Lehninger Principles of Biochemistry 8th edition Nelson Test Bank

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Name:_____ Class:_____ Date:_____

Chapter 01: The Foundations of Biochemistry

1. In a bacterial cell, the DNA is in the:
   a. cell envelope.
   b. cell membrane.
   c. nucleoid.
   d. nucleus.
   e. ribosomes.

   ANSWER: c

2. Which is the major feature that distinguishes eukaryotes from Bacteria and Archaea?
   a. DNA
   b. photosynthetic capability
   c. plasma membranes
   d. ribosomes
   e. the nucleus

   ANSWER: e

3. In eukaryotes, the nucleus is enclosed by a double membrane called the:
   a. cell membrane.
   b. nuclear envelope.
   c. nucleolus.
   d. nucleoplasm.
   e. nucleosome.

   ANSWER: b

4. Which is the range of typical diameters of animal and plant cells?
   a. 0.1 μmto 10 μm
   b. 0.3 μm to 30 μm
   c. 5 μm to 100 μm
   d. 10 nm to 300 nm
   e. 1 μm to 300 μm

   ANSWER: c

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5. Which group of single-celled microorganisms has many members found growing in extreme environments?
   a. bacteria
   b. archaea
   c. eukaryotes
   d. heterotrophs
   e. None of the answers is correct.

   ANSWER: b

6. Organisms that derive energy from the oxidation of chemical fuels and require organic compounds as sources of carbon are classified as:
   a. chemoautotrophs.
   b. chemoheterotrophs.
   c. lithotrophs.
   d. photoautotrophs.
   e. photoheterotrophs.

   ANSWER: b

7. Which is a list of organelles?
   a. mitochondria, chromatin, endoplasmic reticulum
   b. peroxisomes, lysosomes, plasma membrane
   c. proteasomes, peroxisomes, lysosomes
   d. mitochondria, endoplasmic reticulum, peroxisomes
   e. All of the answers are correct.

   ANSWER: d

8. Which list has the cellular components arranged in order of increasing size?
   a. nucleotide < DNA < nucleus < chromatin
   b. nucleotide < DNA < chromatin < nucleus
   c. nucleotide < chromatin < DNA < nucleus
   d. DNA < nucleotide < nucleus < chromatin
   e. DNA < chromatin < nucleus < nucleotide

   ANSWER: b

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9. In supramolecular complexes, macromolecules are held primarily through noncovalent interactions. Which one is NOT considered a noncovalent interaction?
   a. carbon–carbon bonds
   b. hydrogen bonds
   c. hydrophobic interactions
   d. ionic interactions
   e. van der Waals interactions

   ANSWER: a

10. Which element is NOT among the four most abundant in living organisms?
   a. carbon
   b. hydrogen
   c. nitrogen
   d. oxygen
   e. phosphorus

   ANSWER: e

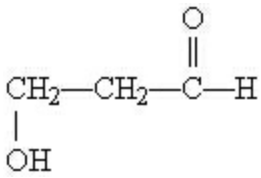
11. The four covalent bonds in methane (CH_4) are arranged around carbon to give which geometry?
   a. linear
   b. tetrahedral
   c. trigonal bipyramidal
   d. trigonal planar
   e. trigonal pyramidal

   ANSWER: b

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12. What functional groups are present on this molecule?



a. ether and aldehyde
b. hydroxyl and aldehyde
c. hydroxyl and carboxylic acid
d. hydroxyl and ester
e. hydroxyl and ketone

ANSWER: b

13. The macromolecules that serve in the storage and transmission of genetic information are:
a. carbohydrates.
b. lipids.
c. membranes.
d. nucleic acids.
e. proteins.

ANSWER: d

14. Stereoisomers that are nonsuperimposable mirror images of each other are known as:
a. anomers.
b. cis-trans isomers.
c. diastereoisomers.
d. enantiomers.
e. geometric isomers.

ANSWER: d

15. The sum of all the proteins functioning in a cell is the:
a. metabolome.
b. proteasome.
c. lysosome.
d. proteome.
e. genome.

ANSWER: d

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16. The enzyme fumarase catalyzes the reversible hydration of fumaric acid to L-malate, but it will not catalyze the hydration of maleic acid, which is the cis isomer of fumaric acid. This is an example of:
    a. biological activity.
    b. chiral activity.
    c. racemization.
    d. stereoisomerization.
    e. stereospecificity.

    ANSWER: e

17. Humans maintain a nearly constant level of hemoglobin by continually synthesizing and degrading it. This is an example of a(n):
    a. dynamic steady state.
    b. equilibrium state.
    c. exergonic change.
    d. free-energy change.
    e. waste of energy.

    ANSWER: a

18. If the free-energy change ΔG for a reaction is –46.11 kJ/mol, the reaction is:
    a. at equilibrium.
    b. endergonic.
    c. endothermic.
    d. exergonic.
    e. exothermic.

    ANSWER: d

19. The breakage of a phosphoanhydride bond in which molecule is a major source of chemical energy to drive cellular reactions?
    a. acetyl triphosphate
    b. adenosine monophosphate
    c. adenosine triphosphate
    d. cytosine tetraphosphate
    e. uridine diphosphate

    ANSWER: c

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20. Enzymes are biological catalysts that enhance the rate of a reaction by:
    a. decreasing the activation energy.
    b. decreasing the amount of free energy released.
    c. increasing the activation energy.
    d. increasing the amount of free energy released.
    e. increasing the energy of the transition state.

