → C + D

A) cannot be determined using the Lineweaver–Burk plot analysis.
B) can be determined by holding one (A or B) at high concentration, while varying the concentration of the other substrate.
C) can be determined for one substrate and not the other.
D) do not indicate the efficiency of the enzyme.

Answer: B
Page Ref: Section 5

32) Which might be a method used for distinguishing among several mechanistic possibilities in a multi–substrate reaction?

A) Measure K_m in the presence of one substrate at a time.
B) Measure the rate with respect to one substrate while varying the concentration of another substrate.
C) Measure the rate while adding inactivators for all but one substrate.
D) Any of the above

Answer: B
Page Ref: Section 6

33) In a certain enzyme–catalyzed reaction the following steps occur:

1. A phosphate group on substrate A is transferred to a side chain of an active site residue of the enzyme.
2. The dephosphorylated form of substrate A dissociates from the enzyme.
3. Substrate B enters the active site and is phosphorylated with simultaneous regeneration of the enzyme in its original form.

What kind of kinetic mechanism is described?

A) random B) sequential C) ordered D) ping–pong

Answer: D
Page Ref: Section 6

34) Two substances are used to produce a certain biological product in an enzyme–catalyzed reaction. It is found that both substrates must bind to the enzyme, first one, then the other before the product is produced. This is an example of a/an ________.

A) linear reaction
B) ordered sequential reaction
C) random sequential reaction
D) ping–pong reaction

Answer: B
Page Ref: Section 6

35) In a ping–pong reaction which does not occur?

A) One product is released before a second substrate is bound.
B) The enzyme covalently binds a portion of the first substrate.
C) The enzyme is permanently converted to an altered form by the first substrate.
D) A group is transferred from one substrate to another.

Answer: C
Page Ref: Section 6

36) Which statement is true about the removal of reversible inhibitors from enzyme solutions?

A) PAGE is the primary technique used for this purpose.
B) Dialysis and gel filtration are often used.
C) These inhibitors cannot be separated from the enzyme without treatment with diisopropylfluorophosphate.
D) Removal of reversible inhibitors is extremely difficult and can be achieved only after many purification steps.

Answer: B
Page Ref: Section 7

37) What distinguishes reversible inhibitors from irreversible inhibitors?

A) Reversible inhibitors are not covalently bound to enzymes but irreversible inhibitors are.

B) There is an equilibrium between bound and unbound reversible inhibitor. There usually is little back reaction for the binding of an irreversible inhibitor.

C) Reversible inhibitors are easier to purify from solutions of enzymes than irreversible inhibitors.

D) All of the above

E) A and B only

Answer: D
Page Ref: Section 7

38) An inhibitor binds to a site other than the active site of the enzyme. Which statement below correlates with this observation?

A) It must be a competitive inhibitor.

B) The inhibition must be irreversible.

C) It could be noncompetitive or uncompetitive inhibition.

D) It could be irreversible, competitive, noncompetitive or uncompetitive. The data do not relate to the type of inhibition.

Answer: C
Page Ref: Section 7

39) Nonclassical competitive inhibition involves ________.

A) binding of the substrate at both the active site and at the inhibitor site

B) binding of either the substrate to the active site or the inhibitor to its own binding site thus preventing the other from binding

C) binding of the inhibitor to the substrate followed by binding of this complex to the active site

D) chemical removal of the substrate from the active site by reaction with the inhibitor

Answer: B
Page Ref: Section 7

40) Which equilibrium below applies to noncompetitive inhibition?

$$\begin{array}{llcccccc}
\text{I.} & E & + & S & \rightleftarrows & ES & \longrightarrow & E + P \\
 & & & & & + & & \\
 & & & & & I & & \\
 & & & & & \downarrow\uparrow & & \\
 & & & & & ESI & &
\end{array}$$

$$\begin{array}{llcccccc}
\text{II.} & E & + & S & \rightleftarrows & ES & \longrightarrow & E + P \\
 & + & & & & + & & \\
 & I & & & & I & & \\
 & \downarrow\uparrow & & & & \downarrow\uparrow & & \\
 & EI & + & S & \rightleftarrows & ESI & &
\end{array}$$

$$\begin{array}{llccccccc}
\text{III.} & E & + & S & \rightleftarrows & ES & \longrightarrow & E & + P \\
 & & & & & & & & + \\
 & & & & & & & & I \\
 & & & & & & & & \downarrow\uparrow \\
 & & & & & & & & PI
\end{array}$$

$$\begin{array}{llcccccc}
\text{IV.} & E & + & S & \rightleftarrows & ES & \longrightarrow & E + P \\
 & + & & & & & & \\
 & I & & & & & & \\
 & \downarrow\uparrow & & & & & & \\
 & EI & & & & & &
\end{array}$$

A) I B) II C) III D) IV

Answer: B
Page Ref: Section 7

41) Ethanol (CH_3CH_2OH) is the alcohol found in beverages. It is oxidized in the body to acetaldehyde by the enzyme alcohol dehydrogenase. Methanol (CH_3OH), also known as wood alcohol, is converted to formaldehyde by the same enzyme. Acetaldehyde is toxic, but formaldehyde is far more toxic to humans, which is why the ingestion of relatively small amounts of methanol can cause blindness or death. One treatment for mild methanol poisoning is the administration of ethanol. Why might a doctor choose this treatment?

A) Ethanol must act as a competitive inhibitor for the alcohol dehydrogenase and therefore slows the formation of formaldehyde.

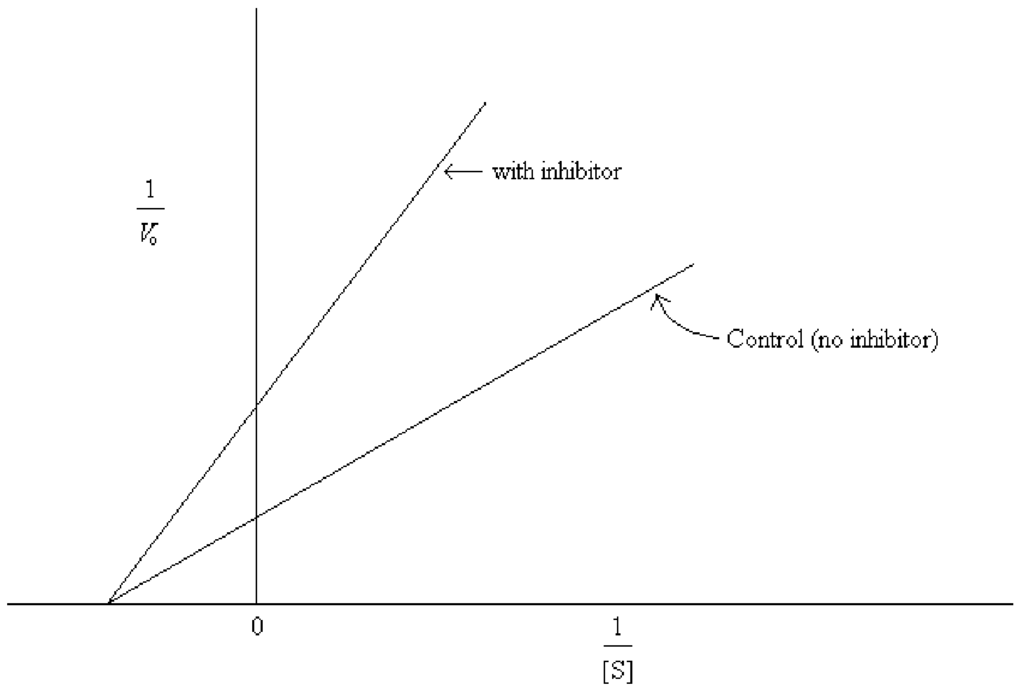
B) Ethanol likely irreversibly binds to alcohol dehydrogenase which prevents the formation of formaldehyde.

C) The ethanol is likely an uncompetitive inhibitor and binds to a site other than the active site of the enzyme.

D) The doctor has given up on the patient and administers ethanol for sedation.

Answer: A
Page Ref: Section 7

42) What type of inhibition is indicated by the data graphed below?



A) competitive

B) uncompetitive

C) noncompetitive

D) irreversible

Answer: C

Page Ref: Section 7

43) The following data were obtained in the presence and absence of inhibitor. What type of inhibition is shown?

Substrate concentration (millimolar)	Rate without inhibitor (mmol/min)	Rate with inhibitor (mmol/min)
0.100	2.5	1.6
0.200	4.2	2.9
0.500	6.6	5.1
0.750	7.4	6.2
1.000	9.9	9.8
2.000	10.0	10.1

A) competitive

B) uncompetitive

C) noncompetitive

D) irreversible

E) cannot tell inhibition type from the information given

Answer: A
Page Ref: Section 7

44) An enzyme is irreversibly inhibited by diisopropylfluorophosphate (DFP). What does this show?

A) The enzyme has been denatured by DFP.

B) Serine is likely an important residue in the active site.

C) DFP is an allosteric modulator of the enzyme.

D) DFP is an analog of the enzyme's substrate.

Answer: B
Page Ref: Section 8

45) Which is not an explanation of why site-directed mutagenesis is a more powerful tool than many other techniques for determining important residues in an enzyme?

A) It is a more specific technique than irreversible inhibition experiments.

B) It can be used on enzymes for which no specific irreversible inhibitor is known.

C) It allows for testing of the specific function of amino acid side chains in an enzyme.

D) It is especially useful for enzymes whose sequence is not known.

Answer: D
Page Ref: Section 9

46) Which statement is false about allosteric regulation?

A) It is usually the mode of regulation for the last step in reaction pathways since this step produces the final product.

B) Cellular response is faster with allosteric control than by controlling enzyme concentration in the cell.

C) The regulation usually is important to the conservation of energy and materials in cells.

D) Allosteric modulators bind non–covalently at sites other than the active site and induce conformational changes in the enzyme.

Answer: A
Page Ref: Section 10

47) Which statement is false about regulatory enzymes that are controlled allosterically?

A) They are always less active when a modulator is bound to them.

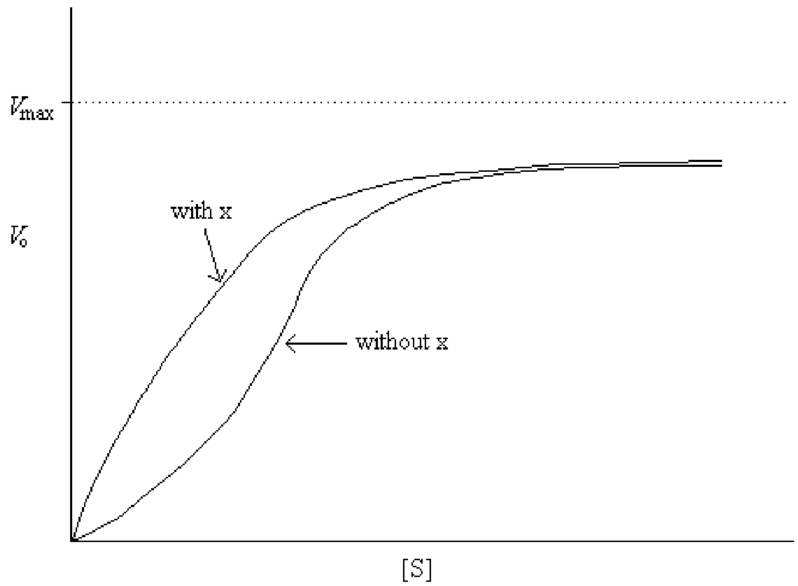
B) They are often larger than other enzymes.

C) They have more than one binding site.

D) They often catalyze the first step in a reaction pathway.

Answer: A
Page Ref: Section 10

48) Two curves showing the rate versus substrate concentration are shown below for an enzyme–catalyzed reaction. One curve is for the reaction in the presence of substance X. The other curve is for data in the absence of substance X. Examine the curves and tell which statement below is <u>false</u>.



A) X is an activator of the enzyme.

B) The enzyme exhibits non–Michaelis–Menten kinetics.

C) X is likely an allosteric modulator.

D) X is a competitive inhibitor.

Answer: D
Page Ref: Section 10

49) In *E. coli* ________ is an activator and ________ is a negative allosteric modulator of the enzyme phosphofructokinase–1.

A) DFP; phosphoenolpyruvate

B) phosphoenolpyruvate; ATP

C) ADP; phosphoenolpyruvate

D) fructose–6–phosphate; ADP

Answer: C
Page Ref: Section 10

50) Allosteric modulators seldom resemble the substrate or product of the enzyme. What does this observation show?

A) Modulators likely bind at a site other than the active site.

B) Modulators always act as activators.

C) Modulators bind non–covalently to the enzyme.

D) The enzyme catalyzes more than one reaction.

Answer: A
Page Ref: Section 10

51) The "T" state refers to the ________.

A) inactive conformation of the enzyme

B) transition state of the product

C) form of the enzyme without the modulator bound at the regulatory site

D) denatured form of the enzyme

Answer: A
Page Ref: Section 10

52) The ________ theory explains cooperative binding by suggesting all subunits of a given protein have the same conformation, either all R or all T.

A) concerted

B) entropy–driven

C) sequential

D) simultaneous

Answer: A
Page Ref: Section 10

53) Protein A has four identical subunits, each of which binds one molecule of ligand Y. The binding of one molecule of Y to one of the subunits induces a conformational change in neighboring subunits that enhances the binding of additional units of Y. This is an example of ________.

A) negative cooperativity

B) competitive activation

C) symmetry–driven binding

D) the sequential theory

Answer: D
Page Ref: Section 10

54) Which statement is false about the sequential theory?

A) It treats the concerted theory as a limiting simple case.

B) It allows for a distribution of high and low affinity subunits in the same protein.

C) It assumes more than one conformation of a particular subunit can have high affinity for the ligand.

D) It is also called the ligand-induced theory and is more general than the concerted theory.

Answer: C
Page Ref: Section 10

55) The quaternary structure of hemoglobin changes from the T state to the R state ________.

A) only after four molecules of O_2 are bound

B) after the binding of one molecule of O_2 causes a change in the primary structure

C) when hemoglobin is completely deoxygenated

D) when at least one subunit on each dimeric unit ($\alpha\beta$ dimer) is oxygenated

Answer: D
Page Ref: Section 10

56) Which statement is false about covalent modification?

A) It is reversible.

B) It is slightly slower than allosteric regulation.

C) It usually uses the same enzyme for activation and inactivation.

D) All of the above

Answer: C
Page Ref: Section 10

57) Interconvertible enzymes ________.

A) are those controlled by covalent modification

B) follow a concerted mechanism to go back and forth between the T and R states

C) catalyze reactions to covalently modify another enzyme

D) are allosteric modulators

Answer: A
Page Ref: Section 10

58) Phosphorylation that changes an enzyme's activity is an example of ________.

A) covalent modification

B) allosteric regulation

C) sequential modification

D) site-directed mutagenesis

Answer: A
Page Ref: Section 10

59) In a multienzyme complex the process of directly transferring a product of one reaction to the next active site without allowing it to enter the bulk solvent is termed ________.

A) a ping–pong reaction
B) metabolite channeling
C) the activity pathway
D) the sequential mode

Answer: B
Page Ref: Section 11

60) Which is not a reason for metabolite channeling?

A) Protection of intermediates from degradation.
B) Increasing the overall rate of a reaction.
C) Producing locally high concentrations of intermediates.
D) Ensuring the enzyme is properly regulated.

Answer: D
Page Ref: Section 11

61) Very few catalytic proficiency values are known because many nonenzymatic reaction rates are so slow that they are difficult to measure.

Answer: TRUE
Page Ref: Section 4

62) In bi–substrate reactions the substrates always bind to the enzyme in a specific order.

Answer: FALSE
Page Ref: Section 6

63) Natural inhibitors often are regulators of metabolic reactions.

Answer: TRUE
Page Ref: Section 7

64) Both reversible and irreversible inhibitors can be separated from solutions of enzymes by dialysis.

Answer: FALSE
Page Ref: Section 7

65) The most common enzyme inhibitors are competitive inhibitors.

Answer: TRUE
Page Ref: Section 7

66) Increasing the concentration of a classic competitive inhibitor has no effect on the maximum velocity of an enzyme–substrate reaction.

Answer: TRUE
Page Ref: Section 7

67) At sufficiently high substrate concentration all types of reversible inhibition can be overwhelmed. At high substrate concentration the enzyme will be saturated and the reaction will proceed at the same maximum velocity as in the absence of inhibitor.

Answer: FALSE
Page Ref: Section 7

68) Rational drug design involves the study of enzyme structure and the use of computers to generate structures of possible enzyme inhibitors.

Answer: TRUE
Page Ref: Section 7

69) A noncompetitive inhibitor can bind to either the enzyme or the enzyme–substrate complex.

Answer: TRUE
Page Ref: Section 7

70) Affinity labels are radioactive competitive inhibitors used to identify the most important residues in an enzyme's active site.

Answer: FALSE
Page Ref: Section 8

71) All irreversible inhibitors known are from man–made sources.

Answer: FALSE
Page Ref: Section 8

72) Allosteric modulators bind covalently to the regulatory site of an enzyme and change its conformation.

Answer: FALSE
Page Ref: Section 10

73) The regulatory and active sites on an oligomeric enzyme can be on different subunits.

Answer: TRUE
Page Ref: Section 10

Select the correct class of enzyme for each of these reactions.

74) L–Glutamate + ATP + NH_4^+ → L–glutamine + ADP + P_i

Page Ref: Section 1

75) L–aspartic acid + a–ketoglutarate → oxaloacetic acid + L–Glutamate

Page Ref: Section 1

76) Lactate + NAD^+ → Pyruvate + NADH + H^+

Page Ref: Section 1

77) Sucrose + H_2O → Fructose + Glucose

Page Ref: Section 1

78) Glucose–6–phosphate → Fructose–6–phosphate

Page Ref: Section 1

79) Pyruvate + H^+ → Acetaldehyde + Carbon dioxide

Page Ref: Section 1

80) Polypeptide + H_2O → Amino acids

Page Ref: Section 1

A) isomerase

B) ligase

C) lyase

D) transferase

E) oxidoreductase

F) hydrolase

74) B 75) D 76) E 77) F 78) A 79) C
80) F

Chapter 6 Mechanisms of Enzymes

1) A detailed description of a chemical reaction in terms of the molecular, atomic or subatomic events is called the reaction ________.

A) mechanism
B) pathway
C) primary sequence
D) motif

Answer: A
Page Ref: Section 1

2) Which mode(s) of catalysis is/are classified as chemical effects?

1. Transition state stabilization
2. Acid–base catalysis
3. Covalent catalysis
4. Proximity effect

A) 3 only
B) 1,2 and 3
C) 2 and 3
D) all of them

Answer: C
Page Ref: Section 1

3) In the reaction below Y^- is ________.

$$Y^- + CH_2X \rightarrow CH_2Y + X^-$$

A) the leaving group
B) the attacking electrophile
C) the reaction intermediate
D) a nucleophile

Answer: D
Page Ref: Section 1

4) Which represents a hydride ion?

A) H_2^-
B) H^-
C) H^+
D) H_3O^+

Answer: B
Page Ref: Section 1

5) The movement of ________ is key to understanding chemical and enzymatic reactions.

A) protons
B) electrons
C) nucleophiles
D) electrophiles

Answer: B
Page Ref: Section 1

6) A chemical group that has a negative charge or an unshared electron pair is called a(an)

A) transition state
B) neutrophile
C) electrophile
D) nucleophile

Answer: D
Page Ref: Section 1

7) Cleavage of a C–C bond produces a carbanion that ________ both electrons and a carbocation that ________ both electrons.

A) loses; loses
B) loses; keeps
C) keeps; loses
D) keeps; keeps

Answer: C
Page Ref: Section 1

8) In the following chemical reaction which species is the reducing agent?

$$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$$

A) CH_4

B) O_2

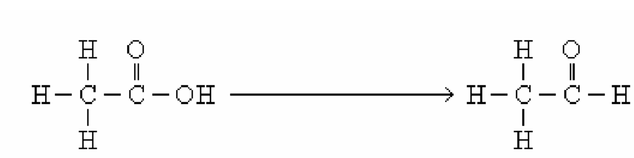
C) CO_2

D) H_2O

E) none of the above, this is not an oxidation–reduction reaction

Answer: A
Page Ref: Section 1

9) In this reaction, the carbon is ________.



(unbalanced reaction)

A) oxidized
B) reduced
C) neutralized
D) hydrolyzed

Answer: B
Page Ref: Section 1

10) Which statement does not apply to transition states?

A) Many have been detected experimentally.

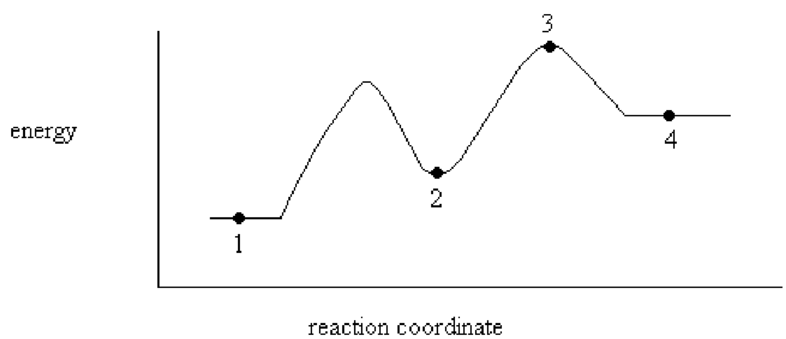
B) Chemical bonds are in the process of being formed and broken.

C) have lifetimes on the order of 10^{-14} to 10^{-13} seconds

D) differ in energy from the ground state by the activation energy

Answer: A
Page Ref: Section 2

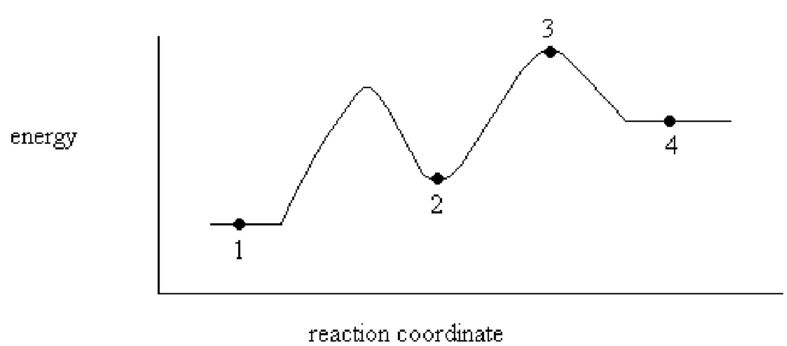
11) On the energy diagram below, which point represents a transition state?



A) Point 1 B) Point 2 C) Point 3 D) Point 4

Answer: C
Page Ref: Section 2

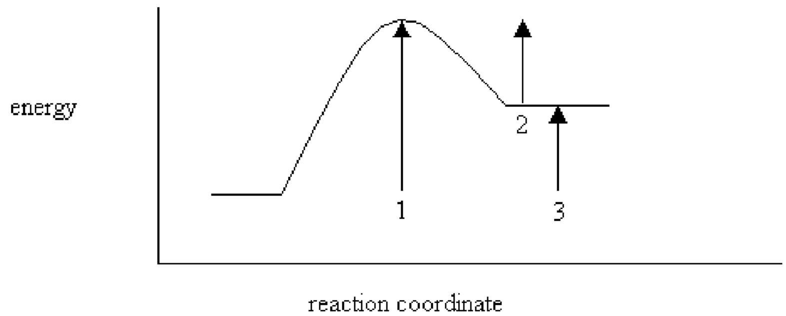
12) On the energy diagram below, which point represents an intermediate?



A) Point 1 B) Point 2 C) Point 3 D) Point 4

Answer: B
Page Ref: Section 2

13) On the energy diagram below, which arrow(s) represent the activation energy for the forward and reverse reactions?



A) Arrow 1 is the activation energy for both the forward and reverse reactions.

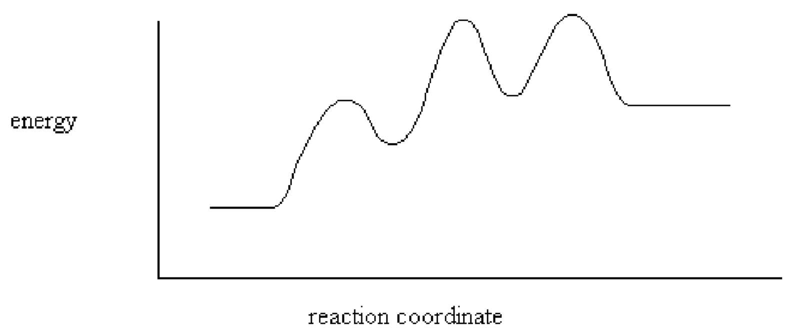
B) Arrow 1 is the activation energy for the forward reaction and arrow 2 is the activation energy for the reverse reaction.

C) Arrow 1 is the activation energy for the forward reaction and arrow 3 is the activation energy for the reverse reaction.

D) Arrow 3 is the activation energy for the forward reaction and arrow 2 is the activation energy for the reverse reaction.

Answer: B
Page Ref: Section 2

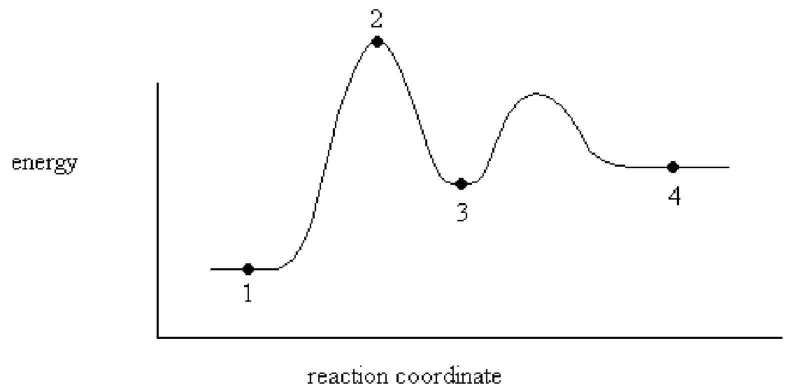
14) How many intermediates are indicated by the energy diagram below?



A) one B) two C) three D) four

Answer: B
Page Ref: Section 2

15) An enzyme stabilizes the transition state that is bound in the active site. What effect will this have on the energy diagram below? The diagram shown below is for the uncatalyzed reaction.



A) Energy of point 1 is raised.

B) Energy of point 2 is raised.

C) Energy of point 2 is lowered.

D) Energy of point 3 is lowered.

E) Energy of point 4 is raised.

Answer: C
Page Ref: Section 2

16) Replacement of the amino acid ________ at or near an active site of an enzyme is more likely to change enzyme activity than the replacement of ________ at or near the active site.

A) histidine; leucine
B) leucine; histidine
C) leucine; isoleucine
D) histidine; aspartate

Answer: A
Page Ref: Section 2

17) Site directed mutagenesis is used to study enzymes by

A) changing the location of the active site.

B) producing enzymes with different amino acid residues.

C) producing enzymes with modified R groups.

D) changing the pH of the environment.

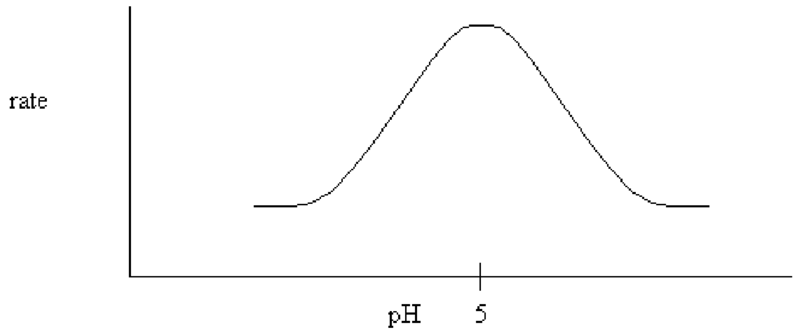
Answer: B
Page Ref: Section 2

18) Which amino acid is least likely to participate in acid–base catalysis?

A) lysine
B) tyrosine
C) aspartate
D) histidine

Answer: B
Page Ref: Section 3

19) The following pH dependence was found for the activity of a certain enzyme–catalyzed reaction.



If it is known that the only two ionizable residues in the active site are both glutamates, which conclusion can be drawn?

A) The glutamates have different microenvironments which cause their pK_a's to differ.

B) One of the glutamates must be amidated.

C) Both glutamates have a pK_a equal to 5.0.

D) Both glutamates are deprotonated during the reaction.

Answer: A
Page Ref: Section 3

20) A histidine was determined to be the critical residue involved in an enzyme–catalyzed reaction. If the pK_a of the histidine is known to be 6.5 in the active site and the pH of maximum catalytic activity is 7.2, what is likely the primary role of histidine in the catalytic reaction?

A) acts as a proton donor

B) forms a covalent bond with the substrate

C) stabilizes a charged intermediate

D) reduces the entropy of the substrate

Answer: A
Page Ref: Section 3

21) The reaction catalyzed by a certain phosphatase enzyme is found to follow ping–pong kinetics and involves the transfer of a phosphate group from substrate A to substrate B. Which mode of catalysis is likely for this reaction?

A) sequential catalysis

B) acid–base catalysis

C) transfer catalysis

D) covalent catalysis

Answer: D
Page Ref: Section 3

22) The active site of a certain enzyme contains a serine residue. When the enzyme is incubated for a short time with its substrate, a form of the enzyme in which the active site serine is acetylated can be isolated and purified. In the native protein the serine is never found to be acetylated. This information supports ________.

A) a covalent catalysis mode

B) intermediate state stabilization effects

C) the acid–base catalysis mode

D) a polar group catalytic mechanism

Answer: A
Page Ref: Section 3

23) Aspartate and lysine are in the active site of an enzyme. They are both known to participate directly in catalysis. The pK_a's of the residues are found to be 3.2 and 9.6, respectively for aspartate and lysine. The optimum pH for the enzyme is 6.4. Which forms of these two residues will predominate when the enzyme is most active?

A) aspartate is protonated; lysine is deprotonated

B) both residues are protonated

C) aspartate is deprotonated; lysine is protonated

D) both residues are deprotonated

Answer: C
Page Ref: Section 3

24) What shape would a graph of reaction velocity versus pH have for an enzyme that uses both a proton donor and a proton acceptor during catalysis (both acid and base catalysis)?

A) sigmoidal

B) hyperbolic

C) exponential

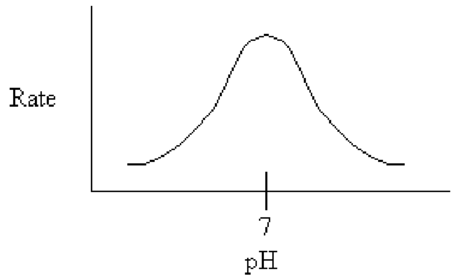
D) bell–shaped

E) linear

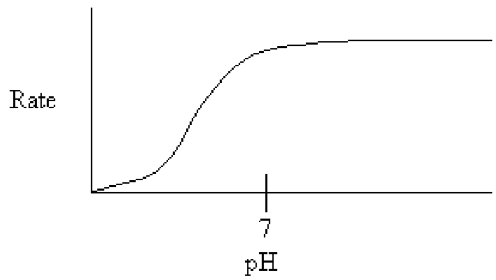
Answer: D
Page Ref: Section 3

25) Which graph might you expect for the pH profile of an enzyme's activity if the only ionizable residue in the active site is aspartate?

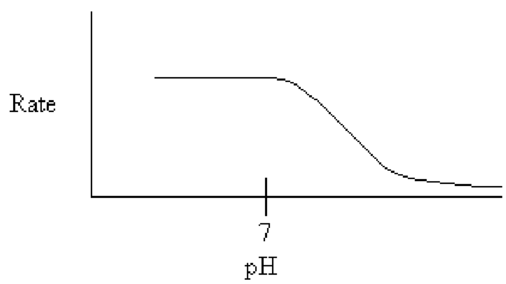
I.



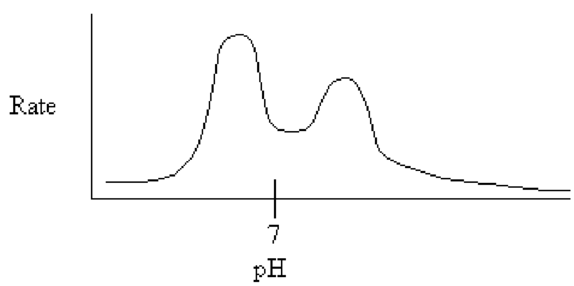
II.



III.



IV.



A) I B) II C) III D) IV

Answer: B
Page Ref: Section 3

26) An enzyme's active site contains an arginine residue and a glutamate residue with pK_a's of 2.9 and 9.1, respectively. Both residues are actively involved in the catalytic mechanism and they are the only two ionizable residues in the active site. What would you expect for the optimum pH of the enzyme?

A) 6.0

B) 7.0

C) 7.4

D) No pH can be determined since the information is irrelevant to the optimum pH.

Answer: A
Page Ref: Section 3

27) Superoxide dismutase enzyme catalysis is faster than the rate of diffusion because it

A) is an acid–base catalyst.

B) is a two–step reaction.

C) has an electric field around the active site.

D) occurs in very high quantities in cells.

Answer: C
Page Ref: Section 4

28) A reaction that occurs with every collision between reactant molecules is called a/an ________.

A) saturation point

B) diffusion–controlled reaction

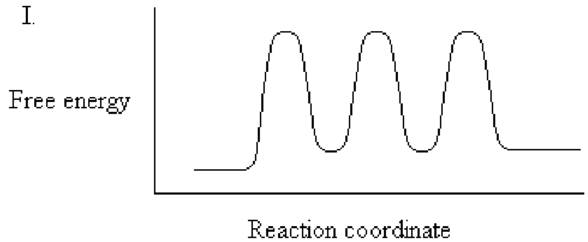
C) rate–determining step

D) first order reaction

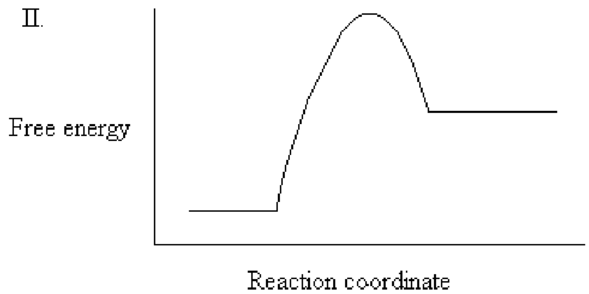
Answer: B
Page Ref: Section 4

29) The graphs below all represent the same chemical reaction, but each employing a different catalyst. Which enzyme uses the most efficient mechanism of catalysis?

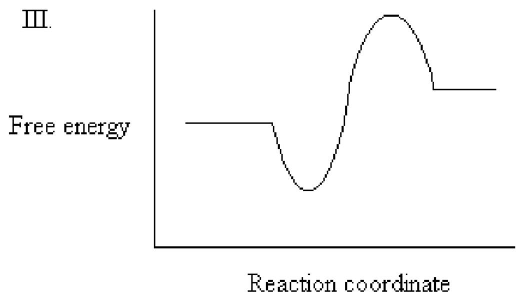
I.



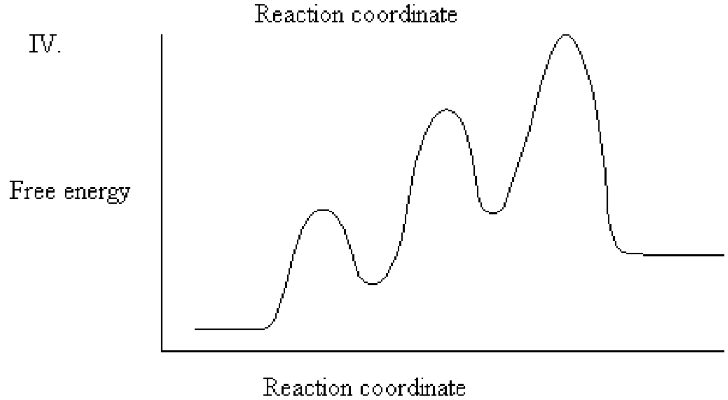
II.



III.



IV.



A) see graph I B) see graph II C) see graph III D) see graph IV

Answer: A
Page Ref: Section 4

30) Acid–base catalysis is estimated to accelerate a typical enzymatic reaction by what factor?

A) 1 to 2 fold increase
B) 10 to 100 fold increase
C) 10^6 fold increase
D) 10^{23} fold increase

Answer: B
Page Ref: Section 5

31) In the nonpolar environment of most enzyme active sites, which statement applies to charge–charge interactions between the enzyme and the substrate?

A) They are rare due to the non–polar environment.
B) They are frequent, but not very strong in the nonpolar environment.
C) They are stronger in the nonpolar environment.
D) The polarity of the active site has no effect on the strength of the charge–charge interactions.

Answer: C
Page Ref: Section 5

32) A thermodynamic pit occurs when

A) ES is not very stable.
B) ES forms faster than it dissociates.
C) ES is highly stable.
D) S is not bound tightly to an enzyme.
E) S is positioned incorrectly to the enzyme.

Answer: C
Page Ref: Section 5

33) Most K_m values of enzymes for their substrates are on the order of ________ M.

A) 10^{-2}
B) 10^{-3}
C) 10^{-4}
D) 10^{-5}
E) 10^{-6}

Answer: C
Page Ref: Section 5

34) When the concentration of a substrate inside a cell falls below the substrate concentration at half maximal velocity ________.

A) ES is formed more easily
B) ES dissociates to E + S
C) ES is closer to the ground state than to the transition state
D) E + S is in equilibrium with ES
E) the reaction will not proceed

Answer: B
Page Ref: Section 5

35) An update of Fischer's lock–and–key theory of enzyme specificity view the ________ as the lock and ________ as the key.

A) enzyme; substrate

B) substrate; enzyme

C) enzyme; transition state

D) transition state; enzyme

E) substrate; transition state

Answer: C
Page Ref: Section 5

36) The enzyme has an active site which

A) fits the substrate exactly.

B) fits the transition state.

C) may contain hydrogen bonds which are covalent–like.

D) A and C

E) B and C

Answer: E
Page Ref: Section 5

37) The proximity effect of speeding an enzyme–catalyzed reaction is explained by ________.

A) a large loss of entropy when reactive groups are brought close to each other

B) a large gain in entropy due to binding of the substrate

C) a conversion of a reaction from endergonic to exergonic

D) increasing the flexibility of the substrate by increasing its degrees of freedom of rotation

Answer: A
Page Ref: Section 5

38) Transition state analogs should

A) stabilize transition states.

B) have a dissociation constant of 10^{-13} M or less.

C) bind very tightly to the enzyme.

D) A and C

E) B and C

Answer: E
Page Ref: Section 5

39) A key role of the hydroxyl group at position 6 in the purine ring in the formation of a transition state by the enzyme adenosine deaminase is obtained by comparing a ________ and a ________.

A) competitive inhibitor; noncompetitive inhibitor

B) transition state analog; normal substrate

C) noncompetitive inhibitor; transition state analog

D) competitive inhibitor; transition state analog

E) All of the above

Answer: D
Page Ref: Section 5

40) Some antibody molecules are enzymatic if they are formed against

A) enzymes.

B) enzymes bound to other proteins.

C) transition state analogs bound to other proteins.

D) transition state analogs.

E) All of the above

Answer: C
Page Ref: Section 5

41) Induced fit of enzyme activation is a result of

A) contact (binding) of substrate.

B) constant small and rapid motions of protein atoms.

C) change to an active form.

D) A and B

E) A, B, and C

Answer: E
Page Ref: Section 6

42) Induced fit studies by Koshland using the enzyme hexokinase showed that there are enzyme forms

A) which react with the hydroxyl group of water.

B) which react only with ATP and glucose present together.

C) which are hydrophobic, excluding the competing hydroxyl group from water.

D) with and without glucose bound to each.

E) that hydrolyze ATP.

Answer: D
Page Ref: Section 6

43) What is the biological function of lysozyme?

A) converts trypsinogen to trypsin

B) is a ligase that accelerates the polymerization of glycogen

C) it regulates vascular constriction in chickens

D) hydrolyzes polysaccharides of bacterial cell walls

Answer: D
Page Ref: Section 6

44) The mechanism of action of lysozyme includes

A) distortion of the substrate.

B) acid catalysis.

C) proximity effects.

D) formation of a half–chair sugar form.

E) All of the above

Answer: E
Page Ref: Section 6

45) X–ray crystallographic examination of the active site of arginine kinase was possible because

A) it could be crystallized in the different structural forms.

B) nitrate could be substituted for phosphate in the reaction.

C) it was readily purified (unlike most other enzymes).

D) MgADP was involved in the reaction.

E) All of the above

Answer: B
Page Ref: Section 6

46) Glycoside hydrolases such as bacterial cellulase have been shown to differ in mechanisms from that of lysozyme. They

A) are alkaline catalysts.

B) form a boat form of the sugar.

C) form a covalent sugar–enzyme intermediate.

D) do not distort the substrate.

E) have no active site side chain interactions.

Answer: C
Page Ref: Section 6

47) Zymogens are inactive enzyme precursors which are made active by

A) a change in structure.

B) selective proteolysis.

C) secretion to new types of cells.

D) A and B

E) A, B and C

Answer: E
Page Ref: Section 7

48) Active trypsin formation by the action of enteropeptidase can be viewed as the master activation step because

A) enteropeptidase can activate its own zymogen.

B) it is allosterically controlled.

C) trypsin activates other pancreatic zymogens.

D) All of the above

Answer: C
Page Ref: Section 7

49) The substrate specificity of serine proteases is primarily due to

A) a specificity pocket in the protein.

B) the positions of specific side chains of serine, histidine, and aspartate.

C) distinct backbone conformations of the individual proteins.

D) A and B

E) A, B and C

Answer: A
Page Ref: Section 7

50) The role of serine at the active site of serine proteases is to act as a(n) ________ catalyst, while the histidine residue serves as a(n) ________ catalyst.

A) strong; weak

B) weak; strong

C) acid–base; covalent

D) covalent; acid–base

E) anionic; ionic

Answer: D
Page Ref: Section 7

51) The catalytic triad of chymotrypsin and other serine proteases consists of

A) three subunits of the enzyme.

B) three amino acid residues adjacent in the primary structure which act to make serine a strong nucleophile.

C) three amino acid residues close enough in space to make serine a strong nucleophile.

D) three enzymes with very similar structural features.

E) None of the above.

Answer: C
Page Ref: Section 7

52) The roles of amino acid residues at the active site of enzymes can be determined by removing certain residues using the technique of

A) specific hydrolysis.

B) covalent binding.

C) acylation of specific residues.

D) site mutagenesis.

E) All of the above

Answer: D
Page Ref: Section 7

53) The role of ser–195 in chymotrypsin cleavage of a peptide bond is that of a(n)

A) acid catalyst.

B) proximity effector.

C) strong nucleophile.

D) weak nucleophile.

Answer: C
Page Ref: Section 7

54) Experiments on the bacterial serine protease subtilisin show that even when all three residues of the catalytic triad are mutated, the catalytic rate of the enzyme is still 3000 times the uncatalyzed reaction rate. Which mode of catalysis is likely responsible for this remaining catalytic activity?

A) acid–base catalysis

B) covalent catalysis

C) transition–state stabilization

D) hydrophobic effects

Answer: C
Page Ref: Section 7

55) A nucleophile is an electron poor species.

Answer: FALSE
Page Ref: Section 1

56) Nucleophiles are often anions or have unshared electrons.

Answer: TRUE
Page Ref: Section 1

57) Radicals are stable, unreactive species that have an unpaired electron.

Answer: FALSE
Page Ref: Section 1

58) The relative orientation of colliding molecules only affects reactions rates when the energy during impact is low. If the energy of impact is high enough, orientation is unimportant.

Answer: FALSE
Page Ref: Section 2

59) Intermediates are more stable and have longer lifetimes than transition states.

Answer: TRUE
Page Ref: Section 2

60) Reaction intermediates are impossible to isolate experimentally.

Answer: FALSE
Page Ref: Section 2

61) Chemical modes of catalysis are more important than binding modes of catalysis in accounting for the accelerated rates of enzymatic reactions.

Answer: FALSE
Page Ref: Section 3

62) If a plot of enzyme activity versus pH is sigmoidal then acid–base catalysis can be ruled out as a mode of catalysis.

Answer: FALSE
Page Ref: Section 3

63) Superoxide dismutase and triosphosphate isomerase are two enzymes that catalyze diffusion–controlled reactions.

Answer: TRUE
Page Ref: Section 4

64) Enzyme–catalyzed reactions that are diffusion–controlled reactions can never proceed any faster than the rate determined by random collision rates.

Answer: FALSE
Page Ref: Section 4

65) Weak substrate binding is an important feature to help describe enzyme catalysis.

Answer: TRUE
Page Ref: Section 5

66) In the modified "lock–and–key" theory of enzyme specificity, the key is still the enzyme while the lock is still the substrate.

Answer: FALSE
Page Ref: Section 5

67) Transition state analogs are usually more potent inhibitors of enzyme activity than substrate analogs.