    ANSWER: a

21. Energy-requiring metabolic pathways that yield complex molecules from simpler precursors are:
    a. amphibolic.
    b. anabolic.
    c. autotrophic.
    d. catabolic.
    e. heterotrophic.

    ANSWER: b

22. Hereditary information (with the exception of some viruses) is preserved in:
    a. deoxyribonucleic acid.
    b. membrane structures.
    c. nuclei.
    d. polysaccharides.
    e. ribonucleic acid.

    ANSWER: a

23. When a region of DNA must be repaired by removing and replacing some of the nucleotides, what ensures that the new nucleotides are in the correct sequence?
    a. DNA cannot be repaired and this explains why mutations occur.
    b. Specific enzymes bind the correct nucleotides.
    c. The new nucleotides base-pair accurately with those on the complementary strand.
    d. The repair enzyme recognizes the removed nucleotide and brings in an identical one to replace it.
    e. The three-dimensional structure determines the order of nucleotides.

    ANSWER: c

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24. The three-dimensional structure of a protein is determined primarily by:
    a. electrostatic guidance from nucleic acid structure.
    b. how many amino acids are in the protein.
    c. hydrophobic interaction with lipids that provide a folding framework.
    d. modification during interactions with ribosomes.
    e. the sequence of amino acids in the protein.

    ANSWER: e

25. In the theory for the origin of life that was tested by Miller and Urey, the prebiotic atmosphere was presumed to:
    a. already contain some primitive RNA molecules.
    b. basically be very similar to the atmosphere of today.
    c. contain many amino acids.
    d. have an abundance of methane, ammonia, hydrogen, and water.
    e. be rich in oxygen.

    ANSWER: d

26. When two genes share detectable sequence similarity, those genes or their gene products, are said to be:
    a. homologs.
    b. symbiologs.
    c. complimentary sequences.
    d. co-genes.
    e. housekeeping genes.

    ANSWER: a

27. Which statement is NOT a distinguishing feature of living organisms?
    a. There exists a high degree of organizational complexity.
    b. The structure of components influences their function.
    c. Organisms can reproduce themselves.
    d. Organisms can exist without interacting with their environment.
    e. Organisms change over time.

    ANSWER: d

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28. Which is NOT a property of living organisms?
    a. precise self-replication
    b. in a dynamic steady state with the environment
    c. evolution over time
    d. composed of cells
    e. conversion of energy into matter

    ANSWER: e

29. Which statement is NOT true regarding the plasma membrane?
    a. It is a physical barrier separating the inside of the cell from its surroundings.
    b. It is flexible, with a hydrophobic internal structure.
    c. The individual lipids and proteins of the plasma membrane are covalently linked.
    d. The plasma membrane incorporates newly made lipid and protein components as a cell grows.
    e. Cell division occurs without loss of the membrane integrity.

    ANSWER: c

30. The major difference between prokaryotes and eukaryotes is that:
    a. prokaryotes have a nucleus, while eukaryotes do not.
    b. eukaryotes have a nucleus, while prokaryotes do not.
    c. eukaryotes have double-stranded DNA, while prokaryotes have single-stranded DNA.
    d. prokaryotes have double-stranded DNA, while eukaryotes have single-stranded DNA.
    e. prokaryotes do not have ribosomes.

    ANSWER: b

31. If an organism is a facultative anaerobe, which statement is true?
    a. The organism requires sulfur to live.
    b. The organism will die if exposed to oxygen.
    c. The organism requires oxygen to live.
    d. The organism does not require oxygen to live but will not die if exposed to oxygen.
    e. The organism requires methane to live.

    ANSWER: d

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32. Which statement is true regarding energy sources used by organisms?
    a. Phototrophs can use carbon dioxide as a carbon source.
    b. Phototrophs can use carbon dioxide as an energy source.
    c. All phototrophs are autotrophs.
    d. All chemotrophs are heterotrophs.
    e. All phototrophs are autotrophs that can use carbon dioxide as a carbon source.

    ANSWER: a

33. Which does NOT contain a double membrane?
    a. mitochondrion
    b. ribosome
    c. chloroplast
    d. endoplasmic reticulum
    e. Golgi body

    ANSWER: b

34. Which method is the MOST versatile for separating subcellular components of tissue into fractions containing things ranging from large (e.g., whole cells) to small (e.g., ribosomes)?
    a. centrifugation
    b. precipitation
    c. chromatography
    d. restriction digest
    e. peroxidation

    ANSWER: a

35. Which is NOT found in both animal and plant cells?
    a. ribosome
    b. Golgi complex
    c. endoplasmic reticulum
    d. vacuole
    e. mitochondrion

    ANSWER: d

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36. Which reason is MOST probable for why carbon is the main element used in living organisms?
    a. Carbon has the simplest isotopic distribution, with no radioactive isotopes.
    b. Carbon's bonds to other elements are easily formed and broken.
    c. Carbon has the most valence electrons for its size.
    d. Carbon has a great capacity to make substances of widely different sizes, shapes, and composition.
    e. Carbon forms primarily aliphatic compounds.