Answer: TRUE
Page Ref: Section 5

68) Antibodies raised against transition state analogs are always enzymatic.

Answer: FALSE
Page Ref: Section 5

69) Enzymes which have induced fit to the substrate are generally more effective than those in an active form initially.

Answer: FALSE
Page Ref: Section 5

70) Transitions states bind to their enzymes more tightly than their substrates do.

Answer: TRUE
Page Ref: Section 5

71) Unlike lysozyme, other glycoside hydrolases such as bacterial cellulase, form covalent glycosyl–enzyme intermediates.

Answer: TRUE
Page Ref: Section 6

72) Zymogens are often active only in the environment in which they are functional.

Answer: TRUE
Page Ref: Section 7

73) Trypsin as well as chymotrypsin can activate chymotrypsinogen to chymotrypsin.

Answer: TRUE
Page Ref: Section 7

74) Both trypsin and its zymogen trypsinogen have a hydrophobic substrate–binding pocket.

Answer: FALSE
Page Ref: Section 7

75) In the Ser–His–Asp catalytic triad in serine proteases, the serine residue serves as an acid–base catalyst, while the histidine residue serves as a covalent catalyst.

Answer: FALSE
Page Ref: Section 7

Chapter 7 Coenzymes and Vitamins

1) Active holoenzymes are formed from ________ in the presence of ________.

A) cofactors; proteins

B) proteins; cofactors

C) apoenzymes; cofactors

D) apoenzymes; proteins

E) apoenzymes; inactive holoenzymes

Answer: C
Page Ref: Introduction

2) Because coenzymes are specific for the chemical groups that they accept and donate, they are referred to as

A) cofactors.

B) reactive centers.

C) activator ions.

D) group–transfer reagents.

E) All of the above

Answer: D
Page Ref: Introduction

3) Ca^{++} or Mg^{++} are most likely to be part of ________, while Zn^{++} or Fe^{++} are present in ________.

A) metal–activated enzymes; metalloenzymes

B) metalloenzymes; metal–activated enzymes

C) cofactors; coenzymes

D) coenzymes; cofactors

E) apoenzymes; holoenzymes

Answer: A
Page Ref: Section 1

4) The role of zinc in the mechanisms of carbonic anhydrase is to

A) maintain the configuration of the holoenzyme.

B) bind to three histidine residues.

C) produce a nucleophilic attack on the substrate.

D) promote ionization of bound water.

E) produce an electrophilic attack on the substrate.

Answer: D
Page Ref: Section 1

5) What is the role of the magnesium ion in kinases that require the magnesium–ATP complex to donate phosphoryl groups?

A) maintain the configuration of the holoenzyme

B) shield the charged phosphate groups of ATP

C) produce an electrophilic attack on the substrate

D) promote ionization of bound water

E) produce ionization of the substrate to be phosphorylated

Answer: B
Page Ref: Section 1

6) An ion commonly found in metalloenzymes and which can undergo reversible oxidation and reduction is

A) Ca^{++}.

B) Mg^{++}.

C) S^{-}.

D) Fe^{++}.

E) All of the above

Answer: D
Page Ref: Section 1

7) Which does <u>not</u> return to its original form after each catalysis?

A) prosthetic groups

B) cosubstrates

C) metalloenzyme

D) None of the above. They all return to their original forms.

Answer: D
Page Ref: Section 2

8) Vitamin C is a vitamin but not a coenzyme because it

A) does not bind to proteins.

B) is a prosthetic group.

C) is a reducing agent during hydroxylation of collagen.

D) is not required in human diets.

Answer: C
Page Ref: Section 2

9) S–adenosylmethionine (SAM) is formed from the amino acid methionine so that

A) methyl groups can be formed.

B) it can react with nucleophilic acceptors.

C) it can donate methyl groups in many biosynthetic reactions.

D) All of the above

E) B and C

Answer: E
Page Ref: Section 3

10) A nucleotide–sugar coenzyme involved in carbohydrate metabolism (UDP–glucose) is formed when UTP reacts with a glucose molecule. More UTP is made available for additional reactions by the transfer of a phosphate group from

A) another carbohydrate.

B) ATP.

C) ADP.

D) UTP.

E) UDP.

Answer: B
Page Ref: Section 3

11) NAD and NADP dependent dehydrogenases catalyze substrates by transferring ________ to C–4 of NAD^+ and $NADP^+$.

A) one electron

B) two electrons

C) one electron and one proton

D) two electrons and one proton

E) two electrons and two protons

Answer: D
Page Ref: Section 4

12) The "+" sign in NAD^+ indicates that

A) this is the reduced form of the coenzyme.

B) the nitrogen atom has a positive charge.

C) the entire molecule is positively charged.

D) it can bind to negatively charged proteins only.

Answer: B
Page Ref: Section 4

13) When NAD^+ is reduced, the UV absorbance at 340 nm

A) decreases.

B) increases.

C) stays the same.

D) decreases, then increases.

E) increases, then decreases.

Answer: B
Page Ref: Section 4

14) The product(s) of lactate dehydrogenase under anaerobic conditions is (are)

A) pyruvic acid.

B) NAD^+.

C) NADH.

D) A and B

E) A and C

Answer: E
Page Ref: Section 4

15) Unlike NADH and NADPH, FAD and FADH

A) donate one electron at a time.

B) donate one or two electrons at a time.

C) do not become positively charged.

D) A and C

E) B and C

Answer: E
Page Ref: Section 5

16) Two–electron transfer reactions can be linked to one–electron transfer reactions by

A) formation of semiquinones.

B) a [Fe–S] cluster.

C) NADH and NADPH.

D) B and C

E) A and C

Answer: A
Page Ref: Section 5

17) Acyl–group–transfer reactions often involve which coenzyme?

A) Coenzyme A

B) NAD^+

C) cytochrome c

D) All of the above

Answer: A
Page Ref: Section 6

18) Which coenzyme is composed of a 2–mercaptoethylamine unit, the vitamin pantothenate and an ADP moiety?

A) NADPH

B) biotin

C) coenzyme A

D) ubiquinone

Answer: C
Page Ref: Section 6

19) The reactive center of coenzyme A is

A) ADP.

B) pantothenate.

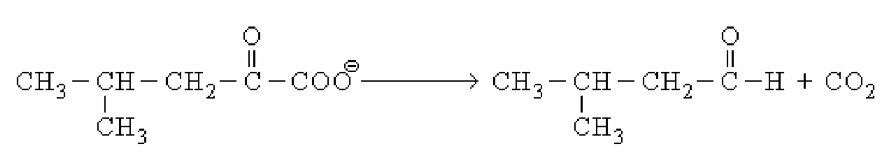
C) b–alanine.

D) 2–mercaptoethylamine.

E) serine.

Answer: D
Page Ref: Section 6

20) Which coenzyme is likely involved in the reaction shown below?



A) TPP

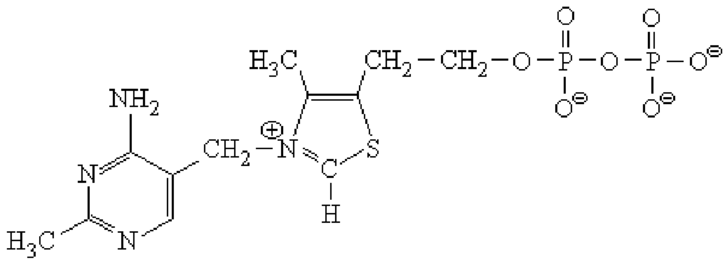
B) biotin

C) coenzyme A

D) FMN

Answer: A
Page Ref: Section 7

21) The structure shown below is which coenzyme?



A) QH_2

B) Vitamin B_{12}

C) Biotin

D) Thiamine pyrophosphate

Answer: D
Page Ref: Section 7

22) TPP is a/an ________ of yeast pyruvate decarboxylase.

A) cosubstrate

B) intrinsic factor

C) metalloenzyme

D) prosthetic group

Answer: D
Page Ref: Section 7

23) Enzymes with vitamin B_6 as the prosthetic group catalyze a variety of reactions involving

A) lipids.

B) sugars.

C) amino acids.

D) other vitamins.

Answer: C
Page Ref: Section 8

24) The degradation of aspartic acid to oxaloacetic acid and NH_4^+ is catalyzed by an enzyme with ________ as its prosthetic group.

A) thiamine

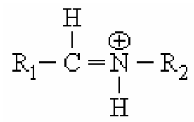
B) biotin

C) pyridoxal phosphate

D) vitamin B_{12}

Answer: C
Page Ref: Section 8

25) Which functional group is shown below?



A) Schiff base

B) secondary amine

C) amide

D) peptide bond

Answer: A
Page Ref: Section 8

26) Which amino acid can form a covalent bond to the coenzyme pyridoxal phosphate?

A) aspartate

B) cysteine

C) lysine

D) serine

Answer: C
Page Ref: Section 8

27) Pyridoxal phosphate is involved in which type of reaction?

A) oxidation of pyruvate

B) production of new amino acids by transamination

C) phosphate-transfer to produce ATP from ADP

D) the regeneration of methionine from homocysteine

Answer: B
Page Ref: Section 8

28) Raw egg white contains a protein called avidin. What happens if you ingest raw egg whites?

A) Avidin helps to build muscle tissue.

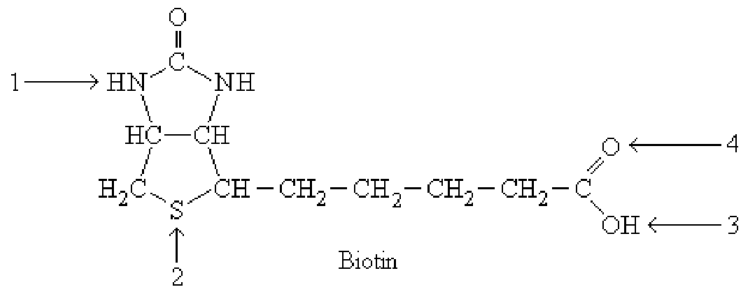
B) Avidin is the main protein involved in *salmonella* poisoning.

C) Avidin binds onto the coenzyme biotin and interferes with its absorption.

D) Avidin, also called intrinsic factor, helps transport cobalamin into the cells of the small intestine.

Answer: C
Page Ref: Section 9

29) Which atom is the reactive center on biotin?



A) Arrow 1
B) Arrow 2
C) Arrow 3
D) Arrow 4

Answer: A
Page Ref: Section 9

30) Which substance would make a good ligand for biotin on the matrix of an affinity chromatography column?

A) ubiquinone
B) avidin
C) oxaloacetate
D) any molecule with an –SH group

Answer: B
Page Ref: Section 9

31) We use the term tetrahydrofolate to designate a family of related compounds. What is the main difference between members of this family?

A) degree of protonation
B) number of methyl groups on the heterocylic rings
C) number of phosphate groups
D) length of the polyglutamate tail group

Answer: D
Page Ref: Section 10

32) Why has dihydrofolate reductase been identified as a potential target for chemotherapy in the treatment of cancer?

A) It is a hormone that is a primary control agent of the rate of mitosis.
B) It is a DNA binding protein that activates a cancer oncogene.
C) It is essential in DNA synthesis. Cell division will not occur without it.
D) It selectively binds to a receptor on the surface of cancer cells and inactivates them.

Answer: C
Page Ref: Section 10

33) Which structure is not a part of folate?

A) porphyrin ring

B) *p*–aminobenzoic acid

C) pterin

D) glutamate residues

Answer: A
Page Ref: Section 10

34) Which statement is <u>false</u> about 5,6,7,8–tetrahydrobiopterin?

A) It is required by the enzyme that catalyzes the synthesis of nitric oxide from arginine.

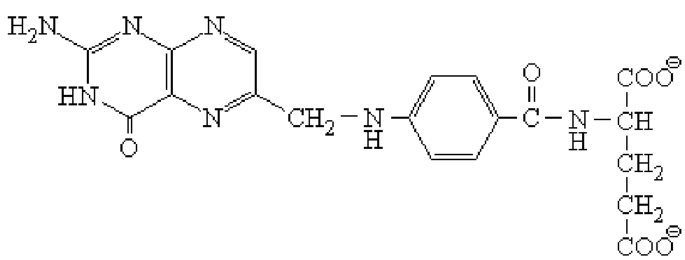
B) It is synthesized by animals and other organisms.

C) It is used in the transfer of phosphate groups during DNA synthesis.

D) It is a reducing agent in the conversion of phenylalanine to tyrosine.

Answer: C
Page Ref: Section 10

35) Which vitamin is shown below?



A) vitamin C

B) thiamin (vitamin B_1)

C) cobalamin (vitamin B_{12})

D) folate

Answer: D
Page Ref: Section 10

36) Which characterizes cobalamin?

A) participates in the conversion of homocysteine to methionine

B) contains a corrin ring prosthetic group

C) requires a glycoprotein for its absorption

D) All of the above

Answer: D
Page Ref: Section 11

37) Which coenzyme links to a lysine residue in a protein's active site?

A) biotin

B) lipoic acid (lipoamide)

C) pyridoxal phosphate

D) biotin and pyridoxal phosphate only

E) All three; biotin, lipoic acid and pyridoxal phosphate

Answer: E
Page Ref: Section 12

38) Which type of atom is involved in the reactive center of lipoamide?

A) sulfur B) nitrogen C) phosphorous D) oxygen

Answer: A
Page Ref: Section 12

39) What kind of reaction is most important for the reactive center of lipoamide?

A) oxidation of a carbonyl group

B) reduction of a disulfide bond

C) formation of a Schiff base

D) a *cis*–*trans* configurational change about a disulfide bond

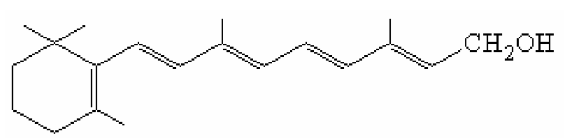
Answer: B
Page Ref: Section 12

40) Which in not a lipid–soluble vitamin?

A) A B) C C) E D) K

Answer: B
Page Ref: Section 13

41) Which structure in shown?



A) retinol B) retinal C) retinoic acid D) β–carotene

Answer: A
Page Ref: Section 13

42) What is the prosthetic group of the retinal vision protein rhodopsin?

A) retinol B) retinal C) retinoic acid D) β-carotene

Answer: B
Page Ref: Section 13

43) Rickets in children and osteomalacia in adults is caused by a lack of ________.

A) thiamin B) hemoglobin C) vitamin D D) vitamin B_{12}

Answer: C
Page Ref: Section 13

44) Vitamin D helps control the utilization of which ion?

A) Mg^{2+} B) Ca^{2+} C) Fe^{2+} D) Co^{2+}

Answer: B
Page Ref: Section 13

45) Another name for α-tocopherol is vitamin ________.

A) A B) B_{12} C) C D) D E) E

Answer: E
Page Ref: Section 13

46) Vitamin K is important in the ________.

A) synthesis of collagen B) absorption of Ca^{2+}
C) coagulation of blood (clotting) D) scavenging of oxygen and free radicals

Answer: C
Page Ref: Section 13

47) Which is the strongest oxidizing agent?

A) ubiquinone B) NAD^+ C) FMN D) Vitamin K

Answer: A
Page Ref: Section 14

48) Which statement is false about plastoquinone?

A) It is water soluble.

B) It is important in photosynthetic electron transport.

C) It contains five-carbon isoprenoid units.

D) It can be converted to a semiquinone form.

Answer: A
Page Ref: Section 14

49) In which type of reactions does Q participate?

A) One electron transfers only.
B) One or two electron transfers.
C) Hydride ion transfers.
D) Acetyl group transfers.

Answer: B
Page Ref: Section 14

50) Which are common protein coenzymes?

A) cytochromes
B) phylloquinones
C) tetrahydrofolates
D) α–tocopherols

Answer: A
Page Ref: Section 15

51) Protein catalysts rely exclusively on the amino acid residues for reactivity at the sites of action.

Answer: FALSE
Page Ref: Introduction

52) Organic compounds are coenzymes and cofactors while inorganic ions are cofactors only.

Answer: TRUE
Page Ref: Introduction

53) Minerals which are cofactors may be reversibly bound and are then usually directly involved in catalytic reactions.

Answer: FALSE
Page Ref: Introduction

54) All enzymes require metallic cations to achieve full catalytic activity.

Answer: FALSE
Page Ref: Section 1

55) Metal–activated enzymes may require a metal ion or simply be stimulated in the presence of the ion.

Answer: TRUE
Page Ref: Section 1

56) Metalloenzymes contain metal ions which are bound tightly to the protein and can attract electrons.

Answer: TRUE
Page Ref: Section 1

57) Mammalian cells can synthesize all needed coenzymes from simple precursors.

Answer: FALSE
Page Ref: Section 2

58) Vitamin deficiency diseases are a result of the lack of formation of certain coenzymes.

Answer: TRUE
Page Ref: Section 2

59) Vitamin C is a coenzyme during the hydroxylation of collagen.

Answer: FALSE
Page Ref: Section 2

60) Lipid vitamins such as A, D, E, and K are stored by animal cells, so excessive daily intake may be toxic.

Answer: TRUE
Page Ref: Section 2

61) Structures of several dehydrogenases indicate that many possess one or more similar NAD or NADP-binding structures consisting of babab units in Rossman folds.

Answer: TRUE
Page Ref: Section 4

62) The reactive center of CoA is the $-NH_3^+$ group.

Answer: FALSE
Page Ref: Section 6

63) Lack of thiamine (vitamin B_1) leads to the disease beriberi.

Answer: TRUE
Page Ref: Section 7

64) Lysine can join the prosthetic group biotin to an enzyme via an amide link at the ε-amino group.

Answer: TRUE
Page Ref: Section 7

65) An internal aldimine forms when PLP is covalently bound to its enzyme.

Answer: TRUE
Page Ref: Section 8

66) Tetrahydrofolate is a more oxidized form of the vitamin folate from which it is derived.

Answer: FALSE
Page Ref: Section 10

67) Pernicious anemia is caused by a deficiency in biotin.

Answer: FALSE
Page Ref: Section 11

68) The corrin ring is very similar to a heme, but the corrin ring containing vitamin B_{12} has a cobalt ion rather than an iron ion as in heme.

Answer: TRUE
Page Ref: Section 11

69) Cobalamin is synthesized by most organisms from simple precursors and does not need to be in the diet.

Answer: FALSE
Page Ref: Section 11

70) Vitamin E is formed non–enzymatically in sun–exposed skin.

Answer: FALSE
Page Ref: Section 13

71) There is little risk in taking megadoses of vitamin A since excess will tend to simply be excreted in the urine.

Answer: FALSE
Page Ref: Section 13

72) Vitamin A is produced from b–carotene by a condensation reaction.

Answer: FALSE
Page Ref: Section 13

73) Another name for vitamin K is phylloquinone.

Answer: TRUE
Page Ref: Section 13

74) Ubiquinone and plastoquinone transport electrons in membranes.

Answer: TRUE
Page Ref: Section 14

75) The oxidized forms of cytochromes *c* absorbs more strongly than the reduced form at the Soret band near 400 nm.

Answer: FALSE
Page Ref: Section 16

Match each of the following vitamins with an associate nutritional deficiency disease.

76) Folate
Page Ref: Section 2

77) Thiamine (B_1)
Page Ref: Section 2

78) Cobalamin (B_{12})
Page Ref: Section 2

79) Biotin
Page Ref: Section 2

80) Ascorbate (C)
Page Ref: Section 2

A) Dermititis in humans

B) Pernicious anemia

C) scurvy

D) beriberi

E) anemia

76) E 77) D 78) B 79) A 80) C

Chapter 8 Carbohydrates

1) Which is not a glycoconjugate?

A) proteoglycan B) glycolipid C) glycoprotein D) homoglycan

Answer: D
Page Ref: Introduction

2) Which does not apply to dihydroxyacetone?

A) ketose B) triose C) chiral D) water–soluble

Answer: C
Page Ref: Section 1

3) Which is true about naturally occurring monosaccharides?

A) The L–isomers predominate.

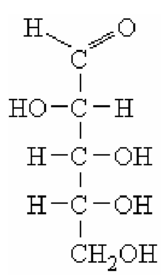
B) The D–isomers predominate.

C) The L and D–isomers occur in equal ratios.

D) The ratio of L and D–isomers varies widely depending on the source.

Answer: B
Page Ref: Section 1

4) The structure of D–arabinose is shown below. How many stereoisomers are possible for this molecule (including the one shown)?

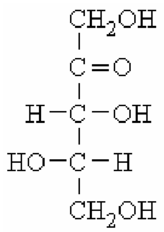


D-Arabinose

A) one B) four C) six D) eight

Answer: D
Page Ref: Section 1

5) Examine the Fischer projection below. How is this carbohydrate classified?



A) L enantiomer; aldopentose

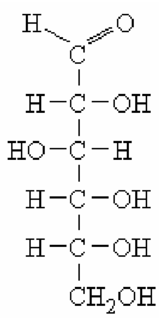
B) L enantiomer; ketopentose

C) D enantiomer; aldohexose

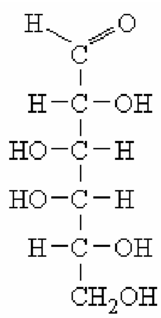
D) D enantiomer; ketopentose

Answer: B
Page Ref: Section 1

6) The Fischer projections of linear D–glucose and D–galactose are shown below. These two molecules are ________.



D-Glucose



D-Galactose

A) epimers

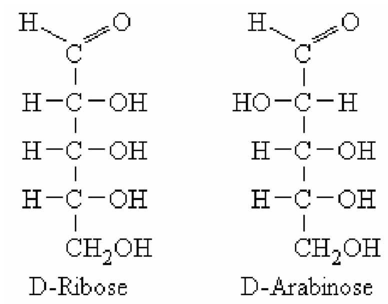
B) enantiomers

C) anomers

D) structural (constitutional) isomers

Answer: A
Page Ref: Section 1

7) The structures of D–ribose and D–arabinose are shown below. These two molecules are ________.



A) epimers B) enantiomers C) tautomers D) anomers

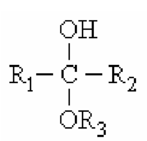
Answer: A
Page Ref: Section 1

8) The intramolecular cyclization reaction of glucose in solution ________.

A) generates a chiral center
B) yields a hemiacetal
C) usually forms a pyranose
D) All of the above

Answer: D
Page Ref: Section 2

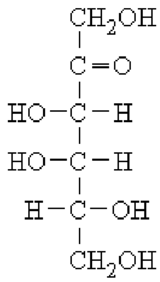
9) The functional group shown is a/an ________.



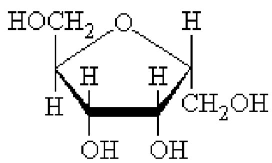
A) hemiacetal B) hemiketal C) acetal D) ketal

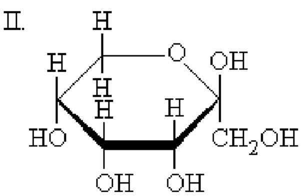
Answer: B
Page Ref: Section 2

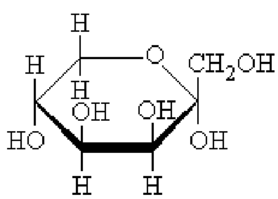
10) Which is a product of the intramolecular cyclization of D–tagatose to form a furanose?

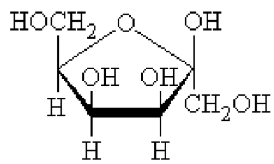


D-Tagatose

I. 

II. 

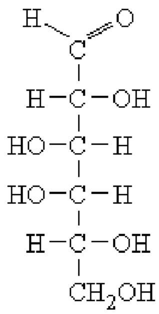
III. 

IV. 

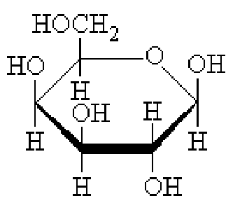
A) I	B) II	C) III	D) IV

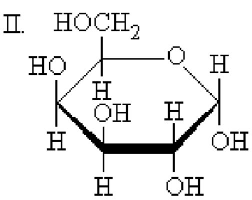
Answer: D
Page Ref: Section 2

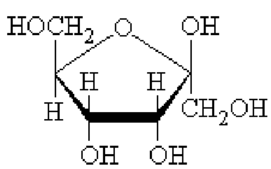
11) Below is the Fischer projection of D–galactose. Which is the proper Haworth projection of β–D–galactopyranose?

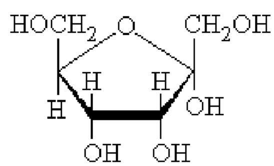


D-Galactose

I. 

II. 

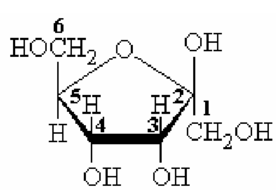
III. 

IV. 

A) I B) II C) III D) IV

Answer: A
Page Ref: Section 2

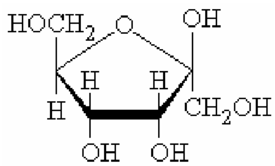
12) Below is the structure for a cyclic D–monosaccharide. Which is the anomeric carbon atom?



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

Answer: B
Page Ref: Section 2

13) Examine the cyclic D–monosaccharide shown below. The ring structure is the ________ and the linear form of this monosaccharide must be a/an ________.



A) α anomer; ketose

B) β anomer; ketose

C) α anomer; aldose

D) β anomer; aldose

Answer: B
Page Ref: Section 2

14) The compounds α–D–fructofuranose and β–D–fructofuranose are ________.

A) enantiomers

B) mutamers

C) anomers

D) conformational isomers

Answer: C
Page Ref: Section 2

15) Anomers can be interconverted ________.

A) by rotation about carbon–carbon bonds

B) via a linear intermediate

C) by an isotopic exchange reaction

D) None of the above. Anomers cannot be interconverted.

Answer: B
Page Ref: Section 2

16) In solution α–D–glucopyranose and β–D–glucopyranose ________.

A) rapidly polymerize to form a heteropolymer

B) can never exist together

C) form a racemic mixture

D) form an equilibrium mixture

Answer: D
Page Ref: Section 2

17) Pyranose rings are usually most stable when the ring adopts a ________ conformation with the bulkiest ring substituents in ________ positions.

A) chair; equatorial
B) chair; axial
C) boat; equatorial
D) boat; axial

Answer: A
Page Ref: Section 3

18) Which are possible conformations of a furanose molecule?

A) envelope and twist
B) chair and boat
C) *cis* and *trans*
D) A and B

Answer: A
Page Ref: Section 3

19) Monosaccharide derivatives in which an amino group replaces one of the hydroxyl groups may have important roles in

A) DNA structure.
B) intermediary metabolisms.
C) vitamin C.
D) sialic acids.
E) All of the above

Answer: D
Page Ref: Section 4

20) Ribitol is a sugar alcohol that is a component of

A) vitamin C.
B) RNA.
C) FMN and FAD.
D) NAD and NADH.
E) sialic acid.

Answer: C
Page Ref: Section 4

21) Which statement is <u>false</u> about the sugar units in DNA?

A) They are cyclic in DNA.
B) It is a deoxy form of ribose
C) It is an epimer of glucose.
D) It has a D–configuration

Answer: C
Page Ref: Section 4

22) The abbreviation for glucose is ________.

A) glu B) gcs C) glc D) gluc

Answer: C
Page Ref: Section 4

23) What distinguishes an aldonic acid from an alduronic acid?

A) The oxidation of the aldehyde group in an aldonic acid and the oxidation of the highest numbered carbon in the alduronic acid.

B) Aldonic acids are derivatives of aldoses, alduronic acids are derivatives of ketoses.

C) Aldonic acids are oxidized forms of linear monosaccharides; alduronic acids are oxidized forms of cyclic monosaccharides.

D) The two terms are synonyms and are used interchangeably.

Answer: A
Page Ref: Section 4

24) What type of bond links the monomers of a polysaccharide?

A) glucotide bond B) phosphate ester bond
C) peptide bond D) glycosidic bond

Answer: D
Page Ref: Section 5

25) The chemical name for table sugar is ________ and it is a ________.

A) lactose; monosaccharide B) lactose; disaccharide
C) sucrose; monosaccharide D) sucrose; disaccharide

Answer: D
Page Ref: Section 5

26) Hydrolysis of maltose will yield ________.

A) glucose and galactose B) fructose and glucose
C) glucose and mannose D) glucose only

Answer: D
Page Ref: Section 5

27) You have two bottles, each of which contains a white, crystalline substance. Your lab director tells you that one contains lactose and the other sucrose. Your job is to determine which bottle contains which sugar. Which procedure would you use?

A) Test both for solubility in water. Sucrose is very soluble; lactose is only minimally soluble.

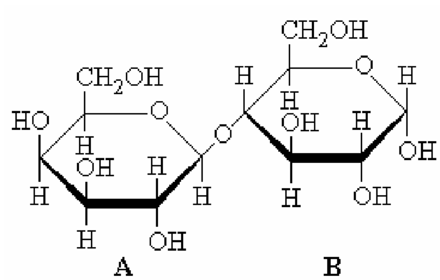
B) Test for the ability to reduce Ag^{+}. Only lactose will react.

C) Dissolve each in water and record the pH. Lactose is far more acidic than sucrose.

D) React each with bromine (Br_2) water. Only sucrose will react.

Answer: B
Page Ref: Section 5

28) The structure of a disaccharide is shown below. Which statement applies?



A) Both rings A and B are in equilibrium with an open chain form.

B) Only ring A is in equilibrium with an open chain form.

C) Only ring B is in equilibrium with an open chain form.

D) Neither ring is in equilibrium with an open chain form.

Answer: C
Page Ref: Section 5

29) A monosaccharide whose anomeric carbon atom has a glycosidic bond to an alcohol, amine or thiol is a ________.

A) glycoside

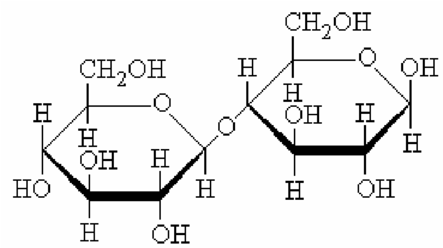
B) glycoprotein

C) heteroglycan

D) glucoconjugate

Answer: A
Page Ref: Section 5

30) What is the name of the disaccharide shown below that is formed by joining two monomers of D–glucose?



A) β–D–glucopyranosyl–(1→4)–β–D–glucopyranose

B) α–D–glucopyranosyl–(1→4)–α–D–glucopyranose

C) β–D–glucofuranosyl–(1→4)–β–D–glucofuranose

D) α–D–glucopyranosyl–(1→3)–β–D–glucopyranose

Answer: A
Page Ref: Section 5

31) A reducing sugar is one that

A) contains a b(1→1) link.

B) has a hemiacetal group.

C) can reduce Cu^{2+} but not Ag^{+}.

D) makes you lose weight.

Answer: B
Page Ref: Section 5

32) Naturally occurring glycosides have roles in cells which include

A) subunits of DNA.

B) chemical signals to plants.

C) food flavoring.

D) units in cell membrane structure.

E) All of the above

Answer: E
Page Ref: Section 5

33) Which is a difference between maltose and cellobiose?

A) One is in cellulose and the other in starch.

B) One is linear and the other is branched.

C) The glycosidic bond is different.

D) The subunit sugars are not glucose for both.

E) All of the above

Answer: C
Page Ref: Section 5

34) When a sugar polymer is analyzed and found to have equal portions of reducing and non–reducing ends, it is likely that

A) it shows directionality.

B) it is linear.

C) it is branched.

D) it is branched, but not very highly.

E) some of the internal glycosidic bonds are in equilibrium with open chain forms.

Answer: B
Page Ref: Section 6

35) Polysaccharide structure can be varied by differences in

A) chain length (number of sugars in each polysaccharide).

B) the kind(s) of sugars in each polysaccharides.

C) the presence of branching.

D) All of the above

Answer: D
Page Ref: Section 6

36) Amylose differs from amylopectin in that amylose

A) has different monomers than amylopectin.

B) has more glucose residues than amylopectin.

C) is highly branched and amylopectin is not.

D) forms a helix and no branch points.

Answer: D
Page Ref: Section 6

37) Both amylose and amylopectin molecules isolated from plant cells can contain as many as ________ glucose residues.

A) 25 B) 500 C) 1000 D) 2000 E) 6000

Answer: C
Page Ref: Section 6

38) Enzymes in the human intestine which are needed to degrade plant starch into limit dextrin are

A) a–Amylase.

B) β–Amylase.

C) debranching enzymes.

D) A and B

E) A, B, and C

Answer: D
Page Ref: Section 6

39) Amylase is a hydrolase that is an ________.

A) endonuclease

B) endoglycosidase

C) exonuclease

D) exoglycosidase that removes maltose

E) exoglycosidase that removes glucose monomers

Answer: D
Page Ref: Section 6

40) Which is not a similarity between glycogen and amylopectin?

A) They each contain about 6000 glucose residues.

B) Each has one reducing end and many nonreducing ends.

C) Each is highly branched.

D) Each has branches of similar chain length.

Answer: D
Page Ref: Section 6

41) Cellulose is not highly branched because it

A) does not have a polysaccharide backbone.

B) it does not have a–(1→6) linkages.

C) it does not have β–(1→4) linkages.

D) it is insoluble in water.

Answer: B
Page Ref: Section 6

42) Highly branched cores of amlyopectin that are resistant to hydrolysis are called ________.

A) core saccharides

B) non–reducing saccharides

C) dextran

D) limit dextrins

Answer: D
Page Ref: Section 6

43) Chitin is

A) found in insect and crustacean shells.

B) found in fungi cell walls.

C) composed of N–acetylglucosamine subunits.

D) composed of linear fibrils like cellulose.

E) All of the above

Answer: E
Page Ref: Section 6

44) The elasticity and resistance to compression of connective tissue is due to

A) the branching of the glycosaminoglycans there.

B) the glycosidic linkage to the serine of proteins in the glycosaminoglycans.

C) the carboxyl and sulfated groups in the glycosaminoglycans.

D) the rigid structure of the glycosaminoglycans.

E) All of the above

Answer: C
Page Ref: Section 6

45) Nodulation factors are ________.

A) polysaccharides that help maintain the integrity of tree bark

B) lipo–oligosaccharides that stimulate the growth of nitrogen–fixing structures in plants

C) polysaccharides used to store energy in the roots of plants

D) lipo–saccharides that are often found in tumors

Answer: B
Page Ref: Section 7

46) The bacterial cell wall is sensitive to penicillin because it

A) blocks the linkage of the MurNAc and GlcNAc subunits.

B) blocks the pentaglycine bridge cross linkage.

C) binds to an enzyme which recognizes D–alanine–D–alanine dipeptide.

D) is not attacked by enzymes in animal cells.

E) All of the above

Answer: C
Page Ref: Section 7

47) The main reasons that glycoproteins are so diverse when compared to other proteoglycans are

A) they may contain different sugars in different combinations and chain lengths.

B) β or a–glycosidic linkages may join various carbon atoms in the sugars.

C) they are found in both bacterial, plant and animal cells.

D) A and B

E) All of the above

Answer: D
Page Ref: Section 7

48) ________ contain NeuNAc residues and sulfated sugars, and their negative charges contribute to the viscosity of mucins.

A) Proteoglycans

B) N–linked polysaccharides

C) O–linked polysaccharides

D) Hyaluronic acid

E) All of the above

Answer: C
Page Ref: Section 7

49) The major proteoglycan in cartilage is ________.

A) hyaluronic acid
B) cellobiose
C) link protein
D) aggrecan

Answer: D
Page Ref: Section 7

50) Most of the carbohydrates on earth are produced by photosynthesis in plants.

Answer: TRUE
Page Ref: Introduction

51) All carbohydrates have the empirical formula $(CH_2O)_n$.

Answer: FALSE
Page Ref: Introduction

52) The simplest aldose is the chiral molecule glyceraldehyde.

Answer: TRUE
Page Ref: Section 1

53) All D–enantiomers of carbohydrates are dextrorotatory.

Answer: FALSE
Page Ref: Section 1

54) The ketohexoses have fewer chiral carbon atoms than the aldohexoses.

Answer: TRUE
Page Ref: Section 1

55) The reaction between one molecule of alcohol and one molecule of aldehyde yields an acetal.

Answer: FALSE
Page Ref: Section 2

56) In solution only one anomeric form of a monosaccharide will be present.

Answer: FALSE
Page Ref: Section 2

57) Furanoses have more three–dimensional conformations than pyranoses.

Answer: TRUE
Page Ref: Section 3

58) Steric strain is a major factor in determining the conformations of a monosaccharide that predominate in solution.

Answer: TRUE
Page Ref: Section 3

59) The chair conformation of furanoses is generally preferred to minimize steric repulsion.

Answer: FALSE
Page Ref: Section 3

60) Vitamin C is an enediol of a lactone and is vital in the synthesis of collagen.

Answer: TRUE
Page Ref: Section 4

61) The sugar derivative found in DNA is an oxidized form of ribose.

Answer: FALSE
Page Ref: Section 4

62) Sugar alcohols do not have a carbonyl group.

Answer: TRUE
Page Ref: Section 4

63) DNA could be referred to as a glycoside.

Answer: TRUE
Page Ref: Section 5

64) Both nucleotides and nucleosides are glycosides.

Answer: TRUE
Page Ref: Section 5

65) For cattle, cellulose is a storage homoglycan.

Answer: FALSE
Page Ref: Section 6

66) The main difference between structures of amylopectin and glycogen is the specific sugar subunit.

Answer: FALSE
Page Ref: Section 6

67) Homoglycans are used for storage, while heteroglycans are used for cell structure.

Answer: FALSE
Page Ref: Section 6

68) a–amylases hydrolyze a–(1→4) linkages and β–amylases hydrolyze β–(1→4) linkages, but neither attack a–(1→6) linkages.

Answer: FALSE
Page Ref: Section 6

69) Enzymes that hydrolyze cellulose cannot hydrolyze amylopectin.

Answer: TRUE
Page Ref: Section 6

70) Cellulose cannot be degraded in cattle.

Answer: FALSE
Page Ref: Section 6

71) Enzymatic lengthening and degradation of glycogen occurs only at the non–reducing ends.

Answer: TRUE
Page Ref: Section 6

72) An oligosaccharide nodulation factor from one species can stimulate symbiosis in another species.

Answer: FALSE
Page Ref: Section 7

73) Unlike proteins, whose primary structures are encoded in DNA, polysaccharides have very little structural variations.

Answer: FALSE
Page Ref: Section 7

74) Heteroglycan chains may or may not be covalently bound to proteins in proteoglycans.

Answer: TRUE
Page Ref: Section 7

75) The heteroglycan component of the cell wall is the same in all bacteria, but the cross–linking polypeptide is not.

Answer: TRUE
Page Ref: Section 7

76) Some glycoproteins may have identical protein components and variable polysaccharide components.

Answer: TRUE
Page Ref: Section 7

77) The large number of possible oligosaccharide structures in glycoproteins is limited in cells by the kinds of enzymes available for their synthesis.

Answer: TRUE
Page Ref: Section 7

Chapter 9 Lipids and Membranes

1) Lipids may be either hydrophobic or ________.

A) hydrophilic   B) amphoteric   C) inorganic   D) amphipathic

Answer: D
Page Ref: Introduction

2) ________ are the simplest lipids but they may be a part of or a source of many complex lipids.

A) Triglycerols

B) Carbohydrates

C) Terpenes

D) Fatty acids

E) Waxes

Answer: D
Page Ref: Section 1

3) Isoprenoids are lipids which neither contain nor are derived from fatty acids and include

A) steroids.

B) waxes.

C) terpenes.

D) A and C only

E) A, B, and C

Answer: D
Page Ref: Section 1

4) A fatty acid designated as 20:0 is ________, while one that is designated 20:3 $D^{5,8,11}$ is ________.

A) simple; complex

B) complex; simple

C) saturated; unsaturated

D) unsaturated; saturated

E) monounsaturated; polyunsaturated

Answer: C
Page Ref: Section 2

5) A fatty acid designated w–3

A) has three double bonds.

B) is saturated.

C) has a double bond three carbons from the end of the chain.

D) has a double bond three carbons from the a–carbon.

Answer: C
Page Ref: Section 2

6) Trans fatty acids have physical properties like those of

A) w–3 fatty acids.

B) cis–fatty acids.

C) unsaturated fatty acids.

D) saturated fatty acids.

Answer: D
Page Ref: Section 2

7) Plasma levels of cholesterol and triglycerides are elevated by

A) margarines.

B) cis–fatty acids.

C) trans–fatty acids.

D) plant oils.

Answer: C
Page Ref: Section 2

8) Fatty acids required in the diet of mammals are called

A) important.

B) dietary.

C) saturated.

D) essential.

E) esters.

Answer: D
Page Ref: Section 2

9) Most lipids in the average human diet are

A) unsaturated fatty acids.

B) saturated fatty acids.

C) glycerophospholipids.

D) triacylglycerols.

Answer: D
Page Ref: Section 3

10) Dietary triacylglycerols are digested as a result of

A) lipase action.

B) bile salts.

C) micelle formation.

D) diffusion and absorption by intestinal cells.

E) All of the above

Answer: E
Page Ref: Section 3

11) Adipocytes contain fat droplets which serve to provide an animal with

A) increased cell volume.

B) insulation.

C) chemical energy.

D) A and B above

E) B and C above

Answer: E
Page Ref: Section 3

12) Triacylglycerols are not found in cell membranes because they are

A) amphipathic.

B) not amphipathic.

C) not abundant in cells.

D) charged at biological pH.

Answer: B
Page Ref: Section 3

13) Polar heads of glycerophospholipids may be

A) + charged.

B) – charged.

C) neutral.

D) a mixture of + and – charges, but not neutral.

E) All of the above

Answer: E
Page Ref: Section 4

14) Ethanolamine, serine and choline can be cleaved from glycerophospholipids by treatment with

A) phospholipase A_1.

B) phospholipase A_2.

C) phospholipase B.

D) phospholipase C.

E) phospholipase D.

Answer: E
Page Ref: Section 4

15) Like plasmologens, sphingolipids are found in relative abundance in

A) bacteria.

B) plant cells.

C) nerve cells.

D) intestinal cells.

E) All of the above

Answer: C
Page Ref: Section 5

16) An unknown lipid is treated with a mixture of phospholipases A_1, A_2, C and D. Since no glycerol is formed after this treatment, the lipid is most likely

A) phosphatidylethanolamine.

B) phosphatidylcholine.

C) plasmologen.

D) ceramide.

E) A mixture of A and B

Answer: D
Page Ref: Section 5

17) A deficiency in the synthesis of sphingomyelins or cerebrosides will most likely result in the improper formation of

A) cell surfaces.

B) cell to cell communication.

C) nerve cells.

D) blood groups.

E) All of the above

Answer: C
Page Ref: Section 5

18) Tay–Sachs disease results from

A) a deficiency of GM_2.
B) defective lysosomes.
C) malfunction of cerebroside metabolism.
D) the accumulation of GM_2.

Answer: D
Page Ref: Section 5

19) Sterols are steroids which have

A) a hydroxyl group at position C–17.
B) a hydroxyl group at position C–3.
C) the ability to accumulate as plaques in blood vessels.
D) 5 fused rings instead of 4 fused rings.
E) hydroxyl groups at both position C–3 and C–17.

Answer: B
Page Ref: Section 6

20) Cholesterol is converted to cholesteryl esters for ________ in cells and are ________ (more, less) hydrophobic than glycerophospholipids.

A) transport; more
B) transport; less
C) storage; more
D) storage; less
E) synthesis; more

Answer: C
Page Ref: Section 6

21) The major groups of lipids can be separated by silicic acid column chromatography by eluting with

A) silicic acid.
B) acetone.
C) chloroform, acetone and methanol.
D) methanol.
E) acetone, methanol and water.

Answer: C
Page Ref: Section 8

22) Triacylglycerols cannot form lipid bilayers because they

A) have hydrophobic tails.

B) do not have polar heads.

C) cannot associate with cholesterol.

D) have polar heads.

E) cannot engage in hydrophobic interactions.

Answer: B
Page Ref: Section 8

23) In a typical eukaryotic plasma membrane

A) oligosaccharides face outward, not toward the cytosol.

B) proteins can move in and out of the bilayer.

C) lipids can move and diffuse through the bilayer.

D) some lipids can rotate within the bilayer.

E) All of the above

Answer: E
Page Ref: Section 8

24) The arrangement of lipid bilayers and other components is the basis for the currently widely accepted description which is called the

A) fluid model.

B) lipid bilayer model.

C) mosaic model.

D) diffusion model.

E) fluid mosaic model.

Answer: E
Page Ref: Section 8

25) A sea creature richer in ________ can more likely live or migrate to an area of low temperature.

A) arachidonic acid

B) unsaturated fatty acids

C) saturated fatty acids

D) eicosanoids

E) All of the above

Answer: B
Page Ref: Section 9

26) Which would you expect for the fatty acyl chains of the membrane phospholipids of bacteria grown at low temperature?

A) Proportion of unsaturated fatty acyl groups increases.

B) Proportion of unsaturated fatty acyl groups decreases.

C) No change in the proportion of saturated versus unsaturated acyl groups.

D) More cholesterol is produced and is inserted between the fatty acyl chains of the membrane.

Answer: A
Page Ref: Section 9

27) What is the role of cholesterol in animal cell membranes?

A) Blocks the association of the fatty acyl chains of phospholipids at high temperature.

B) Aids in the transport of small hydrophobic molecules across the membrane.

C) Is a receptor site for hormones on the surface of membranes.

D) Broadens the temperature range of optimum membrane fluidity.

Answer: D
Page Ref: Section 9

28) Proteins can move from one layer to the other in a cell membrane bilayer by

A) lateral diffusion.

B) biosynthesis.

C) flippases and floppases.

D) increased diffusion.

Answer: C
Page Ref: Section 9

29) Regions on cell membranes called lipid rafts form because

A) membrane proteins form them.

B) cholesterol preferentially associates with sphingolipids.

C) certain membrane protein patches aggregate.

D) cholesterol and proteins bind to form them.

Answer: B
Page Ref: Section 9

30) Which statement is <u>false</u> about lipid rafts?

A) Membrane proteins help maintain the integrity of membrane rafts.

B) They are distributed non–uniformly on the mammal cell surfaces.

C) They occur mostly on the outer mitochondrial membrane.

D) They are patches of cholesterol associated with sphingolipids.

Answer: C
Page Ref: Section 9

31) Determination of the tertiary structure of a membrane protein finds that the outer surface is composed primarily of hydrophobic residues. Which conclusion is most likely from this observation?

A) It is a lipid–anchored membrane protein.

B) It is an integral protein.

C) The protein must be involved in passive transport.

D) The protein can undergo transverse diffusion.

Answer: B
Page Ref: Section 10

32) When red–blood cells are treated extensively with protease most membrane proteins are broken down into small peptides. However, some proteins are very resistant to this treatment. If cleavage by protease is the only type of reaction that occurs in this treatment, how is this explained?

A) They are lipid–anchored membrane proteins.

B) They are peripheral proteins.

C) They contain at least 2 disulfide bonds.

D) They are integral (intrinsic) membrane proteins.

Answer: D
Page Ref: Section 10

33) Which type of membrane protein might be dissociated from the membrane by changing the pH or the ionic strength?

A) integral membrane protein
B) peripheral membrane protein
C) lipid–anchored membrane protein
D) All of the above

Answer: B
Page Ref: Section 10

34) You have purified a cell membrane and wish to isolate a transport protein from it. Which treatment might you select?

A) Add a detergent.
B) Change the ionic strength.
C) React with a protease.
D) Add phenylisothiocyanate (PITC).

Answer: A
Page Ref: Section 10

35) Lipid–anchored membrane proteins that link to an isoprenoid chain via the sulfur atom of cysteine are called ________ proteins.

A) prenylated
B) sulfide–linked
C) cysteine–anchored
D) prostaglandins

Answer: A
Page Ref: Section 10

36) Which statement is false about lipid–anchored membrane proteins?

A) They are found only on the outer leaflet of the plasma membrane.
B) Like integral membrane proteins, they are permanently associated with the membrane.
C) The covalent link to the membrane involves the phosphate group of the lipid anchor.
D) The protein portion that can be removed by treatment with phospholipase most resembles an integral membrane protein.

Answer: D
Page Ref: Section 10

37) Facilitated diffusion (passive transport) through a biological membrane is

A) generally irreversible.
B) driven by the ATP to ADP conversion.
C) driven by a concentration gradient.
D) endergonic.

Answer: C
Page Ref: Section 11

38) Which does not apply to the diffusion of O_2, CO_2 and small hydrophobic molecules across a membrane?

A) Diffusion is driven by the concentration gradient across the membrane.
B) The diffusion is spontaneous and there is a decrease in free energy as diffusion occurs.
C) The transport is saturatable.
D) Membrane proteins are not needed for the diffusion process.

Answer: C
Page Ref: Section 11

39) Why should it not be surprising that for many cells water requires a protein for its transport across a membrane?

A) Water is very polar which inhibits its free diffusion across the membrane.

B) All molecules require transport proteins to cross a membrane.

C) The transport protein is needed to prevent the hydrolysis of the phospholipid chains as water crosses the membrane.

D) There is never a concentration gradient for water across the membrane to drive its transport.

Answer: A
Page Ref: Section 11

40) In the mitochondria phosphate ion (PO_4^{3-}) and H^+ are transported together from the intermembrane space into the matrix. Which statement applies?

A) The transport protein is a symport.

B) The transport protein must have a relatively large central channel to accommodate both ions.

C) The interior of the transport protein must be uncharged.

D) All of the above

Answer: A
Page Ref: Section 11

41) Another name for facilitated diffusion is ________.

A) active transport

B) transverse diffusion

C) lateral diffusion

D) passive transport

Answer: D
Page Ref: Section 11

42) If the concentration of a solute is the same both inside and outside the cell, what might you expect with regard to its transport by a membrane protein?

A) Since there is no concentration gradient, no transport either in or out of the cell is possible.

B) Movement of the solute across the membrane could occur and cause accumulated on one side of the membrane by an active transport protein.

C) The transport protein has been saturated.

D) The solute must be phosphorylated with a phosphate group from ATP before further transport can occur.

Answer: B
Page Ref: Section 11

43) Which is <u>not</u> a similarity between active transport proteins and enzymes?

A) Both undergo conformational changes upon binding a substrate.

B) Both are susceptible to inhibition.

C) Both cause chemical modification to the substrate.

D) Both can reach a saturation limit.

Answer: C
Page Ref: Section 11

44) Which can serve as an energy source for secondary active transport?

A) light

B) ion concentration gradient

C) electron transport

D) ATP → ADP

Answer: B
Page Ref: Section 11

45) Valinomycin is an antibiotic that kills bacteria by surrounding K^+ ions and shuttling them down their concentration gradient and across membranes. Which might be a cause of cell death?

A) Disruption of secondary transport processes that depend on the K^+ concentration gradient.

B) Change in the pH of the bacterial cytosol.

C) Blocking of bacterial pores with K^+ ions.

D) Massive denaturation of bacterial proteins upon change of the K^+ concentration.

Answer: A
Page Ref: Section 11

46) The membrane transport protein Na^+–K^+ ATPase carries both Na^+ and K^+ ions across the plasma membrane. Typically the concentration of K^+ inside cells is about 30 times higher inside the cell than outside. The concentration of Na^+ is about 20 times less inside the cell than outside. Based on this information, which statement below is <u>false</u>?

A) The proper functioning of Na^+–K^+ ATPase could serve as an energy source for secondary active transport proteins.

B) It is a symport.

C) Transport of Na^+ and K^+ must be coupled to an exergonic reaction.

D) Na^+–K^+ ATPase likely undergoes conformational changes during transport.

Answer: B
Page Ref: Section 11

47) Very large molecules (macromolecules) can be transported across membranes by ________.

A) pores or channels with very large openings through the center

B) active transport proteins

C) diffusion down a concentration gradient

D) endocytosis or exocytosis

Answer: D
Page Ref: Section 11

48) In signal transduction what is an effector enzyme?

A) An integral membrane protein that changes conformation upon binding of a ligand to a cell surface receptor.

B) A small molecule that diffuses within a cell and carries a signal to its ultimate destination.

C) A protein bound on the interior of a cell membrane that generates a second messenger.

D) Protein bound on the exterior surface of a cell and is the receptor site for a ligand.

Answer: C
Page Ref: Section 12

49) Which does not generally use a signal transduction mechanism?

A) hydrophilic hormones
B) neurotransmitters
C) growth factors
D) steroids

Answer: D
Page Ref: Section 12

50) Which statement is <u>not</u> true about G proteins?

A) They are integral membrane proteins.

B) They are multisubunit proteins consisting of α, β and γ subunits.

C) They are slowly inactivated by their own GTPase activity.

D) They act as transducers for hormones.

Answer: A
Page Ref: Section 12

51) In the adenyl cyclase signaling pathway the second messenger(s) is(are) ________.

A) ATP and GTP
B) protein kinase A
C) cyclic AMP or cyclic GMP
D) AMP

Answer: C
Page Ref: Section 12

52) The toxins from cholera and whooping cough both interfere with the proper functioning of ________.

A) G proteins
B) DNA polymerase
C) ATP synthesis
D) protein kinase A

Answer: A
Page Ref: Section 12

53) Which is <u>not</u> involved in signal transduction?

A) glycolytic pathway
B) receptor tyrosine kinases
C) adenylyl cyclase pathway
D) inositol–phospholipid pathway

Answer: A
Page Ref: Section 12

54) Fatty acids such as linolenate can assume a variety of steric configurations.

Answer: TRUE
Page Ref: Section 2

55) Margarines made from plant oils are healthier, since they are hydrogenated for spreadability.

Answer: FALSE
Page Ref: Section 2

56) Lipids derived from cholesterol aid digestion and absorption of other lipids such as triacylglycerols.

Answer: TRUE
Page Ref: Section 3

57) Triacylglycerols may have either a net positive charge or a net negative charge.

Answer: FALSE
Page Ref: Section 3

58) All sphingolipids are derivatives of ceramide.

Answer: TRUE
Page Ref: Section 5

59) Most bacteria do not have sphingolipids or steroids.

Answer: TRUE
Page Ref: Section 5

60) Like bacteria, plants do not contain steroids.

Answer: FALSE
Page Ref: Section 6

61) Vitamins A, E and K are all isoprenoids.

Answer: TRUE
Page Ref: Section 7

62) Aspirin can alleviate clinical symptoms because it inhibits the synthesis of certain eicosanoids.

Answer: TRUE
Page Ref: Section 7

63) Bactoprenol synthesis is inhibited by the antibiotic bacitracin. Therefore, it can be used to treat yeast infections.

Answer: FALSE
Page Ref: Section 7

64) According to the current model of cell membrane structure, the two layers of lipids in the bilayer are nearly identical chemically.

Answer: FALSE
Page Ref: Section 8

65) The proportion of lipids to proteins is the same in different cell membranes.

Answer: FALSE
Page Ref: Section 8

66) Cholesterol accounts for 20% to 25% of the mass of lipids in a typical mammalian plasma membrane.

Answer: TRUE
Page Ref: Section 9

67) The membrane–spanning portion of a transmembrane protein is almost always a β–strand.

Answer: FALSE
Page Ref: Section 10

68) The distribution of peripheral membrane proteins is generally identical on both sides of a given membrane.

Answer: FALSE
Page Ref: Section 10

69) Transport of ions and small molecules through a bacterial membrane pore requires energy from an ATP to ADP conversion.

Answer: FALSE
Page Ref: Section 11

70) Proteins that transport water across cell membranes are called aquaporins.

Answer: TRUE
Page Ref: Section 11

71) Symport and antiport proteins must be active transport proteins.

Answer: FALSE
Page Ref: Section 11

72) The constant K_{tr} is the concentration of the molecule being transported at which the transport protein is half-saturated.

Answer: TRUE
Page Ref: Section 11

73) Secondary active transport involves the conversion of ATP to ADP.

Answer: FALSE
Page Ref: Section 11

74) The formation of a specialized lipid vesicle for the transport of a toxic protein out of a cell is called endocytosis.

Answer: FALSE
Page Ref: Section 11

75) The principle advantage of a cascade mechanism in signal transduction is that one molecule of a ligand can affect many intracellular proteins without crossing the plasma membrane.

Answer: TRUE
Page Ref: Section 12

Match each lipid with the appropriate function.

76) prostaglandin E_2
Page Ref: Section 7

77) bactoprenol
Page Ref: Section 7

78) thromboxane A_2
Page Ref: Section 7

79) leukotriene D_4
Page Ref: Section 7

80) wax
Page Ref: Section 7

A) constricts blood vessels

B) synthesis of bacterial cell wall

C) smooth muscle contraction

D) leaf coatings

E) blood clotting

76) A 77) B 78) E 79) C 80) D

Match each technique with its purpose.

81) HPLC
Page Ref: Section 9

82) thin layer chromatography
Page Ref: Section 9

83) silicic acid column chromatography
Page Ref: Section 9

84) cell fusion
Page Ref: Section 9

85) gas chromatography
Page Ref: Section 9

A) separate groups of neutral lipids

B) diacylglycerol separation based on chain length and degree of unsaturation

C) Lateral movement of proteins in cell membranes

D) Separate fatty acid esters

E) Separate neutral lipids and phospholipids

81) B 82) A 83) E 84) C 85) D

Chapter 10 Introduction to Metabolism

1) Intermediary metabolism is the term applied to reactions that ________.

A) degrade molecules

B) synthesize large molecules such as proteins

C) convert glucose to pyruvate

D) involve low molecular weight metabolites

Answer: D
Page Ref: Section 1

2) The percent of genomes involved in intermediary and energy metabolisms in a wide variety of species is about

A) 10%. B) 15–30%. C) 20–50%. D) 30% or more.

Answer: B
Page Ref: Section 1

3) A distinct set of metabolic reactions is called a reaction ________.

A) network B) cycle C) pathway D) mechanism

Answer: C
Page Ref: Section 1

4) The evolution of biochemical pathways can be studied by

A) isolating pathway enzymes from different individuals.

B) comparing pathways in closely related species.

C) comparing pathways in many diverse bacteria.

D) comparing linear and circular pathways.

Answer: C
Page Ref: Section 2

5) Consider the synthesis of a biopolymer in which the addition of successive monomers occurs by the same kind of reaction(s). The synthesis of the polymer is a ________ pathway.

A) linear B) cyclic C) spiral D) branched

Answer: C
Page Ref: Section 2

6) Which statement does not explain why many biochemical processes are carried out via multi–step pathways rather than by single–step reactions (or only a few steps)?

A) Multi–step pathways allow for more control points to regulate biochemical processes.

B) The end products of most pathways can usually be produced only by the pathway reactions that nature has evolved.

C) Sharing of intermediates between pathways is facilitated this way.

D) There is greater control over the amounts of energy that are consumed or released at any one time.

Answer: B
Page Ref: Section 2

7) Which statement is false about most metabolic pathways?

A) Most pathways are reversible under physiological conditions.

B) Pathways serve to increase the efficiency of energy transfers.

C) The rates of pathway reactions vary to respond to changing conditions.

D) The enzymes that catalyze reactions in metabolic pathways generally catalyze only a single step.

Answer: A
Page Ref: Section 2

8) The flow of material through a metabolic pathway is called the ________.

A) current
B) degree of amplification
C) cascade effect
D) flux

Answer: D
Page Ref: Section 2

9) The flow of material through a reaction pathway usually depends on ________.

A) control at several steps in the pathway

B) control of the first step of the pathway

C) covalent modification of the enzyme that catalyzes the reaction

D) feed–forward activation

Answer: A
Page Ref: Section 2

10) For a step in a reaction pathway to serve as a control point it should be ________.

A) irreversible

B) endergonic

C) far from equilibrium

D) Both A and C

E) All of the above

Answer: D
Page Ref: Section 2

11) The glycolytic pathway oxidizes glucose to two molecules of pyruvate and also produces a net of two molecules of ATP. ATP allosterically inhibits the enzyme, PFK–1, that catalyzes the third step of glycolysis. This is an example of ________.

A) feed–forward activation
B) feedback inhibition
C) negative cooperativity
D) competitive inhibition

Answer: B
Page Ref: Section 2

12) Ten people are sitting in a row. Their objective is to whisper a secret from one person to the next all the way down the row. The first person whispers the secret to the second person who passes the secret to the third person and so on. After whispering to the third person, the second person in the row notices the ninth person has fallen asleep in their chair, so she gets up, goes down the row and shakes person nine awake. This example is similar to ________.

A) allosteric control
B) positive cooperativity
C) feed–forward activation
D) negative modulation

Answer: C
Page Ref: Section 2

13) Phosphorylation at the expense of ATP is catalyzed by ________.

A) protein kinases
B) phosphoryl isomerases
C) phosphatases
D) All of the above

Answer: A
Page Ref: Section 2

14) Which is usually the slowest way to regulate a reaction in a metabolic pathway?

A) allosteric modulation

B) covalent modification

C) changing the enzyme concentration

D) All of the above are usually equally as fast

Answer: C
Page Ref: Section 2

15) Which statement is <u>not</u> true about catabolic pathways?

A) They have a net release of energy.

B) They have a net consumption of ATP.

C) They liberate smaller molecules from larger ones.

D) They include the citric acid cycle.

Answer: B
Page Ref: Section 3

16) The degradation of which class of biochemicals does <u>not</u> significantly contribute to the release of energy to cells?

A) nucleic acids B) proteins C) lipids D) carbohydrates

Answer: A
Page Ref: Section 3

17) The most biochemically complex organisms are ________.

A) chemoheterotrophs B) photoheterotrophs

C) heterotrophs D) autotrophs

Answer: D
Page Ref: Section 3

18) An organism that uses organic molecules as carbon sources and obtains energy by oxidizing inorganic molecules is a(an) ________.

A) photoautotroph B) chemoautotroph

C) photoheterotroph D) chemoheterotroph

Answer: D
Page Ref: Section 3

19) The reactions that digest foods in the mouth, stomach and intestine are classified as ________ reactions.

A) proteolytic cleavage
B) hydrolysis
C) free radical
D) reduction

Answer: B
Page Ref: Section 3

20) Which is not generally a molecule used to conserve energy?

A) ATP
B) NADH
C) FAD
D) QH_2

Answer: C
Page Ref: Section 3

21) The ultimate product of complete oxidation of carbohydrates is ________.

A) carbon dioxide
B) acetyl CoA
C) pyruvate
D) acetate ion

Answer: A
Page Ref: Section 3

22) Compartmentation of enzymes

A) helps prevent loss by diffusion.
B) keeps separate pools of metabolites in cells.
C) can help control metabolic pathways.
D) All of the above

Answer: D
Page Ref: Section 4

23) Fatty acid synthesis occurs in the ________, while fatty acid breakdown occurs in the ________.

A) cytosol; mitochondria
B) cytosol; nucleus
C) mitochondria; cytosol
D) Golgi apparatus; cytosol

Answer: A
Page Ref: Section 4

24) Which are membrane associated pathways?

A) electron transport chain in eukaryotes

B) citric acid cycle in bacteria

C) photosynthesis

D) glycolysis

E) Both A and C above

Answer: E
Page Ref: Section 4

25) Anabolic and catabolic reactions in eukaryotes can occur simultaneously in cells. This is possible because ________.

A) they all occur in the cytosol

B) the anabolic and catabolic pathways do not share any intermediate metabolites

C) of the compartmentation of metabolites for the reactions of opposing pathways

D) all catabolic reactions are exergonic and all anabolic reactions are endergonic

Answer: C
Page Ref: Section 4

26) What defines a **near–equilibrium** reaction?

A) Q is close to K_{eq}

B) D$E^{0'} = 0$

C) the reaction is a closed system with no flux in or out of the system

D) pH is approximately equal to pK_{eq}

Answer: A
Page Ref: Section 5

27) A chemical reaction with a negative enthalpy change and a negative entropy change ________.

A) must be spontaneous

B) must be nonspontaneous

C) could be either spontaneous or nonspontaneous depending on the temperature

D) is not possible

Answer: C
Page Ref: Section 5

28) Calculate $\triangle G^{\circ'}$ for the reaction shown if the mass action ratio, Q, is 5.3×10^2 M^{-1} and $\triangle G$ is 46 kJ/mol at a temperature of 298 K. (R = 8.315 J/K–mol)

$$ADP + P_i \rightleftharpoons ATP$$

A) 30 kJ/mol B) –30 kJ/mol C) 61 kJ/mol D) –61 kJ/mol

Answer: A
Page Ref: Section 5

29) Which thermodynamic quantity is used to determine if a reaction in a cell is spontaneous?

A) $\triangle G^{\circ'}$ B) $\triangle G$ C) $\triangle H$ D) $\triangle S$

Answer: B
Page Ref: Section 5

30) A reaction that best serves as a control point for regulation ________.

A) is a near equilibrium reaction
B) has a large positive $\triangle G$
C) is metabolically irreversible
D) follows Michaelis–Menten kinetics

Answer: C
Page Ref: Section 5

31) The hydrolysis of ATP to ADP has a $\triangle G^{\circ'}$ of –30 kJ/mol. If in an *E. coli* cell the concentrations of ATP, ADP and inorganic phosphate are 7.90 mM, 1.04 mM and 7.9 mM, respectively, which statement is true about the hydrolysis of ATP in the cell? (Assume a temperature of 298 K. R = 8.315 J/K–mol)

A) Hydrolysis can proceed spontaneously.
B) The hydrolysis is at equilibrium.
C) The formation of ATP from ADP is occurring more rapidly than the hydrolysis.
D) The hydrolysis is being allosterically controlled.

Answer: A
Page Ref: Section 5

32) The conversion of glucose–1–phosphate to glucose–6–phosphate by the enzyme phosphoglucomutase has a $\triangle G^{\circ'}$ of –7.6 kJ/mol. Calculate the equilibrium constant for this reaction at 298 K and a pH of 7. (R = 8.315 J/K–mol)

A) 0.003 B) 0.047 C) 1.00 D) 21

Answer: D
Page Ref: Section 5

33) The amount of energy recovered as ATP can be estimated by measuring free energy of hydrolysis of

A) phosphoester bond in ATP.

B) phosphoanhydride bonds in ADP.

C) phosphoester bond ADP.

D) phosphoanhydride bonds in ATP.

E) All of the above

Answer: D
Page Ref: Section 6

34) Nucleoside triphosphates exist in a cell as complexes with

A) Phosphate ion.

B) Mg^{2+} only.

C) Mn^{2+} only.

D) Mg^{2+} and sometimes Mn^{2+}.

E) All of the above

Answer: D
Page Ref: Section 6

35) ATP is classified as an energy-rich compound because

A) it complexes with Mg^{2+}.

B) it has a relatively low free energy of hydrolysis.

C) its complete oxidation to carbon dioxide releases a large amount of energy.

D) of the free energy released from cleavage of the phosphoanhydride bond.

Answer: D
Page Ref: Section 6

36) Levels of ATP and ADP are partly maintained in cells by

A) phosphoglucomutase.

B) the ADP concentration.

C) adenylate kinase.

D) and equilibrium with dissolved oxygen.

Answer: C
Page Ref: Section 6

37) The free energy for ATP hydrolysis *in vivo* is actually greater than the standard free energy change of -30 kJ mol^{-1} because

A) it has stronger electrostatic repulsion.

B) of the actual concentrations of ATP and its hydrolysis products in cells.

C) it can easily be formed from other nucleotide triphosphates.

D) it can participate in phosphoryl group transfers.

E) All of the above

Answer: B
Page Ref: Section 6

38) Which of the following is not a factor contributing to the large free energy of hydrolysis of ATP?

A) Electrostatic repulsion of oxygen atoms

B) Better solvation of products than ATP itself

C) Complexes with Mg^{2+} or Mn^{2+} ions

D) Better stability of products than ATP itself

E) Electrical shielding of products of hydrolysis

Answer: C
Page Ref: Section 6

39) In order for a reaction to proceed spontaneously from left to right as written

A) ATP must be involved in the reaction.

B) a common intermediate must be formed.

C) the overall free-energy change must be negative.

D) a phosphate group must be transferred.

E) All of the above

Answer: C
Page Ref: Section 6

40) Which statement is false about ATP?

A) Its concentration in a particular cell usually fluctuates very little.

B) The concentration of ATP in cells is generally much lower than that of AMP.

C) Its concentration is maintained in part by adenylate kinase.

D) The intracellular concentration of ATP varies among cell types.

Answer: B
Page Ref: Section 6

41) ATP can be used to activate a substrate by

A) phosphorylation.
B) adding a nucleotidyl group.
C) producing inorganic phosphate.
D) Both A and B

Answer: D
Page Ref: Section 7

42) g–Glutamyl phosphate is formed as an intermediate in the conversion of glutamate to glutamine by the enzyme glutamine synthetase because

A) it has a large negative free energy.
B) it is positively charged.
C) it is unstable in water.
D) it is a nucleophile.
E) All of the above

Answer: A
Page Ref: Section 7

43) Which compound has a greater free energy of hydrolysis than ATP?

A) glucose 1–phosphate
B) any phosphoester
C) phosphoenolpyruvate
D) acetyl CoA
E) All of the above

Answer: C
Page Ref: Section 7

44) ATP is thermodynamically suited as a carrier of phosphoryl groups in animal cells because

A) it is stable under cell conditions.
B) it is not hydrolyzed in cells without enzyme action.
C) it is intermediate in group–transfer potential.
D) it can be produced from phosphocreatine.
E) All of the above

Answer: E
Page Ref: Section 7

45) The formation of acetyl CoA is driven to completion by

A) the negative standard free energy for the first step of the reaction.

B) the negative standard free energy for the final step of the reaction.

C) removal of the product pyrophosphate by the enzyme pyrophosphatase.

D) the negative free energy for the formation of an ADP intermediate.

E) All of the above

Answer: C
Page Ref: Section 7

46) Thioesters are similar to oxygen esters of carboxylic acids except that

A) the energy associated with their hydrolysis is much less than that of the phosphoanhydride in ATP.

B) they are more stable at neutral pH values in cells.

C) they are less stable because S is present instead of O in the linkage.

D) they are used in glycolysis and the citric acid cycle.

E) they are not hydrolyzed enzymatically.

Answer: C
Page Ref: Section 8

47) The chemical energy generated by oxidation reactions cannot be captured by

A) NADH. B) NADP. C) FMN. D) FAD. E) Q.

Answer: A
Page Ref: Section 9

48) Calculate the equilibrium constant for an oxidation-reduction reaction involving the transfer of 1 mole of electrons with $DE^{0'} = 0.25$ V. ($R = 8.315$ $JK^{-1}mol^{-1}$, $F = 96.48$ $kJV^{-1}mol^{-1}$, $T = 298$ K)

A) 1 B) 6×10^{-5} C) 1.7×10^{4} D) 0.49

Answer: B
Page Ref: Section 9

49) If the standard reduction potential of a certain half–reaction is –0.30 V, which statement below is true for this half–reaction to proceed as a reduction?

A) This half–reaction will proceed if it is coupled to another half–reaction that has a standard reduction potential greater than +0.30 V.

B) This half–reaction will proceed if it is coupled to another half–reaction that has a standard reduction potential greater than –0.30 V.

C) This half–reaction will proceed if it is coupled to another half–reaction that has a standard reduction potential less than –0.30 V.

D) It doesn't matter what half–reaction this is coupled with, it will proceed spontaneously.

Answer: C
Page Ref: Section 9

50) The ability and capacity of coenzymes to become oxidized or reduced (reduction potential) may be found by

A) measuring the flow of zinc and copper electrons.

B) measuring the flow of electrons when compared to hydrogen gas at standard conditions.

C) measuring the number of H atoms present.

D) All of the above

Answer: B
Page Ref: Section 9

51) When a reduction half–reaction is ________ (negative, positive), electrons flow to the more readily reduced substance which is ________ (negative, positive) in value.

A) negative; negative
B) negative; positive
C) positive; positive
D) positive; negative

Answer: B
Page Ref: Section 9

52) The standard potential for electron transfer can be related to the standard free–energy change for redox reactions by using

A) a calorimeter.

B) an electrochemical cell.

C) two solutions separated by a salt bridge.

D) the Nernst equation.

E) the Faraday equation.

Answer: D
Page Ref: Section 9

53) In theory at least, the energy released by the oxidation of one molecule of NADH is sufficient to form ________ ATP molecule(s).

A) 0.5 (meaning it takes about 2 NADH to form 1 ATP)

B) 1

C) several

D) about 20

E) about 50

Answer: C
Page Ref: Section 9

54) Studies of specific enzymes in cells may not give information about cell metabolism since

A) it is difficult to label many enzymes.

B) the pathways are too complex.

C) many enzymes are mutant ones.

D) conditions in isolation may not be like those inside the cell.

E) All of the above

Answer: D
Page Ref: Section 10

55) Mutant organisms can be helpful in the study of metabolism because

A) one can compare the mutant to a non–mutant organism.

B) there may be an indication of a natural role for an enzyme.

C) there may be accumulations of products prior to defective enzymes.

D) the structures of enzymes may be deduced.

E) All of the above

Answer: E
Page Ref: Section 10

56) The biochemical reactions that degrade molecules, such as nutrients, are called anabolic reactions.

Answer: FALSE
Page Ref: Section 1

57) A given cell type tends to maintain relatively constant internal concentrations of inorganic ions, enzymes and metabolites.

Answer: TRUE
Page Ref: Section 1

58) Metabolic pathways generally have easily distinguished starting and stopping points.

Answer: FALSE
Page Ref: Section 1

59) Most metabolic reactions occur continuously at a fixed rate.

Answer: FALSE
Page Ref: Section 2

60) Phosphatases catalyze the hydrolytic removal of phosphate groups.

Answer: TRUE
Page Ref: Section 2

61) Phosphorylation of enzymes involved in catabolic pathways usually activates them.

Answer: TRUE
Page Ref: Section 2

62) All metabolic reactions occur in the cytosol of cells.

Answer: FALSE
Page Ref: Section 4

63) The process of dissolving table salt, NaCl, in water involves an increase in entropy.

Answer: TRUE
Page Ref: Section 5

64) Reactions of most metabolic pathways are in a state of equilibrium and have a $\triangle G$ equal to zero.

Answer: FALSE
Page Ref: Section 5

65) The phosphoester bond and phosphoanhydride bonds in ATP have the approximately same free energies of hydrolysis.

Answer: FALSE
Page Ref: Section 6

66) The presence of Mg^{2+} ions decreases the free energy released by the hydrolysis of ATP.

Answer: TRUE
Page Ref: Section 6

67) By linking a reaction that would not ordinarily proceed to the hydrolysis of ATP, the overall coupled reaction may be completed.

Answer: TRUE
Page Ref: Section 7

68) ATP has the highest possible standard free energy of hydrolysis in cells; therefore it is the most energy-rich compound in living systems.

Answer: FALSE
Page Ref: Section 7

69) ATP is thermodynamically suited as a carrier of phosphoryl groups because it has one of the highest phosphoryl-group-transfer potentials in cells.

Answer: FALSE
Page Ref: Section 7

70) Phosphagens are energy-rich phosphoanhydrides found in animal muscle cells and which have higher group-transfer potentials than ATP.

Answer: FALSE
Page Ref: Section 7

71) The synthesis of acetyl CoA shows that another important role for ATP in cells is to provide its nucleotidyl group for transfer in metabolism.

Answer: TRUE
Page Ref: Section 7

72) Although the CoA thioester is less stable than oxygen esters, it is stable in cells, resisting nonenzymatic hydrolysis at neutral pH values.

Answer: TRUE
Page Ref: Section 8

73) It would be possible for cells to couple glutathione reduction ($E° = -0.23$) to the oxidation of cytochrome c_1 ($E°' = 0.23$).

Answer: FALSE
Page Ref: Section 9

74) Both NADH and NADPH are oxidized in cells, but NADH is more often used in specialized pathways to provide hydride ions for reductive reactions in metabolism.

Answer: TRUE
Page Ref: Section 9

75) Many dehydrogenases can be assayed by measuring the decrease of absorption of NAD^+ or the increase of absorption of NADH.

Answer: TRUE
Page Ref: Section 9

Chapter 11 Glycolysis

1) Which substance is a product of glycolysis, a precursor of gluconeogenesis and a precursor of the citric acid cycle?

   A) glucose B) pyruvate C) ATP D) coenzyme A

   Answer: B
   Page Ref: Introduction

2) How many ATP molecules are consumed in glycolysis for every one molecule of glucose?

   A) 0; ATP is produced, not consumed, by glycolysis
   B) 1
   C) 2
   D) 3
   E) 4

   Answer: C
   Page Ref: Section 1

3) During glycolysis, isomerization occurs during which of the following reactions?

   A) Fructose 1,6–bisphosphate → dihydroxyacetone phosphate and glyceraldehyde 3–phosphate
   B) Fructose 6–phosphate → fructose 1,6–bisphosphate
   C) Glucose 6– phosphate → fructose 6– phosphate
   D) Glucose → glucose 6– phosphate

   Answer: C
   Page Ref: Section 2

4) Transfer of a high–energy phosphoryl group to ADP, resulting in ATP occurs when:

   A) 1,3–bisphosphoglycerate → 3–phosphoglycerate
   B) phosphoenolpyruvate (PEP) → pyruvate
   C) 3–phosphoglycerate → 2–phosphoglycerate
   D) Both A and B
   E) None of the above

   Answer: D
   Page Ref: Section 2

5) An intramolecular phosphoryl–group transfer occurs when

A) 2–phosphoglycerate is converted to phosphoenolpyruvate.

B) 1,3–bisphosphoglycerate is converted to 3–phosphoglycerate.

C) Both A and B

D) None of the above

Answer: D
Page Ref: Section 2

6) In some diabetic patients, glucose increases disproportionately and is unresponsive to an insulin challenge; under these conditions, how would one's liver normally respond?

A) phosphorylating glucose for entry into the glycolytic pathway

B) saturating glucokinase with glucose

C) phosphorylating glucose for entry into the glycogen synthesis pathways

D) A and B only

E) A and C only

Answer: E
Page Ref: Section 2

7) Glucose 6–phosphate allosterically inhibits

A) hexokinase I.

B) glucokinase.

C) hexokinase II.

D) All of the above

E) A and C only

Answer: E
Page Ref: Section 2

8) Isozymes are enzymes

A) from one species that catalyze the same reaction.

B) from different species that catalyze the same reaction.

C) that have isomers as substrates.

D) that have products that are isomers.

Answer: A
Page Ref: Section 2

9) Phosphofructokinase I deficiency results in

A) an overproduction of Fructose 6–phosphate.

B) an overproduction of Fructose 1,6–bisphosphate.

C) fructose 1,6–bisphosphate deficiency.

D) A and C only

E) All of the above

Answer: D
Page Ref: Section 2

10) Glyceraldehyde 3–phosphate dehydrogenase causes

A) the reduction and phosphorylation of glyceraldehyde 3–phosphate to produce 1,3–bisphosphoglycerate.

B) the oxidation of a molecule of NAD^+ to NADH.

C) Neither A nor B

D) Both A and B

Answer: C
Page Ref: Section 2

11) 2,3–bisphosphoglycerate is

A) an essential component of glycolysis for ATP production.

B) converted to 3–phosphoglycerate with formation of ATP.

C) essential for the efficient release of O_2 from hemoglobin.

D) a product of the enzyme phosphofructokinase.

Answer: C
Page Ref: Section 2

12) Which of the following enzymatic reactions are control points for glycolysis?

A) glucose 6–phosphate isomerase

B) aldolase

C) Both A and B

D) Neither A nor B

Answer: D
Page Ref: Section 2

13) Arsenate

A) competes with NAD^+ for the binding site in 1,3–bisphosphoglycerate.

B) competes with phosphate for its binding site in glyceraldehyde 3–phosphate dehydrogenase.

C) produces a stable analog of 1,3–bisphosphoglycerate.

D) All of the above

Answer: B
Page Ref: Section 2

14) In the presence of arsenate poisoning

A) ATP production proceeds via a reaction that involves 1,3–bisphosphoglycerate.

B) glycolysis is interrupted.

C) a net production of 2 molecules of ATP occurs.

D) All of the above

E) None of the above

Answer: E
Page Ref: Section 2

15) Arsenite

A) poisons by the same mechanism as arsenate.

B) is less toxic than arsenate.

C) binds tightly to lipoamide sulfur atoms.

D) None of the above

Answer: C
Page Ref: Section 2

16) Substrate level phosphorylation

A) describes the conversion of ADP into ATP with the addition of inorganic phosphate every place throughout the cell.

B) describes the formation of ADP by phosphoryl group transfer from 1,3 bisphosphoglycerate.

C) is the formation of ATP by phosphoryl group transfer from a higher energy compound.

D) Both A and C

Answer: C
Page Ref: Section 2

17) Mutases are described as

A) polymerases that catalyze phosphoryl group transfers.

B) isomerases that catalyze the transfer of phosphoryl groups from one part of a substrate molecule to another.

C) forming intermediate free phosphate (Pi).

D) All of the above

Answer: B
Page Ref: Section 2

18) Which amino acid's residue plays a role in the phosphoglycerate mutase reaction in glycolysis for muscle and yeast?

A) leucine B) lysine C) alanine D) histidine

Answer: D
Page Ref: Section 2

19) Which of the following mutases catalyze the formation of a 2,3–BPG intermediate?

A) muscle phosphoglycerate mutases

B) plant phosphoglycerate mutases

C) yeast phosphoglycerate mutases

D) A and C only

E) All of the above

Answer: D
Page Ref: Section 2

20) Which of the following elements is required for the enzymatic reaction that produces phosphoenolpyruvate?

A) potassium B) calcium C) magnesium D) manganese

Answer: C
Page Ref: Section 2

21) Which of the following is not regulated in glycolysis?

A) pyruvate kinase B) phosphoglycerate kinase

C) hexokinase D) PFK–1

Answer: B
Page Ref: Section 2

22) Transfer of the phosphoryl group from PEP to ADP is an example of

A) a mutase reaction.
B) isomerization.
C) dehydrogenase.
D) substrate–level phosphorylation.

Answer: D
Page Ref: Section 2

23) Which of the following is not a metabolically irreversible enzymatic reaction of glycolysis?

A) pyruvate kinase reaction
B) PFK–1 reaction
C) hexokinase/Glucokinase reaction
D) None of the above

Answer: D
Page Ref: Section 2

24) Enzymes that catalyze the same reaction are called ________.

A) isozymes
B) complementary enzymes
C) cofactors
D) catalytes

Answer: A
Page Ref: Section 2

25) Cells that form ATP mainly by glycolysis are

A) anaerobic yeasts.
B) lactic acid bacteria.
C) kidney medulla cells.
D) A and B
E) A, B and C

Answer: E
Page Ref: Section 3

26) The conversion of pyruvate to ethanol also causes the ________.

A) oxidation of NADH
B) production of ADP
C) consumption of O_2
D) generation of an ion gradient across mitochondrial membranes

Answer: A
Page Ref: Section 3

27) Yeast will normally convert pyruvate to ethanol. Why is this better for the yeast than a conversion to lactate?

A) Conversion to ethanol releases more NAD^+ per mole than the conversion to lactate.

B) The carbon atoms are more oxidized in ethanol than in lactate.

C) Ethanol is neutral, but lactate production is accompanied by a sharp decrease in pH.

D) Ethanol production is not better. Yeast normally produces ethanol and lactate in equilmolar amounts.

Answer: C
Page Ref: Section 3

28) Compared to pyruvate, the carbon atoms in lactate ________.

A) are more reduced
B) are more oxidized
C) are equally as oxidized
D) carry more charge

Answer: A
Page Ref: Section 3

29) The enzyme that catalyzes the conversion of pyruvate to lactate is ________.

A) lactate reductase
B) pyruvate kinase
C) lactoenolpyruvate
D) lactate dehydrogenase

Answer: D
Page Ref: Section 3

30) Which is not among the possible fates of pyruvate after glycolysis?

A) conversion to lactate

B) further reduction by the citric acid cycle

C) conversion to ethanol

D) used in the biosynthesis of alanine

31) What happens to pyruvate if it is destined for the citric acid cycle?

A) It is converted to carbon dioxide and acetaldehyde.

B) It is converted to ethanol.

C) It is converted to lactate.

D) Nothing, pyruvate enters the citric acid cycle directly.

Answer: A
Page Ref: Section 3

32) Under what situation might lactic acidosis occur?

A) Lactate dehydrogenase is inactive.

B) Transport of glucose into cells is accelerated.

C) Oxygen supply to tissues is inadequate.

D) PFK–1 is over–activated.

Answer: C
Page Ref: Section 3

33) Hamsters love to run on exercise wheels. Prolonged running at a high rate of speed requires ATP. Could a hamster with a defective gene for the enzyme lactate dehydrogenase meet the extra ATP demand for prolonged, fast wheel–running by maintaining a high rate of glycolysis? Why or why not?

A) No, not enough NAD^+ can be regenerated for glycolysis to continue at a high rate.

B) No, the defective gene will cause a rapid decline in pH in the muscles used for running.

C) Yes, the defective enzyme has no effect on the glycolytic pathway.

D) Yes, the enzyme alcohol dehydrogenase will supply the needed NAD^+ if the lactose dehydrogenase cannot.

Answer: A
Page Ref: Section 3

34) Which substance causes muscles to ache during strenuous exercise?

A) pyruvic acid

B) lactose dehydrogenase

C) lactate ion

D) lactic acid

Answer: D
Page Ref: Section 3

35) Seven of the ten reactions in the glycolytic pathway have free energy values close to zero. What does this tell us about those reactions?

A) They are near equilibrium reactions.

B) They are not control points for pathway regulation.

C) They are reversible reactions.

D) All of the above

E) None of the above

Answer: D
Page Ref: Section 4

36) The overall $\triangle G$ for glycolysis is −72 kJ/mol in erythrocytes. Which statement below is true?

A) The value of $\triangle G^{0\prime}$ is also −72 kJ/mol since the cytosol pH is close to 7.

B) The free energy of glycolysis is found as the sum of the standard free energy changes for the individual pathway reactions.

C) The negative sign of $\triangle G$ shows that this pathway will proceed toward product (pyruvate) under normal cellular conditions.

D) All of the above

Answer: C
Page Ref: Section 4

37) What chemical species activates the GLUT4 protein to transport glucose into cells?

A) adrenaline
B) insulin
C) protein kinase A
D) PFK−2

Answer: B
Page Ref: Section 5

38) Once inside a cell, glucose is rapidly phosphorylated to glucose−6−phosphate. What is the main purpose of this phosphorylation?

A) to keep glucose inside the cell
B) to form a high−energy compound
C) to activate PFK−1
D) to prevent mutarotation

Answer: A
Page Ref: Section 5

39) The activity of which glycolytic enzyme shown below is not used to control the rate of glycolysis?

A) PFK−1
B) pyruvate kinase
C) triose phosphate isomerase
D) hexokinase

Answer: C
Page Ref: Section 5

40) There are four enzymes that can catalyze the first step of glycolysis. They are hexokinases I, II and III and glucokinase (hexokinase IV). Hexokinases I, II and III have K_m values near 0.1 mM. Glucokinase has a K_m range of 2–5 mM. If after a heavy meal the blood glucose level rises to 8 mM which statement will be true?

A) At this high blood glucose level all four hexokinases are saturated with substrate.

B) Hexokinases I, II and III are catalyzing at their maximum rate, but glucokinase can still respond to increases in blood glucose levels.

C) None of the enzymes is saturated. All of them help to increase the rate of glycolysis.

D) The flux through glucokinase will be extremely low. The only significant catalysis is done by hexokinases I, II and III.

Answer: B
Page Ref: Section 5

41) ATP is a cosubstrate of the enzyme PFK–1. In most species ATP is also an inhibitor of PFK–1 at higher concentrations. This seems to violate Le Chatelier's Principle. Which statement below would provide a suitable explanation?

A) PFK–1 must be phosphorylated by ATP in the active site and the phosphorylated PFK–1 must be the less active form.

B) There must be another cofactor interacting with ATP at high concentrations to achieve inhibition of PFK–1.

C) ATP actually activates the reverse of the reaction preceding the PFK–1 step in the pathway. It likely has no direct effect on PFK–1.

D) There are two sites on PFK–1 that bind ATP. One is the active site; the other is the regulatory site where inhibition occurs.

Answer: D
Page Ref: Section 5

42) More than one step in the glycolytic pathway is subject to regulation. It might seem most efficient to regulate only the first step of a pathway to avoid buildup of intermediates and to conserve materials and energy. Why is the first step of glycolysis not the only regulated step?

A) Some sugars can enter the glycolytic pathway beyond the first step. If steps other than step one were not regulated, the breakdown of these sugars would be essentially uncontrolled.

B) Having more than one regulated step in the pathway allows for feedback inhibition.

C) Control of a single step in a reaction pathway is difficult because the concentrations of enzymes in cells are very low. It's easier to control more than one enzyme.

D) All the ATP in a cell would be depleted very quickly if only the first step of glycolysis were regulated.

Answer: A
Page Ref: Section 5

43) In strenuously working muscle the pH decreases. This inhibits the activity of PFK–1 and glycolysis slows. Why would it be desirable to slow glycolysis when the demand for ATP is high?

A) Inhibition of PFK–1 allows for the complete oxidation of pyruvate via the citric acid cycle.

B) Slowing glycolysis slows the rate of decrease in pH. A low pH can be harmful and potentially fatal.

C) The less active form of PFK–1 is a potent allosteric activator of creatine, so even though glycolysis is slowed, ATP production is actually increased by the activation of creatine.

D) As PFK–1 is inhibited, its isozyme, PFK–2 is activated. PFK–2 is functional at a much lower pH than PFK–1.

Answer: B
Page Ref: Section 5

44) PFK–2 and fructose 2,6–*bis*phosphatase are two names for the same enzyme. The name PFK–2 is used for the enzyme's catalysis of the phosphorylation of fructose 6–phosphate to fructose 2,6–*bis*phosphate. The name fructose 2,6–*bis*phosphatase is used for its catalysis of the reverse reaction. What is unique about this enzyme that makes it logical to use two names?