    ANSWER: d

37. Which are the four MOST abundant elements in living organisms?
    a. carbon, hydrogen, oxygen, iron
    b. carbon, hydrogen, nitrogen, oxygen
    c. carbon, hydrogen, phosphorous, oxygen
    d. carbon, nitrogen, phosphorous, oxygen
    e. carbon, hydrogen, sulfur, oxygen

    ANSWER: b

38. Jacques Monod wrote, "What is true of *E. coli* is true of the elephant." What did he mean?
    a. Bacterial cells are identical to animal cells.
    b. Bacterial cells can synthesize ivory under certain conditions.
    c. Bacterial cells have protein repair mechanisms similar to animal cells.
    d. Bacterial cells contain enzymes similar to those found in animal cells.
    e. Bacterial cells contain molecules with complexity similar to molecules found in the "mineral world."

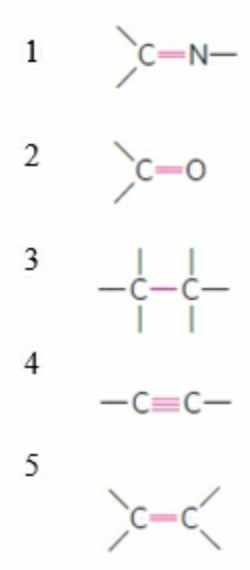
    ANSWER: d

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39. Which ranking correctly describes the rigidity of the red bond (the central bond) shown in the figure?



a. 2 = most rigid, 3 = least rigid
b. 1 = most rigid, 5 = least rigid
c. 4 = most rigid, 3 = least rigid
d. 2 = most rigid, 1 = least rigid
e. 4 = most rigid, 1 = least rigid

ANSWER: c

40. Which choice correctly lists the molecular masses from smallest to largest?
a. 18 kDa < 15,000 Da < 15,100 amu < 1.8 MDa < 1.8 mDa
b. 1.8 mDa < 15,000 Da < 15,100 amu < 18 kDa < 1.8 MDa
c. 1.8 MDa < 15,000 Da < 15,100 amu < 18 kDa < 1.8 mDa
d. 1.8 mDa < 15,100 amu < 15,000 Da < 18 kDa < 1.8 MDa
e. 1.8 MDa < 18 kDa < 15,100 amu < 1.8 mDa < 15,000 Da

ANSWER: b

41. Which substance is NOT a secondary metabolite in plants?
a. adenine
b. morphine
c. quinine
d. nicotine
e. caffeine

ANSWER: a

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42. Which list of descriptive terms for biological molecules is placed in correct order from smallest to largest?
    a. monomer, oligomer, polymer
    b. monomer, multimer, macromer
    c. oligomer, monomer, polymer
    d. polymer, oligomer, monomer
    e. metamer, oligomer, polymer

    ANSWER: a

43. Which answer choice represents the largest percentage, by weight, of an *E. coli* cell?
    a. RNA
    b. DNA
    c. protein
    d. lipids
    e. water

    ANSWER: e

44. Which discipline uses an approach that tries to understand complex interactions among intermediates and pathways in quantitative terms?
    a. metabolomics
    b. genomics
    c. systems biology
    d. proteomics
    e. lipidomics

    ANSWER: c

45. If a scientist wanted to know whether a particular hydrocarbon was in use in a cell's plasma membrane, they could search the organism's:
    a. metabolome.
    b. lipidome.
    c. glycome.
    d. proteome.
    e. genome.

    ANSWER: b

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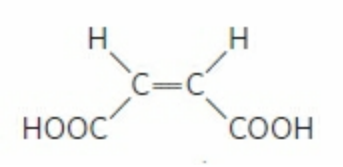
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46. Which types of molecules can serve as informational macromolecules in cells?
    a. proteins
    b. nucleic acids
    c. oligosaccharides
    d. both proteins and nucleic acids
    e. proteins, nucleic acids, and oligosaccharides

    ANSWER: e

47. What is the correct name for the configuration of the molecule shown?



    a. orthogonal
    b. trans
    c. cis
    d. zis
    e. chiros

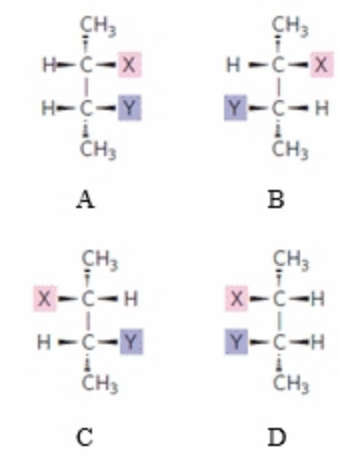
    ANSWER: c

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48. Which statement correctly describes the molecules shown?



a. A and D are enantiomers, and B and C are enantiomers.
b. A and D are diastereomers, and B and C are enantiomers.
c. A and C are enantiomers, and B and D are diastereomers.
d. A and C are diastereomers, and B and D are enantiomers.
e. All are diastereomers to each other.

ANSWER: a

49. Which is true about a racemic mixture?
a. The components are not separable by any means.
b. It has no optical rotation.
c. It is a mixture of diastereomers.
d. It contains both polar and nonpolar substances.
e. It can be separated into its components by differential centrifugation.