A) It is one of very few enzymes that can catalyze both the forward and reverse reactions.

B) The enzyme is a monomer when catalyzing the phosphorylation reaction and a dimer when catalyzing the reverse reaction.

C) The forward and reverse reactions occur in different compartments within the cell, so a different name is used for each activity.

D) The enzyme is bifunctional. The forward and reverse reactions are catalyzed by different sites on the same enzyme.

Answer: D
Page Ref: Section 5

45) Which applies to fructose 1,6–*bis*phosphate?

A) inhibitor of pyruvate kinase

B) product of PFK–1 catalyzed step in glycolysis

C) isomer of glucose 1,6–*bis*phosphate

D) All of the above

Answer: D
Page Ref: Section 5

46) The slowing of glycolysis in the presence of oxygen is called the ________ effect.

A) Bohr

B) Michaelis–Menton

C) Pastuer

D) Pauling

Answer: C
Page Ref: Section 5

47) What are the effects of protein kinase A on PFK–2 and pyruvate kinase?

A) phosphorylates PFK–2; dephosphorylated pyruvate kinase; both enzymes are inhibited

B) phosphorylates both enzymes; inhibits both enzymes

C) dephosphorylates both enzymes; inhibits both enzymes

D) dephosphorylates PFK–2; phosphorylates pyruvate kinase; activates PFK–2; inhibits pyruvate kinase

Answer: B
Page Ref: Section 5

48) A patient is found to be deficient in the enzyme galactose 1–phosphate uridylyltransferase. Specifically due to this deficiency what might a doctor recommend?

A) avoid all strenuous exercise

B) eat a fat–free diet

C) increase intake of vitamin C

D) avoid ingestion of milk and milk products

Answer: D
Page Ref: Section 6

49) How does the number of molecules of ATP produced compare for conversion of one molecule of either glucose or fructose to pyruvate?

A) fructose produces one less ATP than glucose

B) fructose and glucose produce the same number of ATP's

C) fructose produces one more ATP than glucose

D) fructose produces twice the number of ATP compared to glucose

Answer: B
Page Ref: Section 6

50) The molecule 1,3–*bis*phosphoglycerate can be converted to 3–phosphoenolpyruvate two ways. One way is catalyzed by the glycolytic pathway enzyme phosphoglycerate kinase. The other route is a two step reaction sequence that uses the enzymes *bis*phosphoglycerate mutase and 2,3–*bis*phosphoglycerate phosphatase. The intermediate product of the two–step sequence is 2,3–BPG which is an allosteric inhibitor of hemoglobin. What disadvantage would there be if the glycolytic pathway only used the two–step reaction sequence?

A) The step catalyzed by phosphoglycerate kinase is one of the ATP producing steps of glycolysis. Using only the two–step reaction sequence would reduce the number of ATP's produced.

B) There is no disadvantage to the two–step sequence other than having to use more than one enzyme.

C) The molecule 2,3–BPG is also a potent inhibitor of PFK–1. Even transient production of 2,3–BPG will significantly slow glycolysis.

D) Too much 2,3–BPG would be produced which would cause clumping of red blood cells.

Answer: A
Page Ref: Section 6

51) How does mannose enter the glycolytic pathway?

A) It is converted mannose 6–phosphate and then isomerized to fructose 6–phosphate which enters the pathway.

B) It can enter directly into the first step of glycolysis because hexokinase converts mannose to glucose 6–phosphate.

C) Mannose is first split into two trioses that are directly converted to glyceraldehyde 3–phosphate.

D) Mannose is not metabolized via glycolysis. It enters a separate pathway.

Answer: A
Page Ref: Section 6

52) The genetic disorder galactosemia can cause ________ in infants.

A) inability to properly digest milk due to its galactose content

B) jaundice

C) damage to the nervous system

D) liver damage

E) All of the above

Answer: E
Page Ref: Section 6

53) Which statement is <u>false</u> about the Entner–Doudoroff pathway?

A) It produces less ATP per glucose molecule than glycolysis.

B) Organisms that have this pathway use it only under conditions of low glyceraldehyde 3–phosphate isomerase concentrations.

C) It is useful for bacteria that do not have PFK–1.

D) The pathway produces pyruvate and glyceraldehyde 3–phosphate.

E) It enables some bacteria to survive on gluconate and other organic acids that cannot be metabolized via glycolysis.

Answer: B
Page Ref: Section 7

54) Which is not part of the Entner–Doudoroff pathway?

A) consumption of ATP

B) the enzyme gluconolactonase

C) an unusual dehydrase reaction from 6–phosphogluconate to KDPG

D) the production of pyruvate

E) the production of NADPH

Answer: A
Page Ref: Section 7

55) Two molecules of ATP are consumed per glucose during the triose stage of glycolysis.

Answer: FALSE
Page Ref: Section 1

56) Glycolysis occurs in the cytosol of eukaryotes.

Answer: TRUE
Page Ref: Section 1

57) Two molecules of ATP are produced per glucose during the hexose stage of glycolysis.

Answer: FALSE
Page Ref: Section 1

58) In glycolysis, there is a net yield of two molecules of ATP per molecule of glucose.

Answer: TRUE
Page Ref: Section 1

59) Four molecules of ATP are consumed per glucose during the hexose stage of glycolysis.

Answer: FALSE
Page Ref: Section 1

60) Two molecules of ATP are consumed per glucose molecule during the hexose stage of glycolysis.

Answer: TRUE
Page Ref: Section 1

61) Isozymes are different proteins from one species which catalyze different chemical reactions.

Answer: FALSE
Page Ref: Section 2

62) The reaction catalyzed by PFK–1 is metabolically reversible.

Answer: FALSE
Page Ref: Section 2

63) Glucose is the only hexose which can enter the glycolytic pathway.

Answer: FALSE
Page Ref: Section 2

64) Glyceraldehyde 3–phosphate and dihydroxyacetone phosphate are substrates in an oxidation and phosphorylation reaction, which yields a high energy mixed anhydride.

Answer: FALSE
Page Ref: Section 2

65) Triose phosphate isomerase is diffusion controlled.

Answer: TRUE
Page Ref: Section 2

66) Under aerobic conditions yeast cells convert pyruvate to ethanol and carbon dioxide.

Answer: FALSE
Page Ref: Section 3

67) Mammals can convert pyruvate to either ethanol or lactate depending on the availability of oxygen.

Answer: FALSE
Page Ref: Section 3

68) Lactic acid produced by certain bacteria is used to curdle milk during cheese–making.

Answer: TRUE
Page Ref: Section 3

69) All ten steps of the glycolytic pathway must have negative free energies for glycolysis to proceed.

Answer: FALSE
Page Ref: Section 4

70) Glucose is normally transported into cells by an active transport protein since the concentration of glucose inside cells is normally higher than that in the blood.

Answer: FALSE
Page Ref: Section 5

71) An increase in blood insulin concentration increases the rate of glucose uptake in adipose tissue and striated muscle cells.

Answer: TRUE
Page Ref: Section 5

72) Citrate is an intermediate in the citric acid cycle, yet it is also an inhibitor of PFK–1. This is an example of feedback inhibition.

Answer: TRUE
Page Ref: Section 5

73) Glucagon is a pancreatic hormone that is produced in response to low blood sugar levels. At high glucagon concentrations glycolysis is slowed.

Answer: TRUE
Page Ref: Section 5

74) Glucagon triggers the adenylate cyclase signally pathway. This activates protein kinase A which phosphorylates serine residues.

Answer: TRUE
Page Ref: Section 5

75) Glucose is the only monosaccharide that can enter the glycolytic pathway at the first step. All other monosaccharides enter at a subsequent step in the pathway.

Answer: FALSE
Page Ref: Section 6

Chapter 12 Gluconeogenesis, The Pentose Phosphate Pathway, and Glycogen Metabolism

1) Gluconeogenesis uses the same enzymatic reactions of glycolysis except for the ________.

A) pyruvate kinase catalyzed step
B) 4 irreversible reactions in glycolysis
C) 3 irreversible reactions in glycolysis
D) 2 irreversible reactions in glycolysis

Answer: C
Page Ref: Introduction

2) Glucose is stored as ________ in bacteria and animals.

A) glucagons
B) starch
C) glycogen
D) NADPH

Answer: C
Page Ref: Introduction

3) Gluconeogenesis is the ________.

A) result of amylase activity
B) formation of glycogen
C) formation of starches
D) formation of glucose from simple two and three–carbon precursors
E) formation of glucose from other carbohydrates

Answer: D
Page Ref: Introduction

4) Glucose that is not part of a diet may be provided by degradation of

A) stored glycogen.
B) starch.
C) dextrin.
D) A and B
E) A, B and C

Answer: D
Page Ref: Introduction

5) The ________ is the site of most gluconeogenesis in mammals.

A) liver
B) pancreas
C) cytosol of all cells
D) small intestine

Answer: A
Page Ref: Section 1

6) An intermediate found in gluconeogenesis and not glycolysis is

A) 2-phosphoglycerate.
B) oxaloacetate.
C) phosphoenolpyruvate.
D) fructose 1,6-*bis*phosphate.

Answer: B
Page Ref: Section 1

7) The activity of phosphoenolpyruvate carboxykinase (PEPCK) is most affected by

A) glucagon concentration.
B) insulin concentration.
C) the level of PEPCK gene transcription.
D) the elevation of cAMP concentration on fasting.

Answer: C
Page Ref: Section 1

8) Gluconeogenesis shares some, but not all, enzymes with the glycolytic pathway. It would appear to be more efficient if both pathways used all of the same enzymes since the pathways are essentially the reverses of each other. Why don't both pathways use all of the same enzymes?

A) The reactions where enzymes differ occur in different parts of the cell for glycolysis versus gluconeogenesis.
B) Enzymes can catalyze a reaction only in one direction, so naturally the two pathways have some enzymes that differ.
C) In tissues where gluconeogenesis occurs, the glycolytic enzymes are present at extremely low concentrations.
D) Three of the reaction steps in gluconeogenesis would have prohibitively large, positive free energies if they used glycolytic enzymes for their catalysis.

Answer: D
Page Ref: Section 1

9) In the Cori cycle, gluconeogenesis occurs in ________ and glycolysis in ________.

A) liver; muscle
B) liver; liver
C) muscle; muscle
D) muscle; liver

Answer: A
Page Ref: Section 2

10) Any compound that can be converted to ________ can be a precursor for gluconeogenesis.

A) citrate

B) pyruvate

C) oxaloacetate

D) All of the above

E) B or C

Answer: E
Page Ref: Section 2

11) Which of the following is not a precursor for gluconeogenesis?

A) alanine

B) glycerol

C) oxaloacetate

D) acetate

E) ethanol

Answer: E
Page Ref: Section 2

12) The sequence of glucose oxidation to lactate in peripheral tissues, delivery of lactate to the liver, formation of glucose from lactate in the liver, and delivery of glucose back to peripheral tissues is known as the ________.

A) glyoxylate cycle
B) Kreb's cycle
C) Cori cycle
D) gluconeogenesis cycle

Answer: C
Page Ref: Section 2

13) In ruminants, microorganisms produce propionate. The three-carbon acid must be converted to ________ before entering the gluconeogenesis pathway.

A) acetyl CoA
B) lactate
C) citric acid
D) succincyl CoA

Answer: D
Page Ref: Section 2

14) The reaction that converts amino acids into keto acids (such as pyruvate) is called

A) the Cori cycle.
B) catabolism.
C) transamination.
D) dehydrogenation.

Answer: C
Page Ref: Section 2

15) Glycerol is converted to ________ when it is used for gluconeogenesis.

A) dihydroxyacetone phosphate
B) phosphoenolpyruvate
C) oxaloacetate
D) 3–phosphoglycerate

Answer: A
Page Ref: Section 2

16) A substrate cycle in a metabolic pathway ________.

A) is a good point for regulation of the pathway
B) includes only diffusion–controlled reactions
C) allows for substrates to be passed to alternative pathways
D) is a point that starts a cascade effect

Answer: A
Page Ref: Section 3

17) The interconversion of which pair of substrates is used as a regulatory point in gluconeogenesis?

A) lactate and pyruvate
B) dihydroxyacetone phosphate and glyceraldehyde–3–phosphate
C) fructose 1,6–*bis*phosphate and fructose 6–phosphate
D) phosphoenolpyruvate and 2–phosphoglycerate

Answer: C
Page Ref: Section 3

18) Fructose 2,6–*bis*phosphate ________ glycolysis while it ________ gluconeogenesis.

A) stimulates; stimulates
B) stimulates; inhibits
C) inhibits; stimulates
D) inhibits; inhibits

Answer: B
Page Ref: Section 3

19) Which is an intermediate formed in the conversion of glucose to fructose?

A) glucose–1–phosphate
B) sorbitol
C) ribose
D) aldose reductase

Answer: B
Page Ref: Section 3

20) Which substance is <u>not</u> needed for the conversion of glucose to fructose?

A) NADPH
B) Aldose reductase
C) QH_2
D) NAD^+

Answer: C
Page Ref: section 3

21) What types of reactions are involved in the two–step conversion of glucose to fructose?

A) reduction followed by oxidation
B) two sequential hydrolysis reactions
C) hydrolysis followed by isomerization (rearrangement)
D) phosphorylation followed by dephosphorylation

Answer: A
Page Ref: Section 3

22) What is a cause of cataracts in the eye lens of individuals with diabetes?

A) Accumulation of sorbitol and protein precipitation in the lens.
B) Precipitation of glucose not oxidized by glycolysis in the lens.
C) The absence of membrane transport proteins for pyruvate in the lens cells.
D) Lack of regulation of gluconeogenesis in the lens and the accumulation of fructose.

Answer: A
Page Ref: Section 3

23) The pentose phosphate pathway has two primary products. They are ________.

A) ATP and NADPH
B) oxaloacetate and acetyl CoA
C) sorbitol and fructose
D) ribose–5–phosphate and NADPH

Answer: D
Page Ref: Section 4

24) The non–oxidative stage of the pentose phosphate pathway ________.

A) produces NADPH and releases CO_2
B) consists entirely of near–equilibrium reactions
C) contains two reactions whose enzymes are allosterically inhibited by NADPH
D) consumes four ATP molecules

Answer: B
Page Ref: Section 4

25) The pentose phosphate pathway can alternatively be called the *pentose phosphate cycle* because ________ is a net product of the pathway that can be recycled.

A) glucose 6–phosphate

B) $NADP^{+}$

C) carbon dioxide

D) phosphate

E) UDP

Answer: A
Page Ref: Section 4

26) Deficiencies in G6PDH (glucose–6–phosphate dehydrogenase) in humans causes

A) varying degrees of hemolytic anemia.

B) increased resistance to malaria.

C) lack of NADPH in many cells.

D) All of the above

E) A and B

Answer: E
Page Ref: Section 4

27) The major regulatory step of the pentose phosphate pathway is catalyzed by which enzyme?

A) transaldolase

B) phosphofructokinase–1

C) glucose 6–phosphate dehydrogenase

D) ribose 5–phosphate isomerase

Answer: C
Page Ref: Section 4

28) The non–oxidative stage of the pentose phosphate pathway produces substances that are intermediates of ________.

A) glycolysis

B) the citric acid cycle

C) the Cori cycle

D) glycogenolysis

Answer: A
Page Ref: Section 4

29) Fragments containing three carbons can be transferred from a ketose phosphate to an aldose phosphate by the enzyme ________.

A) pyruvate carboxylase

B) transaldolase

C) debranching enzyme

D) ribose–5–phosphate isomerase

Answer: B
Page Ref: Section 4

30) What is the prosthetic group of transketolase?

A) thiamine pyrophosphate
B) biotin
C) pyridoxal phosphate
D) NAD^+

Answer: A
Page Ref: Section 4

31) Which is not a function of the main products of the pentose phosphate pathway?

A) To maintain the reduced form of iron in hemoglobin.
B) To provide reducing power for the synthesis of fatty acids.
C) To serve as precursors in the biosynthesis of RNA and DNA.
D) To raise the concentration of cAMP.

Answer: D
Page Ref: Section 4

32) The activity of glycogen phosphorylase can be controlled by

A) phosphorylation.
B) ATP.
C) glucose 6-phosphate.
D) protein subunit separation.
E) All of the above

Answer: E
Page Ref: Section 5

33) Why does glycolysis produce more energy (more ATP) from glucose units released by glycogen degradation than from free glucose?

A) Limit dextrin contains additional molecules.
B) The debranching enzyme releases free glucose.
C) The glucose is already phosphorylated after glycogen phosphorylase action.
D) The glucose from glycogen degradation bypasses glycolysis.
E) All of the above

Answer: C
Page Ref: Section 5

34) Glucose 1–phosphate formed by glycogen degradation is converted to glucose 6–phosphate by phosphoglucomutase. Why is this beneficial?

A) Glucose 6–phosphate is more stable.

B) Glucose 6–phosphate is converted to free glucose.

C) Glucose 6–phosphate is an intermediate in several pathways, including glycolysis.

D) Glucose 6–phosphate can be transported to the liver.

E) All of the above

Answer: C
Page Ref: Section 5

35) Glycogen synthesis in vertebrates requires ________ to activate glucose 1–phosphate.

A) ATP

B) ADP

C) UTP

D) UDP

E) All of the above

Answer: C
Page Ref: Section 5

36) What is the driving force for the reaction catalyzed by UDP–glucose pyrophosphorylase that converts glucose 1–phosphate to UDP–glucose?

A) its large negative free energy change

B) the formation of an energy–rich product

C) the subsequent hydrolysis of pyrophosphate

D) the change in concentration of UTP

Answer: C
Page Ref: Section 5

37) Which statement is true about the reaction catalyzed by glycogen synthase?

A) It polymerizes free glucose to glycogen in the liver.

B) It requires UTP–glucose for chain lengthening.

C) It can both lengthen glycogen chains as well as form new branches.

D) It requires a primer of four to eight linked glucose residues.

Answer: D
Page Ref: Section 5

38) Glycogen degradation occurs in

A) muscle.

B) liver.

C) muscle and liver.

D) saliva.

E) brain cells.

Answer: C
Page Ref: Section 5

39) The enzyme for the key regulatory step in glycogen biosynthesis is

A) glycogen synthase.

B) glycogenin.

C) branching enzyme.

D) phosphoglucomutase.

E) UDP–glucose pyrophosphorylase.

Answer: A
Page Ref: Section 5

40) Glucagon is excreted when blood glucose is ________ (high, low), while insulin is secreted when blood glucose is ________ (high, low).

A) high; high B) high; low C) low; low D) low; high

Answer: D
Page Ref: Section 6

41) Protein kinase A, which stimulates glycogen degradation, is activated directly by

A) glucagon.

B) insulin.

C) epinephrine.

D) cyclic AMP.

E) adrenergic receptors.

Answer: D
Page Ref: Section 6

42) Binding of epinephrine to a_1–adrenergic receptors has what effect?

A) elevates the degradation rate of glycogen

B) activates protein kineses A

C) lowers the rate of glycogen synthesis

D) reduces the effects of insulin

E) All of the above

Answer: D
Page Ref: Section 6

43) Glycogen phosphorylase is ________ (more, less) active when phosphorylated, and it is ________ (activated, inhibited) by glucose 6–phosphate.

A) more; activated

B) less; activated

C) more; inhibited

D) less; inhibited

Answer: C
Page Ref: Section 6

44) Phosphorylation can be used to either inactive or activate enzymes. This is a key element in the regulation of glucose metabolism. Phosphorylation of glycogen phosphorylase ________ it; phosphorylation of glycogen synthase ________ it.

A) activates; activates

B) activates; inactivates

C) inactivates; inactivates

D) inactivates; activates

Answer: B
Page Ref: Section 6

45) In addition to control of activity by phosphorylation, phosphorylase kinase is activated by

A) Calmodulin.

B) Ca^{2+}.

C) cAMP.

D) Inhibitor–1.

Answer: B
Page Ref: Section 6

46) The sequence of enzymes active in liver to degrade glycogen in response to glucagon is:________. (~P indicates phosphorylation)

A) phosphorylase kinase, glycogen phosphorylase b, protein kinase A, glucagon

B) glucagon, phosphorylase kinase, glycogen phosphorylase b, protein kinase A

C) glucagon, Protein kinase A, phosphorylase kinase~P, glycogen phosphorylase a~P

D) glucagon, protein kinase A, glycogen phosphorylase a~P, phosphorylase kinase~P

Answer: C
Page Ref: Section 6

47) Unlike liver tissue, muscle and some other tissues differ in regulation of glycogen metabolism because

A) the enzymes are different.

B) there is no effect of glucagon.

C) there is no effect of insulin.

D) inhibitor–1 controls protein phosphatase–1.

E) there is no role for cyclic AMP.

Answer: D
Page Ref: Section 6

48) Which statement is <u>false</u> about glucagon?

A) It forms a protein scaffold for glycogen.

B) It is a hormone that contains 29 amino acids.

C) Elevated levels are associated with a fasting state.

D) It is produced in the pancreas.

Answer: A
Page Ref: Section 6

49) During fasting, what role does gluconeogenesis play?

A) Aids in the release of glucose from stored glycogen in the liver.

B) Uses alanine to restore blood glucose levels.

C) Produces products that slow the oxidation of pyruvate.

D) Helps transport glucose across the blood–brain barrier to maintain brain glucose levels.

Answer: B
Page Ref: Section 7

50) Which is a reasonable concentration for glucose in the blood?

A) 5 μM   B) 5 mM   C) 50 mM   D) 5 M

Answer: B
Page Ref: Section 7

51) Under starvation conditions, about how long does it take in humans for the body to deplete the glycogen store in the liver?

A) 10 minutes   B) 4 hours   C) 24 hours   D) 1 week

Answer: C
Page Ref: Section 7

52) All species can make glucose from two–carbon or three–carbon precursors.

Answer: TRUE
Page Ref: Introduction

53) More energy in the form of ATP is required to synthesize glucose than can be obtained from it by glycolysis alone.

Answer: TRUE
Page Ref: Section 1

54) Glucagon increases the transcription of the gene for phosphoenolpyruvate carboxykinase (PEPCK) in gluconeogenesis, while insulin decreases it.

Answer: TRUE
Page Ref: Section 1

55) Glycerol can supply electrons to the electron transport chain at the same time as it can be a precursor in gluconeogenesis.

Answer: TRUE
Page Ref: Section 2

56) All blood glucose in humans is derived from carbohydrate sources included in the diet.

Answer: FALSE
Page Ref: Section 2

57) Ruminants, like cows, can utilize propionate as a precursor for gluconeogenesis.

Answer: TRUE
Page Ref: Section 2

58) Fructose 2,6–*bis*phosphate is a modulator that can stimulate either glycolysis or gluconeogenesis, depending on cellular glucose concentrations.

Answer: FALSE
Page Ref: Section 3

59) At high glucagon concentrations gluconeogenesis will be favored over glycolysis.

Answer: TRUE
Page Ref: Section 3

60) The reaction catalyzed by polyol dehydrogenase involves the reduction of sorbitol.

Answer: FALSE
Page Ref: Section 3

61) Glucose 1,6–*bis*phosphate is the primary starting substrate for the pentose phosphate pathway.

Answer: FALSE
Page Ref: Section 4

62) Two molecules of NADPH are generated for each molecule of glucose 6–phosphate that enters the pentose phosphate pathway.

Answer: TRUE
Page Ref: Section 4

63) Rapidly dividing cells generally have a high pentose phosphate pathway activity.

Answer: TRUE
Page Ref: Section 4

64) The enzyme transketolase transfers 2–carbon units from ketose phosphates to aldose phosphates.

Answer: TRUE
Page Ref: Section 4

65) The enzymes transketolase and transaldolase of the pentose phosphate pathway are each very specific for only one substrate.

Answer: FALSE
Page Ref: Section 4

66) There are no branched polysaccharide chains in limit dextrin.

Answer: FALSE
Page Ref: Section 5

67) UDP–glucose is a precursor of glycogen in all cells.

Answer: FALSE
Page Ref: Section 5

68) Glycogenin is a protein scaffold for glycogen as well as an enzyme catalyzing extension of the glycogen primer.

Answer: TRUE
Page Ref: Section 5

69) Glycogen storage disease results in glycogen accumulation in the liver and kidneys. It can be controlled by changing the diet.

Answer: TRUE
Page Ref: Section 6

70) Glycogen phosphorylaseacts on the non–reducing ends of glycogen.

Answer: TRUE
Page Ref: Section 5

71) Epinephrine can stimulate glycogen degradation while at the same time, lowering glycogen synthesis.

Answer: TRUE
Page Ref: Section 6

72) Enzymes to regulate glycogen metabolism are always active when phosphorylated by protein kinases.

Answer: FALSE
Page Ref: Section 6

73) Since caffeine inhibits cAMP phosphodiesterase, too much coffee can result in the synthesis of too much glycogen.

Answer: FALSE
Page Ref: Section 6

74) The brain normally uses both glucose and fatty acids as energy sources.

Answer: FALSE
Page Ref: Section 7

75) Under fasting conditions the liver increases its rate of gluconeogenesis to maintain blood glucose levels, but this can only be maintained for a few days before the rate decreases.

Answer: TRUE
Page Ref: Section 7

Chapter 13 The Citric Acid Cycle

1) The citric acid cycle oxidizes pyruvate, and some of the pathway intermediates are starting materials for many biosynthetic pathways. This means the citric acid cycle is ________.

A) amplifying
B) catabolic
C) anabolic
D) catabolic and anabolic

Answer: D
Page Ref: Introduction

2) Compounds like succinate, fumarate and α–ketoglutarate have a catalytic effect on the consumption of oxygen in a cell suspension. The rate of oxygen consumption is far more than that required for their own oxidation. This is evidence that ________.

A) they are intermediates in glycolysis
B) they act as enzymes to cause the oxidation of other compounds
C) they are involved in a cyclic pathway
D) they must be cofactors for enzymes that are oxidoreductases

Answer: C
Page Ref: Introduction

3) In eukaryotes the enzymes of the citric acid cycle are found in the ________.

A) cytosol
B) mitochondria
C) nucleus
D) endoplasmic reticulum

Answer: B
Page Ref: Section 1

4) The order of prosthetic groups as they act in the three proteins of the PDH(pyruvate dehydrogenase) complex is:

A) FAD → thiamine pyrophosphate → NAD^+
B) FAD → thiamine pyrophosphate → dihydrolipoamide
C) thiamine pyrophosphate → dihydrolipoamide → FAD
D) NAD^+ → FAD → dihydrolipoamide

Answer: C
Page Ref: Section 1

5) The arrangement of subunits in the PDH(pyruvate dehydrogenase) complex ensures that ________.

A) ATP is formed

B) the product of one enzyme is delivered to the next in turn

C) the dihydrolipoamide arm can react with NAD^+

D) acetyl CoA enters into the series of reactions

Answer: B
Page Ref: Section 1

6) Some bacteria and anaerobic eukaryotes not using PDH(pyruvate dehydrogenase) form acetyl CoA and CO_2 from pyruvate with ________.

A) PDH modified with methyl groups

B) pyruvate:ferredoxin oxidoreductase

C) 2-oxoacid dehydrogenase

D) an isoenzyme of PDH

Answer: B
Page Ref: Section 1

7) Pyruvate passes through the outer mitochondrial membrane by ________.

A) porin proteins

B) passive transport

C) pyruvate translocase

D) simple diffusion through the lipid bilayer

Answer: A
Page Ref: Section 1

8) The enzyme pyruvate translocase is located ________.

A) in the cytosol

B) in the inner mitochondrial membrane

C) in the mitochondrial matrix

D) in the endoplasmic reticulum

Answer: B
Page Ref: Section 1

9) Pyruvate translocase is a/an ________ protein that transports ________.

A) antiport; pyruvate and H^+ in opposite directions

B) uniport; only pyruvate

C) symport; pyruvate and H^+ in the same direction

D) antiport; pyruvate and CO_2 in opposite directions

Answer: C
Page Ref: Section 1

10) Which is not a component of the pyruvate dehydrogenase complex?

A) dihydrolipoamide dehydrogenase
B) isocitrate dehydrogenase
C) pyruvate dehydrogenase
D) dihydrolipoamide acetyltransferase

Answer: B
Page Ref: Section 1

11) Which cofactor is not used by the pyruvate dehydrogenase complex?

A) lipoamide
B) thiamine pyrophosphate
C) FAD
D) QH_2

Answer: D
Page Ref: Section 1

12) Which carbon atom(s) of pyruvate is(are) first converted to carbon dioxide by pyruvate dehydrogenase complex?

A) the carboxylate carbon (#1)
B) the carbonyl carbon (#2)
C) the methyl carbon (#3)
D) both carbons #1 and #3 in equal amounts

Answer: A
Page Ref: Section 1

13) A deficiency in thiamine causes the disease beriberi. Which might you expect to have a higher than normal blood concentration in an individual with this condition?

A) isocitrate
B) pyruvate
C) oxaloacetate
D) acetyl CoA

Answer: B
Page Ref: Section 1

14) Most of the energy released in citric acid cycle reactions is conserved in ________.

A) GTP
B) ATP
C) NADH and QH_2
D) ADP

Answer: C
Page Ref: Section 2

15) When energy–rich acetyl CoA is oxidized to carbon dioxide, eight electrons are released. Most often, electrons are released in such reactions because

A) double bonds formed in CO_2 share electron pairs.

B) there are more electrons in the reactants than in the products.

C) water is not available in the reaction.

D) an electron acceptor is linked to the reaction.

Answer: A
Page Ref: Section 2

16) Citrate can react asymmetrically in the citric acid cycle because the enzyme aconitase

A) binds citrate asymmetrically.

B) binds either form of citrate.

C) binds both forms of isocitrate.

D) does not distinguish the $-CH_2COO^-$ group.

Answer: A
Page Ref: Section 2

17) What type of reaction is the conversion of fumarate to malate?

A) oxidative decarboxylation
B) hydration
C) dehydrogenation
D) condensation

Answer: B
Page Ref: Section 2

18) Carbons from acetyl CoA are transferred to the citric acid cycle. Which is the first round of the citric acid cycle that could possibly release a carbon atom originating from this acetyl CoA?

A) first round
B) second round
C) third round
D) fourth round

Answer: B
Page Ref: Section 2

19) Which enzyme is the same in both the pyruvate dehydrogenase and α–ketoglutarate complexes?

A) dihydrolipoamide dehydrogenase

B) aconitase

C) pyruvate decarboxylase

D) The two complexes have no components that are similar.

Answer: A
Page Ref: Section 3

20) Which step in the citric acid cycle is a rearrangement reaction?

A) succinyl CoA to succinate

B) fumarate to L–malate

C) citrate to isocitrate

D) glucose 1,6–*bis*phosphate to fructose 1,6–*bis*phosphate

Answer: C
Page Ref: Section 3

21) Which is not produced by the citric acid cycle?

A) NADH B) FMN C) CO_2 D) QH_2

Answer: B
Page Ref: Section 3

22) Which enzyme does not catalyze a reaction that releases carbon dioxide?

A) α–ketoglutarate dehydrogenase complex

B) pyruvate dehydrogenase

C) malate dehydrogenase

D) isocitrate dehydrogenase

Answer: C
Page Ref: Section 3

23) After passing through the citric acid cycle, one mole of pyruvate will result in the formation of ________ moles of carbon dioxide and ________ mole(s) of ATP (or GTP).

A) 2; 2 B) 2; 1 C) 3; 2 D) 3; 1

Answer: D
Page Ref: Section 3

24) Which statement is true about lactate dehydrogenase and malate dehydrogenase?

A) Both enzymes are highly specific for their own substrates.

B) A single amino acid change can convert lactate dehydrogenase to a malate dehydrogenase.

C) The naturally occurring enzymes do not have much sequence similarity, but do have closely related three–dimensional structures.

D) All of the above

Answer: D
Page Ref: Section 3

25) Which intermediate of the citric acid cycle has a plane of symmetry?

A) succinate
B) citrate
C) succinyl CoA
D) α–ketoglutarate

Answer: A
Page Ref: Section 3

26) The step at which acetyl CoA enters the citric acid cycle is classified as a ________ reaction.

A) condensation
B) substrate–level phosphorylation
C) decarboxylation
D) dehydrogenation

Answer: A
Page Ref: Section 3

27) Which enzyme catalyzes the conversion of citrate to isocitrate?

A) aldolase
B) citrate synthase
C) citrate isomerase
D) aconitase

Answer: D
Page Ref: Section 3

28) Which 5–carbon intermediate of the citric acid cycle is converted to a 4–carbon molecule with the release of carbon dioxide?

A) fumarase
B) α–ketoglutarate
C) succinate
D) isocitrate

Answer: B
Page Ref: Section 3

29) A carbon atom that has single bond to four substituents with exactly two of the four substituents identical is called a ________.

A) prochiral carbon atom
B) tetrahedral stereocenter
C) divalent carbon atom
D) anomeric carbon atom

Answer: A
Page Ref: Section 3

30) Which of the following enzymatic reactions is not an example of substrate level phosphorylation?

A) succinyl Co–A synthetase
B) pyruvate kinase
C) phosphoglycerate kinase
D) All of the above

Answer: D
Page Ref: Section 3

31) During catalysis, succinyl CoA synthetase generates

A) an energy deficient, unstable phosphoenzyme intermediate.

B) an energy rich, unstable phosphoenzyme intermediate.

C) an energy rich, stable phosphoenzyme intermediate.

D) All of the above

Answer: C
Page Ref: Section 3

32) The succinate dehydrogenase complex catalyzes

A) the formation of a single hydrogen bond in the oxidation of succinate to fumarate.

B) the formation of a double bond in the oxidation of succinate to fumarate.

C) Both A and B

D) None of the above

Answer: B
Page Ref: Section 3

33) Which of the following is/are true statements about the succinate dehydrogenase reactions?

A) It is stereospecific.

B) Only the *cis*–isomer of the product is formed.

C) It is not stereospecific.

D) Both B and C

Answer: A
Page Ref: Section 3

34) Which of the following are components of the succinate dehydrogenase complex?

A) FAD prosthetic group

B) iron–sulfur clusters

C) malonate

D) All of the above

E) A and B only

Answer: E
Page Ref: Section 3

35) Malonate

A) is a structural analogy of succinate.

B) binds to the substrate–binding site of the succinate dehydrogenase complex but does not react.

C) undergoes an oxidation reaction.

D) Both A and B

E) All of the above

Answer: D
Page Ref: Section 3

36) NAD–dependent malate dehydrogenase

A) catalyzes the oxidation of malate to regenerate oxaloacetate.

B) catalyzes the conversion of fumarase to malate.

C) catalyzes a reaction which results in the formation of an NADH molecule.

D) All of the above

E) A and C only

Answer: E
Page Ref: Section 3

37) About how many total ATP equivalents are generated by the complete oxidation of one molecule of acetyl CoA?

A) 1.5
B) 2.5
C) 3
D) 10
E) 30

Answer: D
Page Ref: Section 4

38) Pyruvate dehydrogenase kinase catalyzes

A) the dephosphorylation and activation of E_1.

B) the dephosphorylation and inactivation of E_1.

C) the phosphorylation and inactivation of E_1.

D) the phosphorylation and activation of E_1.

Answer: C
Page Ref: Section 5

39) Which of the following inhibit(s) pyruvate dehydrogenase kinase?

A) pyruvate
B) NADH
C) acetyl–CoA
D) All of the above

Answer: A
Page Ref: Section 5

40) Elevated calcium levels lead to

A) phosphorylation of the E_1 subunit and an increase in flux through the pyruvate dehydrogenase complex.

B) dephosphorylation of the E_1 subunit and a decrease in flux through the pyruvate dehydrogenase complex.

C) Neither of the above

Answer: B
Page Ref: Section 5

41) Each of the following catalyzed reactions of the citric acid cycle appears to be regulated except

A) citrate synthase.

B) fumarase.

C) isocitrate dehydrogenase.

D) a-ketoglutarate dehydrogenase complex.

Answer: B
Page Ref: Section 5

42) Which of the following allosterically activates mammalian isocitrate dehydrogenase?

A) ADP

B) NADH

C) calcium

D) All of the above

E) A and C only

Answer: E
Page Ref: Section 5

43) Each of the following leads to a biosynthetic pathway except

A) a-ketoglutarate.

B) Succinyl CoA.

C) oxaloacetate.

D) citrate.

E) None of the above

Answer: E
Page Ref: Section 6

44) Which of the following is not a fate of a citric acid cycle intermediate?

A) a-ketoglutarate reversibly converting to glutamate

B) the biosynthesis of porphyrins from succinyl CoA's interaction with glycine

C) oxaloacetate as a carbohydrate precursor

D) None of the above

Answer: D
Page Ref: Section 6

45) The glyoxylate cycle is

A) a catabolic pathway in plants and some microorganisms.

B) an anabolic pathway in plants and some microorganisms.

C) regarded as a shunt within the citric acid cycle.

D) A and C only

E) B and C only

Answer: E
Page Ref: Section 7

46) The following enzyme(s) is/are unique to the glyoxylate cycle.

A) malate synthase

B) malate dehydrogenase

C) isocitrate lyase

D) All of the above

E) A and C only

Answer: E
Page Ref: Section 7

47) True statements about the glyoxylate cycle include

A) four carbon atoms of the acetyl group of acetyl CoA are released as carbon dioxide during operation of the glyoxylate cycle.

B) the net formation of a four carbon molecule from two acetyl CoA molecules supplies a precursor that can be converted to glucose.

C) the reaction catalyzed by malate synthase is the first bypass enzyme of the glyoxylate cycle.

D) it is inactive in oily seed plants.

Answer: B
Page Ref: Section 7

48) The glyoxylate cycle leads from two carbon compounds to glucose in each organism below except

A) animals.

B) plants.

C) bacteria.

D) yeast.

E) None of the above

Answer: A
Page Ref: Section 7

49) Which statement is false about the glyoxylate cycle?

A) In mammals the glyoxylate cycle is used to replenish citric acid cycle intermediates.

B) It is an anabolic alternative for the metabolism of acetyl CoA.

C) It can be regarded as a shunt in the citric acid cycle.

D) In eukaryotes, metabolites must be transferred from the mitochondria to the cytosol to be used in the glyoxylate cycle.

Answer: A
Page Ref: Section 7

50) Which process is not implicated in the evolution of the citric acid cycle pathway?

A) gene duplication

B) palindromic inversion

C) pathway extension

D) pathway reversal

E) enzyme theft

Answer: B
Page Ref: Section 8

51) The overall goal of the citric acid cycle is to oxidize pyruvate, form reduced coenzymes, and produce ATP.

Answer: TRUE
Page Ref: Introduction

52) The citric acid cycle is an anaerobic pathway that occurs in the mitochondria of eukaryotes.

Answer: FALSE
Page Ref: Introduction

53) Pyruvate translocase is specific for transporting pyruvate across the inner mitochondrial membrane.

Answer: TRUE
Page Ref: Section 1

54) The mechanism of pyruvate dehydrogenase complex is an example of channeling.

Answer: TRUE
Page Ref: Section 1

55) ATP is consumed by the pyruvate dehydrogenase complex during the synthesis of acetyl CoA.

Answer: FALSE
Page Ref: Section 1

56) The carbon atoms that enter the citric acid cycle via acetyl CoA are the same ones released as carbon dioxide during one round of the citric acid cycle.

Answer: FALSE
Page Ref: Section 2

57) The citric acid cycle can be viewed as a multi–step catalyst simply because it returns to its original state after each round of reactions.

Answer: TRUE
Page Ref: Section 3

58) The only reaction in the citric acid cycle to generate a carbon–carbon bond is catalyzed by citrate synthase.

Answer: TRUE
Page Ref: Section 3

59) Isocitrate is more easily oxidized than citrate because it has a secondary alcohol group, whereas citrate's alcohol group is tertiary.

Answer: TRUE
Page Ref: Section 3

60) A racemic mixture of the enantiomeric forms of isocitrate is produced during the citric acid cycle reactions.

Answer: FALSE
Page Ref: Section 3

61) The eukaryotic succinate dehydrogenase complex is dissolved in the mitochondrial matrix.

Answer: FALSE
Page Ref: Section 3

62) In aerobic prokaryotes, the succinate dehydrogenase complex is embedded in the inner mitochondrial membrane.

Answer: FALSE
Page Ref: Section 3

63) Citric acid cycle components are dissolved in the cytosol for all prokaryotic and eukaryotic species.

Answer: FALSE
Page Ref: Section 3

64) All members of the aconitase family of proteins contain an iron sulfur cluster.

Answer: TRUE
Page Ref: Section 3

65) The a–ketoglutarate and succinate dehydrogenase complexes are the only oligomeric enzymes used in the citric acid cycle.

Answer: FALSE
Page Ref: Section 3

66) Malonate is a competitive inhibitor of the succinate dehydrogenase complex.

Answer: TRUE
Page Ref: Section 3

67) The recycling of NAD allows glycolysis to continue in the absence of oxygen.

Answer: TRUE
Page Ref: Section 4

68) The activity of dihydrolipoamide acetyltransferase (E_2) is inhibited when the concentration of of acetyl CoA is decreased.

Answer: FALSE
Page Ref: Section 5

69) The activity of dihydrolipoamide dehydrogenase (E_3) is inhibited by a high NADH/NAD^+ ratio.

Answer: TRUE
Page Ref: Section 5

70) Most bacteria do not have a complete citric acid cycle.

Answer: TRUE
Page Ref: Section 8

Please match the following reactions to their respective energy yielding products. Please note that a product may be used once, more than once, or not at all as an answer.

71) Isocitrate dehydrogenase
Page Ref: Section 4

72) a–ketoglutarate dehydrogenase complex
Page Ref: Section 4

73) Malate dehydrogenase
Page Ref: Section 4

74) Succinate dehydrogenase complex
Page Ref: Section 4

75) Succinyl CoA synthetase
Page Ref: Section 4

A) NADH

B) ADP

C) GTP or ATP

D) NADH

E) QH_2

F) NAD^+

71) D 72) A 73) D 74) E 75) C

Chapter 14 Electron Transport and Oxidative Phosphorylation

1) In the mitochondria NADH and QH_2 are essentially oxidized by ________ since it is the terminal electron acceptor.

A) carbon dioxide
B) hydrogen peroxide
C) ozone
D) oxygen

Answer: D
Page Ref: Introduction

2) The enzyme complexes associated with oxidative phosphorylation and the electron transport chain can be classified as ________ proteins.

A) integral membrane
B) peripheral membrane
C) lipid–anchored membrane
D) water–soluble
E) Both A and C

Answer: A
Page Ref: Section 2

3) Which of the following substances can freely pass through the inner mitochondrial matrix?

A) H^+
B) acetate
C) CO_2
D) ATP

Answer: C
Page Ref: Section 2

4) In the respiratory electron transport chain electrons are passed from ________.

A) NADH and QH_2 to O_2
B) O_2 to NAD^+ and Q
C) O_2 to NADH
D) ATP to O_2

Answer: A
Page Ref: Section 2

5) Compare the pH of the mitochondrial matrix and the inner membrane space.

A) The pH is lower in the matrix.

B) The pH in both regions is the same.

C) The pH is lower in the inner membrane space.

D) The comparison of pH varies from moment to moment depending on energy needs of the cell.

Answer: C
Page Ref: Section 2

6) The ________ is between the inner and outer membranes of the mitochondria.

A) matrix

B) intermembrane space

C) intracellular fluid

D) ATP synthase complex

Answer: B
Page Ref: Section 2

7) Oxidative phosphorylation requires all of the items listed below <u>except</u>

A) ATP synthase in the correct position in the membrane.

B) enzyme complexes embedded in a membrane.

C) the flow of electrons from NADH and QH_2 in the membrane.

D) a matrix more positively charged than the intermembrane space.

E) a terminal electron acceptor which is H_2O in mitochondria.

Answer: D
Page Ref: Section 2

8) ATP synthase is located in the ________ of the mitochondrion.

A) outer membrane

B) inner membrane

C) matrix

D) intermembrane space

Answer: B
Page Ref: Section 2

9) The inner membrane of mitochondria is permeable to ________, but not to ________.

A) protons; water

B) cations; anions

C) charged molecules; uncharged molecules

D) uncharged molecules; charged molecules

Answer: D
Page Ref: Section 2

10) Which of the following is mismatched?

A) outer mitochondrial membrane – permeable to ions and water

B) inner mitochondrial membrane – permeable to O_2 and CO_2

C) outer mitochondrial membrane – folded into cristae

D) inner mitochondrial membrane – location of ATP synthase

E) matrix – some ATP synthase subunits extend here

Answer: C
Page Ref: Section 2

11) The inner mitochondrial membrane contributes to the formation of a proton gradient mainly because it

A) contains ATP synthase complex.

B) is the location of specific transporter proteins.

C) is a barrier to protons.

D) is not rich in proteins.

E) is rich in proteins.

Answer: C
Page Ref: Section 2

12) The chemiosmotic theory is a concept that ________.