ANSWER: b

50. Which factor can be changed without breaking covalent bonds?
a. conformation
b. configuration
c. chirality
d. stereochemistry
e. None of the answers is correct.

ANSWER: a

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51. Living cells produce only one chiral form of a biomolecule because:
    a. biomolecules, by definition, can exist as only one chiral form.
    b. living cells can only create L isomers.
    c. living cells choose to express only the correct isomer.
    d. living cells have enzymes that are also chiral.
    e. living cells can produce the opposite chiral form only under certain metabolic conditions.

    ANSWER: d

52. Which statement about living systems is NOT true?
    a. Living organisms can be described as an open system.
    b. Living organisms maintain a more or less constant composition at maturity.
    c. Living systems are in equilibrium with their surroundings.
    d. Living systems exist in a dynamic steady state.
    e. Living systems have efficient mechanisms to convert chemical energy from one form into another.

    ANSWER: c

53. When energy is used by a system, can it be "used up"?
    a. Yes, it is used up when the energy source is depleted.
    b. Yes, it is used up when all energy is converted into chemical energy.
    c. No, all energy is converted into potential energy.
    d. No, all energy is converted into kinetic energy.
    e. No, energy can be converted into kinetic and potential energy.

    ANSWER: e

54. An increase in the entropy of a system can be described as an increase in the total amount of _____ of a system.
    a. kinetic energy
    b. potential energy
    c. oxidative energy
    d. disorder
    e. heat energy

    ANSWER: d

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55. In an oxidation-reduction reaction, the reactant that is oxidized _____, and the reactant that is reduced _____.
    a. is energized; is de-energized
    b. is de-energized; is energized
    c. loses electrons; gains electrons
    d. gains electrons; loses electrons
    e. maintains the same number of electrons; loses electrons

    ANSWER: c

56. The joining of two amino acids via a peptide bond (the process of protein synthesis) has a positive ΔG value. What does this imply?
    a. Forming a peptide bond is endergonic and must be coupled to another reaction.
    b. Forming a peptide bond is exergonic and must be coupled to another reaction.
    c. Forming a peptide bond is spontaneous and does not need to be coupled to another reaction.
    d. Forming a peptide bond is spontaneous and can sometimes be coupled to another reaction.
    e. Forming a peptide bond increases the entropy of a system.

    ANSWER: a

57. Reaction 1 has a $\Delta G°$ of –12.3 kJ/mol, and reaction 2 has a $\Delta G°$ of –23.4 kJ/mol. Which statement is true of these two reactions?
    a. Reaction 1 occurs faster.
    b. Reaction 2 occurs faster.
    c. Both reactions occur at the same rate.
    d. Reaction 2 will not occur.
    e. It is impossible to know which reaction occurs faster with this information.

    ANSWER: e

58. Fructose-1-phosphate can be hydrolyzed into fructose and inorganic phosphate (P_i) with a $\Delta G°$ of –16.0 kJ/mol. If ATP can be hydrolyzed into ADP and P_i with a $\Delta G°$ of –30.5 kJ/mol, what is the free-energy change for the reaction shown?
    fructose + ATP → fructose-1-phosphate + ADP
    a. –46.5 kJ/mol
    b. –14.5 kJ/mol
    c. 46.5 kJ/mol
    d. 14.5 kJ/mol
    e. –1.45 kJ/mol

    ANSWER: b

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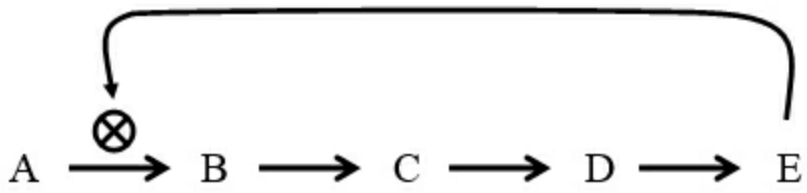
59. Which statement is true when $K_{eq} >> 1$?
    a. $\Delta G°$ is large and negative
    b. $\Delta G°$ is large and positive
    c. $\Delta G°$ is small and negative
    d. $\Delta G°$ is small and positive
    e. the value of $\Delta G°$ is independent of K_{eq}

    ANSWER: a

60. _____ pathways _____ large molecules, _____ energy.
    a. Catabolic; break down; releasing
    b. Anabolic; break down; releasing
    c. Catabolic; break down; storing
    d. Anabolic; break down; storing
    e. Anabolic; build up; releasing

    ANSWER: a

61. The diagram is a generic example of what process?



    a. systems biology
    b. feedback inhibition
    c. positive feedback
    d. equilibrium
    e. catabolism

    ANSWER: b

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62. In double-stranded DNA, the two polynucleotide strands are held together by _____ bonds.
    a. covalent
    b. ionic
    c. polypeptide
    d. hydrogen
    e. phosphodiester

    ANSWER: d

63. The typical three-dimensional structure of a protein in a cell, or _____ conformation, is critical to a protein's function.
    a. native
    b. molecular
    c. chaperone
    d. macromolecular
    e. high-affinity

    ANSWER: a

64. Accurate folding of a protein does NOT depend on:
    a. proper pH.
    b. correct ionic strength.
    c. correct temperature.
    d. correct metal ion concentration.
    e. binding to DNA.

    ANSWER: e

65. The similarities of gene sequences and metabolic pathways across the three domains of life are evidence that:
    a. all modern organisms are derived from a common evolutionary progenitor.
    b. multiple evolutionary progenitors converged to a single evolutionary model.
    c. cross-species genetic transfer happens with ease.
    d. evolution ceases when an organism is successful in its niche.
    e. All of the above.

    ANSWER: a

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66. Which statement is true about genetic mutations?
    a. Mutations may arise from an unrepaired mistake in DNA replication.
    b. Mutations may arise from incorrectly repaired damage to one of the DNA strands.
    c. Mutations in reproductive cells can be passed to offspring.
    d. Mutations may better equip an organism or cell to survive in its environment.
    e. All of the statements are true.

    ANSWER: e

67. When Stanley Miller, in Harold Urey's laboratory, subjected a gaseous mixture mimicking the prebiotic atmosphere on Earth to electrical sparks, he found that _____ were formed.
    a. amino acids
    b. aldehydes
    c. ribonucleotides
    d. both amino acids and aldehydes
    e. amino acids, aldehydes, and ribonucleotides

    ANSWER: d

68. Which present-day observable piece of evidence supports the RNA world hypothesis?
    a. RNA molecules participate in biologically significant reactions.
    b. RNA can serve as an information-carrying molecule.
    c. RNA nucleotides catalyze peptide bond formation.
    d. RNA molecules participate in biologically significant reactions, and RNA nucleotides catalyze peptide bond formation.
    e. RNA molecules participate in biologically significant reactions, RNA can serve as an information-carrying molecule, and RNA nucleotides catalyze peptide bond formation.

    ANSWER: e

69. Which statement is NOT true about the formation of early organisms?
    a. The first organisms were anaerobic because the atmosphere was devoid of oxygen.
    b. The original electron donor for photosynthetic processes was probably H_2S.
    c. Oxygen, a powerful oxidant, was probably welcomed by anaerobic organisms as a preferable choice for metabolic reactions.
    d. The transfer of electrons to O_2 releases more energy than transferring electrons to SO_4^{2-}.
    e. Cyanobacteria are modern descendants of early photosynthetic oxygen-producers.

    ANSWER: c

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70. Which organelle probably originated as an endosymbiotic engulfing of an aerobic bacterium by a eukaryotic cell?
    a. ribosome
    b. mitochondrion
    c. Golgi body
    d. nucleus
    e. endoplasmic reticulum

    ANSWER: b

71. The _____ of homologous proteins or genes can be used to estimate the degree of evolutionary relatedness.
    a. three-dimensional structure
    b. expression profiles
    c. sequence similarity
    d. endosymbiotic nature
    e. chromosomes

    ANSWER: c

72. _____ are typically expressed under all conditions and are not subject to regulation.
    a. Housekeeping genes
    b. Homologous genes
    c. Bacterial genomes
    d. Eukaryotic genomes
    e. Endosymbiotic genes

    ANSWER: a

73. What six characteristics distinguish living organisms from inanimate objects?

    ANSWER: Living organisms (1) are chemically complex and highly organized; (2) extract, transform, and use energy from their environment; (3) have the capacity to precisely self-replicate and self-assemble; (4) exploit a chemical interplay with their environment; (5) possess programmatically defined functions; and (6) evolve to new forms over many generations.

74. All cells are surrounded by a plasma membrane composed of lipid and protein molecules. What is the function of the plasma membrane?

    ANSWER: The plasma membrane acts as a barrier to the free passage of inorganic ions and most other charged or polar compounds into or out of the cell. It contains proteins that can transport specific ions or molecules. Other membrane proteins act as receptors that transmit signals from the outside to the inside of the cell.

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75. *E. coli* is known as a gram-negative bacterial species. (a) How is this determined? (b) How do gram-negative bacteria differ structurally from gram-positive bacteria?

ANSWER: (a) Gram-negative bacteria have little affinity for the dye gentian violet used in Gram's stain, but gram-positive bacteria retain Gram's stain. (b) Gram-negative bacteria have an outer membrane and a peptidoglycan layer; gram-positive bacteria lack an outer membrane and the peptidoglycan layer is much thicker.

76. Most cells of higher plants have a cell wall outside the plasma membrane. What is the function of the cell wall?

ANSWER: The cell wall provides a rigid, protective shell for the cell. It is porous, allowing water and small molecules to pass readily, but it is rigid enough to resist the swelling of the cell caused by the accumulation of water (see Fig. 1-8).

77. (a) List the types of noncovalent interactions that are important in providing stability to the three-dimensional structures of macromolecules. (b) Why is it important that these interactions be noncovalent, rather than covalent, bonds?

ANSWER: (a) Noncovalent interactions include hydrogen bonds, ionic interactions between charged groups, van der Waals interactions, and hydrophobic interactions. (b) Because noncovalent interactions are weak, they can form, break, and re-form more rapidly and with less energy input than can covalent bonds. This is important to maintain the flexibility needed in macromolecules.