A) the transport of Na^+ and K^+ across cell membranes is by active transport

B) explains how transport by facilitated diffusion reaches a saturation limit

C) explains the blood–brain barrier

D) a proton gradient that drives the formation of ATP

Answer: D
Page Ref: Section 3

13) Which statement is true about two reactions that are coupled?

A) One reaction will normally not occur without the other.

B) One is always exergonic and the other is always endergonic.

C) Only oxidation–reduction reactions can be coupled.

D) Coupled reactions are always driven by the ATP to ADP conversion.

Answer: A
Page Ref: Section 3

14) In the presence of oxygen and in the absence of ADP, what occurs if the uncoupler 2,4–dinitrophenol is added to a suspension of normal mitochondria five minutes after an oxidizable substrate has been added?

A) The substrate will be oxidized until the addition of the 2,4–dinitrophenol, which blocks further oxidation.

B) There is no effect; oxidation of the substrate continues at the same rate before and after the addition of 2,4–dinitrophenol.

C) The substrate cannot be oxidized either with or without 2,4–dinitrophenol unless ADP is also present.

D) Oxidation of the substrate does not occur until the 2,4–dinitrophenol is added. Afterward, oxidation proceeds rapidly until all of the substrate is consumed.

Answer: D
Page Ref: Section 3

15) The protonmotive force is a result of ________.

A) the flow of electrons from the matrix to the inner membrane space

B) a combination of an electrical potential and a chemical potential

C) the flow of protons within the inner mitochondrial membrane

D) All of the above

Answer: B
Page Ref: Section 3

16) At one time the uncoupler 2,4–dinitrophenol was used as a weight reducing drug. Its side–effects, including death, resulted in its discontinued use. How could this drug cause weight loss?

A) The uncoupler allows the oxidation of fats from adipose tissue without the production of ATP. This allows the oxidation to proceed continuously and use up the fats.

B) The uncoupler causes ATP to be produced at a much higher rate than normal and this causes weight loss.

C) The uncoupler inhibits the transport of pyruvate into the matrix of the mitochondria. Fats are then degraded to glycerol and subsequently to pyruvate to provide the necessary energy. Thereby depleting fat stores.

D) The uncoupler is an allosteric activator of ATP synthase. This increases the rate of translocation of H^+ and the oxidation of fuels, including fats.

Answer: A
Page Ref: Section 3

17) For normal mitochondria in the presence of an oxidizable substrate and an uncoupler such as 2,4–dinitrophenol which do you expect?

A) oxygen consumption even in the absence of ADP

B) a rise in temperature to dissipate energy that would otherwise have been used to generate ATP

C) the flow of protons into the mitochondria matrix

D) All of the above

E) None of the above

Answer: D
Page Ref: Section 3

18) If the difference in pH across a membrane is 0.60 and the membrane potential is –0.10 V, about what percent of the Gibbs free energy change, $\triangle G$, is from the pH difference at 37 ^{o}C? (R = 8.315 J K^{-1} mol^{-1}; F = 96,485 J V^{-1} mol^{-1})

A) 15% B) 27% C) 73% D) 85%

Answer: B
Page Ref: Section 3

19) What is the Gibbs free energy change, $\triangle G$, across a membrane with a pH difference of 0.50 and a membrane potential of –0.10 V at 310 K? (R = 8.315 J K^{-1} mol^{-1}; F = 96,485 J V^{-1} mol^{-1})

A) –6.85 kJ mol^{-1} B) –12.6 kJ mol^{-1}
C) 38.6 kJ mol^{-1} D) 57.9 kJ mol^{-1}

Answer: B
Page Ref: Section 3

20) The chemiosmotic theory explains

A) the phosphorylation of ADP.

B) the electron transport chain.

C) the differences between inner and outer mitochondrial membranes.

D) the source of energy for formation of mitochondrial ATP.

E) aerobic respiration.

Answer: D
Page Ref: Section 3

21) What feature of cytochromes makes them valuable in electron transport systems?

A) aspartate residues in the active site B) the porphyrin ring
C) the multiple α–helices D) the iron ion

Answer: D
Page Ref: Section 4

22) Which has the highest reduction potential?

A) NADH B) complex I C) complex II D) O_2

Answer: D
Page Ref: Section 4

23) To reduce one molecule of O_2, ________ electron(s) must be passed through the electron transport chain and ________ molecule(s) of NADH is(are) oxidized.

A) 4; 2 B) 2; 1 C) 1; 1 D) 1; 2 E) 4; 4

Answer: A
Page Ref: Section 4

24) In a series of oxidation–reduction agents, the ________ (strongest, weakest) reducing agent has the ________ (highest, lowest) reduction potential.

A) strongest; highest B) strongest; lowest
C) weakest; highest D) weakest; lowest

Answer: B
Page Ref: Section 4

25) A lipid–soluble cofactor that can diffuse freely in the membrane of the electron transport chain and carry electrons across the membrane is ________.

A) ubiquinone (Q) B) Fe–S
C) cytochrome *c* D) $FADH_2$

Answer: A
Page Ref: Section 4

26) Iron sulfur clusters (Fs–S) that can accept or donate one electron are found in which complexes of the electron transport chain?

A) I B) II and III C) I, II and III D) I, II, III and IV

Answer: C
Page Ref: Section 4

27) Which is a component of complex I?

A) FAD B) FMN C) Q D) TPP

Answer: B
Page Ref: Section 5

28) What is the role of FMN in complex I?

A) Converts a two–electron transfer to a one–electron transfer.

B) Converts a one–electron transfer to a two–electron transfer.

C) Transports four H^+ across the membrane.

D) None, there is no FMN in complex I.

Answer: A
Page Ref: Section 5

29) How many protons are translocated across the membrane by complex I for every pair of electrons that are passed from NADH to QH_2?

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

Answer: D
Page Ref: Section 5

30) Which complex in the electron transport chain does <u>not</u> contribute to the proton gradient?

A) I B) II C) III D) IV E) V

Answer: B
Page Ref: Section 6

31) Which is <u>not</u> a component of complex II?

A) Fe–S clusters

B) FAD

C) heme

D) cytochrome *b*

E) All of the above are components of complex II.

Answer: D
Page Ref: Section 6

32) The ultimate electron acceptor from complex II is ________.

A) Q

B) QH_2

C) cytochrome *c*

D) O_2

E) FMN

Answer: A
Page Ref: Section 6

33) Which best describe the structure of complex II?

A) An L–shaped structure that spans the membrane and partially extends into the mitochondrial matrix.

B) A structure firmly anchored to the membrane by many a–helices that span the lipid–bilayer.

C) Three identical multisubunit enzymes that associate to form a mushroom–shaped structure.

D) Has a core structure of three conserved subunits, one of which forms a b–barrel on the exterior surface of the membrane.

Answer: C
Page Ref: Section 6

34) Complex II in the electron transport chain supplies electrons as ________ to the rest of the chain (complexes III and IV).

A) $FADH_2$ B) Fe–S C) succinate D) QH_2

Answer: D
Page Ref: Section 6

35) The terminal electron acceptor for complex III of the electron transport chain is ________.

A) Q B) Fe–S C) FAD D) cytochrome *c*

Answer: D
Page Ref: Section 7

36) How many protons are translocated across the inner mitochondrial membrane by complex III for each pair of electrons passing through the electron transport chain?

A) 0 B) 1 C) 2 D) 4

Answer: D
Page Ref: Section 7

37) During the Q–cycle ________ molecule(s) of QH_2 is(are) oxidized and ________ molecule(s) of Q is(are) produced.

A) 1; 1 B) 1; 2 C) 2; 1 D) 2; 2

Answer: C
Page Ref: Section 7

38) Which complex in the electron transport chain carries electrons from cytochrome *c* to molecular oxygen, reducing it to water?

A) I B) II C) III D) IV E) V

Answer: D
Page Ref: Section 8

39) Which statement is false about complex IV?

A) A binuclear center that contains an iron ion and heme–a_3 is the site of the reduction of molecular oxygen to water.

B) Bacterial and eukaryotic forms of complex IV have very similar structures and number of subunits per functional unit.

C) The core structure of the cytochrome *c* oxidase in complex IV has three conserved subunits.

D) Copper ions shift from a +2 oxidation state to a +1 oxidation state as electrons are passed through the complex.

Answer: B
Page Ref: Section 8

40) How many protons are translocated across the inner mitochondrial membrane by complex IV for every pair of electrons passing through the electron transport chain?

A) 0 B) 1 C) 2 D) 3 E) 4

Answer: C
Page Ref: Section 8

41) The synthesis of one molecule of ATP from ADP requires ________ to be translocated across the inner mitochondrial membrane.

A) one proton
B) three protons
C) hundreds of protons
D) 1 mole of protons

Answer: B
Page Ref: Section 9

42) Rotation of the ________ subunit of ATP synthase causes conformational changes in the catalytic sites that produce ATP.

A) a B) b C) c D) e E) g

Answer: E
Page Ref: Section 9

43) Heat can be generated in the brown adipose tissue of hibernating mammals due to ________.

A) increased ATP production by ATP synthase

B) uncoupling by thermogenin

C) a greater pH gradient across the inner mitochondrial membrane by complex IV

D) insufficient NADH production during the citric acid cycle due to less active pyruvate translocase.

Answer: B
Page Ref: Section 9

44) Which component of ATP synthase is the site of the proton channel?

A) F_0 B) F_1 C) F_2 D) b subunit E) g subunit

Answer: A
Page Ref: Section 9

45) Which statement is not true about the transport of ATP across the inner mitochondrial membrane on its way to the cytosol?

A) It is accomplished by adenine nucleotide translocase.

B) The same enzyme that transports ATP also transport ADP in the opposite direction.

C) It is complexed with Mg^{2+} to reduce the draw on the electrical part of the protonmotive force.

D) The transport causes the loss of a net charge of –1 in the matrix.

Answer: C
Page Ref: Section 10

46) The P/O ratio for passing electrons through complexes I, III and IV is ________.

A) 1 B) 1.5 C) 2 D) 2.5 E) 3

Answer: D
Page Ref: Section 11

47) The oxidation–reduction cofactor in the multisubunit enzyme fumarate reductase in *E. coli* which has the greatest reduction potential is

A) FAD.

B) iron clusters.

C) ubiquinone.

D) menaquinone.

E) NADH.

Answer: D
Page Ref: Section 13

48) The oxidizing agent in the enzyme superoxide dismutase is

A) superoxide anion ($\cdot O_2^-$).

B) H_2O_2.

C) Copper.

D) O_2.

E) All of the above

Answer: C
Page Ref: Section 14

49) Superoxide dismutase protects cells from damage caused by ________.

A) $\cdot O_2^-$ B) O_3^{2-} C) H_2O_2 D) H_3O^+

Answer: A
Page Ref: Section 14

50) In bacteria, oxidative phosphorylation occurs in the mitochondrial membrane.

Answer: FALSE
Page Ref: Introduction

51) Electron transport chains occur only in the inner mitochondrial membrane of animal cells or the plasma membrane of bacteria.

Answer: FALSE
Page Ref: Introduction

52) In mammals the enzyme complexes of oxidative phosphorylation are in the inner mitochondrial matrix.

Answer: FALSE
Page Ref: Section 2

53) Mitochondria are about the size of an *E. coli* cell.

Answer: TRUE
Page Ref: Section 2

54) The number of mitochondria per cell is relatively constant among cell types and species.

Answer: FALSE
Page Ref: Section 2

55) Oxidative phosphorylation occurs in the mitochondrial membrane in eukaryotes and the plasma membrane in bacteria.

Answer: TRUE
Page Ref: Section 2

56) The numbers of mitochondria in cells is closely associated with cell function.

Answer: TRUE
Page Ref: Section 2

57) The inner mitochondrial membrane is permeable to water but the outer membrane is not.

Answer: FALSE
Page Ref: Section 2

58) White muscle cells contain fewer mitochondria than red muscle cells, so they rely on anaerobic glycolysis for energy needs.

Answer: TRUE
Page Ref: Section 2

59) A muscle cell from an alligator jaw contains more mitochondria than a wing muscle of a migrating bird such as a goose.

Answer: FALSE
Page Ref: Section 2

60) Most of the free energy needed to drive ATP formation in the mitochondria is the result of an electrical contribution from a charge gradient across the inner mitochondrial membrane.

Answer: TRUE
Page Ref: Section 3

61) The protonmotive force is the free energy due to the proton gradient across the inner mitochondrial membrane.

Answer: TRUE
Page Ref: Section 3

62) If an inhibitor disrupts the flow of protons from the matrix into the intermembrane space of mitochondria, no ATP will be formed.

Answer: TRUE
Page Ref: Section 3

63) In the presence of an uncoupler, more substrate can be oxidized.

Answer: TRUE
Page Ref: Section 3

64) Mitochondrial electron transport and ATP formation are interdependent.

Answer: TRUE
Page Ref: Section 3

65) The chemiosmotic theory explains that the energy for driving ATP formation in mitochondria comes from a proton concentration gradient.

Answer: TRUE
Page Ref: Section 3

66) The source of energy to produce ATP in mitochondria is a proton gradient formed across the outer mitochondrial membrane.

Answer: FALSE
Page Ref: Section 3

67) ATP directly provides the energy to transport protons across the inner membrane from the matrix to the inner–membrane space of mitochondria.

Answer: FALSE
Page Ref: Section 3

68) The enzyme complexes I–IV in the electron transport chain associate with each other by a combination of hydrophobic interactions, disulfide bridges and hydrogen bonding.

Answer: FALSE
Page Ref: Section 4

69) The reduction potential of Complex I is lower than that of Complex III.

Answer: TRUE
Page Ref: Section 4

70) Complex I contains a porin protein subunit that transports H^+ across the inner mitochondrial membrane.

Answer: FALSE
Page Ref: Section 5

71) Complex II participates in both the electron transport chain and the citric acid cycle.

Answer: TRUE
Page Ref: Section 6

72) The P/O ratio is independent of whether electrons originate from complex I or complex II.

Answer: FALSE
Page Ref: Section 11

73) NADH and QH_2 for oxidative phosphorylation are produced only through the citric acid cycle under aerobic conditions.

Answer: FALSE
Page Ref: Section 12

74) Menaquinone has greater reduction potential than FAD.

Answer: TRUE
Page Ref: Section 13

75) *E. coli* can use electron carriers to grow aerobically or anaerobically.

Answer: TRUE
Page Ref: Section 13

76) Fumarate reductase essentially catalyzes the reverse reaction catalyzed by the succinate dehydrogenase.

Answer: TRUE
Page Ref: Section 13

77) Both fumarate reductase and succinate dehydrogenase can function at the same time in *E. coli*.

Answer: FALSE
Page Ref: Section 13

78) Electron flow to oxidize electron carriers does not occur in anaerobic organisms.

Answer: FALSE
Page Ref: Section 13

79) An obligate anaerobe cannot grow in the presence of oxygen.

Answer: TRUE
Page Ref: Section 14

80) The presence of superoxide dismutase(SOD) in mammalian cells can be harmful or beneficial, depending on the location.

Answer: TRUE
Page Ref: Section 14

81) White blood cells in mammals can produce toxic superoxide ions to kill bacterial cells.

Answer: TRUE
Page Ref: Section 14

82) Bacteria with superoxide dismutase (SOD) can usually grow anaerobically.

Answer: FALSE
Page Ref: Section 14

Chapter 15 Photosynthesis

1) Two interdependent processes which comprise photosynthesis are (1) the formation of carbohydrates from CO_2 and (2) the formation of ________.

A) ADP B) ATP C) NAD^+ D) NADPH E) B and D

Answer: E
Page Ref: Introduction

2) The photosynthetic dark reactions ________.

A) occur only in the dark (nocturnal)
B) are the main source of ATP in photosynthesis
C) convert carbon dioxide to carbohydrates
D) produce the reduced coenzyme NADH

Answer: C
Page Ref: Introduction

3) The formation of ATP is a/an ________ reaction in plants.

A) dark
B) light independent
C) light dependent
D) anaerobic
E) carbon fixation

Answer: C
Page Ref: Introduction

4) The region of the chlorophyll molecule that helps anchor it in the membrane is the

A) Mg^{2+} ion.
B) chlorin ring.
C) phytol side chain.
D) tetrapyrrole ring.
E) All of the above

Answer: C
Page Ref: Section 1

5) The main difference between photosynthesis and respiratory electron transport is

A) the tetrapyrolle ring of the pigments involved.

B) the coenzymes that carry electrons.

C) the sources of electrons.

D) the formation of ATP.

Answer: B
Page Ref: Section 1

6) Carotenoids, phycobilins, xanthophylls and chlorophyll molecules (that are not in the special pair) ________.

A) can transfer light energy to chlorophylls

B) can absorb light energy

C) may prevent the formation of reactive superoxide anion

D) A, B and C

E) A and B only

Answer: D
Page Ref: Section 1

7) Which term is not used for a photosystem or a part of a photosystem?

A) PS I

B) PS II

C) special pair

D) light complexes

E) antenna pigments

Answer: D
Page Ref: Section 1

8) Plant pigments which can absorb light include

A) chlorophyll *a*.

B) chlorophyll *b*.

C) carotenoids and phycobilins.

D) All of the above

E) A and B only

Answer: D
Page Ref: Section 1

9) In the Z scheme describing electron flow in photosynthesis, the electron donor to P680 is ________, while the electron donor to P700 is ________.

A) H_2O; plastocyanin

B) plastocyanin; H_2O

C) O_2; plastocyanin

D) plastocyanin; O_2

E) O_2; H_2O

Answer: A
Page Ref: Section 2

10) Photosynthesis by green sulfur bacteria and cyanobacteria are different because green sulfur bacteria ________.

A) have only cyclic photosynthesis

B) use photosystem I, but not photosystem II

C) use both photosystems I and II

D) use cytochromes

Answer: B
Page Ref: Section 2

11) Cyanobacteria have evolved photosynthetic features not found in green sulfur bacteria. These include

A) cytochrome *bc.*

B) synthesis of NADH.

C) electron acceptor P700.

D) an oxygen-evolving complex.

E) All of the above

Answer: D
Page Ref: Section 2

12) The source of electrons for green sulfur bacteria is ________, and the source of electrons for cyanobacteria is ________.

A) NADPH; NAD^+

B) H_2S; H_2O

C) H_2O; H_2S

D) cytochrome *c*; cytochrome *bf*

Answer: B
Page Ref: Section 2

13) What is the correct sequence for the following components in photosynthesis as described by the Z scheme?

A) NADPH → P700 → P700* → cytochrome *bf* complex → P680 → P680* → water

B) Water → P700 → P700* → cytochrome *bf* complex → P680* → P680 → NADPH

C) Water → P680 → P680* → cytochrome *bf* complex → P700 → P700* → NADPH

D) Water → P700 → P700* → cytochrome *bf* complex → P680 → P680* → NADPH

E) NADPH → P680 → P680* → cytochrome *bf* complex → P700 → P700* → water

Answer: C
Page Ref: Section 2

14) The production of O_2 from water supplies an electron first for

A) photosystem I.

B) photosystem II.

C) cytochrome *bf* complex.

D) plastocyanin.

Answer: B
Page Ref: Section 2

15) Electron carriers between activated P680* and P700 photosystems include

A) plastoquinones.

B) pheophytin.

C) ferredoxin and iron – sulfur clusters.

D) All of the above

E) A and B

Answer: E
Page Ref: Section 2

16) The site of light–dependent reactions in the chloroplast is

A) the stroma.

B) the thylakoids.

C) the outer membrane.

D) the lumen.

E) All of the above

Answer: B
Page Ref: Section 3

17) Which statement is false about bacteriorhodopsin?

A) It occurs in archaebacteria.

B) A molecule of retinal inside bacteriorhodopsin converts from the *trans* to the *cis* configuration when light is absorbed.

C) It creates a light–induced proton gradient across a membrane.

D) Its activity is coupled to PSI and PSII.

Answer: D
Page Ref: Section 3

18) Within the chloroplast, grana are ________.

A) stacks of enfolded thylakoid membrane

B) the stroma

C) stromal lamellae

D) the site of carbon fixation reactions

Answer: A
Page Ref: Section 3

19) In plants, light energy channeled to PSII and PSI drives electron transport through a series of electron carriers. At the same time, protons are translocated into the ________.

A) stroma

B) lumen

C) granum

D) plasma membrane

Answer: B
Page Ref: Section 3

20) Which statement is false about the photosynthesis in plants?

A) PSII is not directly exposed to the stroma.

B) PSI produces ferredoxin.

C) ATP is synthesized in the lumen.

D) PQH_2 can diffuse within the thylakoid membrane.

Answer: C
Page Ref: Section 4

21) Which statement is false about ferredoxin?

A) It is produced by PSII.

B) It is formed in the stroma.

C) It participates in the reduction of $NADP^+$.

D) It can serve as an electron donor to cytochrome *bf*.

Answer: A
Page Ref: Section 4

22) Which is <u>not</u> a name for the reactions of the Calvin cycle?

A) proton translocation cycle
B) reductive pentose phosphate cycle
C) C_3 pathway
D) dark reactions

Answer: A
Page Ref: Section 4

23) Which molecule is the CO_2 acceptor in the first step of the Calvin cycle?

A) rubisco
B) ribulose 1,5–*bis*phosphate
C) 3–phosphoglycerate
D) glyceraldehyde–3–phosphate

Answer: B
Page Ref: Section 4

24) Which is <u>not</u> required to activate rubisco?

A) CO_2

B) Mg^{2+}

C) light

D) $NADP^+$

E) All of the above are required

Answer: D
Page Ref: Section 4

25) Which enzyme is <u>not</u> part of the Calvin cycle?

A) triose phosphate isomerase
B) rubisco
C) plastocyanin
D) transketolase

Answer: C
Page Ref: Section 4

26) Which is the correct order for the stages of the Calvin cycle?

A) Carboxylation → Reduction → Regeneration

B) Regeneration → Carboxylation → Reduction

C) Carboxylation → Regeneration → Reduction

D) Reduction → Carboxylation → Regeneration

Answer: A
Page Ref: Section 4

27) What is the product of the reaction catalyzed by rubisco in the Calvin cycle?

A) dihydroxyacetone phosphate

B) 3–phosphoglycerate

C) ribose 5–phosphate

D) fructose 6–phosphate

Answer: B
Page Ref: Section 4

28) How many ATP molecules are required for the fixation of one CO_2 molecule via the Calvin cycle to a triose phosphate?

A) 1

B) 2

C) 3

D) 4

Answer: C
Page Ref: Section 4

29) The Calvin cycle occurs in the ________ of plant chloroplasts and in the ________ of bacteria.

A) lumen; plasma membrane

B) stroma; cytosol

C) granal lamellae; cytosol

D) stroma; plasma membrane

E) lumen; cytosol

Answer: B
Page Ref: Section 4

30) Attempts to genetically modify rubisco to help increase food production might include trying to ________.

A) enhance the carboxylation reaction and suppress the oxygenation reaction

B) suppress the carboxylation reaction and enhance the oxygenation reaction

C) decrease the value of k_{cat} by site–directed mutagenesis

D) increase rubisco's activity in the dark

Answer: A
Page Ref: Section 4

31) Photorespiration in plants involves the ________.

A) fixation of carbon dioxide to a four-carbon acid

B) light-dependent uptake of O_2 catalyzed by rubisco, followed by the release of CO_2

C) reduction of surface-exposed disulfides in the regulation of rubisco

D) exclusive fixation of carbon dioxide at night by plants such as cacti

Answer: B
Page Ref: Section 4

32) The reaction catalyzed by which enzyme in the Calvin cycle is <u>unlikely</u> to be a regulatory step?

A) phosphoglycerate kinase
B) triose phosphate isomerase
C) phosphoribokinase
D) rubisco

Answer: B
Page Ref: Section 4

33) Which is <u>not</u> a substance produced from the carbon dioxide assimilated via the Calvin cycle?

A) cellulose
B) starch
C) sucrose
D) chitin

Answer: D
Page Ref: Section 5

34) The synthesis of sucrose in plants occurs in the ________.

A) cytoplasm
B) chloroplast
C) vacuole
D) lumen

Answer: A
Page Ref: Section 5

35) Which is the proper order of substrates in the synthesis of starch?

A) glucose 1-phosphate → glucose 6-phosphate → ADP-glucose → starch

B) glucose 1-phosphate → fructose 6-phosphate → UDP-fructose → starch

C) glucose 3-phosphate → glucose 1-phosphate → ADP-glucose → starch

D) glucose 6-phosphate → glucose 1-phosphate → ADP-glucose → starch

Answer: D
Page Ref: Section 5

36) Which statement is true about starch?

A) It is synthesized during daylight and consumed at night.

B) Its synthesis occurs at a fairly continuous rate both day and night.

C) Its synthesis is inhibited by high concentrations of 3–phosphoglycerate.

D) Starch can be hydrolyzed by amylase to produce triose phosphates.

E) A and D

Answer: A
Page Ref: Section 5

37) Which is <u>not</u> an intermediate in the biosynthesis of sucrose in plants?

A) ADP–glucose
B) glucose 6–phosphate
C) fructose 6–phosphate
D) fructose 1,6–*bis*phosphate

Answer: A
Page Ref: Section 5

38) What is the main advantage for plants that use the C4 pathway in addition to the Calvin cycle for the fixation of carbon dioxide?

A) Fewer ATP are consumed to produce carbohydrates using the C4 pathway as opposed to the Calvin cycle.

B) The C4 pathway allows for fixation of carbon dioxide at night.

C) The C4 pathway aids in the avoidance of the oxygenation of ribulose 1,5–*bis*phosphate.

D) The C4 cycle allows photosynthesis to occur at a wide range of wavelengths of light.

Answer: C
Page Ref: Section 6

39) The initial carbon dioxide acceptor of the C4 pathway is ________.

A) phosphoenolpyruvate
B) oxaloacetate
C) ribulose 1,5–*bis*phosphate
D) PEP carboxylase

Answer: A
Page Ref: Section 6

40) The initial reactions of the C4 pathway occur in the ________.

A) chloroplast stroma
B) mesophyll cells
C) bundle sheath cell cytosol
D) stomata plasma membrane

Answer: B
Page Ref: Section 6

41) On a hot summer day which would you expect about the ratio of oxygenation versus carboxylation of ribulose 1,5–*bis*phosphate in C_3 plants as compared to a cooler day?

A) No change because oxygenation does not occur in C_3 plants.

B) The ratio is not affected by temperature.

C) The ratio rises due to increased rate of oxygenation.

D) The ratio decreases due to decreased rate of oxygenation.

Answer: C
Page Ref: Section 6

42) Which statement is false about C_4 plants?

A) They tend to grow at high temperatures and high light intensities.

B) They decrease the ratio of CO_2 to O_2 in cells where Rubisco is active.

C) Corn is an example of a C_4 plant.

D) They avoid wasteful photorespiration by means of secondary pathways for carbon dioxide fixation.

Answer: B
Page Ref: Section 6

43) The reactions that allow plants such as cacti and orchids to assimilate carbon at night are referred to as ________.

A) the Calvin cycle
B) nocturnal photorespiration
C) the C_4 pathway
D) Crassulacean acid metabolism

Answer: D
Page Ref: Section 6

44) In cacti ________ accumulates in the cell vacuoles at night that is released in the day and decarboxylated.

A) phosphoenolpyruvate
B) malate
C) oxaloacetate
D) bicarbonate ion

Answer: B
Page Ref: Section 6

45) The nocturnal fixation of carbon dioxide in cacti helps ________.

A) stimulate photorespiration

B) minimize use of ATP

C) minimize water loss

D) transport CO_2 to the bundle sheath cells

Answer: C
Page Ref: Section 6

46) Solar energy is captured in chemical form as ATP and NADPH by the process of photosynthesis.

Answer: TRUE
Page Ref: Introduction

47) The light reactions of photosynthesis form carbohydrates from ATP, NADPH, H^+ and CO_2.

Answer: FALSE
Page Ref: Introduction

48) Dark reactions of photosynthesis must occur in the absence of light.

Answer: FALSE
Page Ref: Introduction

49) The only plant pigments responsible for light harvesting are chlorophylls.

Answer: FALSE
Page Ref: Section 1

50) Chlorophyll molecules contain hydrophilic regions containing bonds for light-absorbing and hydrophobic regions anchoring them to membranes.

Answer: TRUE
Page Ref: Section 1

51) Phycoerythrin and β-carotene absorb light in ranges broader than that absorbed by chlorophylls, and this light energy is ultimately used by the plant for photosynthesis.

Answer: TRUE
Page Ref: Section 1

52) Although a variety of pigments absorb light, only the special pair of chlorophyll molecules at photosystems I and II can become activated and thereby provide electrons for transport.

Answer: TRUE
Page Ref: Section 1

53) All photosynthetic bacteria give off O_2 as an end–product of photosynthesis.

Answer: FALSE
Page Ref: Section 2

54) The cytochrome *bf* complex connects the electron flow from photosystem I (PSI) to photosystem II (PSII) according to the Z scheme describing electron flow in photosynthesis.

Answer: FALSE
Page Ref: Section 2

55) Vitamin K is part of the electron chain in photosystem II.

Answer: FALSE
Page Ref: Section 2

56) The light–dependent reactions are located in the thylakoid membrane of chloroplasts, while the dark reactions are located within the lumen.

Answer: FALSE
Page Ref: Section 3

57) The translocation of protons across the thylakoid membrane creates a proton motive force necessary for ATP synthesis.

Answer: TRUE
Page Ref: Section 3

58) In plants the light–harvesting complex (LHCII) completely surrounds PSII.

Answer: TRUE
Page Ref: Section 3

59) Photosystems I and II are located in the same region of the chloroplast structure, since both contain chlorophyll.

Answer: FALSE
Page Ref: Section 3

60) Rubisco often makes up to 50% of the soluble protein in plant leaves.

Answer: TRUE
Page Ref: Section 4

61) The structure of Rubisco is nearly identical in all phototrophs. All known forms of Rubisco have the same number of subunits.

Answer: FALSE
Page Ref: Section 4

62) The compound 2–carboxyarabinitol 1–phosphate is present in plants only at night and is a strong activator of rubisco.

Answer: FALSE
Page Ref: Section 4

63) Most plants contain a rubisco enzyme that catalyzes only a carboxylation reaction in the fixation of carbon dioxide.

Answer: FALSE
Page Ref: Section 4

64) Photorespiration is a vital plant pathway that provides energy for cellular metabolism.

Answer: FALSE
Page Ref: Section 4

65) The C_4 pathway helps increase the concentration of carbon dioxide in the bundle sheath cells. This is important because the cell walls of these cells are impermeable to gases.

Answer: TRUE
Page Ref: Section 6

66) The CAM pathway and the Calvin cycle generally occur simultaneously in plants during the daytime.

Answer: FALSE
Page Ref: Section 6

67) In Crassulacean Acid Metabolism (CAM) acetate accumulated at night supplies CO_2 for carbon assimilation during the day.

Answer: FALSE
Page Ref: Section 6

68) Both the C_4 and CAM carbon–assimilation pathways use bicarbonate ions to convert phosphoenolpyruvate to oxaloacetate.

Answer: TRUE
Page Ref: Section 6

69) In terrestrial plants diffusion of carbon dioxide into plant leaves is controlled by the stomata.

Answer: TRUE
Page Ref: Section 6

70) The round(R) and wrinkled(r) peas studied by Gregor Mendel differ in the gene for starch branching enzyme.

Answer: TRUE
Page Ref: Section 6

Chapter 16 Lipid Metabolism

1) Why are triacylglycerols able to provide more energy than carbohydrates (gram for gram)?

A) The triacylglycerols have an extremely high group transfer potential.

B) The carbohydrates are already in a more oxidized state than the triacylglycerols.

C) The carbohydrates contain fewer carbon–carbon bonds.

D) The triacylglycerols are less soluble in water than the carbohydrates.

Answer: B
Page Ref: Introduction

2) Which of the following is a true statement for fatty acid synthesis?

A) It occurs in the mitochondria.

B) The reducing power for synthesis is supplied by NAD^+ and ubiquinone.

C) Both A and B

D) None of the above

Answer: D
Page Ref: Section 1

3) Which of the following is not a stage of fatty acid synthesis?

A) condensation of precursors
B) rearrangement
C) reduction
D) dehydration

Answer: B
Page Ref: Section 1

4) The elongation of fatty acids is a repetition of three reactions adding carbons from ________ after each cycle until completion.

A) malonyl CoA
B) malonyl ACP
C) acetyl CoA
D) acetyl ACP

Answer: B
Page Ref: Section 1

5) Fatty acid synthesis is different in bacteria than in eukaryotic cells because ________.

A) bacteria do not form malonyl CoA

B) eukaryotes use acetyl CoA to form malonyl CoA

C) bacteria do not form acetyl ACP

D) bacteria do not form acetoacetyl CoA

Answer: C
Page Ref: Section 1

6) Which of the following is the regulated step of fatty acid synthesis in eukaryotes?

A) carboxylation of acetyl CoA

B) transportation of mitochondrial acetyl CoA into the cytosol

C) assembly of the fatty acid chain

D) All of the above

Answer: A
Page Ref: Section 1

7) The first step in fatty acid synthesis is the formation of ________ from acetyl CoA and carbon dioxide.

A) acetyl ACP
B) acetoacetyl ACP
C) malonyl CoA
D) acetoacetyl CoA

Answer: C
Page Ref: Section 1

8) Which of the following is true for carboxylation of acetyl CoA?

A) In animals and yeast, it requires three separate protein subunits.

B) It is a metabolically reversible reaction.

C) In bacteria, it is catalyzed by a bifunctional enzyme.

D) The regulatory enzyme is acetyl–CoA carboxylase.

Answer: D
Page Ref: Section 1

9) The reaction, Palmitoyl–ACP→Palmitate + HS–ACP proceeds via which of the following enzymes?

A) thioesterase
B) ketoacyl–ACP synthase
C) transacylase
D) None of the above

Answer: A
Page Ref: Section 1

10) Linoleate is an essential fatty acid in mammalian diets because mammalian cells ________.

A) synthesize it from arachidonate

B) do not use this acid for biosynthesis

C) can use it to synthesize eicosanoids

D) do not have a desaturase that acts beyond the carbon–9 position

Answer: D
Page Ref: Section 1

11) Phosphatidate is an intermediate in the synthesis of ________.

A) triacylglycerols and glycerophospholipids

B) glycerophospholipids only

C) sphingolipids

D) cholesterol

Answer: A
Page Ref: Section 2

12) The cyclooxygenase–hydroperoxidase pathway is a precursor for each of the following except

A) thromboxane A2.

B) prostacyclin.

C) prostaglandins.

D) epinephrine.

Answer: D
Page Ref: Section 3

13) Eicosanoids are not like hormones in that they

A) can alter blood flow.

B) act in the area where they are formed.

C) can mediate inflammation and swelling.

D) are chemically diverse.

Answer: B
Page Ref: Section 3

14) Properties of aspirin may include

A) inhibition of COX activity.

B) increased production of prostaglandins.

C) Both A and B

D) None of the above

Answer: A
Page Ref: Section 3

15) All of the following occur during synthesis of ether lipids except

A) esterification of an acyl group from fatty acyl CoA to dihydroxyacetone phosphate.

B) displacement of the fatty acid of 1–acyldihydroxyacetone phosphate by a fatty alcohol.

C) oxidation of the keto group of 1–acyldihydroxyacetone by NADPH.

D) esterification of 1–alkylglycero–3–phosphate to produce 1–alkyl–2–acylglycero–3–phosphate.

Answer: C
Page Ref: Section 4

16) Which sphingolipid is a precursor for all other types of sphingolipids?

A) sphingomyelin
B) cerebroside
C) ganglioside
D) ceramide

Answer: D
Page Ref: Section 5

17) Lysosomal storage diseases occur when mutations cause defects in ________.

A) sphingolipid biosynthesis enzymes
B) sphingolipid degradation enzymes
C) lysosome formation
D) formation of N–acetylgalactosamine derivatives

Answer: B
Page Ref: Section 5

18) Which of the following is a true statement, concerning HMG–CoA reductase?

A) It is regulated by covalent modification of a serine in its active site.
B) It catalyzes the first committed step in cholesterol biosynthesis.
C) It causes the production of NADPH.
D) The product of the reaction it catalyzes is acetoacetyl CoA.

Answer: B
Page Ref: Section 6

19) Cholesterol is a precursor for each of the following, except

A) bile salts.
B) vitamin D.
C) testosterone.
D) vitamin C.

Answer: D
Page Ref: Section 6

20) Drugs called statins lower cholesterol levels because they ________.

A) degrade HMG–CoA reductase
B) bind serum cholesterol
C) inhibit HMG–CoA reductase
D) bind bile salts

Answer: C
Page Ref: Section 6

21) Which of the following is mis–matched?

A) bile salts – intestinal absorption of lipids

B) b–estradiol – sex characteristics

C) cholesterol – membrane fluidity

D) squalene – lipid vitamin

Answer: D
Page Ref: Section 6

22) Isopentenyl pyrophosphate is the precursor for which of the following?

A) terpenes

B) vitamin K

C) quinones

D) All of the above

E) None of the above

Answer: D
Page Ref: Section 6

23) Which lipid form is transported across the inner mitochondrial membrane before β–oxidation?

A) acylcarnitine

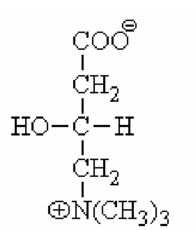
B) fatty acyl CoA

C) acetoacetyl CoA

D) lysophospholipid CoA

Answer: A
Page Ref: Section 7

24) What structure is shown below and what is its main function?



A) coenzyme A; activation of fatty acids before β–oxidation

B) carnitine; transport of fatty acyl CoA into the mitochondrial matrix

C) taurocholate; one of the bile salts

D) acetoacetate; synthesis of fatty acids

Answer: B
Page Ref: Section 7

25) Fatty acids are oxidized in the ________.

A) mitochondrial matrix
B) cytosol
C) endoplasmic reticulum
D) mitochondrial inner membrane space

Answer: A
Page Ref: Section 7

26) There are four steps in the β–oxidation pathway. Some reaction types are listed below. Give the proper reaction types in the order that they occur in the β–oxidation pathway.

1. condensation
2. oxidation
3. reduction
4. thiolysis
5. hydration
6. phosphorylation
7. rearrangement

A) 1,7,2,2
B) 6,3,4,2
C) 1,2,3,5
D) 2,5,2,4

Answer: D
Page Ref: Section 7

27) Which of the following is a true statement for fatty acid oxidation?

A) It occurs in the cytosol.
B) Oxidation requires a three carbon substrate, which transfers a two–carbon unit to the chain.
C) Both NADH and QH_2 are produced.
D) None of the above

Answer: C
Page Ref: Section 7

28) If the carbonyl carbon of a fatty acyl CoA molecule with a C_{10} chain is labeled with ^{14}C, how many rounds of β–oxidation are required to produce a radioactively labeled acetyl CoA?

A) one
B) two
C) four
D) five

Answer: A
Page Ref: Section 7

29) How many cycles of β–oxidation are required to completely process a saturated C_{18} fatty acid?

A) 6
B) 8
C) 9
D) 18

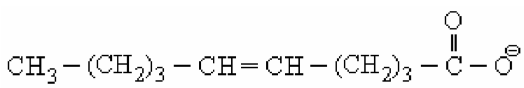
Answer: B
Page Ref: Section 7

30) Which enzyme is needed for the oxidation of odd–chain saturated fatty acids that is not needed for even–chain fatty acids?

A) methylmalonyl–CoA mutase
B) propionyl–CoA carboxylase
C) methylmalonyl–CoA racemase
D) All of the above

Answer: D
Page Ref: Section 7

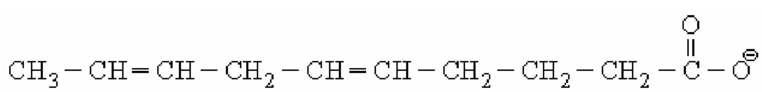
31) To oxidize the fatty acid molecule shown below, what enzyme(s) are needed in addition to the enzymes needed for β–oxidation?



A) enoyl–CoA isomerase only
B) 2,4–dienoyl–CoA reductase only
C) both enoyl–CoA isomerase and 2,4–dienoyl–CoA reductase
D) No additional enzymes are needed besides the normal ones for β–oxidation.

Answer: A
Page Ref: Section 7

32) To oxidize the fatty acid molecule shown below, what enzyme(s) is(are) needed in addition to the enzymes needed for β–oxidation?



A) enoyl–CoA isomerase only
B) 2,4–dienoyl–CoA reductase only
C) both enoyl–CoA isomerase and 2,4–dienoyl–CoA reductase
D) No additional enzymes are needed besides the normal ones for β–oxidation.

Answer: C
Page Ref: Section 7

33) The conversion of the fatty acid palmitate (C_{16}) to carbon dioxide via β–oxidation, the citric acid cycle and oxidative phosphorylation yield approximately ________ ATP equivalents.

A) 3
B) 32
C) 106
D) 800

Answer: C
Page Ref: Section 7

34) How many QH_2 and NADH are produced by one round of the β–oxidation pathway?

A) 1 each

B) 1 QH_2 and 2 NADH

C) 2 each

D) 2 QH_2 and 1 NADH

Answer: A
Page Ref: Section 7

35) Which enzyme requires adenosylcobalamin as a cofactor?

A) carnitine acyl transferase I

B) methylmalonyl–CoA mutase

C) enoyl–CoA hydratase

D) propionyl–CoA carboxylase

Answer: B
Page Ref: Section 7

36) What is the main function of the carnitine shuttle system?

A) To transport fatty acids into the mitochondrion.

B) To transport newly synthesized sphingolipids to the blood.

C) To carry cholesterol from its site of synthesis in the endoplasmic reticulum to the plasma membrane.

D) To aid in the assembly of chylomicrons.

Answer: A
Page Ref: Section 7

37) Which statement is false about polyunsaturated fatty acids?

A) They have both odd–numbered and even–numbered double bonds.

B) Their synthesis is more energy–efficient than the synthesis of saturated fatty acids.

C) Some double bonds are rearranged during their degradation.

D) They require D^3, D^2–enoyl–CoA isomerase for their oxidation.

Answer: B
Page Ref: Section 7

38) Phosphatidylcholine synthesis occurs in the ________.

A) endoplasmic reticulum of eukaryotic cells

B) Golgi apparatus

C) mitochondrion

D) plasma membrane

Answer: A
Page Ref: Section 8

39) Why is poor plasmalogen synthesis potentially fatal?

A) The nervous system is affected because plasmalogens are important constituents of the myelin sheath.

B) The mitochondria will not function properly due to lack of plasmalogen produced cardiolipin.

C) Poor nutrient absorption will occur in the small intestine where plasmalogens aid with the absorption of lipid–soluble vitamins and other hydrophobic substances.

D) Protein synthesis is affected due to the inability of plasmalogens binding ribosomes to the endoplasmic reticulum.

Answer: A
Page Ref: Section 8

40) Elevated levels of the hormone ________ stimulate the conversion of triacylglycerols stored in adipose cells to free fatty acids and monoacylglycerols to provide energy when carbohydrate stores are depleted.

A) insulin B) glucagon C) epinephrine D) ergosterol

Answer: C
Page Ref: Section 9

41) Each of the following is a principle hormonal regulator of fatty acid metabolism, except

A) glucagon. B) adrenaline. C) insulin. D) epinephrine.

Answer: B
Page Ref: Section 9

42) During the fed state, which of the following occur(s)?

A) insulin inhibition of the hydrolysis of stored triacylglycerols

B) insulin stimulation of malonyl CoA formation

C) allosteric inhibition of carnitine acyltransferase I

D) All of the above

Answer: D
Page Ref: Section 9

43) What is the fate of most glycerol that is released during the hydrolysis of triacylglycerols from adipocytes?

A) It is transported to the kidneys and excreted in the urine.

B) It is used in the synthesis of sphingolipids.

C) It is converted to glucose via gluconeogenesis in the liver.

D) It is absorbed by the chylomicrons.

Answer: C
Page Ref: Section 9

44) Which of the following does (do) not occur during the fasting state?

A) increased insulin levels

B) inhibition of lipolysis

C) an increase in the concentration of albumin–bound fatty acids in the blood

D) A and B only

E) All of the above

Answer: D
Page Ref: Section 9

45) Regulation of acetyl CoA–carboxylase is accomplished by

A) inhibition by fatty acyl CoA.

B) activation by citrate (*in vitro*).

C) inactivation by high levels of glycagon.

D) All of the above

Answer: D
Page Ref: Section 9

46) Why is it undesirable to have high concentrations of free fatty acids in cells?

A) They are unstable, free radicals that can react to form toxic substances.

B) They polymerize easily and can cause the cytosol to become too gel–like.

C) They are amphipathic and act as detergents that can degrade membranes.

D) They inhibit the uptake of pyruvate by mitochondria.

Answer: C
Page Ref: Section 10

47) The main function of the bile salts is to ________.