78. What is the difference, if any, between cytosol and cytoplasm?

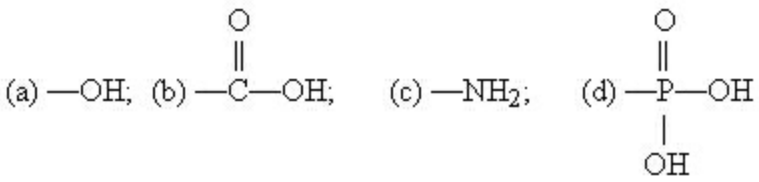
ANSWER: The cytoplasm is the internal volume enclosed by the plasma membrane; the cytosol is the aqueous portion of the cytoplasm.

79. Provide a brief explanation for the observation that macromolecules diffuse at a slower rate in the cytosol than they do in dilute solution.

ANSWER: The cytosol is very crowded and gel-like. The diffusion of macromolecules is slowed by collisions with other large molecules and structures.

80. Draw the structures of the functional groups in their nonionized forms for (a) hydroxyl, (b) carboxyl, (c) amino, (d) phosphoryl.

ANSWER:



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81. What is the underlying, organizing biochemical principle that results in the chemical similarity of virtually all living things? Given this biochemical similarity, how is the structural and functional diversity of living things possible?

    ANSWER: Living things are composed primarily of macromolecules, polymers of simple compounds of just a few different types. The properties of these polymers are determined by their sequence of monomers and these can be combined in many different ways. Diversity is thus achieved through the nearly limitless variety of sequences that can exist when amino acids are linked to form proteins, nucleotides are linked to form nucleic acids, and monosaccharides are linked to form polysaccharides. Branching in the latter can contribute additional heterogeneity. Each type of organism constructs a unique set of macromolecules from these monomeric units, resulting in the structural and functional diversity among species.

82. Explain the difference, if any, between a proteome and a proteasome.

    ANSWER: A proteome is the list of all proteins that function in a given cell. A proteasome is a molecular machine or supramolecular structure responsible for protein degradation in a cell.

83. Name two functions of (a) proteins, (b) nucleic acids, (c) polysaccharides, (d) lipids.

    ANSWER: Many answers are possible including: (a) proteins function as enzymes, structural elements, signal carriers, transporters; (b) nucleic acids store and transmit genetic information and act as both structural and catalytic elements; (c) polysaccharides serve as energy-yielding fuel stores and cellular and extracellular structural and recognition elements; (d) lipids function as membrane components, fuel stores, and cellular signals.

84. How is chirality generated by an asymmetric carbon atom and why is this important in the study of biochemistry?

    ANSWER: An asymmetric carbon has four different substituents attached, and cannot be superimposed on its mirror image, just as a right hand cannot fit into a left glove. Thus, a molecule with one asymmetric (chiral) carbon will have two stereoisomers, which may be distinguishable from one another in a biological system.

85. Differentiate between configuration and conformation.

    ANSWER: Configuration denotes the spatial arrangement of the atoms of a molecule that is conferred by the presence of either double bonds or rings, around which there is no freedom of rotation, or chiral centers, which give rise to stereoisomers. Configurational isomers can only be interconverted by temporarily breaking covalent bonds. Conformation refers to the spatial arrangement of substituent groups that, without breaking any bonds, are free to assume different positions in space because of the freedom of bond rotation.

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86. (a) What is optical activity? (b) How did Louis Pasteur arrive at an explanation for the phenomenon of optical activity?

ANSWER: (a) Optical activity is the capacity of a substance to rotate the plane of plane-polarized light. (b) Using fine forceps, he was able to separate the two types of crystals found in tartaric acid (racemic acid) that are identical in shape, but mirror images of each other. One sample rotated polarized light to the left; the mirror image crystals rotated polarized light to the right.

87. A chemist working in a pharmaceutical lab synthesized a new drug as a racemic mixture. Why is it important that the chemist separate the two enantiomers and test each for its biological activity?

ANSWER: Biomolecules such as receptors for drugs are stereospecific, so each of the two enantiomers of the drug may have very different effects on an organism. One may be beneficial, the other toxic; or one enantiomer may be ineffective and its presence could reduce the efficacy of the other enantiomer.

88. Explain why living organisms are able to produce *particular* chiral forms of different biomolecules while laboratory chemical synthesis usually produces a racemic mixture.

ANSWER: Laboratory syntheses usually use achiral reagents and thus produce racemic mixtures of products. In contrast, because all enzymes are made of chiral precursors, all enzymes are inherently chiral catalysts. Thus, they will show strong stereoselectivity in reactants and mechanisms, leading to the production of chiral products.

89. Proteins are constantly being synthesized in a living cell. Why doesn't the number of protein molecules become too great for the cell to contain, leading to cell destruction?

ANSWER: The proteins in a cell are continuously being synthesized and degraded. The cell maintains a dynamic steady state in which the amount of each protein remains fairly constant at the level required under given conditions.

90. Describe the relationship between a living organism and its surroundings in terms of both matter and energy.

ANSWER: Living organisms are open systems and exchange both matter and energy with their surroundings. They are not at equilibrium with their surroundings; that is, the exchange of matter and energy with the surroundings is not constant and equal in both directions. To maintain this situation, the organism must acquire energy from its surroundings, either in the form of chemical energy or directly from sunlight.