A) transport lipids to the intestinal wall

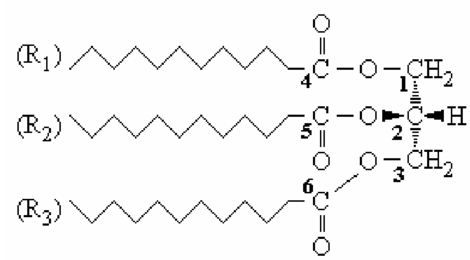
B) act as counterions for the ionized forms of lipids

C) cleave the ester bonds in triacylglycerols to release free fatty acids

D) form the surface layer of chylomicrons

Answer: A
Page Ref: Section 10

48) Which bonds of the triacylglycerol shown are hydrolyzed by pancreatic lipase?



A) The carbon–carbon bonds between atoms 1,2 and 3.

B) The ester bond at carbon 2 only.

C) The bonds between the carbonyl carbons 4 and 6 and the first carbon of the hydrocarbon chains.

D) The ester bonds at carbons 1 and 3 only.

Answer: D
Page Ref: Section 10

49) What is the major role of phospholipase A_2?

A) To cleave the phosphate group from phospholipids.

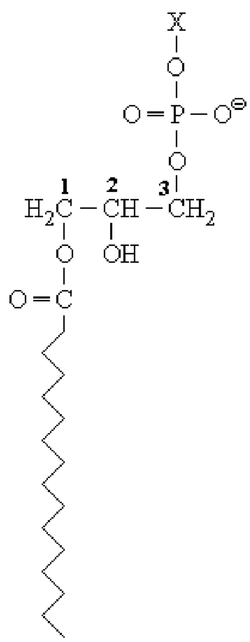
B) To phosphorylate the enzyme enoyl–CoA.

C) To hydrolyze an ester bond in glycerophospholipids to form lysophosphoglyceride.

D) To transport glycerophospholipids in the blood.

Answer: C
Page Ref: Section 10

50) The structure shown below is ________.



A) taurocholate

B) glycerophospholipid

C) carnitine

D) lysophosphoglyceride

Answer: D
Page Ref: Section 10

51) Which dietary lipid usually contains no ester bonds?

A) cholesterol

B) triacylglycerides

C) glycerophospholipids

D) None of the above, all dietary lipids are esterified

Answer: A
Page Ref: Section 10

52) The largest lipoproteins are the ________.

A) chylomicrons

B) VLDLs

C) LDLs

D) HDLs

Answer: A
Page Ref: Section 10

53) Which do you expect to have the highest protein content by percent?

A) VLDLs

B) ILDs

C) HDLs

D) All of the lipids above have about the same protein content.

Answer: C
Page Ref: Section 10

54) A patient is found to have a high concentration of cholesterol in the blood and deposits of cholesterol under the skin. The patient is diagnosed with familial hypercholesterolemia. What is the likely cause of this condition?

A) A deficiency in insulin production by the pancreas.

B) Insufficient chylomicron concentration in the blood.

C) Overproduction of lysosomal lipases.

D) Lack of LDL receptors on the surfaces of nonhepatic cells.

Answer: D
Page Ref: Section 10

55) Which is <u>not</u> a ketone body?

A) dihydroxyacetone

B) acetoacetate

C) acetone

D) β–hydroxybutyrate

Answer: A
Page Ref: Section 11

56) Non–insulin–dependent diabetes mellitus (NIDDM) is characterized by ________.

A) insulin secretion that is always at levels well below normal

B) insufficient insulin levels initiated during gestational diabetes

C) a shortage of insulin receptors that leads to accumulation of blood glucose

D) an inherited genetic abnormality in the insulin gene that yields a much less active insulin

Answer: C
Page Ref: Section 11

57) Triacylglycerols are more efficient to store than carbohydrates because their hydrophobicity allows them to be stored in adipose cells without large amounts of bound water molecules.

Answer: TRUE
Page Ref: Introduction

58) In adult mammals fatty acid synthesis largely occurs in the cytosol of liver cells and adipocytes.

Answer: TRUE
Page Ref: Section 1

59) A biotin–dependent enzyme is responsible for catalyzing the carboxylation of acetyl CoA.

Answer: TRUE
Page Ref: Section 1

60) Animals use a type I fatty acid synthesis system (FAS I) while bacteria use a type II fatty acid synthesis system (FAS II).

Answer: TRUE
Page Ref: Section 1

61) In eukaryotes the enzyme complex called fatty acid synthase is responsible for the assembly of the fatty acid chain.

Answer: TRUE
Page Ref: Section 1

62) Double bonds positioned farther than nine carbons from the carboxyl end of fatty acids occur only in vertebrates.

Answer: FALSE
Page Ref: Section 1

63) In mammals the oxidation of fatty acids produces a two–carbon product and the synthesis of fatty acids begins with a two–carbon substrate.

Answer: FALSE
Page Ref: Sections 1,7

64) S–adenosylmethionine methylates phosphatidylethanolamine to form phosphatidylcholine.

Answer: TRUE
Page Ref: Section 2

65) CoA derivatives are the active thioesters in fatty acid oxidation.

Answer: TRUE
Page Ref: Section 7

66) The enzyme for b–oxidation is trifunctional with a_2b_2 tertiary structure.

Answer: TRUE
Page Ref: Section 7

67) An increase in glucagon levels activates the enzyme which catalyzes malonyl CoA synthesis in the liver.

Answer: FALSE
Page Ref: Section 9

68) Most of the lipids in the diets of mammals are free fatty acids.

Answer: FALSE
Page Ref: Section 10

69) The bile salts taurocholate and glycocholate are amphipathic derivatives of cholesterol.

Answer: TRUE
Page Ref: Section 10

70) High levels of VLDLs have been found to have a protective effect against atherosclerosis.

Answer: FALSE
Page Ref: Section 10

71) Snake venom can cause the lysis of red blood cells due to the presence of phospholipase A_2.

Answer: TRUE
Page Ref: Section 10

72) Chylomicrons are found in high concentrations in the blood only during fasting when lipids from adipose tissue are mobilized.

Answer: FALSE
Page Ref: Section 10

73) Ketone bodies are normally broken down in the liver in preparation for excretion.

Answer: FALSE
Page Ref: Section 11

74) Cytosolic HMG–CoA is used for ketone body synthesis.

Answer: FALSE
Page Ref: Section 11

75) During starvation ketone bodies can take the place of glucose as a fuel for brain cells.

Answer: TRUE
Page Ref: Section 11

Chapter 17 Amino Acid Metabolism

1) Ammonia is incorporated into amino acids via which of the following?

A) glutamate
B) glutamine
C) carbamoyl phosphate
D) All of the above

Answer: D
Page Ref: Section 1

2) Industrially, nitrogen for use in fertilizers is converted to ammonia by ________.

A) a simple, energy efficient reaction of N_2 with water

B) a cryogenic (very low temperature) process between N_2 and H_2

C) special catalysts which drive the reduction of N_2 by H_2

D) a reaction between nitric acid and hydrogen gas

Answer: C
Page Ref: Section 1

3) Nitrogen fixation may occur via all of the following bacteria, except

A) *Azobacter*.
B) *Klebsiella*.
C) cyanobacteria.
D) *E. coli.*

Answer: D
Page Ref: Section 1

4) Microorganisms capable of fixing nitrogen into a form usable by animals obtain the energy for this process from ________.

A) lightning
B) oxidation and reduction (respiration)
C) photosynthesis of host plants
D) soil nutrients

Answer: C
Page Ref: Section 1

5) Nitrogenases

A) are protected from oxygen to prevent inactivation.

B) consist of two protein components.

C) contain an electron transport system.

D) A and B only

E) All of the above

Answer: E
Page Ref: Section 1

6) At neutral pH, the main ionic form of ammonia is ________.

A) N_2

B) NH_4^+

C) NH_3

D) NH_2^-

E) None of the above

Answer: B
Page Ref: Section 2

7) Glutamate dehydrogenase has different roles in different organisms. Which of these listed is mismatched?

A) *E. coli* (bacterium) – generates NH_4^+ + glutamate

B) *N. crassa* (fungus) – aminates a–ketoglutarate

C) mammals – degradation of amino acids and release of NH_4^+

D) mammals – formation of glutamate

Answer: D
Page Ref: Section 2

8) Physiological roles for glutamate dehydrogenase include all of the following, except

A) the generation of glutamate when NH_4^+ is present at high concentrations in *E. coli.*

B) the conversion of glutamate to glutamine in most organisms.

C) the use of an NADPH–dependent enzyme for reductive amination in *Neurospora crassa.*

D) the degradation of amino acids and generation of NH_4^+ in mammals.

Answer: B
Page Ref: Section 2

9) Which of the following is/are true statement(s) about glutamine?

A) It is a nitrogen donor in many biosynthetic reactions.

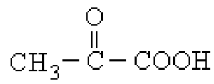
B) It is a nitrogen source for glutamate synthase.

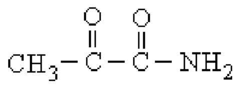
C) It carries nitrogen and carbon between tissues, thus avoiding high toxic levels of NH_4^+ in blood.

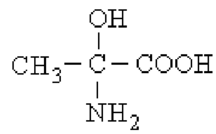
D) All of the above

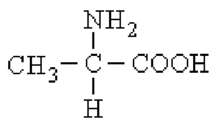
Answer: D
Page Ref: Section 2

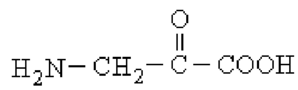
10) What would be the product of the transamination of the structure shown below? (The unionized forms are shown.)



I. 

II. 

III. 

IV. 

A) I B) II C) III D) IV

Answer: C
Page Ref: Section 2

11) Which of the following is/are true concerning transanimation reactions?

A) They can convert a–keto acids to a–amino acids.

B) All require the coenzyme pyridoxal phosphate.

C) The catalyzed reactions are near–equilibrium.

D) All of the above

Answer: D
Page Ref: Section 2

12) Transamination reactions require which coenzyme?

A) PLP B) TPP C) ATP D) FMN

Answer: A
Page Ref: Section 2

13) Which of the following is an amide–containing amino acid?

A) alanine B) arginine C) aspartate D) asparagine

Answer: D
Page Ref: Section 3

14) Which of the following amino acids is/are derived from 3–phosphoglycerate?

A) serine
B) glycine
C) cysteine
D) All of the above

Answer: D
Page Ref: Section 3

15) a–ketoglutarate is a precursor for each of the following, except

A) glutamine.
B) arginine.
C) proline.
D) glycine.

Answer: D
Page Ref: Section 3

16) An amino acid formed by transamination of a citric acid cycle intermediate is ________.

A) aspartate
B) cysteine
C) serine
D) alanine

Answer: A
Page Ref: Section 3

17) Because they lack aspartate kinase and aspartate semialdehyde dehydrogenase, ________ cannot synthesize lysine, methionine or threonine.

A) bacteria
B) fungi
C) tobacco plants
D) mammals

Answer: D
Page Ref: Section 3

18) A key precursor in the synthesis of aromatic amino acids (tryptophan, tyrosine and phenylalanine) is ________.

A) prephenate
B) chorismate
C) 4–hydroxyphenylpyruvate
D) indole

Answer: B
Page Ref: Section 3

19) Aspartate is the precursor for which of the following amino acids?

A) lysine
B) threonine
C) methionine
D) All of the above

Answer: D
Page Ref: Section 3

20) Which is not part of the synthesis reactions for histidine?

A) phosphoribosyl pyrophosphate (PRPP)

B) glutamine

C) imidazole glycerol phosphate

D) indole glycerol phosphate

E) None of the above

Answer: D
Page Ref: Section 3

21) Glycine is a precursor for all of the following except

A) cytidine.

B) creatine phosphate.

C) porphobilinogen.

D) bile salts.

E) glyoxylate.

Answer: A
Page Ref: Section 4

22) Nitric oxide is produced from which reaction?

A) arginine to citrulline

B) glutamate to α–ketoglutarate

C) bicarbonate to carbamoyl phosphate

D) tryptophan to acetyl CoA

Answer: A
Page Ref: Section 4

23) Nitric oxide is formed from arginine. It is a messenger molecule with several functions that include all below except

A) macrophage activation.

B) reacting with superoxide anions to form more toxic substances.

C) constricting red blood cells.

D) neurotransmitter in the brain.

Answer: C
Page Ref: Section 4

24) The changes that occur in cells that lead to its death are called ________.

A) cellular necroptosis

B) programmed lysis

C) apoptosis

D) morpholytic degradation

Answer: C
Page Ref: Section 5

25) The proteases responsible for cell death are called ________. They cleave on the carboxyl side of ________ residues.

A) caspases; aspartate
B) typsins; lysine and arginine
C) carnitines; cysteine
D) ureases; uridine

Answer: A
Page Ref: Section 5

26) Which statement is <u>false</u> about protein turnover?

A) The turnover rate is directly proportional to the stability of the protein's tertiary structure.
B) Rapid turnover ensures that some regulatory proteins are degraded so that the cell can respond to changing conditions.
C) The half–life of a given protein is similar in different organs and species.
D) Turnover rates vary to give half–lives from a few minutes to several weeks.

Answer: A
Page Ref: Section 5

27) Which type of protein might have a very short half–life and be specifically targeted for degradation?

A) transport protein
B) mutated (abnormal protein)
C) ribosomal protein
D) hormone protein

Answer: B
Page Ref: Section 5

28) If an amino acid is glucogenic, it will <u>not</u> be degraded to ________.

A) pyruvate
B) glutamate
C) fumarate
D) acetoacetate

Answer: D
Page Ref: Section 6

29) The degradation of arginine, histidine and proline all lead to the product ________.

A) pyruvate
B) acetyl CoA
C) acetoacetate
D) glutamate

Answer: D
Page Ref: Section 6

30) The degradation of which amino acid requires the coenzyme tetrahydrofolate?

A) histidine
B) serine
C) leucine
D) alanine

Answer: A
Page Ref: Section 6

31) Defects in which of the following may result in elevated levels of phenylalanine?

A) deficiencies in dihydropteridine reductase

B) deficiencies in 4a–carbinolamine dehydratase

C) defects in the biosynthesis of tetrahydrobiopterin

D) All of the above

Answer: D
Page Ref: Section 6

32) In amino acid catabolism the α–amino groups are initially released as ________.

A) nitrous oxide
B) ammonium ion
C) nitrate ion
D) glutamine

Answer: B
Page Ref: Section 6

33) What type of reaction is shown below?

Amino acid + α–Ketoglutarate $\leftrightharpoons$ α–Keto acid + Glutamate

A) reductive amination
B) oxidation
C) transamination
D) hydrolysis

Answer: C
Page Ref: Section 6

34) Which is <u>not</u> produced from the degradation of branched–chain amino acids?

A) succinyl CoA
B) acetyl CoA
C) malonyl CoA
D) propionyl CoA

Answer: C
Page Ref: Section 6

35) Phenylketonuria (PKU) is a disease caused by a defect in ________ formation.

A) phenylalanine
B) a–ketoglutarate
C) tyrosine
D) urea

Answer: C
Page Ref: Section 6

36) Phenylalanine hydroxylase requires molecular ________ and tetrahydrobiopterin.

A) hydrogen
B) nitrogen
C) water
D) oxygen

Answer: D
Page Ref: Section 6

37) Which disease is caused by a defect in ornithine transaminase activity?

A) alcaptonuria

B) gyrate atrophy

C) cystinuria

D) maple syrup urine disease

E) nonketotic hyperglycinemia

Answer: B
Page Ref: Section 6

38) Which amino acids are purely ketogenic?

A) arginine and lysine

B) valine and isoleucine

C) tryptophan only

D) lysine and leucine

E) all essential amino acids

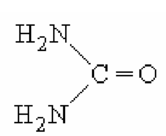
Answer: D
Page Ref: Section 6

39) Which type of organisms can eliminate excess nitrogen by the direct excretion of ammonia?

A) mammals B) birds C) fish D) reptiles

Answer: C
Page Ref: Section 7

40) The structure shown below is ________.



A) urea B) uridine C) uric acid D) carbodiamine

Answer: A
Page Ref: Section 7

41) Which statement(s) apply to urea?

A) highly soluble in water

B) produced in the liver

C) major solute in urine of mammals

D) compound used as a means of removing excess nitrogen

E) All of the above

Answer: E
Page Ref: Section 7

42) The carbon in urea originates from ________.

A) aspartate B) ornithine C) bicarbonate D) ATP

Answer: C
Page Ref: Section 7

43) ________ is hydrolytically cleaved to directly yield urea in the urea cycle.

A) Ornithine

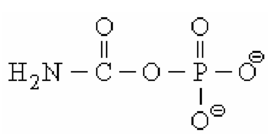
B) Glutamate

C) Arginine

D) Carbamoyl phosphate

Answer: C
Page Ref: Section 7

44) The enzyme ________ is one of the most abundant in liver mitochondria and catalyzes the synthesis of the molecule shown below.



A) arginase

B) carbamoyl phosphate synthetase I

C) 4a–carbinolamine dehydratase

D) transaminase

Answer: B
Page Ref: Section 7

45) In mammals, ureogenesis occurs almost exclusively in the ________.

A) liver

B) kidney

C) pancreas

D) lining of the small intestine

Answer: A
Page Ref: Section 7

46) Carbamoyl phosphate synthetase

A) is an essential precursor in pyrimidine biosynthesis.

B) catalyzes the synthesis of carbamoyl phosphate from bicarbonate and glutamine.

C) is one of the most abundant enzymes in liver mitochondria.

D) A and B only

E) All of the above

Answer: E
Page Ref: Section 7

47) How many ATP are consumed in the conversion of bicarbonate to carbamoyl phosphate?

A) one B) two C) three D) none

Answer: B
Page Ref: Section 7

48) In the urea cycle the nitrogen atoms originate from ________.

A) α–ketoglutarate B) ornithine

C) lysine D) aspartate

Answer: D
Page Ref: Section 7

49) At the subcellular level where does the urea cycle occur?

A) mitochondrial matrix only

B) mitochondrial matrix and the mitochondrial inner membrane

C) mitochondrial matrix and the cytosol

D) cytosol only

Answer: C
Page Ref: Section 7

50) In the urea cycle which molecule is transported from the mitochondrial matrix to the cytosol as ornithine is transported in the opposite direction?

A) arginine B) citrulline C) glutamate D) carnitine

Answer: B
Page Ref: Section 7

51) In mammals, most amino acids undergo deamination in the ________.

A) liver

B) kidney

C) pancreas

D) mitochondria of all cell types

Answer: A
Page Ref: Section 7

52) The glucose–alanine cycle provides ________.

A) an alternate site for production of urea in the kidney

B) transport of important enzymes for gluconeogenesis

C) an indirect means for muscle to eliminate nitrogen and replenish its energy supply

D) a cycle for the direct synthesis of carbohydrates in muscle

Answer: C
Page Ref: Section 7

53) A patient is experiencing uncontrolled diabetes mellitus with an overproduction of β–hydroxybutyric acid. Which statement is false?

A) The patient will exhale extra amounts of carbon dioxide.

B) Glutamine will be catabolized to reform lost bicarbonate ion.

C) The basic amino acids, lysine and arginine, neutralize the β–hydroxybutyric acid in the blood.

D) The anion of β–hydroxybutyric acid will be excreted in the urine.

Answer: C
Page Ref: Section 8

54) The essential amino acids are those that mammals cannot synthesize, but must obtain from the diet.

Answer: TRUE
Page Ref: Introduction

55) A large percentage of nitrogen, undergoing metabolism, comes from nitrogen fixation.

Answer: FALSE
Page Ref: Section 1

56) Nitrogenase catalyzes the reduction of N_2 to nitrate.

Answer: FALSE
Page Ref: Section 1

57) Virtually all of the nitrogen used in metabolism comes directly from nitrogen fixation.

Answer: FALSE
Page Ref: Section 1

58) Most green plants contain both nitrate reductase and nitrite reductase to reduce nitrogen oxides to ammonia.

Answer: TRUE
Page Ref: Section 1

59) In animals glutamate synthase is essential for the production of glutamate.

Answer: FALSE
Page Ref: Section 2

60) Oxaloacetate is the amino–group acceptor in the synthesis of aspartate.

Answer: TRUE
Page Ref: Section 3

61) Chorismate is a key branch–point intermediate in aromatic amino acid synthesis.

Answer: TRUE
Page Ref: Section 3

62) Tryptophan synthase's a subunit catalyzes the cleavage of indole glycerol phosphate to glyceralde 3–phosphate and indole.

Answer: TRUE
Page Ref: Section 3

63) Nitric oxide is a very reactive compound. In vivo it reacts with oxygen and water to form nitrates and nitrites within seconds.

Answer: TRUE
Page Ref: Section 4

64) Nitric oxide functions as a neurotransmitter in the brain.

Answer: TRUE
Page Ref: Section 4

65) Only growing and reproducing cells require a continuous supply of amino acids for the synthesis of new protein molecules.

Answer: FALSE
Page Ref: Section 5

66) Protein turnover of regulatory proteins helps cells to quickly respond to changing conditions.

Answer: TRUE
Page Ref: Section 5

67) During the catabolism of amino acids, the carbon skeleton is first degraded, followed by the removal of the amino group.

Answer: FALSE
Page Ref: Section 6

68) Amino acids that are degraded to pyruvate or citric acid cycle intermediates are called ketogenic.

Answer: FALSE
Page Ref: Section 6

69) All 20 common amino acids are metabolized through the citric acid cycle by first being converted to either pyruvate or acetyl CoA.

Answer: FALSE
Page Ref: Section 6

70) The amino acids tyrosine and tryptophan are both ketogenic and glucogenic.

Answer: TRUE
Page Ref: Section 6

71) The disease alcaptonuria is caused by a defect in the kidney transport of cysteine.

Answer: FALSE
Page Ref: Section 6

72) Most animals and plants can tolerate moderately high cellular concentrations of ammonia; however, unusable excess is generally eliminated via the urea cycle.

Answer: FALSE
Page Ref: Section 7

73) Periportal cells of the liver are nearest to the inflow of blood and have a higher capacity for urea synthesis than the perivenous cells that are near the outflow.

Answer: TRUE
Page Ref: Section 7

Chapter 18 Nucleotide Metabolism

1) Which are purines?

A) adenine and thymine
B) guanine and adenine
C) cytosine and thymine
D) uracil and guanine

Answer: B
Page Ref: Section 1

2) A ribose sugar is added to ________ rings <u>after</u> their synthesis and to ________ rings <u>during</u> their synthesis.

A) purine; pyrimidine
B) pyrimidine; purine
C) purine; purine
D) pyrimidine; pyrimidine

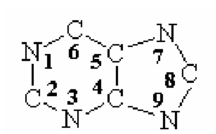
Answer: B
Page Ref: Section 1

3) The first nucleotide product in the de novo biosynthetic pathway of purines is

A) AMP.
B) GMP.
C) IMP.
D) XMP.

Answer: C
Page Ref: Section 1

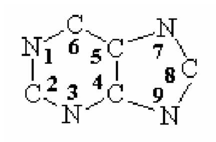
4) The purine ring system is shown below. What is the source of the nitrogen atoms 3 and 9 during the de novo biosynthesis of purines?



A) aspartate
B) glycine
C) arginine
D) glutamine

Answer: D
Page Ref: Section 1

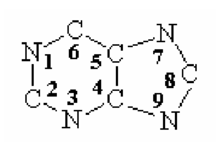
5) The purine ring system is shown below. What is the source of the carbon atoms 2 and 8 during de novo biosynthesis of purines?



A) carbon dioxide
B) aspartate
C) 10–formyltetrahydrofolate
D) glutamine

Answer: C
Page Ref: Section 1

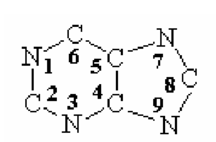
6) The purine ring system is shown below. What is the source of the atoms 5 and 7 during de novo biosynthesis of purines?



A) glycine
B) glutamine
C) aspartate
D) arginine

Answer: A
Page Ref: Section 1

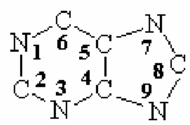
7) The purine ring system is shown below. What is the source of the N–1 atom during de novo biosynthesis of purines?



A) glycine
B) glutamine
C) aspartate
D) arginine

Answer: C
Page Ref: Section 1

8) The purine ring system is shown below. What is the source of the C–6 atom during de novo biosynthesis of purines?



A) carbon dioxide
B) tetrahydrofolate
C) carbamoyl phosphate
D) glycine

Answer: A
Page Ref: Section 1

9) Which amino acid is not directly involved in the de novo biosynthesis of purines?

A) glycine
B) glutamine
C) aspartate
D) arginine

Answer: D
Page Ref: Section 1

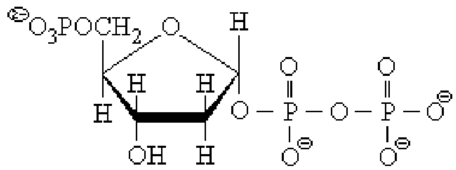
10) Which is the source of the ribose ring in purine nucleotides?

A) ATP
B) AMP
C) PRPP
D) cGDP

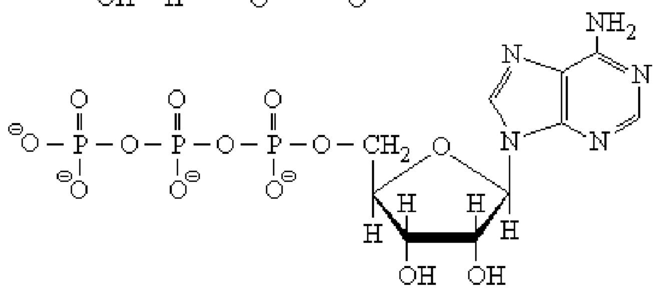
Answer: C
Page Ref: Section 1

11) Which structure below is PRPP?

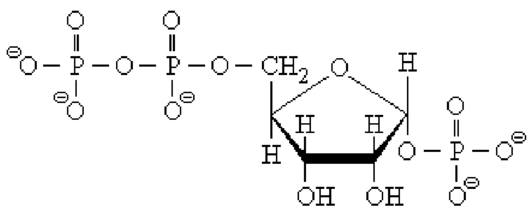
I.



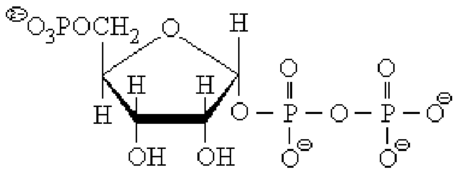
II.



III.



IV.



A) I
B) II
C) III
D) IV

Answer: D
Page Ref: Section 1

12) The first step in the de novo biosynthesis of IMP is a reaction between glutamine and PRPP. Which statement is <u>not</u> true about this reaction?

A) An amine group is attached to the anomeric carbon atom of the ribose ring.

B) The configuration of the anomeric carbon atom is inverted from β to α.

C) A pyrophosphate is lost from PRPP.

D) The reaction is catalyzed by glutamine–PRPP aminotransferase.

Answer: B
Page Ref: Section 1

13) Four of the ten enzymes required for the biosynthesis of IMP are listed below. In which order do the reactions these enzymes catalyze occur during the synthesis of IMP?

1. IMP cyclohydrolase
2. GAR synthase
3. glutamine-PRPP amidotransferase
4. AIR carboxylase

A) $1 \rightarrow 2 \rightarrow 3 \rightarrow 4$
B) $4 \rightarrow 3 \rightarrow 2 \rightarrow 1$
C) $3 \rightarrow 2 \rightarrow 4 \rightarrow 1$
D) $2 \rightarrow 3 \rightarrow 4 \rightarrow 1$

Answer: C
Page Ref: Section 1

14) Which is a common precursor in the de novo synthesis of purine nucleotides?

A) inosine 5'-monophosphate
B) xanthosine monophosphate
C) orotate
D) adenylosuccinate

Answer: A
Page Ref: Section 2

15) ________ is a precursor for the de novo synthesis of AMP and GMP.

A) OMP
B) XMP
C) Adenylosuccinate
D) IMP

Answer: D
Page Ref: Section 2

16) Which enzyme catalyzes the step in purine nucleotide biosynthesis that is the principal site of regulation for the pathway?

A) adenylsuccinate lyase
B) OPM decarboxylase
C) IMP cyclohydrolase
D) glutamine-PRPP amidotransferase

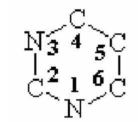
Answer: D
Page Ref: Section 2

17) Which is a method by which the synthesis of AMP or GMP is regulated?

A) covalent modification
B) feedback inhibition
C) feed-forward activation
D) competitive inhibition

Answer: B
Page Ref: Section 2

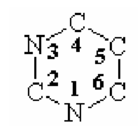
18) The pyrimidine ring system is shown below. What is the source of the N–3 during the de novo biosynthesis of pyrimidines?



A) ammonia B) glutamine C) arginine D) urea

Answer: B
Page Ref: Section 3

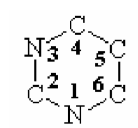
19) The pyrimidine ring system is shown below. What is the source of the C–2 during the de novo biosynthesis of pyrimidines?



A) aspartate B) PRPP
C) bicarbonate D) tetrahydrofolate

Answer: C
Page Ref: Section 3

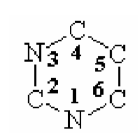
20) The pyrimidine ring system is shown below. What is the source of the N–1 during the de novo biosynthesis of pyrimidines?



A) aspartate B) urea C) asparagine D) IMP

Answer: A
Page Ref: Section 3

21) The pyrimidine ring system is shown below. What is the source of the carbons 4,5 and 6 during the de novo biosynthesis of pyrimidines?



A) glutamine B) aspartate
C) 3 bicarbonate ions D) pyruvate

Answer: B
Page Ref: Section 3

22) Inhibition of ATCase by a ________ nucleotide and activation of ATCase by a ________ nucleotide keep the balance of purine and pyrimidine pools in *E. coli*.

A) purine (ATP); purine (ATP)
B) pyrimidine; pyrimidine
C) pyrimidine; purine (ATP)
D) purine (ATP); pyrimidine

Answer: C
Page Ref: Section 3

23) Which is not a direct precursor of pyrimidines in their de novo biosynthesis?

A) HCO_3^-
B) glutamine
C) glycine
D) aspartate

Answer: C
Page Ref: Section 3

24) Which is the precursor of all pyrimidine ribo– and deoxyribonucleotides?

A) dTMP
B) CTP
C) IMP
D) UMP

Answer: D
Page Ref: Section 3

25) Which catalytic site is <u>not</u> contained in the eukaryotic multifunctional protein dihydroorotate synthase?

A) orotate phosphoribosyltransferase
B) ATCase
C) carbamoyl phosphate synthetase II
D) dihydroorotase

Answer: A
Page Ref: Section 3

26) Carbamoyl phosphate synthetase I is located in the ________ in eukaryotes and uses ________ as a nitrogen source.

A) mitochondria; glutamine
B) mitochondria; ammonia
C) cytosol; glutamine
D) cytosol; ammonia

Answer: B
Page Ref: Section 3

27) The conversion of UTP to CTP involves ________.

A) hydrolysis of a phosphate group
B) oxidation of an OH group
C) transfer of an NH_2 group
D) formation of a carbon–carbon double bond

Answer: C
Page Ref: Section 4

28) High levels of ________ will almost totally inhibit ATCase.

A) CTP
B) ATP
C) CTP and UTP
D) ADP and UDP

Answer: C
Page Ref: Section 4

29) Which is the correct order for the synthesis of CTP?

A) UMP → UDP→ UTP → CTP
B) GMP → GDP→ GTP → CTP
C) UTP → TTP→ CTP
D) UMP → CMP→ CDP → CTP

Answer: A
Page Ref: Section 4

30) Substrates for reduction to form deoxyribonucleotides are

A) mononucleotides.
B) dinucleotides.
C) trinucleotides.
D) B and C
E) All of the above

Answer: D
Page Ref: Section 5

31) The ribonucleotides that are reduced to deoxyribonucleotides in most organisms are ________.

A) nucleosides
B) mononucleotides
C) dinucleotides
D) trinucleotides

Answer: C
Page Ref: Section 5

32) Which type of enzymes catalyze the phosphorylation of dADP, dGDP and dCDP?

A) nucleotide phosphorylases
B) nucleoside diphosphate kinases
C) triphosphatases
D) deoxyribosylphosphatases

Answer: B
Page Ref: Section 5

33) The reduction of ribonucleotides by ribonucleotide reductase requires the formation of a/an ________.

A) covalent intermediate
B) free radical protein
C) intermediate methyl group
D) acid–base catalyst

Answer: B
Page Ref: Section 5

34) The source of the hydrogen to form water during the reduction of nucleoside triphosphates is ________.

A) thioredoxin
B) NADP
C) NADH
D) NADPH
E) $FADH_2$

Answer: D
Page Ref: Section 5

35) Eukaryotic cells maintain the correct balance of deoxyribonucleotides needed in a species DNA by ________.

A) controlling the activity of ribonucleotide reductase
B) controlling the specificity of ribonucleotide reductase
C) controlling both the specificity and activity of ribonucleotide reductase at the same time
D) feedback inhibition
E) controlling the balance of NADPH formed

Answer: C
Page Ref: Section 5

36) dUTP is not a direct precursor of dTTP because ________.

A) there are no enzymes for this reaction
B) dUTP controls DNA synthesis
C) it could possibly be incorporated into DNA
D) All of the above

Answer: C
Page Ref: Section 6

37) What is unusual about the reaction catalyzed by ribonucleotide reductase?

A) It involves the conversion of –SH groups to –OH groups.

B) It uses a rare derivative of tetrahydrofolate.

C) It has a free radical mechanism.

D) This enzyme and its reaction occur only in a few species of archaebacteria.

Answer: C
Page Ref: Section 6

38) The one–carbon group needed to convert dUMP into dTMP is derived from

A) methanol.

B) 5,10–methylenetetrahydrofolate.

C) glycine.

D) serine.

E) biotin.

Answer: B
Page Ref: Section 6

39) DNA synthesis is often measured by using radioactive

A) biotin.

B) thymine.

C) thiamine.

D) thymidine.

E) All of the above

Answer: D
Page Ref: Section 6

40) Which is the correct order for the synthesis of dTMP?

A) dUDP → dUTP→ dTTP → dTDP→ dTMP

B) UMP → UDP→ dUDP → dUMP→ dTMP

C) UMP → TMP→ dTMP

D) UMP → dUMP→ dTMP

Answer: B
Page Ref: Section 6

41) Dihydrofolate reductase and thymidylate synthetase are major targets for anticancer drugs because

A) these enzymes are unique in cancer cells.

B) cancer cell grow rapidly and are very dependent upon the activities of these enzymes.

C) they donate one–carbon groups.

D) cancer cells lack sufficient amounts of these enzymes.

E) All of the above

Answer: B
Page Ref: Section 6

42) When phosphoribosyl pyrophosphate (PRPP) is used to form AMP from adenine (as well as in numerous other cell reactions), the reaction is rendered irreversible because

A) PRPP has such a high affinity for the enzyme involved.

B) the rate of the reaction favors formation of the product(s).

C) this reaction is thermodynamically feasible.

D) the presence of pyrophosphatase hydrolyzes pyrophosphate formed.

E) All of the above

Answer: D
Page Ref: Section 7

43) Lesch–Nyhan syndrome, a result of hypoxanthine–guanine phosphoribosyltransferase deficiency, there is a/an ________.

A) accumulation of hypoxanthine

B) accumulation of GMP

C) complete breakdown of purine biosynthesis

D) excess of degradation of IMP and GMP

E) accumulation of IMP

Answer: D
Page Ref: Section 7

44) Allopurinol may be used to treat gout due to an excess of uric acid production because it can be converted to oxypurinol by ________, and oxypurinol strongly inhibits ________.

A) xanthine oxidase; urease

B) urease; xanthine oxidase

C) xanthine oxidase; xanthine oxidase

D) urease; urease

E) xanthine oxidase; sodium urate

Answer: C
Page Ref: Section 7

45) In birds and reptiles, purine nucleotides and surplus nitrogen from amino acid catabolism is disposed of in the form of ________ while humans form that, as well as ________ in nitrogenous waste.

A) xanthine, uric acid

B) uric acid; xanthine

C) uric acid; urea

D) urea; uric acid

E) urea; guanine

Answer: C
Page Ref: Section 8

46) In the reactions catalyzed by xanthine oxidase, electrons are transferred to ________ to form ________.

A) O_2; H_2O_2 B) H_2O_2; O_2 C) H_2O; O_2 D) O_2; H_2O

Answer: A
Page Ref: Section 8

47) Pigs excrete guanine rather that further catabolizing it because ________.

A) deamination leads to a product toxic to pigs

B) guanase is produced in extremely small amounts and is only activated under conditions of starvation

C) guanine is a component of antibiotics fed to pigs to enhance their growth

D) pigs lack the enzyme guanase

Answer: D
Page Ref: Section 8

48) Xanthine oxidase catalyzes the formation of ________.

A) xanthine

B) uric acid

C) hypoxanthine

D) xanthine and uric acid

E) All of the above

Answer: D
Page Ref: Section 8

49) The excretory products of uric acid catabolism vary among organisms depending on their ability to ________.

A) tolerate the end-product

B) remove the end-product to less toxic products

C) solubilize the end-product

D) remove an end-product like ammonia to the environment

E) All of the above

Answer: E
Page Ref: Section 8

50) The purine nucleotide cycle serves to form ________ for the citric acid cycle while recycling ________ formed in contracting muscle cells.

A) ATP; AMP

B) fumarate; AMP

C) citrate; AMP

D) fumarate; ADP

E) ATP; fumarate

Answer: B
Page Ref: Section 9

51) Pyrimidines are catabolized to ammonia, bicarbonate, and either ________ (from cytosine or uracil) or ________ (from thymine).

A) succinyl CoA; acetyl CoA

B) β-alanine; β-aminobutyrate

C) fumarate; succinyl CoA

D) acetyl CoA; succinyl CoA

E) acetyl CoA; acetyl CoA

Answer: D
Page Ref: Section 10

52) Virtually all organisms and tissues can synthesize nucleotides.

Answer: TRUE
Page Ref: Introduction

53) During de novo biosynthesis of the purine nucleotides, the purine ring is first formed as a free base before being attached to the ribose 5–phosphate moiety.

Answer: FALSE
Page Ref: Section 1

54) Nucleotides have a β configuration about the anomeric carbon atom of the ribose or deoxyribose ring.

Answer: TRUE
Page Ref: Section 1

55) The coenzyme biotin is required for the carboxylation of aminoimidazole ribonucleotide (AIR) during the de novo synthesis of IMP by the enzyme AIR carboxylase.

Answer: FALSE
Page Ref: Section 1

56) The pathway for the synthesis of IMP releases considerable energy and is an important source of ATP.

Answer: FALSE
Page Ref: Section 1

57) In prokaryotes, carbamoyl phosphate is an intermediate in the de novo biosynthesis of pyrimidine nucleotides.

Answer: TRUE
Page Ref: Section 3

58) In pyrimidine nucleotide biosynthesis orotate is the molecule that displaces the pyrophosphate group on PRPP.

Answer: TRUE
Page Ref: Section 3

59) In eukaryotes all enzymes for the biosynthesis of the pyrimidine nucleotides occur exclusively in the cytosol.

Answer: FALSE
Page Ref: Section 3

60) Channeling is an important process in the biosynthesis of pyrimidine nucleotides in mammals.

Answer: TRUE
Page Ref: Section 3

61) In the de novo synthesis of the deoxyribonucleotides, the deoxy form of PRPP is used in place of the PRPP used in the synthesis of the ribonucleotides.

Answer: FALSE
Page Ref: Section 5

62) Ribonucleotides are produced from oxidation of the deoxyribonucleotides at the 2' carbon atom.

Answer: FALSE
Page Ref: Section 5

63) dCMP, dGMP, dAMP and dTMP are substrates for a reductase that phosphorylates them to the triphosphate levels for incorporation into DNA.

Answer: FALSE
Page Ref: Section 5

64) When a purine or a purine triphosphate is bound to the specificity site of ribonucleotide reductase, the activity of the catalytic site of the enzyme is specific for a pyrimidine or a pyrimidine triphosphate.

Answer: FALSE
Page Ref: Section 5

65) The cofactor, methylenetetrahydrofolate, can donate a variety of one–carbon groups as well as act as a reducing agent in biochemical reactions.

Answer: TRUE
Page Ref: Section 6

Chapter 19 Nucleic Acids

1) Which of the following is mismatched?

A) Miescher – discovery of DNA
B) Avery – DNA is the genetic material
C) Watson – DNA structure
D) Hoppe–Seyler – DNA sequence

Answer: D
Page Ref: Introduction

2) Purines which are found mainly in both deoxyribonucleotides and ribonucleotides are

A) thymine and cytosine.
B) thymine, cytosine and uracil.
C) adenine and thymine.
D) guanine and cytosine.
E) adenine and guanine.

Answer: E
Page Ref: Section 1

3) ATP is not a nucleoside because it ________.

A) has phosphate groups
B) has three phosphates instead of just one
C) lacks the deoxyribosyl group
D) is not connect to a carbohydrate group

Answer: A
Page Ref: Section 1

4) Purines and pyrimidines exist in two tautomeric forms (lactam and lactim); nucleosides exist in two conformations (syn and anti). The most common forms found in cells are

A) lactam and anti.
B) lactam and syn.
C) lactim and anti.
D) lactim and syn.

Answer: A
Page Ref: Section 1

5) In DNA, phosphodiester bonds form with hydroxyl groups of carbons number ________ and ________ of each deoxyribose sugar.

A) 2'; 3'
B) 2'; 4'
C) 3'; 4'
D) 3'; 5'
E) 4'; 5'

Answer: D
Page Ref: Section 1

6) Cells fed5–methyl uracil (radioactive in the methy group) will form radioactive ________.

A) RNA

B) DNA

C) ribosomes

D) tRNA

E) A, C and D

Answer: B
Page Ref: Section 1

7) Deoxythymidine is a ________ found mainly in DNA.

A) nucleotide

B) eeoxynucleotide

C) nucleoside

D) deoxynucleoside

E) glycoside

Answer: D
Page Ref: Section 1

8) The difference between dGMP and GMP is

A) the type of phosphodiester linkage.

B) one hydroxyl group.

C) syn versus anti conformation.

D) the presence of DNA or RNA.

Answer: B
Page Ref: Section 1

9) Adenylate and AMP each contain ________ phosphate groups.

A) 0

B) 1

C) 2

D) 3

E) None of the above

Answer: B
Page Ref: Section 1

10) The abbreviation dGp indicates

A) 5' deoxyguanylate.

B) 3' deoxyguanylate.

C) 3', 5' deoxyguanylate.

D) 5', 3'deoxyguanylate.

E) None of the above

Answer: B
Page Ref: Section 1

11) The abbreviation pdAp indicates

A) 5', 3' deoxyadenylate.

B) 3', 5' deoxyadenylate.

C) 5' deoxyadenylate.

D) 3' deoxyadenylate.

E) None of the above

Answer: A
Page Ref: Section 1

12) The abbreviation pppT indicates

A) TMP.

B) TDP.

C) TTP.

D) 3, 5' TP.

E) None of the above

Answer: C
Page Ref: Section 1

13) According to Chargaff's observations of nucleotide composition of DNA samples

A) % of (G + C) + % of (A + T) = 100%.

B) A = T.

C) G = C.

D) %A + %G + %C + %T = 100%.

E) All of the above

Answer: E
Page Ref: Section 2

14) Much of the stability of the double–stranded DNA structure is the result of

A) hydrogen bonding between purines.

B) the phosphodiester backbone.

C) the angle of the planes of the bases with respect to the helix axis.

D) the stacking interactions between base pair.

Answer: D
Page Ref: Section 2

15) The rise and pitch of B–DNA are 0.33 nm and 3.40 nm, respectively. About how many helical turns are there in a fragment 1 mm in length?

A) 3030

B) 294

C) 330

D) 0.0034

E) Cannot calculate from the information given.

Answer: B
Page Ref: Section 2

16) Regions of DNA that are most easily unwound have

A) about half G and half C.

B) alternating A and G.

C) greater G:C content.

D) greater A:T content.

Answer: D
Page Ref: Section 2

17) Which is <u>not</u> true of the different conformations of DNA?

A) Z–DNA is a left–handed spiral.

B) A–DNA and B–DNA are right–handed spirals.

C) A–DNA and Z–DNA segments are limited to short regions of DNA.

D) Both A–DNA and B–DNA are dehydrated.

Answer: D
Page Ref: Section 2

18) In addition to knowing the chemical structures of the nucleotides, Watson and Crick used ________ of Franklin and Wilkins and the chemical equivalencies of Chargaff in order to propose their model of DNA structure.

A) sequence information

B) UV spectra

C) % (G + C) and % (A + T)

D) X–ray diffraction data

Answer: D
Page Ref: Section 2

19) In proteins, amino acids are linked by peptide bonds; in polynucleotides, nucleotides are linked by

A) phosphoanhydride bonds.

B) 3'–5'phosphodiester bonds.

C) 5'–3'phosphodiester bonds.

D) B and C

E) All of the above

Answer: B
Page Ref: Section 2

20) The tetranucleotide AGTC (in DNA) has a free hydroxyl group on

A) A. B) A, G, T, and C. C) C. D) G, T, and C.

Answer: C
Page Ref: Section 2

21) "Five prime to three prime" description of a DNA strand refers to

A) the phosphorylated 5' carbon at one end, the 3' at the other end.

B) the location of the hydroxyl groups.

C) the phosphodiester backbone of DNA.

D) the phosphorylated 5' carbon on one sugar and the 3' carbon on the next sugar.

Answer: A
Page Ref: Section 2

22) It is easier to melt DNA richer in AT than GC because

A) it is more heat sensitive.

B) there is one less hydrogen bond.

C) the helix pitch is longer in AT rich regions.

D) All of the above

Answer: B
Page Ref: Section 2

23) As B–DNA is gradually heated, the absorbance at 260 nm

A) increases.

B) decreases.

C) stays the same.

D) is half way between that of poly (AT and poly (GC).

Answer: A
Page Ref: Section 2

24) Which of the following is mismatched?

A) B–DNA: dehydrated

B) Z–DNA: left–handed helix

C) A–DNA: dehydrated

D) Z–DNA: no major or minor grooves

E) B–DNA: right–handed helix

Answer: A
Page Ref: Section 2

25) Which is <u>not</u> a difference between B–DNA and A–DNA?

A) A–DNA forms under more dehydrating conditions than B–DNA.

B) For polynucleotide strands containing the same number of nucleotides, the A–DNA strand will be shorter from end–to–end than the corresponding B–DNA.

C) Both are helical, but B–DNA is right–handed and A–DNA is left–handed.

D) The planes of the nitrogenous bases are not perpendicular to the helix axis in A–DNA.

Answer: C
Page Ref: Section 2

26) Changes in the topology and three–dimensional shape of B–DNA can result from

A) incubation with proteases.

B) supercoiling.

C) isomerization.

D) hydration.

Answer: B
Page Ref: Section 3

27) Which does <u>not</u> apply to most bacterial DNA?

A) circular

B) relaxed

C) not packed into nucleosomes

D) supercoiled

Answer: B
Page Ref: Section 3

28) Supercoiling of pure circular DNA is a result of ________.

A) underwinding or overwinding of the helix

B) entanglements because of the long length of the strands

C) the lack of associated histones

D) the activity of exonucleases

Answer: A
Page Ref: Section 3

29) What is the function of DNA toposiomerases?

A) cleaving nucleotides from the ends of DNA

B) adding or removing supercoils

C) methylation of the nitrogenous bases

D) packaging of DNA into nucleosomes

Answer: B
Page Ref: Section 3

30) ________ plays an important role in storing the energy needed for the unwinding of DNA during replication, recombination, repair and transcription.

A) A high percent of G:C base pairs

B) The charge on basic side chains of histone proteins

C) Negative supercoiling

D) Overwinding of the helix

Answer: C
Page Ref: Section 3

31) Which of the following is mismatched?

A) rRNA: 80% of cellular RNA

B) tRNA: carry amino acids during protein synthesis

C) mRNA: stable RNA carrying the coded information from DNA

D) small RNA: catalytic with or without proteins

Answer: C
Page Ref: Section 4

32) Stem–loop is a type of secondary structure not usually found in

A) rRNA. B) tRNA. C) mRNA. D) small RNA.

Answer: C
Page Ref: Section 4

33) Which type of RNA is the most abundant in living cells (by percent)?

A) ribosomal B) messenger C) small D) transfer

Answer: A
Page Ref: Section 4

34) Which is not a difference between RNA and DNA?

A) The sugar ring of RNA is more oxidized than that in DNA.

B) RNA contains uracil; DNA usually does not.

C) RNA cannot form helices.

D) RNA is single–stranded; DNA is double–stranded.

Answer: C
Page Ref: Section 4

35) Which type of RNA carries activated amino acids to the ribosome for assembly into proteins?

A) rRNA B) tRNA C) mRNA D) sRNA

Answer: B
Page Ref: Section 4

36) Which is not a biological function of RNA?

A) Participates in the modification of newly synthesized RNA.

B) It is the genome of some viruses.

C) Serves as a scaffold component for chromosomes.

D) Composes an integral part of the ribosome.

E) None of the above; all are functions of RNA

Answer: E
Page Ref: Section 4

37) Stem–loop structures in RNA resemble the ________ form of double–helical DNA.

A) A B) B

C) Z D) supercoiled circular

Answer: A
Page Ref: Section 4

38) Chromatin was first observed and named by ________.

A) Walter Flemming B) Francis Crick

C) Oswald Avery D) Friedrich Miescher

Answer: A
Page Ref: Section 5

39) What is the approximate diameter of a chromatin fiber?

A) 3 nm B) 30 nm C) 300 nm D) 3 mm E) 30 mm

Answer: B
Page Ref: Section 5

40) The packaging of DNA in cells results in about a ________-fold reduction in length compared to the fully extended DNA (fully stretched out).

A) 10 B) 700 C) 8000 D) 200,000

Answer: C
Page Ref: Section 5

41) Which statement is not true about histones?

A) They are positively charged at biological pH.

B) They only occur in eukaryotes.

C) Most species that have histones contain five different types.

D) There is wide variation in the amino acid sequences of histones among species.

Answer: D
Page Ref: Section 5

42) DNA wraps around an octamer of histones to form bead-like structures called ________.

A) nucleoids B) nucleosomes C) nucleoli D) chromatids

Answer: B
Page Ref: Section 5

43) What is the order of packaging of chromatin in eukaryotic cells from smallest to largest size?

A) double-helix → solenoid → nucleosome → chromosome

B) double-helix → chromatin → solenoid → chromosome

C) single-stranded DNA → chromatin → histones → chromosome

D) double-helix → nucleosomes → solenoid → chromosome

Answer: D
Page Ref: Section 5

44) Histone ________ is not part of the histone octamer, but binds to linker DNA and is responsible for higher-order chromatin structure.

A) H1

B) H2

C) H3

D) H4

E) None of the above

Answer: A
Page Ref: Section 5

45) Histones associate with DNA primarily through ________.

A) hydrogen bonding

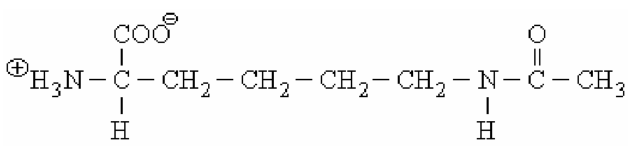
B) hydrophobic interactions with the exposed bases in the major groove

C) ionic interactions with the phosphate groups

D) disulfide linkages

Answer: C
Page Ref: Section 5

46) A HATS enzymes reacts with the side-chain of lysine to form the following structure: What effect will the HATS enzymes have on histones?



A) No effect, since histones contain few lysine residues.

B) HATS will increase the affinity of histones for DNA.

C) HATS will allow for easier unravelling of histone-DNA structures.

D) HATS activate histones for interaction with mRNA.

Answer: C
Page Ref: Section 5

47) The 30 nm fibers of a chromosome are attached to a/an ________ scaffold that holds the fibers in large loops.

A) RNA-protein B) glycoprotein C) actin filament D) histone

Answer: A
Page Ref: Section 5

48) Which best describes the structure of a nucleosome core particle?

A) A histone octamer with DNA threaded through its center.

B) About 50 bp of DNA associated with one histone H1 molecule.

C) One nucleosome plus one histone H1 and linker DNA.

D) A histone octamer wrapped approximately two times around with DNA.

Answer: D
Page Ref: Section 5

49) About how many nucleosomes could be made from a DNA strand consisting of 1000 base pairs?

A) 5

B) 50

C) 500

D) This is not enough DNA to make even one nucleosome.

Answer: A
Page Ref: Section 5

50) ________ catalyze the hydrolysis of phosphodiester linkages to release nucleotide residues from only one end of a polypeptide chain.

A) Topoisomerases
B) Endonucleases
C) Exonucleases
D) Restriction enzymes

Answer: C
Page Ref: Section 6

51) Bacteria produce many restriction endonucleases. What prevents these enzymes from degrading the host DNA?

A) A bacterium will produce endonucleases that recognize sequences that are not present in its own DNA.

B) The strong association between the histones and bacterial DNA prevent the endonucleases from acting on them.

C) The endonucleases are transported out of the cell so quickly they cannot significantly affect the host DNA.

D) The host DNA is specifically methylated and is therefore protected from cleavage.

Answer: D
Page Ref: Section 6

52) Which recognition sequence is <u>not</u> a palindrome? (DNA sequences are shown in the standard 5' →3' direction)

A) GGGCCC

B) TCTAGA

C) AAGCTT

D) Both B and C

E) None of the above. <u>All</u> of the sequences shown are palindromes.

Answer: E
Page Ref: Section 6

53) What is the effect of incubating a mixture of RNA and DNA with 0.1 M NaOH?

A) RNA is hydrolyzed to nucleoside monophosphates.

B) DNA is hydrolyzed to nucleoside monophosphates.

C) Both RNA and DNA are hydrolyzed to nucleoside monophosphates.

D) No effect. RNA and DNA are resistant to base hydrolysis.

Answer: A
Page Ref: Section 6

54) Which are the products of the RNase A–catalyzed hydrolysis of pGpApUpApApCpG?

A) pG + pA + pUpA + pA + pCpG

B) pGpApU + pApApC + pG

C) pG + pApUpApApCpG

D) pGpApUp + ApApCp + G

E) two pG + three pA + pU + pC

Answer: D
Page Ref: Section 6

55) Which does <u>not</u> occur during the hydrolysis of RNA by RNase A?

A) Covalent catalysis involving a bond between a pyrimidine and a lysine of RNase A.

B) Acid–base catalysis to cleave the phosphodiester bond.

C) Abstraction of a proton from the 2'–hydroxyl group by histidine.

D) Transition–state stabilization of a pentavalent phosphorous atom.

Answer: A
Page Ref: Section 6

56) The recognition site of some restriction enzymes are shown. Which will produce sticky ends?

A) *Eco*RI G↓AATTC

B) *Sma*I CCC↓GGG

C) *Xho*I C↓TCGAG

D) both *Eco*RI and *Xho*I

E) All the enzymes shown will leave sticky ends.

Answer: D
Page Ref: Section 6

57) Restriction endonucleases recognize specific DNA sequences by ________.

A) contacting base pairs in the major groove

B) inserting amino acid side chains between the base pairs and interrupting the stacking interactions

C) hydrogen bonding with base pairs in the minor groove

D) detecting base pair–depended variations in the sugar–phosphate backbone

Answer: A
Page Ref: Section 6

58) What is a restriction map?

A) the nucleotide sequence recognized by a particular restriction enzyme

B) diagram of a DNA molecule to show specific cleavage sites of endonucleases

C) table of enzymes that have a least one site in a species' DNA

D) a diagram of the compaction of DNA by packing into nucleosomes and solenoids

E) a gel electrophoresis technique used for the purpose of DNA fingerprinting

Answer: B
Page Ref: Section 7

59) Which enzyme would be <u>least</u> useful for recombination experiments that introduce new fragments of DNA into an existing DNA molecule?

A) *Eco*RI G↓AATTC

B) *Sma*I CCC↓GGG

C) *Xho*I C↓TCGAG

D) All are equally useful

Answer: B
Page Ref: Section 7

60) It is possible to synthesize DNA containing specific polynucleotide bases today.

Answer: TRUE
Page Ref: Introduction

61) It is often not possible to determine the exact sequence of large polynucleotides such as RNA and DNA.

Answer: FALSE
Page Ref: Introduction

62) All genomes are composed of RNA.

Answer: FALSE
Page Ref: Introduction

63) The genome of a species does not include the DNA in mitochondrial and chlorplast DNA.

Answer: TRUE
Page Ref: Introduction

64) Five different bases are found in most DNA and RNA molecules.

Answer: TRUE
Page Ref: Section 1

65) Uracil is found in most RNA, while 5–methyluracil is found in most DNA.

Answer: TRUE
Page Ref: Section 1

66) Deoxyribonucleosides and ribonucleotides contain two hydroxyl groups that can be phosphorylated.

Answer: FALSE
Page Ref: Section 1

67) The two strands of double–stranded DNA have the same content of each of the bases A, T, G and C.

Answer: FALSE
Page Ref: Section 2

68) In any species, the % (A + T) is equal to the % (G + C).

Answer: FALSE
Page Ref: Section 2

69) In any species, the ratio of the % (A + T) to the % (G + C) is constant.

Answer: TRUE
Page Ref: Section 2

70) For double–stranded DNA ending in an AT pair, both A and T will have a phosphate at the 5' position.

Answer: FALSE
Page Ref: Section 2

71) The major and minor grooves are the same in B–DNA, A–DNA, and Z–DNA.

Answer: FALSE
Page Ref: Section 2

72) Absorption of single-stranded DNA at 260 nm is less than that of double-stranded DNA.

Answer: FALSE
Page Ref: Section 2

73) There are many viruses whose entire genome is Z-DNA.

Answer: FALSE
Page Ref: Section 2

74) Topoisomerases cut one or both coiled DNA strands, wind the ends by rotation, and then rejoin the cut ends.

Answer: TRUE
Page Ref: Section 3

75) It is not possible for linear DNA to be supercoiled. Only circular DNA, which has no ends, can have regions of supercoiling.

Answer: FALSE
Page Ref: Section 3

76) The supercoiling of double-stranded circular DNA can be removed by cleaving a single phosphodiester bond on only one strand (nicking).

Answer: TRUE
Page Ref: Section 3

77) RNAs are single-stranded molecules with little complex secondary structure.

Answer: FALSE
Page Ref: Section 4

78) RNA does not have a double strand form.

Answer: FALSE
Page Ref: Section 4

79) Messenger RNA is the least stable type of cellular ribonucleic acid.

Answer: TRUE
Page Ref: Section 4

80) Strands in the stem of stem-loop RNA structures are parallel.

Answer: FALSE
Page Ref: Section 4

81) Prokaryotic DNA is organized into protein–DNA structures called nucleoids.

Answer: TRUE
Page Ref: Section 5

82) About 150 bp of DNA wrap around the histone octamer to form a bead–like structure. The "beads" are separated by about 50 bp of linker DNA.

Answer: TRUE
Page Ref: Section 5

83) Alkaline hydrolysis with 0.1 M NaOH is an effective method of degrading RNA and DNA for determining the percent composition of each type of nucleotide monomer.

Answer: FALSE
Page Ref: Section 6

84) Alkaline hydrolysis of RNA produces a mixture of 2' and 3' – nucleotides. Hydrolysis by RNase A produces on the 3'–nucleotides.

Answer: TRUE
Page Ref: Section 6

85) Treatment of an individual's DNA with restriction endonucleases produces a unique set of DNA fragments. This is the basis of DNA fingerprinting.

Answer: TRUE
Page Ref: Section 7

Chapter 20 DNA Replication, Repair, and Recombination

1) During the elongation stage

A) replication proteins assemble at the DNA replication site.

B) DNA is replicated semiconservatively.

C) the protein machine disassembles.

D) replication ends.

Answer: B
Page Ref: Introduction

2) The replication of DNA is ________ because ________.

A) conservative; one strand of parental DNA is retained in each daughter DNA

B) conservative; each daughter molecule has two new strands copied from the parental DNA template

C) semiconservative; one strand of parental DNA is retained in each daughter DNA

D) semiconservative; each daughter molecule has two new strands copied from the parental DNA template

Answer: C
Page Ref: Introduction

3) The incorporation of new nucleotides into a growing strand of DNA occurs during ________.

A) the elongation stage
B) nucleation
C) initiation
D) assembly of the protein machine

Answer: A
Page Ref: Introduction

4) DNA that has been liberally labeled with radioactive ^{14}C is used as the template for replication. Replication is carried out in a medium containing only <u>unlabeled</u> nucleotides. After two rounds of replication, what percent of DNA molecules are still labeled?

A) 25%
B) 50%
C) 75%
D) 100%

Answer: B
Page Ref: Introduction

5) Meselson and Stahl's experiments involved growing *E. coli* on a medium containing ^{15}N (heavy nitrogen) which increased the density of the bacterial DNA. Cells were then grown on a medium containing only ^{14}N. DNA samples were obtained for analysis after one, two and three rounds of replication (generations) and centrifuged on a density gradient. The double–helical DNA forms bands in the gradient depending on its density. How many bands did Meselson and Stahl see after two generation of cells were grown on the ^{14}N medium?

A) One with DNA containing both ^{15}N and ^{14}N.

B) Two, one with DNA containing only ^{15}N and one with DNA containing only ^{14}N.

C) Two, one with DNA containing both ^{15}N and ^{14}N and one with DNA containing only ^{14}N.

D) Three, one with DNA containing only ^{15}N, one with DNA containing both ^{15}N and ^{14}N and one with DNA containing only ^{14}N.

Answer: C
Page Ref: Introduction

6) The protein machine that carries out DNA replication is called ________.

A) DNA polymerase
B) the replication fork
C) the Klenow fragment
D) the replisome

Answer: D
Page Ref: Section 1

7) How many replisomes are required for one complete round of DNA replication in *E. coli*?

A) one
B) two
C) four
D) more than 4

Answer: B
Page Ref: Section 1

8) Approximately ________ base pairs are added per second during DNA *in vivo* replication in *E. coli.*

A) 10
B) 100
C) 1000
D) 1,000,000

Answer: C
Page Ref: Section 1

9) At the normal rate of replication, about how many minutes does it take for the entire *E. coli* chromosome (4.6×10^3 kbp) to be duplicated?

A) 5
B) 20
C) 40
D) 80

Answer: C
Page Ref: Section 1

10) It takes about the same amount of time for eukaryotic chromosomes to be replicated *in vivo* as it does for *E. coli.* Why is this true?

A) Eukaryotes have multiple origins of replication; *E. coli* has one unique origin.

B) Most chromosomes are approximately the same size.

C) Eukaryotic replication occurs at a faster rate, enabling replication of the larger chromosomes in about the same amount of time.

D) The replication of DNA in eukaryotes is faster due to a quicker, more accurate repair of mismatches.

Answer: A
Page Ref: Section 1

11) Which DNA polymerase is most responsible for chain elongation in *E. coli*?

A) DNA polymerase I
B) DNA polymerase II
C) DNA polymerase III
D) DNA polymerase IV

Answer: C
Page Ref: Section 2

12) DNA polymerase III requires a/an ________ for synthesis of DNA to occur.

A) DNA template
B) RNA primer
C) free 3'–OH end of a DNA strand
D) All of the above

Answer: D
Page Ref: Section 2

13) The e subunit of DNA polymerase III is responsible for its ________ activity.

A) 5' → 3' polymerase
B) sliding clamp
C) 3' → 5' exonuclease (proof reading)
D) ribosome assembly

Answer: C
Page Ref: Section 2

14) *E. coli* DNA polymerase catalyzes polymerization in the ________ direction(s).

A) 5' → 3'

B) 3' → 5'

C) 2' → 5'

D) both 5' → 3' and 3' → 5'

E) All of the above

Answer: A
Page Ref: Section 2

15) Enzymes that remain bound to their nascent chains through many polymerization steps are said to be ________.

A) constitutive B) distributive C) conjugated D) processive

Answer: D
Page Ref: Section 2

16) The processivity of *E. coli* DNA polymerase III holoenzyme accounts for all of the following except

A) the relatively small number of enzymes needed to replicate the entire chromosome.

B) the directionality of polymerization.

C) the rapid rate of polymerization.

D) the ability of a single holoenzyme to add many nucleotides to a growing DNA chain.

Answer: B
Page Ref: Section 2

17) The 3' → 5' exonuclease activity of *E. coli* DNA polymerase III accounts for the ________ of polymerization.

A) low error rate B) high speed

C) directionality D) All of the above

Answer: A
Page Ref: Section 2

18) Polymerization of the lagging strand is catalyzed by ________.

A) a second core complex on the same polymerase holoenzyme that polymerizes the leading strand

B) a completely separate replisome from that which polymerizes the leading strand

C) DNA polymerase I holoenzyme

D) the same polymerase holoenzyme that polymerized the leading strand, but with opposite directionality

Answer: A
Page Ref: Section 3

19) The RNA primer at the beginning of each Okazaki fragment is removed by

A) DNA polymerase I.

B) DNA polymerase II.

C) DNA polymerase III.

D) 3' → 5' exonuclease subunit of DNA polymerase III.

Answer: A
Page Ref: Section 3

20) Nick translation is a process for

A) filling in and sealing the gap in DNA after removal of the RNA primer.

B) synthesis of the protein for primase from mRNA.

C) removal of the RNA primer by DNA polymerase I.

D) removal of Okazaki fragments.

Answer: A
Page Ref: Section 3

21) Okazaki fragments are ________.

A) the smallest subunits of DNA polymerase III

B) short stretches of DNA formed on the lagging strand

C) short RNA primers needed for initiation of polymerization

D) fragments of DNA polymerase I that lack 5' → 3' exonuclease activity

Answer: B
Page Ref: Section 3

22) What is the function of the primosome?

A) Removal of RNA from the lagging strand.

B) Synthesis of short RNA fragments.

C) Assembly of DNA polymerase III holoenzyme.

D) Detection of the origin of replication.

Answer: B
Page Ref: Section 3

23) What is a reasonable length for an RNA primer in *E. coli*?

A) a few nucleotides

B) 50 nucleotides

C) 100 nucleotides

D) 1000 nucleotides

Answer: A
Page Ref: Section 3

24) Fragments on the lagging strand are joined by the enzyme ________.

A) DNA polymerase I

B) DNA synthase

C) DNA primosome

D) DNA ligase

Answer: D
Page Ref: Section 3

25) Why does *E. coli* need both DNA polymerse III and DNA polymerase I?

A) DNA polymerase III lacks the 5' → 3' exonuclease activity needed to remove RNA primers.

B) Each polymerase is specific for only one strand of DNA. DNA polymerase III acts only on the leading strand, and DNA polymerase I acts only on the lagging strand.

C) DNA polymerase I is needed to join the Okazaki fragments.

D) The DNA replication is bidirectional; one polymerase is used for each direction.

E) Only DNA polymerase I has proofreading ability.

Answer: A
Page Ref: Section 3

26) Which is <u>not</u> an activity for DNA polymerase I?

A) 5' → 3' polymerase activity

B) joining of Okazaki fragments

C) 5' → 3' exonuclease activity

D) nick translation

E) 3' → 5' proofreading activity

Answer: B
Page Ref: Section 3

27) What is a Klenow fragment?

A) A fragment of DNA polymerase I that lacks 5' → 3' exonuclease activity.

B) A topoisomerase responsible for unwinding DNA at the replication fork.

C) A portion of the replisome responsible for RNA primer synthesis.

D) Short stretches of DNA formed during polymerization of the lagging strand.

Answer: A
Page Ref: Section 3

28) Which is <u>not</u> part of the replisome?

A) helicase DnaB
B) the primosome
C) gyrase
D) single–stranded binding protein

Answer: C
Page Ref: Section 4

29) RNA primers are synthesized about once every ________.

A) millisecond
B) second
C) minute
D) 40 minutes

Answer: B
Page Ref: Section 4

30) Which proteins are responsible for the unwinding of the double-stranded DNA during replication?

A) ligases

B) helicases

C) topoisomerases

D) primases

E) lyases

Answer: B
Page Ref: Section 4

31) The sequence of genes and proteins used in the initiation and termination of DNA replication is

A) Tus → ter → origin → DnaA → dnaA

B) dnaA → DnaA → origin → Tus → ter

C) Origin → DnaA → dnaA → ter → Tus

D) DnaA → ter → Tus → origin → ter → dnaA

Answer: B
Page Ref: Section 5

32) Which of the following is mismatched?

A) ter : Tus

B) dnaA : DnaA

C) Ori : primer

D) Tus : helicase inhibitor

Answer: C
Page Ref: Section 5

33) The best enzyme to use in the Sanger method for DNA sequence determination is

A) DNA polymerase I .

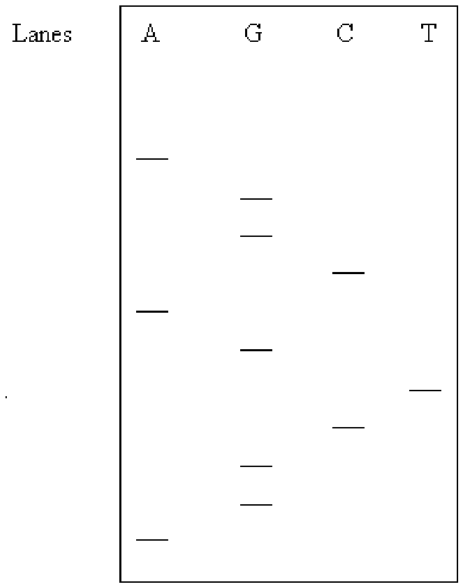
B) Klenow fragment of DNA polymerase I.

C) DNA polymerase from a high temperature bacterium.

D) SSB protein.

Answer: C
Page Ref: Section 6

34) What is the DNA sequence (5' → 3') determined in this gel? Assume the samples were applied near the top of the gel.



A) AGGCTGGACGA
B) AGGGGCTAGCA
C) AGGCTGACGGA
D) AGGCAGTCGGA

Answer: C
Page Ref: Section 6

35) The main difference between prokaryotic and eukaryotic DNA replication mechanisms is

A) no Okazaki fragments are made in eukaryotes.
B) both leading and lagging strands are continuous in eukaryotes.
C) no primer synthesis is needed in eukaryotes.
D) the replication fork moves slower in eukaryotes.

Answer: D
Page Ref: Section 6

36) Functions of DNA polymerases and accessory proteins in eukaryotic DNA replication include

A) PCNA protein, a sliding clamp unit for DNA.
B) β– DNA polymerase, for repair of damaged DNA.
C) RPC protein, and equivalent of SSB proteins in bacteria.
D) RPC protein, used for mitochondrial DNA synthesis.
E) All of the above

Answer: E
Page Ref: Section 6

37) In packaging the eukaryotic DNA into nucleosomes, it is thought that the requirement for ________ and their synthesis is a cause of the slower rate of movement of the replication fork.

A) Okazaki fragments

B) larger DNA molecules

C) increase number of accessory proteins

D) histone proteins

E) lagging strands

Answer: D
Page Ref: Section 6

38) Why is only one copy of DNA made per cell division cycle in eukaryotes despite the presence of multiple origins of replication?

A) There is only one origin of replication per chromosome.

B) The rate of elongation proceeds at a rate that allows only one copy to be made by the time the cell divides.

C) The activity of an S–phase protein kinase controls the formation of the pre–replication complex.

D) Primase is activated by phosphorylation only at the onset of S–phase by S–phase protein kinase.

Answer: C
Page Ref: Section 6

39) The reaction catalyzed by DNA photolyase is an example of what type of repair?

A) recombination B) excision C) mismatch D) direct

Answer: D
Page Ref: Section 7

40) In photoreactivation, DNA damage caused by UV light is reversed by DNA photolyase which

A) is activated by UV light to form a complex.

B) removes nicks in the DNA backbone.

C) forms a complex with thymine dimers which absorbs visible light and reverses the dimerization.

D) binds to the adenine bases opposite the thymine dimer.

E) All of the above

Answer: C
Page Ref: Section 7

41) Why is DNA damage in skin cells from exposure to excessive UV light not completely reversed by photoreactivation?

A) DNA photolyase in humans is activated only under conditions of heat shock.

B) Humans lack a photoreactivation repair mechanism.

C) The presence of histones greatly slows photoreactivation, thus humans depends primarily on other forms of DNA repair.

D) Photoreactivation is specific for the removal of thymine dimers. Thymine dimers do not form in human DNA.

Answer: B
Page Ref: Section 7

42) The general excision repair pathway for DNA repair has the following order:

A) endonuclease cuts → helicase or endonuclease removes → DNA polymerase → DNA ligase

B) DNA ligase → DNA polymerase → helicase or endonuclease removes → endonuclease cuts

C) endonuclease cuts → DNA polymerase repairs → helicase opens up → DNA ligase

D) endonuclease cuts → DNA ligase removes → endonuclease removes → DNA ligase

Answer: A
Page Ref: Section 7

43) In DNA repair, DNA glycosylases recognize deaminated bases within the DNA polymer and remove the deaminated

A) nucleoside.

B) nucleotide.

C) thymine dimers.

D) bases.

Answer: D
Page Ref: Section 7

44) Deaminated bases must be removed from DNA because

A) they distort the molecule.

B) they form thymine dimers.

C) they pair incorrectly during replication.

D) the mRNA formed may be irregular.

Answer: C
Page Ref: Section 7

45) In the Holliday model describing recombination

A) homologous sequences line up.

B) strands of DNA are nicked.

C) DNA strands associate with the homologous strand ("strand invasion").

D) strands rotate then are cleaved at the crossover point.

E) All of the above

Answer: E
Page Ref: Section 8

46) During recombination in *E. coli*, ________ recognize(s) regions of sequence similarity and promote(s) strand invasion, while ________ bind(s) to a Holliday junction promoting strand migration.

A) RuvA and RuvB; RecBCD

B) RecBCD; RecA

C) RecA; RecBCD

D) RecA; RuvA and RuvB

Answer: D
Page Ref: Section 8

47) The sequence of proteins used in bacterial recombination is

A) RuvC → RuvB → RecA → RecBCD

B) RecBCD → RecA → RuvAB → RuvC

C) RecA → RecBCD → RuvAB → RuvC

D) RuvAB → RuvC → RecBCD → RecA

Answer: C
Page Ref: Section 8

48) How are the BRCA proteins and their genes implicated in breast cancer?

A) The BRCA proteins damage DNA by generating double-stranded breaks which can lead to cancer.

B) Cells become more susceptible to damage if the genes for these proteins are damaged.

C) BRCA proteins inhibit excision repair mechanisms.

D) BRCA proteins initiate recombination between non-homologous DNA sequences.

Answer: B
Page Ref: Section 8

49) In *E. coli* replication begins at the origin of replication and proceeds in one direction until the entire circular DNA molecule has been copied.

Answer: FALSE
Page Ref: Section 1

50) The chromosome of the fruit fly (*D. melanogaster*) is about twice as large as the *E. coli* chromosome.

Answer: FALSE
Page Ref: Section 1

51) Prokaryotic DNA replication occurs in two steps. First, ATP provides a phosphate to the growing DNA chain. This is followed by addition of a nucleoside.

Answer: FALSE
Page Ref: Section 1

52) DNA polymerase III is the largest DNA polymerase in *E. coli*.

Answer: TRUE
Page Ref: Section 2

53) The β subunits of *E. coli* DNA polymerase form a sliding clamp that surrounds the DNA strands at the replication fork.

Answer: TRUE
Page Ref: Section 2

54) The polymerization of DNA is essentially irreversible due to the hydrolysis of pyrophosphate.

Answer: TRUE
Page Ref: Section 2

55) On average about twenty errors are made during each replication of the human genome.

Answer: FALSE
Page Ref: Section 2

56) DNA polymerase I possesses 5' → 3' exonuclease activity.

Answer: TRUE
Page Ref: Section 3

57) All DNA ligase enzymes use ATP as a cosubstrate.

Answer: FALSE
Page Ref: Section 3

58) The purpose of SSB is to prevent single–stranded DNA from folding back on itself to form double–helical regions.

Answer: TRUE
Page Ref: Section 4

59) Proteins bind to both origin sites and termination sites on DNA during DNA replication.

Answer: TRUE
Page Ref: Section 5

60) In the Sanger method for DNA sequencing, the gels are read from bottom to top, since the smallest fragments travel farthest in the sequencing gel.

Answer: TRUE
Page Ref: Section 6

61) DNA polymerase I which is inhibited by dideoxynucleoside triphosphates is used in the Sanger method for DNA sequencing.

Answer: FALSE
Page Ref: Section 6

62) Sanger DNA sequencing requires inhibition of DNA polymerization by a specific dideoxynucleoside every time it is copied in the replication process.

Answer: FALSE
Page Ref: Section 6

63) The Klenow fragment can be used for DNA sequencing if proteins such as SSB protein are added.

Answer: TRUE
Page Ref: Section 6

64) A short primer is added to the DNA polymerase reaction mix for Sanger DNA sequencing that has a 5' free hydroxyl to which new nucleotides can be added.

Answer: TRUE
Page Ref: Section 6

65) In a sequencing gel, all fragment in one of the four lanes terminates in the same type of nucleotide base.

Answer: TRUE
Page Ref: Section 6

66) Eukaryotic cells contain at least five DNA polymerases all of which are responsible for nuclear DNA replication.

Answer: FALSE
Page Ref: Section 6

67) Since the rate of form movement in eukaryotes is much slower than that of bacteria, chromosomes require more than an hour to replicate.

Answer: FALSE
Page Ref: Section 6

68) Although histones and DNA are made in the same parts of the eukaryotic cell, the packaging of them in the nucleosome slows down replication so that it is slower than that of prokaryotes.

Answer: FALSE
Page Ref: Section 6

69) There are more replication forks during replication of eukaryotic DNA than prokaryotic DNA.

Answer: TRUE
Page Ref: Section 6

70) DNA is the only cell macromolecule that can be repaired.

Answer: TRUE
Page Ref: Section 7

71) DNA fingerprinting is possible for identification because each person accumulates over a hundred mutations during his or her lifetime.

Answer: FALSE
Page Ref: Section 7

72) DNA repair cannot be done without breaking the phosphodiester backbone of DNA.

Answer: FALSE
Page Ref: Section 7

73) Since deamination is a common cause of DNA damage, and since the deamination of cytosine forms a product similar in structure to uracil, repair enzymes cannot repair this damage easily.

Answer: FALSE
Page Ref: Section 7

74) Homologous recombination is the exchange of DNA between closely related DNA sequences.

Answer: TRUE
Page Ref: Section 8

75) All recombination events involve homologous recombination between closely related DNA sequences.

Answer: FALSE
Page Ref: Section 8

76) At one point during DNA recombination in *E. coli* there is formation of a triple–stranded DNA.

Answer: TRUE
Page Ref: Section 8

Chapter 21 Transcription and RNA Processing

1) Francois Jacob and Jacques Monod are responsible for

A) discovering that the sequence of an mRNA molecule is complementary to a segment of one of the DNA strands.

B) predicting the "central dogma" of molecular biology.

C) proposing that a single unit of heredity directed the production of a single enzyme.

D) All of the above

Answer: A
Page Ref: Section 1

2) Which of the following is/are incorrect?

A) tRNAs are extremely stable molecules.

B) Eukaryotic mRNA is highly stable.

C) Bacterial mRNA is not rapidly degraded.

D) All of the above

3) The type of RNA that is least stable in cells is ________.

A) tRNA B) rRNA C) mRNA D) small RNA

Answer: C
Page Ref: Section 1

4) Which statement about RNA polymerase is false?

A) The large beta subunit comprises the active site of the enzyme.

B) The alpha subunits are the scaffold for assembly of the other subunits.

C) The role of the omega subunit is well characterized.

D) All of the above are false

Answer: C
Page Ref: Section 2

5) Which is not a property of RNA polymerase?

A) polymerizes in the 5' → 3' direction

B) catalyzes the formation of phosphodiester linkages

C) polymerizes a reaction assisted by pyrophosphate hydrolysis

D) has exonuclease proof-reading activity

Answer: D
Page Ref: Section 2

6) Which subunit of the *E. coli* core RNA polymerase ($a_2bb'w$) contributes to DNA binding?

A) a B) b C) b' D) w

Answer: C
Page Ref: Section 2

7) Which of the following is true about transcription?

A) Promoters are regions of DNA which serve as transcription initiation sites.

B) Initiation is the rate-limiting step in transcription.

C) Each gene, in eukaryotic cells, usually has its own promoter.

D) All of the above

Answer: D
Page Ref: Section 3

8) Which of the following is correct?

A) Transcription proceeds in the 5' → 3' direction.

B) The template strand is copied from the 5' end to the 3' end.

C) RNA polymerization proceeds in the 3' → 5' direction.

D) None of the above

Answer: A
Page Ref: Section 3

9) The template strand of DNA is copied by RNA polymerase from

A) both 3' → 5' and 5' → 3' ends.

B) 5-10 nucleotides before the +1 transition site.

C) 3' → 5' end.

D) 5' → 3' end.

Answer: C
Page Ref: Section 3

10) Which is matched incorrectly?

A) RP_o-RNA polymerase at a transcription bubble of DNA

B) RP_c-RNA polymerase bound to single-stranded DNA

C) NusA -helps convert RNA polymerase to an elongation form

D) s-protein factor aiding promoter binding

Answer: B
Page Ref: Section 3

11) What does it mean to say that the most common type of promoter in *E. coli* is bipartite?

A) The promoter region is divided into two parts which flank the sequence for the gene.

B) There are two separate regions of sequence similarity in the promoter.

C) The sequence of the promoter has dyad symmetry.

D) The promoter must bind two RNA polymerase holoenzymes to transcribe the gene.

Answer: B
Page Ref: Section 3

12) RNA polymerase uses the ________ strand of DNA in transcription.

A) sense B) antisense C) coding D) un–coded

Answer: B
Page Ref: Section 3

13) When a sequence of double–strand DNA is displayed

A) the coding strand is written in the 3' → 5' direction.

B) the template strand is written in the 5' → 3' direction.

C) the coding strand is identical to the RNA product.

D) None of the above

Answer: D
Page Ref: Section 3

14) Which of the following are correct matches for the given genes?

A) rpoN : nitrogen metabolism B) rpoH : heat shock

C) Gene 55 : bacteriophage T4 D) All of the above

Answer: D
Page Ref: Section 3

15) The sigma–70 subunit

A) increases the affinity of the core polymerase for nonpromoter sequences.

B) decreases the affinity of the core polymerase for specific promoter sequences.

C) is responsible for transcribing many genes.

D) is associated with a holoenzyme, enabling the formation of more stable complexes.

E) All of the above.

Answer: D
Page Ref: Section 3

16) A consensus sequence

A) is a hypothetical sequence.

B) indicates the nucleotides most commonly found at each position.

C) describes the most efficient promoter sequence for the RNA polymerase holoenzyme.

D) All of the above

Answer: D
Page Ref: Section 3

17) Which of the following is true for the unwinding of the DNA helix and the synthesis of a short stretch of RNA?

A) The process requires a helicase and a primase as in DNA replication.

B) In transcription, these steps proceed via an RNA polymerase holoenzyme.

C) The unwinding and subsequent synthesis above serve as a primer for chain elongation.

D) All of the above

Answer: D
Page Ref: Section 3

18) Transcription termination

A) occurs at certain DNA sequences where the elongation complex is unstable.

B) sometimes requires a specific protein, rho, which facilitates disassembly.

C) often occurs near pause sites.

D) All of the above

Answer: D
Page Ref: Section 4

19) For an RNA hairpin loop to form, the transcribed region of the DNA sequence must ________.

A) be a palindrome

B) have dyad symmetry

C) contain an intron

D) have a tandem repeat

Answer: B
Page Ref: Section 4

20) Which of the following is true, concerning rho?

A) It is a heptameric protein with potent ATPase activity.

B) It has an affinity for single–stranded DNA .

C) It may function as an RNA–DNA helicase.

D) None of the above

Answer: C
Page Ref: Section 4

21) Rho–dependent termination

A) is due to destabilization of the RNA–DNA hybrid.

B) is due to indirect contact between the transcription complex and rho as rho binds RNA.

C) may cause the RNA polymerase to bind to template DNA.

D) All of the above

Answer: A
Page Ref: Section 4

22) Which of the following is an incorrect association between RNA polymerase and its products?

A) RNA polymerase I : 35 – 47S pre–rRNA

B) RNA polymerase I: 5S rRNA

C) RNA polymerase II : mRNA precursors

D) RNA polymerase III : tRNA

E) None of the above

Answer: B
Page Ref: Section 5

23) Which statement is <u>false</u> concerning the general transcription factor, TFIID?

A) It binds to the promoter.

B) Its TBP subunit binds to the region containing the TATA box.

C) It interacts with TFIIA in the presence of DNA.

D) It is the RNA polymerase II initiation factor.

E) None of the above

Answer: C
Page Ref: Section 5

24) Most of the RNA polymerase activity in eukaryotic cells occurs in the

A) cytoplasm. B) mitochondria. C) nucleolus. D) nucleoplasm.

Answer: C
Page Ref: Section 5

25) Which of the following is an incorrect association between transcription factors and their characteristics?

A) TFIIB : interacts with RNA polymerase II.

B) SPI: binds to GC–rich sequence.

C) TFIIH: couples transcription to DNA repair.

D) TFIIE : recognizes the core sequence CCAAT.

E) All of the above

Answer: D
Page Ref: Section 5

26) Which of the following is/are true concerning TAFs and TBP?

A) They are subunits of TFIIB and TFIID, respectively.

B) TBP is required to initiate transcription of class I and class III genes .

C) They are not associated with RNA polymerase I and RNA polymerase III.

D) All of the above

Answer: B
Page Ref: Section 5

27) Which statement is true about the relative number of accessory proteins necessary for RNA polymerization in eukaryotes versus *E. coli*?

A) Eukaryotes require many more accessory proteins.

B) They require about the same number of accessory proteins.

C) Eukaryotes require far fewer accessory proteins.

D) The number required varies widely by species. Some eukaryotes require less than *E. coli* and some require more.

Answer: A
Page Ref: Section 5

28) The genes that encode proteins are transcribed by RNA polymerase ________.

A) I B) II C) III D) IV

Answer: B
Page Ref: Section 5

29) Which observation is <u>not</u> evidence that supports the theory that mitochondria and chloroplasts originate from symbiotic bacteria?

A) Genes for both mitochondrial and chloroplast RNA polymerase are encoded in the DNA of these organelles.

B) Both mitochondria and chloroplasts are about the same size as bacterial cells.

C) Chloroplast RNA polymerase is similar in sequence to that of cyanobacteria.

D) Both mitochondria and chloroplasts have their own DNA.

Answer: A
Page Ref: Section 5

30) The σ^{70} subunit in *E. coli* RNA polymerase acts as a/an ________.

A) repressor
B) sliding clamp
C) helicase
D) initiation factor

Answer: D
Page Ref: Section 5

31) The transcription of ________ RNA accounts for most of the transcriptional activity of a cell.

A) transfer
B) ribosomal
C) messenger
D) heterogeneous nuclear

Answer: B
Page Ref: Section 5

32) Which statement is <u>not</u> true about the TATA box?

A) The TBP portion of the general transcription factor TFIID binds to the TATA box forming a molecular clamp.

B) It is located about 19–27 bp upstream from the transcription start site of class II genes.

C) Its sequence is highly conserved among all species.

D) This region of DNA is more easily unwound to an open complex than other general sections of DNA.

Answer: C
Page Ref: Section 5

33) Which statement is <u>not</u> true about the binding of TBP (TATA binding protein)?

A) The TBP subunit is only required for the initiation of transcription of class II genes.

B) The binding of TBP to DNA distorts the DNA out of the standard B–DNA form.

C) Contacts between TBP and DNA are mainly in the minor groove.

D) TBP forms a saddle–shaped molecular clamp that surrounds DNA at the TATA box.

Answer: A
Page Ref: Section 5

34) Which of the following is true about transcription?

A) A repressor protein activates transcription of a negatively regulated gene.

B) A positively regulated gene can be transcribed only in the absence of active repressor.

C) In the absence of an activator, a negatively regulated gene is poorly transcribed.

D) The initiation of transcription of regulated genes is controlled by regulatory proteins which bind to specific DNA sequences.

E) All of the above

Answer: D
Page Ref: Section 6

35) When a repressor protein is ________ (bound, unbound) to a promoter region transcription is allowed; when an activator protein is ________ (bound, unbound) to a promoter transcription is stimulated.

A) bound; unbound
B) unbound; bound
C) bound; bound
D) unbound; unbound

Answer: B
Page Ref: Section 6

36) Characteristics of ligands involved in transcription include:

A) They can modify the function of repressors and activators.

B) They are considered inducers when they bind to repressors and activate them.

C) They are considered corepressors when they bind to repressors and inactivate them.

D) All of the above

Answer: A
Page Ref: Section 6

37) Constitutive genes

A) have products that are maintained at constant levels.

B) are genes expressed by all cells.

C) are transcribed continuously.

D) All of the above

E) None of the above

Answer: D
Page Ref: Section 6

38) Protein X is found to bind to a certain gene's promoter only when substance A is not present. The gene can be transcribed in the presence of both X and A. It is not transcribed in the presence of X alone. Protein X is a/an ________. Substance A is a/an ________.

A) repressor; inducer
B) repressor; corepressor
C) activator; inducer
D) activator; corepressor

Answer: A
Page Ref: Section 6

39) Positive regulation of a gene requires ________.

A) an activator protein
B) positive cooperativity
C) an allosteric inducer
D) the conversion of ATP to ADP and inorganic phosphate

Answer: A
Page Ref: Section 6

40) An operon is ________.

A) a set of genes whose transcription is controlled by a single promoter
B) the site of repressor binding
C) a protein that activates the transcription of a whole class of genes
D) a multisubunit complex responsible for the splicing of exons

Answer: A
Page Ref: Section 7

41) An extremely large lactose source is encountered by an *E. coli* cell in the lumen of the small intestine of a human who just ate an entire carton of ice cream. Which of the following would most likely be a contributor to why the *E. coli* does not metabolize any of the lactose?