91. The free-energy change for the formation of a protein from the individual amino acids is positive and is thus an endergonic reaction. How, then, do cells accomplish this process?

ANSWER: The endergonic (thermodynamically unfavorable) reaction is coupled to an exergonic (thermodynamically favorable) reaction through a shared intermediate, so that the overall free-energy change of the coupled reactions is negative (the overall reaction is exergonic).

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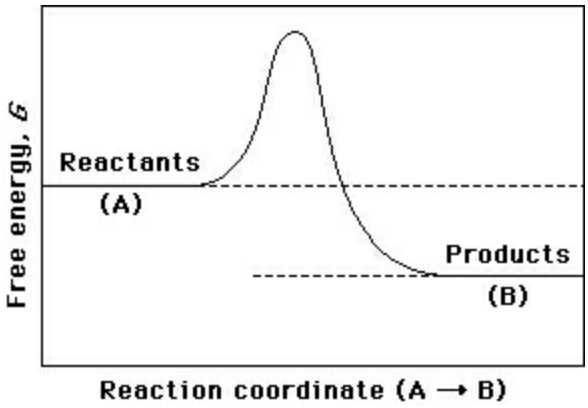
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92. Instant cold packs get cold when the contents, usually solid urea and liquid water, are mixed, producing an aqueous solution of urea. Although this process is clearly spontaneous, the products are colder than the reactants. Explain how this is possible in terms of the difference between ΔG and ΔH.

ANSWER: Since the dissolution reaction is spontaneous, the ΔG must be negative. Since the reaction absorbs heat, the ΔH must be positive. Given $\Delta G = \Delta H - T\Delta S$, this is possible if the ΔS is very large and positive, as one would expect for a solid dissolving.

93. (a) On the reaction coordinate diagram, label the transition state and the overall free-energy change (ΔG) for the uncatalyzed reaction A→B. (b) Is this an exergonic or endergonic reaction? (c) Draw a second curve showing the energetics of the reaction if it were enzyme-catalyzed.



ANSWER: (a) and (c) see Fig. 1-28 (b) exergonic reaction

94. What is meant by feedback inhibition and why is it important in a living organism?

ANSWER: feedback inhibition is the regulation of a biochemical pathway in which a reaction product inhibits an earlier (usually the first) step in the pathway. It is an important type of regulation because it ensures that energy is not wasted by an organism producing molecules it does not need.

95. How is the genetic information encoded in DNA, and how is a new copy of DNA synthesized?

ANSWER: The genetic information is encoded in the linear sequence (order) of the four different deoxyribonucleotides in the DNA. When a new copy of DNA is needed, the two strands of the DNA unwind and each strand serves as a template on which a new strand is synthesized.

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96. Hereditary transmission of genetic information can be viewed as a balance between stability and change. Explain.

ANSWER: Hereditary transmission of genetic information occurs via replication of DNA, the information-containing molecule. This process is very accurate and thus results in relatively few changes in genetic information. This stability is important to maintain individual and species characteristics over long periods of time. On the other hand, regular changes in genetic information (mutations) do occur, primarily as a result of infrequent errors in replication. These mutations are essential for generating genetic diversity, which allows for adaptation of species.

97. Discuss how a mutation in DNA could be harmful or beneficial to an organism.

ANSWER: Some mutations lead to the synthesis of an inactive or defective enzyme or other protein that can no longer carry out its proper function, which is thus harmful to the organism. However, other mutations may lead to a more stable enzyme or to a protein that is better able to carry out its function in a particular environment, making it beneficial to the organism.

98. Describe Stanley Miller's experiment (1953) and its relevance.

ANSWER: Miller subjected a gaseous mixture of ammonia, methane, water vapor, and hydrogen to electrical sparks for periods of a week or more. When he analyzed the contents of the closed reaction vessel, the gas phase contained CO and CO_2, as well as unreacted starting materials. The water phase contained a variety of organic compounds, including some amino acids, hydroxy acids, aldehydes, and hydrogen cyanide. This experiment established the possibility of abiotic production of biomolecules in relatively short times under relatively mild conditions.

99. Describe the RNA world hypothesis.

ANSWER: Initially, RNA molecules were both genes and catalysts. Self-replication of these molecules over long periods of time produced variants that were able to catalyze polymerization of amino acids to form peptides that assumed the function of catalysts. Eventually, genomic RNA was copied into DNA, which assumed the function of genetic information storage.

100. Describe how the rise of O_2-producing bacteria might have led to the eventual predominance of aerobic organisms on Earth.

ANSWER: The rise of O_2-producing bacteria would result in an increase in the levels of O_2 in Earth's atmosphere. This would give a selective advantage to aerobic organisms (which utilized O_2 as electron acceptor) over anaerobic organisms for which O_2 was toxic.

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101. What is meant by endosymbiotic association? How can this concept explain the evolution of eukaryotic cells that are capable of carrying out photosynthesis and/or aerobic metabolism?

ANSWER: An endosymbiotic association is the envelopment of one organism by another to form a relationship that is beneficial to both organisms. It is believed that primitive eukaryotic cells, which were incapable of photosynthesis or aerobic metabolism, formed endosymbiotic associations with photosynthetic and/or aerobic bacteria. The aerobic bacteria then evolved into the mitochondria found in modern eukaryotic cells, and the photosynthetic bacteria evolved into the chloroplasts found in plant cells (see Fig. 1-37).