A) presence of allolactose
B) presence of phosphorylated adenylate cyclase
C) absence of glucose
D) absence of cAMP

Answer: D
Page Ref: Section 7

42) Which statement is false about the utilization of lactose as a carbon source by *E. coli*?

A) In the presence of both glucose and lactose, the enzymes necessary for lactose catabolism are produced only in limited amounts.

B) Lactose is the inducer for the enzymes responsible for its own catabolism.

C) In the absence of lactose, the repressor binds to a single site upstream of the *lac* genes.

D) The catabolic enzymes are encoded in a three-gene operon controlled by a single promoter.

Answer: C
Page Ref: Section 7

43) The product of the *lac*Z gene is ________.

A) *lac* repressor

B) β-galactosidase

C) thiogalactoside transacetylase

D) lactose permease

Answer: B
Page Ref: Section 7

44) Which is not part of the *lac* operon?

A) *lac*A

B) *lac*I

C) *lac*Y

D) *lac*Z

E) None of the above; they are all part of the *lac* operon

Answer: B
Page Ref: Section 7

45) Which is not true about the *lac* repressor?

A) Its gene is part of the *lac* operon and is transcribed along with *lacZ*, *lacA* and *lacY*.

B) When it binds to DNA, it forms a loop-type structure.

C) It likely blocks both RNA polymerase binding as well as transcription initiation.

D) It binds to DNA by interaction of an α-helix with the major groove.

Answer: A
Page Ref: Section 7

46) Which statement is <u>false</u> about operons that have the feature of catabolic repression?

A) Several different multisubunit repressors can block the transcription of such an operon.

B) Operons with catabolic repression have characteristically weak promoters.

C) Their transcription is lowered in the presence of glucose.

D) Transcription of such an operon is increased as the concentration of cAMP increases.

Answer: A
Page Ref: Section 7

47) Which is <u>not</u> generally associated with RNA processing?

A) addition of nucleotides
B) removal of nucleotides
C) covalent modification of bases
D) phosphorylation at the 3' end

Answer: D
Page Ref: Section 8

48) The sequence CCA <u>must</u> occur ________.

A) at the 3' end of both prokaryotic and eukaryotic tRNA

B) immediately upstream from the TATA box

C) at the 5' end of an intron

D) at the origin of replication in *E. coli*

Answer: A
Page Ref: Section 8

49) Which does <u>not</u> apply to the post–transcriptional processing of ribosomal RNA?

A) The subunits of rRNA are produced in equal amounts since they originate from the same transcript.

B) tRNA precursors are sometimes cleaved from the primary transcript of rRNA precursor.

C) A polyA tail is added to the 5' end of the 30S subunit.

D) After initial cleavage of the primary transcript, specific endonucleases trim nucleotides from the ends of rRNA molecules.

Answer: C
Page Ref: Section 8

50) Which has its primary transcript produced in the nucleolus?

A) tRNA
B) mRNA
C) rRNA
D) sRNA

Answer: C
Page Ref: Section 8

51) Which is not a feature of eukaryotic mRNA processing?

A) addition of a 5'–5' triphosphate linkage to GTP

B) methylation of the terminal CCA triad

C) addition of a polyA tail to the 3' end

D) removal of intron sequences

Answer: B
Page Ref: Section 9

52) A gene contains two 100 bp introns and three 50 bp exons. About how long is the mature RNA transcribed from this gene?

A) 75 bp

B) 150 bp

C) 200 bp

D) 350 bp

E) Cannot tell from the information given

Answer: B
Page Ref: Section 9

53) The purpose of the GTP cap on mRNA is ________.

A) to prevent the formation of hairpin loops

B) to serve as a site for binding to the ribosome

C) to assist in the transport of mRNA out of the nucleus

D) to prevent exonuclease attack

Answer: D
Page Ref: Section 9

54) Sequences that are removed from the primary RNA transcript in eukaryotes are called ________.

A) introns B) operons C) exons D) mRNA

Answer: A
Page Ref: Section 9

55) The large RNA–protein complex that processes introns and exons is called ________.

A) the replisome B) the catalytic RNA complex

C) the spliceosome D) RNA ligase

Answer: C
Page Ref: Section 9

56) Transcription is the process by which the information in mRNA molecules is interpreted and the appropriate proteins synthesized.

Answer: FALSE
Page Ref: Introduction

57) A small percentage of the total RNA in a cell is ribosomal RNA.

Answer: FALSE
Page Ref: Section 1

58) RNA polymerase catalyzes DNA–directed RNA synthesis.

Answer: TRUE
Page Ref: Section 2

59) RNA polymerase requires a high–precision fit when catalyzing the formation of a new phosphodiester linkage.

Answer: TRUE
Page Ref: Section 2

60) A transcription complex does not form when one or more proteins bind to the promoter sequence and to RNA polymerase in eukaryotes.

Answer: FALSE
Page Ref: Section 3

61) The unwinding of DNA at the initiation site is an example of a conformational change.

Answer: TRUE
Page Ref: Section 3

62) Rho–dependent termination requires exposure of single–stranded RNA.

Answer: TRUE
Page Ref: Section 4

63) Rho–dependent termination occurs at pause sites within the coding region.

Answer: FALSE
Page Ref: Section 4

64) The genes encoding the chloroplast RNA polymerase are not similar in sequence to those of RNA polymerase in cyanobacteria.

Answer: FALSE
Page Ref: Section 5

65) TFIIB can bind to DNA in the absence of TFIID.

Answer: FALSE
Page Ref: Section 5

66) Class I genes encode large ribosomal RNA.

Answer: TRUE
Page Ref: Section 5

67) The same RNA polymerase that transcribes the ribosomal RNA transcribes all mitochondrial genes.

Answer: FALSE
Page Ref: Section 5

68) TATA binding protein is the only transcription factor common among all eukaryotic RNA polymerases.

Answer: TRUE
Page Ref: Section 5

69) Regulation of gene expression can only occur at the level of transcription.

Answer: FALSE
Page Ref: Section 6

70) All housekeeping genes have weak promotors and are regulated to maintain their gene products at constant low level concentrations.

Answer: FALSE
Page Ref: Section 6

71) Activators and repressors are often allosteric proteins.

Answer: TRUE
Page Ref: Section 6

72) Operons are a common gene arrangement found in all living organisms.

Answer: FALSE
Page Ref: Section 7

73) The gene products of the *lacZ, lacA* and *lacY* genes are specific for the hydrolysis of a different β–galactoside sugar.

Answer: FALSE
Page Ref: Section 7

74) The CRP–cAMP complex is an activator of the *lac* operon.

Answer: TRUE
Page Ref: Section 7

75) Post–transcriptional modification of mRNA in eukaryotes occurs after they are transported to the cytosol, but before they bind to the ribosome.

Answer: FALSE
Page Ref: Section 9

76) The splicing of exons does not occur in prokaryotes.

Answer: TRUE
Page Ref: Section 9

77) Mutations in sequences that are removed from the primary RNA transcript never affect RNA processing.

Answer: FALSE
Page Ref: Section 9

Chapter 22 Protein Synthesis

1) How many possible codons (of normal size) are possible using the bases found in DNA?

A) 4 B) 16 C) 20 D) 64

Answer: D
Page Ref: Section 1

2) Of all the possible triplet codons, ________ do not code for an amino acid.

A) 0 B) 1 C) 2 D) 3 E) 4

Answer: D
Page Ref: Section 1

3) The reading frame of DNA is fixed by

A) mRNA. B) the initiation codon.

C) one of three stop codons. D) the codon UUU.

Answer: B
Page Ref: Section 1

4) Use the table below to determine which template strand **DNA** sequence (written in the 5' → 3' direction) specifies the tripeptide with the sequence gly–ala–leu.

First position (5' end)	Second position U	C	A	G	Third position (3' end)
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	STOP	STOP	A
	Leu	Ser	STOP	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

A) GGGGCUCUC
B) CUCUCGGGG
C) CCCCGAGAG
D) GAGAGCCCC

Answer: D
Page Ref: Section 1

5) Which statement is true about the number of initiation and STOP codons?

A) One initiation codon; one STOP codon
B) One initiation codon; multiple STOP codons
C) Multiple initiation codons; one STOP codon
D) Multiple codons for both initiation and STOP

Answer: B
Page Ref: Section 1

6) Different codons that specify the same amino acid are called ________ codons.

A) synonymous
B) repetitive
C) variable
D) multiplex

Answer: A
Page Ref: Section 1

7) Which is <u>not</u> true about the genetic code?

A) Some amino acids share the same codon.

B) The first two nucleotides of a codon are often enough to specify a given amino acid.

C) Some codons do not specify an amino acid.

D) Nearly all organisms use the same genetic code.

Answer: A
Page Ref: Section 1

8) The initiation codon ________.

A) specifies uracil

B) specifies methionine

C) binds a protein complex that starts translation

D) is part of the TATA box

Answer: B
Page Ref: Section 1

9) The unambiguity and degeneracy of the genetic code can best be respectively exemplified by which of the following?

A) UUU and UUC both code for Phe; UUU codes only for Phe

B) UUU codes only for Phe; UUU and UUC both code for Phe

C) UUU codes for both Phe and Ser; UUU and UUC both code for Phe and Ser

D) UUU and UUC both code for Phe and Ser; UUU codes for both Phe and Ser

Answer: B
Page Ref: Section 2

10) ________ carries the anticodon.

A) rRNA B) mRNA C) tRNA D) DNA

Answer: C
Page Ref: Section 2

11) The acceptor stem of tRNA consists of the ________.

A) loop that includes the anticodon

B) terminal CCA only

C) 5' end and a region near the end 3' end that are base-paired to each other

D) variable arm and the D arm

Answer: C
Page Ref: Section 2

12) What is the 5' → 3' anticodon for an amino acid with the codon CAG?

A) GAC B) CUG C) GUC D) CTG

Answer: B
Page Ref: Section 2

13) The anticodon of $tRNA^{ala}$ can bind to three different codons for alanine (GCU, GCC and GCA) because

A) there are different bases at the 5' end position of the anticodon.

B) there are different bases at the 3' end position of the anticodon.

C) the base at the 5' position of the anticodon is I and is the wobble position.

D) the base at the 3' position of the anticodon is I and is the wobble position.

Answer: C
Page Ref: Section 2

14) The codon for the amino acid specified by the anticodon at the anticodon arm of tRNA is covalently linked to tRNA at the

A) variable arm. B) D arm. C) TyC arm. D) acceptor arm.

Answer: D
Page Ref: Section 2

15) If the anticodon on tRNA is GTC (tyrosine)(5' → 3'), the sequence of the 5' → 3' template strand of the gene in DNA that specifies this amino acid is

A) AUG. B) TAC. C) GTC. D) CTG.

Answer: C
Page Ref: Section 2

16) Amino acids are attached to tRNA at the ________.

A) anticodon region B) 5' end

C) 3' end D) variable arm

Answer: C
Page Ref: Section 2

17) At the ribosome, the codon and anticodon associate by ________.

A) hydrogen bonding

B) disulfide bonds

C) ionic attractions

D) covalent bonding

E) hydrophobic interactions

Answer: A
Page Ref: Section 2

18) What is a reasonable number of nucleotides in a tRNA molecule?

A) 20

B) 80

C) 500

D) 1000

E) The number of nucleotides in tRNA molecules varies by several orders of magnitude, depending on the species.

Answer: B
Page Ref: Section 2

19) Which statement is not true about the "wobble" position?

A) It is in the 5' position on the anticodon.

B) Base pairing other than Watson–Crick base pairing is allowed at this position.

C) It allows anticodons to recognize more than one codon.

D) Often has inosinate at the 3' position of the codon.

Answer: D
Page Ref: Section 2

20) Different tRNA molecules that bind the same amino acid are called ________ tRNA molecules.

A) synonymous

B) complementary

C) homologous

D) isoacceptor

Answer: D
Page Ref: Section 2

21) The link between an activated amino acid and tRNA is an ________ bond between the ________ of the amino acid and a hydroxyl group of the tRNA.

A) ester; carboxylate group
B) amide; carboxylate group
C) amide; amino group
D) imine; amino group

Answer: A
Page Ref: Section 3

22) Which statement is <u>false</u> concerning aminoacyl–tRNA synthetase?

A) It recognizes only one amino acid, but may recognize more than one tRNA.
B) It requires a conversion from ATP to ADP.
C) Hydrolysis of pyrophosphate essentially makes its reaction irreversible.
D) Some synthetases bind the anticodon and others do not.

Answer: B
Page Ref: Section 3

23) The net effect of all amino acid tRNA synthetases binding to a tRNA is to position the ________ of tRNA in the active site.

A) 3' end
B) 5' end
C) anticodon
D) D arm

Answer: A
Page Ref: Section 3

24) Which help cells avoid mis–insertion of amino acids in protein synthesis?

A) the specificity of codon:anticodon interactions
B) the specificity of tRNA: amino acid pairs
C) the proofreading ability of tRNA synthetases
D) All of the above

Answer: D
Page Ref: Section 3

25) Which is true about proofreading activity during the synthesis of aminoacyl–tRNAs?

A) Proofreading is accomplished as an amino acid enters the active site of the enzyme. Incorrect amino acids are rejected before any reaction occurs.
B) Proofreading occurs just after aminoacyl–adenylate formation.
C) A separate cytosolic proofreading enzyme catalyzes the hydrolysis of incorrect aminoacyl–tRNAs.
D) No proofreading activity is necessary due to the high level of specificity of all aminoacyl–tRNA synthetases.

Answer: C
Page Ref: Section 3

26) At the ribosome the template mRNA is translated in the ________ direction, while the protein is synthesized in the ________ direction.

A) 5' → 3'; N–terminal to C–terminal
B) 5' → 3'; C–terminal to N–terminal
C) 3' → 5'; N–terminal to C–terminal
D) 3' → 5'; C–terminal to N–terminal

Answer: A
Page Ref: Section 4

27) Which statement is false concerning ribosomes and their components?

A) All ribosomes have two subunits of unequal size.
B) The genes for eukaryotic rRNA occur as tandem arrays of hundreds of copies.
C) The 30S and 50S ribosomal subunits of *E. coli* combine to generate an 80S subunit.
D) Sequences exist in prokaryotic and eukaryotic rRNA that are so similar, they likely derive from a common ancestor.

Answer: C
Page Ref: Section 4

28) The deaminoacylated tRNA leaves the ribosome as the growing polypeptide passes through the tunnel of the large ribosomal subunit from the ________.

A) 30S or 40S subunit
B) protein factors
C) E site
D) P site

Answer: C
Page Ref: Section 4

29) The first amino acid incorporated into proteins ________.

A) can be any of the 20 standard amino acids
B) is an *N*–formylmethionine in *E. coli* and methionine in other organisms
C) is always inosinate
D) is an amidated methionine residue that is cleaved following termination of translation

Answer: B
Page Ref: Section 5

30) Shifting of the reading frame by one nucleotide results in ________.

A) the production of a completely different protein that is likely non–functional
B) a substitution only at the first amino acid
C) the generation of homologous proteins
D) a protein that has one less or one more amino acid

Answer: A
Page Ref: Section 5

31) Which of the following is mismatched?

A) initiator tRNA – recognizes AUG codons during initiation at the P site

B) Shine–Dalgarno sequence – upstream of the initator codon and plays a role in initiation

C) Shine–Dalgarno sequence – pyrimidine–rich stretch at the 3' end of 16S rRNA

D) eukaryotic initiation factors – IF–1, IF–2, IF–3

Answer: D
Page Ref: Section 5

32) What statement is <u>not true</u> about the Shine–Dalgarno sequence?

A) It is a pyrimidine–rich region of mRNA.

B) It is present only in prokaryotes.

C) It is complementary to a sequence of an rRNA sequence.

D) It helps position the initiation codon at the P site on the ribosome.

Answer: A
Page Ref: Section 5

33) Prokaryotic mRNA molecules that contain several coding regions that encode several polypeptides are ________.

A) synonymous

B) tandemly coded

C) polycistronic

D) impossible

Answer: C
Page Ref: Section 5

34) In eukaryotes what is the function of eIF–4 (cap binding protein)?

A) It assists in the dissociation of the ribosomal complex following termination of translation.

B) It cleaves the first amino acid on a newly translated protein.

C) It binds to the 5' end of mRNA and assists in the formation of the pre–initiation complex.

D) It acts as a general acid–base catalyst during the formation of the peptide bond.

Answer: C
Page Ref: Section 5

35) The correct order for the formation of the prokaryotic 70S initiation complex is

A) 50S → IF–1, IF–2 → mRNA → fMet–tRNA$_f^{met}$ → 30S

B) 30S → IF–1, IF–3 → fMet–tRNA$_f^{met}$ → IF–2 → mRNA → 50S

C) 30S → IF–1, IF–3 → IF–2 → fMet–tRNA$_f^{met}$ → mRNA → 50S

D) 30S → IF–1, IF–2 → IF–3 → fMet–tRNA$_f^{met}$ → mRNA → 50S

Answer: C
Page Ref: Section 5

36) Which statement is <u>false</u> about polysomes?

A) They consist of mRNA and many translation complexes that are separated by about 100 nucleotides.

B) They serve to amplify the information contained in mRNA many–fold.

C) The number of translation complexes one contains depends on the efficiency of initiation.

D) They do not occur in prokaryotes.

Answer: D
Page Ref: Section 6

37) How many GTP are hydrolyzed for every aminoacyl–tRNA that is successfully inserted into the A site of the ribosome?

A) zero B) 1 C) 2 D) 4

Answer: B
Page Ref: Section 6

38) At the end of the initiation step, the ribosome has a vacant

A) A site.

B) P site.

C) mRNA site.

D) tRNA.

E) All of the above

Answer: A
Page Ref: Section 6

39) Chain elongation consists of three steps: (1) positioning the correct aminoacyl–tRNA to the A site, (2) forming the peptide bond and (3) ________.

A) dissociation of the 30S and 50S subunits

B) removal of the fMet–tRNA$_f^{met}$ from the complex

C) moving the mRNA along one codon

D) All of the above

E) None of the above

Answer: C
Page Ref: Section 6

40) After the action of peptidyl transferase, the peptidyl–tRNA is located at the

A) P site.

B) A site.

C) E site.

D) partly in the A site and partly in the P site.

Answer: D
Page Ref: Section 6

41) Unlike bacterial mRNA, eukaryotic mRNA must undergo ________ before it may be used for translation.

A) splicing

B) capping

C) polyadenylation

D) export to the cytoplasm

E) All of the above

Answer: E
Page Ref: Section 6

42) The role of EF–Tu in bacterial protein synthesis is

A) formation of the peptide bond.

B) positioning the correct aminoacyl–tRNA at the A site.

C) positioning the correct aminoacyl–tRNA at the P site.

D) moving the mRNA by one codon.

E) All of the above

Answer: B
Page Ref: Section 6

43) The role of GTP in the elongation phase of protein synthesis is to supply energy for

A) peptide bond formation.

B) formation of aminoacyl–tRNA molecules.

C) movement of mRNA along the ribosome.

D) changing the configuration of EF–Tu–GTP.

E) All of the above

Answer: D
Page Ref: Section 6

44) An elongation factor EF–Ts serves mainly to

A) hydrolyze GTP.

B) exchange GTP for GDP.

C) eeliver the aminoacyl–tRNA to the ribosome.

D) hydrolyze GDP.

E) All of the above

Answer: B
Page Ref: Section 6

45) The peptide bond is formed by

A) a protein–catalyzed reaction.

B) an RNA–catalyzed reaction.

C) a combination of A and B.

D) hydrolysis of ATP.

E) hydrolysis of CTP.

Answer: B
Page Ref: Section 6

46) At the beginning of translocation, the growing peptide chain is attached to tRNA located at the ________ on the ribosome.

A) P site and part of the A site

B) A site and part of the P site

C) A site only

D) P site only

Answer: B
Page Ref: Section 6

47) The role of GTP in the translocation step of protein synthesis is to supply energy for

A) peptide bond formation.

B) dissociation of EF–G–GDP.

C) movement of the peptidyl–tRNA from the P site to the A site.

D) movement of the peptidyl–tRNA from the A site to the P site.

E) None of the above

Answer: D
Page Ref: Section 6

48) The E site on the ribosome is the location of

A) EF factors.

B) a tunnel in the ribosome.

C) the deaminoacylated tRNA.

D) the aminoacylated tRNA.

E) None of the above

Answer: C
Page Ref: Section 6

49) Translation begins to be terminated when

A) three release factors appear at the ribosome complex.

B) three release factors enhance the hydrolysis of the peptide.

C) an fMet tRNA codon is in the mRNA.

D) a termination codon is in the mRNA.

E) the ribosomal subunits dissociate from the mRNA.

Answer: D
Page Ref: Section 7

50) For each amino acid added to a polypeptide chain, ________ phosphoanhydride bonds are cleaved.

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

Answer: D
Page Ref: Section 8

51) Puromycin is an antibiotic that inhibits protein synthesis because

A) it binds a ribosomal protein.

B) it inhibits peptidyl transferase.

C) it binds to the 50S subunit preventing translocation.

D) it looks like aminoacyl–tRNA and binds to the A site.

E) it binds to the E site.

Answer: D
Page Ref: Section 9

52) Ribosomal protein synthesis is controlled by inhibitor proteins, the genes of which are located on the ribosomal protein operon, and which bind to ________ when ribosome assembly slows and bind to ________ when ribosome assembly is proceeding at a steady rate.

A) rRNA; mRNA

B) 30S; 50S

C) 50S; 30S

D) mRNA; rRNA

E) 50S; mRNA

Answer: D
Page Ref: Section 9

53) If there is more globin than heme present in a reticulocyte, globin synthesis is stopped by

A) the activation of HCI (heme–controlled inhibitor).

B) the inactivation of HCI.

C) increasing heme synthesis.

D) decreasing heme synthesis.

E) activating eIF–2.

Answer: A
Page Ref: Section 9

54) Tryptophan synthesis is controlled by a repressor protein which is activated by a corepressor which is

A) leader peptide.

B) promoter locus.

C) operator locus.

D) tryptophan.

Answer: D
Page Ref: Section 9

55) Tryptophan synthesis can be controlled by a process called attenuation in which the levels of tryptophan in the cell control translation by

A) the binding of the RNA polymerase to the genome.

B) the alteration of the repressor protein.

C) the folding of mRNA into hairpin loops.

D) genes rich in codons for tryptophan.

Answer: C
Page Ref: Section 9

56) Which statement is true about the attenuation mechanism of regulation?

A) Eukaryotes lack this mechanism because transcription and translation occur in different parts of the cell.

B) Attenuation is the modern term for repression in prokaryotes.

C) It is a form of regulation at the level of transcription, thereby preventing any translation.

D) Attenuation is the most common type of regulation found in plants.

Answer: A
Page Ref: Section 9

57) Arrange the events listed below in order according to the signal hypothesis:

I. Signal sequence binds to SRP
II. Translation stops
III. Translation starts
IV. Ribophorins anchor complex
V. SRP dissociates; GTP hydrolyzed
VI. SRP–signal complex binds to docking protein

A) I → II → II → IV → V → VI

B) I → III → VI → V → II → IV

C) V → III → IV → VI → II → I

D) I → II → VI → IV → III → V

Answer: D
Page Ref: Section 10

58) When an oligosaccharide is covalently bonded to an asparagine (or other amino acid) side chain, the resulting product is a(n)

A) protein glycoside.

B) glyocophorin.

C) glycoprotein.

D) oligoprotein.

Answer: C
Page Ref: Section 10

59) In prokaryotes the codons can be arranged in an overlapping fashion. In eukaryotes they are arranged only in a non–overlapping fashion.

Answer: FALSE
Page Ref: Section 1

60) Termination (stop) codons are recognized by specific proteins that cause newly synthesized peptides to be released from the ribosome.

Answer: TRUE
Page Ref: Section 1

61) Methionine and tryptophan are the only amino acids that do not have multiple codons.

Answer: TRUE
Page Ref: Section 1

62) The anticodon is found on the variable arm of tRNA.

Answer: FALSE
Page Ref: Section 2

63) Inosinate (I) is an acetylated form of G and it can base–pair with A, C, or U.

Answer: FALSE
Page Ref: Section 2

64) Isoacceptor tRNAs can only differ in primary sequence at the anticodon.

Answer: FALSE
Page Ref: Section 2

65) Class II aminoacyl–tRNA synthetases are often multimeric enzymes that do not bind to the anticodon.

Answer: TRUE
Page Ref: Section 3

66) The genes for rRNA tend to have very strong promoters.

Answer: TRUE
Page Ref: Section 4

67) Most mature mRNA transcripts contain multiple reading frames.

Answer: FALSE
Page Ref: Section 5

68) In eukaryotes the initiation codon is the first AUG triplet from the 5' end of mRNA.

Answer: TRUE
Page Ref: Section 5

69) Translation at the ribosomes of eukaryotes is usually a much faster process than DNA replication.

Answer: FALSE
Page Ref: Section 6

70) Coupling of transcription and translation occurs in both animal and bacterial cells.

Answer: FALSE
Page Ref: Section 6

71) There are five times more ribosomes in eukaryotic cells than in most bacterial cells.

Answer: TRUE
Page Ref: Section 6

72) The EF–Tu–GTP complex recognizes fMet–tRNA$_f^{met}$ in bacteria but not in eukaryotic cells.

Answer: FALSE
Page Ref: Section 6

73) EF–Ts promotes the dissociation of GDP from the EF–Tu–GDP complex to recycle this elongation factor.

Answer: TRUE
Page Ref: Section 6

74) Peptidyl transferase catalyzes peptide bond formation, and the activity is contained within the protein portion of the large ribosomal subunit.

Answer: FALSE
Page Ref: Section 6

75) Chaperone proteins help to fold newly translated proteins into correct configurations.

Answer: TRUE
Page Ref: Section 6

76) Release factors fit into the A site when one of three codons (UGA, UAG, or UAA) is positioned there.

Answer: TRUE
Page Ref: Section 7

77) More energy is used to form a single peptide bond than is required for the bond formation alone.

Answer: TRUE
Page Ref: Section 8

78) Streptomycin can be used clinically because it inhibits bacterial protein synthesis but not eukaryotic protein synthesis.

Answer: TRUE
Page Ref: Section 9

79) Puromycin can be used clinically because it inhibits bacterial protein synthesis by resembling aminoacyl–tRNA.

Answer: FALSE
Page Ref: Section 9

80) The main control of the rate of globin synthesis is due to the activity of GEF (guanine nucleotide exchange factor).

Answer: FALSE
Page Ref: Section 9

81) The gene for inhibiting ribosomal protein synthesis lies within the operon for the ribosomal proteins.

Answer: TRUE
Page Ref: Section 9

82) Tryptophan synthesis can be controlled by controlling transcription but not translation.

Answer: FALSE
Page Ref: Section 9

83) After proteins emerge from the ribosome, the N–terminal end starts to fold even before the entire protein is made.

Answer: TRUE
Page Ref: Section 10

84) Proteins destined to enter a cell membrane contain a signal peptide at the C–terminal end of the peptide.

Answer: FALSE
Page Ref: Section 10

85) Proteins processed through the Golgi apparatus and usually destined for export from the cell are modified by glycosylation only.

Answer: FALSE
Page Ref: Section 10

Chapter 23 Recombinant DNA Technology

1) DNA molecules which are constructed with DNA from different sources are called

A) exons.
B) introns.
C) transgenic DNA molecules.
D) recombinant DNA molecules.

Answer: D
Page Ref: Section 1

2) General steps in the generation of a recombinant DNA molecule in the laboratory include

A) ligation of DNA segments.
B) cleavage of DNA into small fragments.
C) insertion of DNA fragments into a vector.
D) All of the above

Answer: D
Page Ref: Section 1

3) ________ is the propagation of individual host cells containing a recombinant DNA molecule.

A) Transformation
B) Cloning
C) Transduction
D) None of the above

Answer: B
Page Ref: Section 1

4) ________ is the direct uptake of foreign DNA by a host cell.

A) Transfection
B) Transduction
C) Transformation
D) Conjugation

Answer: C
Page Ref: Section 1

5) Results of research on the Human Genome Project should enable which of the following?

A) precise diagnosis of disease
B) individual risk assessment
C) prediction of the course of a disease
D) All of the above

Answer: D
Page Ref: Section 1

6) Which of the following can function as a cloning vector?

A) plasmids

B) bacteriophages

C) viruses

D) All of the above

E) None of the above

Answer: D
Page Ref: Section 2

7) Which of the following is <u>false</u>?

A) Blunt end fragments of DNA can be ligated.

B) A sheared DNA fragment can be given sticky ends.

C) The enzyme deoxynucleotidyl transferase cannot generate sticky ends.

D) A synthetic DNA fragment, called a linker, can connect blunt end DNA fragments.

Answer: C
Page Ref: Section 2

8) Properties of cloning vectors include each of the following, except

A) they may contain sequences which allow them to be replicated autonomously within a compatible host cell.

B) they may contain sequences which enable integration into the host genome.

C) only a select few of them may have a unique cloning site which can be cut by restriction endonucleases.

D) the most important vectors have restriction sites which are grouped together in a polylinker.

Answer: C
Page Ref: Section 2

9) Insert DNA may be produced by

A) the mechanical shearing of long DNA molecules.

B) digesting DNA with type II restriction endonucleases.

C) the action of reverse transcriptase on rRNA.

D) All of the above

E) Only A and B

Answer: E
Page Ref: Section 2

10) Which of the following statements is true concerning sticky ends?

A) They are fragments with single strand extensions at only the 5' end of a restriction endonuclease.

B) They can transiently base pair to complementary sticky ends on vector DNA.

C) They can covalently join to the vector in a reaction catalyzed by DNA gyrase.

D) All of the above

Answer: B
Page Ref: Section 2

11) ________ are small, circular double-stranded DNA molecules used as vectors for DNA fragments up to 20kb in size.

A) Exons B) Plasmids C) Introns D) Cosmids

Answer: B
Page Ref: Section 2

12) Which of the following is true, concerning the plasmid vector, pBR322?

A) It contains an origin of replication (ori).

B) It contains genes which confer resistance to the antibiotics ampicillin and tetracycline.

C) It contains a number of restriction sites that are useful for constructing RNA.

D) All of the above

E) Only A and B

Answer: E
Page Ref: Section 2

13) Plasmids are usually introduced into bacterial cells by ________.

A) transfusion B) transfection

C) transduction D) transformation

Answer: D
Page Ref: Section 2

14) Bacterial artificial chromosomes (BACs) require ________ in order to successfully enter into bacterial cells.

A) transfection B) electroporation

C) the use of complementary nucleotides D) linkers

Answer: B
Page Ref: Section 2

15) Which of the following is an advantage of phage vectors over plasmid vectors?

A) Recombinant DNA must be packaged into phage particles in vitro.

B) It is not possible to isolate a line of cells that can propagate the recombinant DNA molecule.

C) Transfection is more efficient than transformation for larger pieces of DNA.

D) All of the above

Answer: C
Page Ref: Section 2

16) ________ replicate in either prokaryotic or eukaryotic cells.

A) Phage vectors
B) Shuttle vectors
C) Cosmids
D) Transposons

Answer: B
Page Ref: Section 2

17) Inserting DNA into a cloning site within the *tet*^{R} gene may cause the following

A) inactivation of the *tet*^{R} gene.

B) produce transformants which are sensitive to ampicillin.

C) produce transformants which are resistant to tetracycline.

D) All of the above

Answer: A
Page Ref: Section 3

18) Which of the following list gives the amount of foreign DNA that can be inserted into vectors is <u>not true</u>?

A) YAC – 400 to 500 kb
B) Plasmids – 20 kb
C) Bacteriophage l – up to 22 kb
D) Cosmids – up to 5 kb

Answer: D
Page Ref: Section 3

19) In a blue/white screen

A) the blue colonies represent cells transformed with cloning vectors which contain inserts.

B) the white colonies represent cells transformed with recombinants.

C) the presence of blue dye identifies cells containing a disrupted a–galactosidase gene.

D) All of the above

Answer: B
Page Ref: Section 3

20) To be useful as a vector, restriction enzyme reaction sites should be placed

A) around antibiotic resistance genes.
B) within antibiotic resistance genes.
C) in the *ori* site.
D) inside TRP1 or URA3 genes.

Answer: B
Page Ref: Sections 3,4

21) The human genome contains about ________ bp of DNA.

A) 3.2 thousand
B) 3.2 million
C) 3.2 billion
D) 3.2 trillion

Answer: C
Page Ref: Section 4

22) Which of the following is true concerning genomic libraries?

A) Genomic libraries often use cloning vectors derived from plasmid vectors.
B) Total restriction digestion frequently is used to ensure that the library contains every gene.
C) Genomic libraries include both expressed and non–expressed DNA from an organism.
D) All of the above

Answer: C
Page Ref: Section 4

23) Mechanical shearing is often the preferred method of fragmenting genomic DNA when constructing a genomic DNA library. Why would this method be preferred over complete digestion with restriction enzymes?

A) Enzymes might produce fragments that are too small or too large to be cloned.
B) Enzyme cleavage can interrupt important gene sequences, in which case not all genes may be represented in the library.
C) Shearing ensures the library contains overlapping fragments of DNA, which makes it possible to perform a chromosome walk.
D) All of the above

Answer: D
Page Ref: Section 4

24) The construction of a cDNA library is completed by

A) purifying mRNA molecules from eukaryotes.
B) ligating the cDNA molecules to vectors and introducing the recombinants into host cells.
C) incubating the mRNA population with oligodeoxythymidylate.
D) adding synthetic oligonucleotides to sticky–ended cDNA molecules.

Answer: B
Page Ref: Section 5

25) cDNA libraries from liver cells are different than cDNA libraries from kidney cells because

A) the DNA is not the same in the two types of cells.

B) reverse transcriptase acts differently in the two types of cells.

C) mRNA is different in the two types of cells.

D) polyA is present at 3' ends of mRNA in one cell type only.

Answer: C
Page Ref: Section 5

26) Which formula may be implemented to determine the probability (P) that a library of a given size contains a particular clone? (N is the number of recombinant clones in the library; n is the frequency of occurrence of a desired clone)

A) $P = 1 + (1 - N)^n$
B) $P = 1 - (1 - N)^n$
C) $P = 1 - (1 - n)^N$
D) $P = 1 + (1 - n)^N$

Answer: C
Page Ref: Section 6

27) In a genomic DNA library the frequency of occurrence of a desired clone, n, also represents

A) the number of recombinant clones in the library.

B) the abundance of the relevant mRNA molecule.

C) the ratio of the size of the insert to the size of the genome.

D) the probability that a library of a given size contains a particular clone.

Answer: C
Page Ref: Section 6

28) How many recombinant clones must be present in a cDNA library to be 95% certain that the library contains one clone of a particular mRNA molecule representing 0.005% of the total mRNA?

A) 5.9×10^3
B) 6×10^4
C) 6×10^6
D) 5×10^5

Answer: B
Page Ref: Section 6

29) To discover whether a species has a gene that is similar but not identical to the cDNA of another species, one can

A) prepare proteins from one species only.

B) isolate the two different genes first.

C) hybridize using histone.

D) alter the temperature and salt concentrations used in the hybridization.

Answer: D
Page Ref: Section 6

30) A molecule that specifically recognizes the desired piece of DNA in a large library is known as a

A) cosmid. B) plasmid. C) probe. D) vector.

Answer: C
Page Ref: Section 6

31) Which of the following may function as a labeled probe?

A) oligonucleotides

B) antibodies

C) radioactive isotopes

D) fluorescent dyes

E) All of the above

Answer: E
Page Ref: Section 6

32) How many recombinant clones must be screened in order to be 99% certain that a particular gene is found in a YAC library of human DNA where the average size of an insert is 500 kbp? The human genome size is about 3.2×10^6 kbp.

A) 6000 B) 30,000 C) 1,000,000 D) 30,000,000

Answer: B
Page Ref: Section 6

33) Which is true about the frequency of occurrence of a desired clone from a genomic DNA library?

A) It depends on the abundance of the associated mRNA.

B) It is directly proportional to the size of the genome.

C) It is found as a ratio of the size of the insert to the size of the genome.

D) It cannot be calculated. It is totally random.

Answer: C
Page Ref: Section 6

34) In a cDNA library the probability of finding the desired clone depends on ________.

A) the abundance of the original mRNA B) the genome size

C) the average length of mRNA D) All of the above

Answer: A
Page Ref: Section 6

35) Which is(are) appropriate for use as a labeled probe(s) to screen a DNA library?

A) cloned cDNA
B) antibodies
C) mRNA
D) All of the above

Answer: D
Page Ref: Section 6

36) Under normal conditions, about what minimum range of sequence similarity is desired to obtain hybridization between a cDNA probe and the desired gene in a library?

A) 5% to 10%
B) 30% to 40%
C) 60% to 70%
D) 90% to 95%

Answer: C
Page Ref: Section 6

37) What is the frequency of occurrence of a desired clone from a YAC library of genomic DNA if the insert size is 400 kbp and the genome contains 2×10^6 kbp?

A) 2×10^{-4}
B) 8×10^8
C) 5×10^3
D) 1.25×10^{-9}

Answer: A
Page Ref: Section 6

38) ________ is a technique used to link noncontiguous recombinants from the same gene or to identify genes whose sequence and gene product are unknown other than by the effects of mutation.

A) Transformation
B) Polymerase chain reaction
C) Antibody screening
D) Chromosome walking

Answer: D
Page Ref: Section 7

39) A/an ________ is often used to enable bacteria to produce large amounts of eukaryotic protein.

A) cosmid
B) transgenic phage
C) expression vector
D) cDNA clone

Answer: C
Page Ref: Section 8

40) Which is not necessary as part of an expression vector used in *E. coli*?

A) marker gene
B) ribosome binding site
C) *Taq* polymerase gene
D) strong promoter sequence

Answer: C
Page Ref: Section 8

41) It can be difficult for bacteria to produce functional eukaryotic proteins even when all the components necessary for gene expression are present because ________.

A) eukaryotes do not use the Shine–Dalgarno sequence

B) many eukaryotic proteins must be post–translationally modified

C) of the size difference between eukaryotic and prokaryotic ribosomes

D) of differences in the prokaryotic and eukaryotic genetic codes

Answer: B
Page Ref: Section 8

42) A mouse embryo is transformed with recombinant DNA from a rat. The resulting mouse is a ________ organism.

A) mosaic B) composite C) transgenic D) sterile

Answer: C
Page Ref: Section 8

43) The Ti plasmid is derived from ________.

A) the bacterium *E. coli*

B) a soil bacterium, *Agrobacterium tumefaciens*

C) yeast, *S. cerevisiae*

D) the tobacco plant

Answer: B
Page Ref: Section 9

44) How might infection of a plant by *E. coli* transformed with a recombinant Ti plasmid be used to have a new gene (e.g. insect toxin) expressed in all cells of the plant?

A) The original plant will eventually express the new gene in all its cells even if only a few cells of the plant are initially infected by *E. coli.*

B) Pollen cells must be infected and then used to produce the next generation of plants which will express the new gene in all cells.

C) Any cell from the original plant that is infected with the *E. coli* is removed and treated to dedifferentiate and eventually to grow into an entire new plant in which the new gene is expressed throughout.

D) All of the above

Answer: C
Page Ref: Section 9

45) ________ was the first bacterial genome sequence to be published.

A) *Haemophilus influenzae*
B) *E. coli*
C) *Agrobacterium tumefaciens*
D) *S. cerevisiae*

Answer: A
Page Ref: Section 9

46) Restriction fragment length polymorphisms are the result of ________.

A) mutation
B) chromosome deletions
C) chromosome recombination
D) all of the above

Answer: D
Page Ref: Section 10

47) Restriction fragment length polymorphisms refer to ________.

A) variations in the size of mature mRNA transcripts from one individual to the next
B) variations in the lengths of genomic DNA fragments from a single individual from samples that are treated with different endonucleases
C) variations in the lengths of genomic DNA fragments among DNA from different tissues in a single individual that are treated with the same endonuclease
D) variations in the lengths of genomic DNA fragments among individuals that are treated with the same endonuclease

Answer: D
Page Ref: Section 10

48) Why is *Taq* polymerase used in PCR rather than DNA polymerases from other sources?

A) It is heat stable.
B) It is faster than most other DNA polymerases.
C) It is cheaper and easier to isolate than other DNA polymerases.
D) All of the above

Answer: A
Page Ref: Section 11

49) After ten cycles of PCR, by approximately what factor will the number of DNA molecules in a sample be increased? Assume maximum efficiency.

A) 10
B) 20
C) 1000
D) 10,000,000,000

Answer: C
Page Ref: Section 11

50) What is the purpose of the heating cycle during PCR?

A) activates *Taq* polymerase

B) denatures the DNA

C) facilitates the attachment of RNA primers

D) increases the rate of polymerization by increasing the rate of diffusion of free nucleotides

Answer: B
Page Ref: Section 11

51) Which of the following is not an application of PCR?

A) formation of proteins from RNA fragments

B) investigation of molecular evolution

C) amplification of genes in paternity testing

D) construction of phylogenetic trees

E) detection of microoranisms from clinical specimens (blood, urine, etc.)

Answer: A
Page Ref: Section 11

52) Which component is not necessary for a PCR experiment?

A) free nucleotides

B) reverse transcriptase

C) RNA primers

D) DNA polymerase

E) template DNA

Answer: B
Page Ref: Section 11

53) Which is not an important feature of site–directed mutagenesis of cloned DNA?

A) It can be used to introduce point mutations.

B) It is faster than the complete *in vitro* synthesis of mutant genes.

C) It can be used to exponentially amplify the amount of DNA in a sample.

D) It allows for easy screening of transformants by using labeled oligonucleotides.

Answer: C
Page Ref: Section 12

54) Who won the Nobel Prize in 1993 for his work on site–directed mutagenesis?

A) Kary Mullis B) Michael Smith C) Herbert Boyer D) James Watson

Answer: B
Page Ref: Section 12

55) Restriction enzymes randomly cleave DNA.

Answer: FALSE
Page Ref: Section 2

56) Plasmids replicate autonomously within a host.

Answer: TRUE
Page Ref: Section 2

57) Shine–Dalgarno sequences are components of plasmid vectors which help to maximize the expression of inserted genes.

Answer: TRUE
Page Ref: Section 2

58) Yeast artificial chromosomes (YACs) are introduced into yeast cells as circular molecules.

Answer: FALSE
Page Ref: Section 2

59) Reverse transcriptase is a vital enzyme in the development of a genomic DNA library.

Answer: FALSE
Page Ref: Section 4

60) It is possible to clone a gene for a protein that is not expressed in the tissue from which the cDNA library was derived.

Answer: FALSE
Page Ref: Section 5

61) Exons and introns are equally represented in a cDNA library.

Answer: FALSE
Page Ref: Section 5

62) The oligodeoxythymidylate (oligo dT) fragment functions as a primer for synthesis of a complementary DNA strand by reverse transcriptase.

Answer: TRUE
Page Ref: Section 5

63) Complementary DNA (cDNA) is single–stranded DNA made with reverse transcriptase.

Answer: FALSE
Page Ref: Section 5

64) Cloned cDNA is used less frequently than mRNA as a probe for protein encoding genes in genomic DNA libraries.

Answer: FALSE
Page Ref: Section 6

65) In general, when constructing a YAC library of genomic DNA the smaller the insert used the fewer clones are needed.

Answer: FALSE
Page Ref: Section 6

66) Changing factors such as the salt concentration and temperature can be used to vary the stringency of hybridization and allow for more or less mismatches in base pairing.

Answer: TRUE
Page Ref: Section 6

67) For genes that are highly conserved, probes developed from one species can be used to screen clones from many other species.

Answer: TRUE
Page Ref: Section 6

68) Chromosome walking involves the isolation and sequencing of consecutive segments of DNA isolated after treatment with a restriction endonuclease.

Answer: FALSE
Page Ref: Section 7

69) It is possible for eukaryotic genes with introns to be isolated from genomic libraries and expressed directly in yeast cells.

Answer: TRUE
Page Ref: Section 8

70) An individual is treated for cystic fibrosis by a recombinant virus administered through an inhaler so the virus can "infect" the cells lining the lungs. In the lungs, the recombinant DNA is incorporated into the patient's genomic DNA and produces a protein product that helps relieve the symptoms of the disease. Children born to this patient after the treatment can be expected to also carry the recombinant genes and benefit from them if they too suffer from cystic fibrosis.

Answer: FALSE
Page Ref: Section 9

71) Insulin and growth hormones are two examples of proteins that can be produced in great quantities by their synthesis in bacteria.

Answer: TRUE
Page Ref: Section 10

72) RFLPs are very useful in determining paternity.

Answer: TRUE
Page Ref: Section 10

73) RFLP analysis is a very useful technique for genetic analysis and forensic studies, but it is not precise enough to distinguish genetic differences between highly related individuals such as siblings or parents and children.

Answer: FALSE
Page Ref: Section 10