102. List and explain the factors that limit the dimensions of living cells on both the lower and upper limits.

ANSWER: On the lower end, cell dimensions are limited by the minimum number of biomolecules necessary for function. On the upper end, cells are limited by the rate of diffusion of solutes such as oxygen.

103. Briefly, compare and contrast the three domains of life.

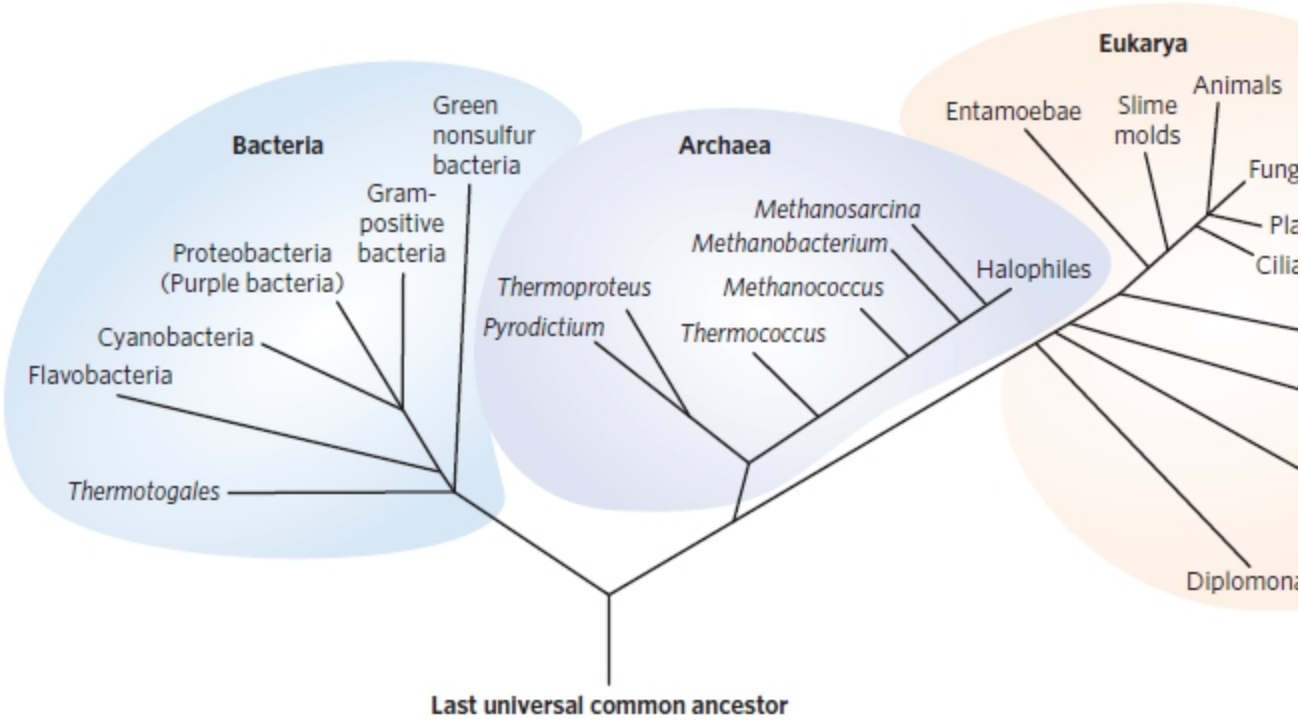
ANSWER: Bacteria and Archaea consist of unicellular organisms, while Eukarya contains both single- and multicellular organisms. Bacteria and Archaea have been found in all kinds of environments. Archaea historically were characterized from extreme environments. Neither bacteria nor archaea have chromosomes separated from the cytoplasm by a nuclear membrane, but eukaryotes have chromosomes inside a membrane-bounded nucleus.

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104. (a) What is the diagram? (b) Describe what it illustrates about the relationship between animals, halophiles, slime n positive bacteria. (c) Explain the evidence used in construction of this diagram.



ANSWER: (a) This diagram is a phylogenetic tree. (b) It illustrates the evolutionary distance between different org domains of life. Of the organisms listed, animals are most closely related to slime molds, next closest t Archaea and Eukarya are more similar to each other than either is to Bacteria, making gram-positive l distant relative to all of the organisms listed in this question. (c) The distances between the branches o calculated by comparing sequence similarity between homologous proteins in different organisms.

105. What is meant by the term "in vitro"? What are the challenges and benefits to studying enzymes in vitro?

ANSWER: "In vitro" means "in glass"—in the test tube. Challenges include that the experiment may not include all of the molecules that influence an enzyme's activity, the rate of reaction may differ from in vivo due to concentration and crowding/diffusion effects. Benefits include that the enzyme activity is isolated from interfering components, and that the reaction takes place in a thoroughly stirred solution.

106. Why is the use of the expression M_r = 18,000 daltons incorrect?

ANSWER: M_r is a ratio and therefore dimensionless. Daltons are only used when describing molecular mass, not molecular weight or relative molecular mass.

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