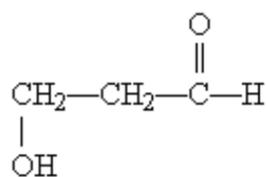


Name: _____ Date: _____

- In a bacterial cell, the DNA is in the:
 - cell envelope.
 - cell membrane.
 - nucleoid.
 - nucleus.
 - ribosomes.
- A major change occurring in the evolution of eukaryotes from prokaryotes was the development of:
 - DNA.
 - photosynthetic capability.
 - plasma membranes.
 - ribosomes.
 - the nucleus.
- In eukaryotes, the nucleus is enclosed by a double membrane called the:
 - cell membrane.
 - nuclear envelope.
 - nucleolus.
 - nucleoplasm.
 - nucleosome.
- The dimensions of living cells are limited, on the lower end by the minimum number of biomolecules necessary for function, and on the upper end by the rate of diffusion of solutes such as oxygen. Except for highly elongated cells, they usually have lengths and diameters in the range of:
 - 0.1 μm to 10 μm .
 - 0.3 μm to 30 μm .
 - 0.3 μm to 100 μm .
 - 1 μm to 100 μm .
 - 1 μm to 300 μm .
- Which group of single-celled microorganisms has many members found growing in extreme environments?
 - bacteria
 - archaea
 - eukaryotes
 - heterotrophs
 - None of the answers is correct.
- The bacterium *E. coli* requires simple organic molecules for growth and energy—it is therefore a:
 - chemoautotroph.
 - chemoheterotroph.
 - lithotroph.
 - photoautotroph.
 - photoheterotroph.
- Which is a list of organelles?
 - mitochondria, chromatin, endoplasmic reticulum
 - peroxisomes, lysosomes, plasma membrane
 - proteasomes, peroxisomes, lysosomes
 - mitochondria, endoplasmic reticulum, peroxisomes
 - All of the answers are correct.
- Which list has the cellular components arranged in order of INCREASING size?
 - amino acid < protein < mitochondrion < ribosome
 - amino acid < protein < ribosome < mitochondrion
 - amino acid < ribosome < protein < mitochondrion
 - protein < amino acid < mitochondrion < ribosome
 - protein < ribosome < mitochondrion < amino acid
- The three-dimensional structure of macromolecules is formed and maintained primarily through noncovalent interactions. Which one of the following is NOT considered a noncovalent interaction?
 - carbon-carbon bonds
 - hydrogen bonds
 - hydrophobic interactions
 - ionic interactions
 - van der Waals interactions

10. Which element is NOT among the four most abundant in living organisms?
- carbon
 - hydrogen
 - nitrogen
 - oxygen
 - phosphorus
11. The four covalent bonds in methane (CH₄) are arranged around carbon to give which geometry?
- linear
 - tetrahedral
 - trigonal bipyramidal
 - trigonal planar
 - trigonal pyramidal

12. What functional groups are present on this molecule?

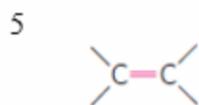
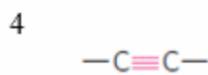
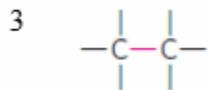
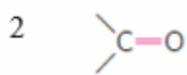
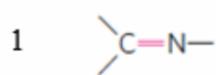


- ether and aldehyde
 - hydroxyl and aldehyde
 - hydroxyl and carboxylic acid
 - hydroxyl and ester
 - hydroxyl and ketone
13. The macromolecules that serve in the storage and transmission of genetic information are:
- carbohydrates.
 - lipids.
 - membranes.
 - nucleic acids.
 - proteins.
14. Stereoisomers that are nonsuperimposable mirror images of each other are known as:
- anomers.
 - cis-trans isomers.
 - diastereoisomers.
 - enantiomers.
 - geometric isomers.
15. The catalog of all proteins functioning in a cell is the:
- metabolome.
 - proteasome.
 - lysosome.
 - proteome.
 - genome.
16. Use the terms a) chemoautotrophs, b) chemoheterotrophs, c) photoautotrophs, and d) photoheterotrophs and identify the answer that CORRECTLY finishes the statement:
Carnivores are _____ and herbivores are _____.
- b; c
 - b; d
 - b; b
 - a; b
 - a; a
17. The enzyme fumarase catalyzes the reversible hydration of fumaric acid to l-malate, but it will not catalyze the hydration of maleic acid, the cis isomer of fumaric acid. This is an example of:
- biological activity.
 - chiral activity.
 - racemization.
 - stereoisomerization.
 - stereospecificity.

18. 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.
19. If heat energy is absorbed by the system during a chemical reaction, the reaction is said to be:
- A) at equilibrium.
 - B) endergonic.
 - C) endothermic.
 - D) exergonic.
 - E) exothermic.
20. 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.
21. The major carrier of chemical energy in all cells is:
- A) acetyl triphosphate.
 - B) adenosine monophosphate.
 - C) adenosine triphosphate.
 - D) cytosine tetraphosphate.
 - E) uridine diphosphate.
22. 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.
23. Energy requiring metabolic pathways that yield complex molecules from simpler precursors are:
- A) amphibolic.
 - B) anabolic.
 - C) autotrophic.
 - D) catabolic.
 - E) heterotrophic.
24. Hereditary information (with the exception of some viruses) is preserved in:
- A) deoxyribonucleic acid.
 - B) membrane structures.
 - C) nuclei.
 - D) polysaccharides.
 - E) ribonucleic acid.
25. 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.
26. 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.

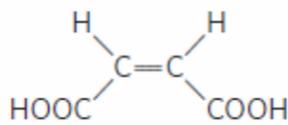
27. According to Oparin's theory for the origin of life, the prebiotic atmosphere:
- already contained some primitive RNA molecules.
 - basically was very similar to the atmosphere of today.
 - contained many amino acids.
 - had an abundance of methane, ammonia, and water.
 - was rich in oxygen.
28. When two genes in an organism share detectable sequence similarity, those genes or their gene products, are said to be:
- homologues.
 - orthologues.
 - paralogues.
 - both homologues and orthologues.
 - both homologues and paralogues.
 - both orthologues and paralogues.
29. Which statement is NOT a distinguishing feature of living organisms?
- There exists a high degree of organizational complexity.
 - The structure of components influences their function.
 - Organisms can reproduce themselves.
 - Organisms do not need to interact with their environment.
 - Organisms change over time.
30. Which organic molecules can be considered "alive"?
- proteins
 - carbohydrates
 - nucleic acids
 - saccharides
 - None of the answers is correct.
31. Which statement is NOT true regarding the plasma membrane?
- It is a physical barrier separating the inside of the cell from its surroundings.
 - It is a flexible, hydrophobic structure.
 - The individual lipids and proteins of the plasma membrane are covalently linked.
 - The plasma membrane incorporates newly made lipid and protein components as a cell grows.
 - Cell division occurs without loss of the membrane integrity.
32. The major difference between prokaryotes and eukaryotes is that:
- prokaryotes have a nucleus, while eukaryotes do not.
 - eukaryotes have a nucleus, while prokaryotes do not.
 - eukaryotes have double-stranded DNA, while prokaryotes have single-stranded DNA.
 - prokaryotes have double-stranded DNA, while eukaryotes have single-stranded DNA.
 - prokaryotes do not have ribosomes.
33. If an organism is a *facultative anaerobe*, which statement is TRUE?
- The organism requires sulfur to live.
 - The organism will die if exposed to oxygen.
 - The organism requires oxygen to live.
 - The organism does not require oxygen to live but will not die if exposed to oxygen.
 - The organism requires methane to live.
34. Which statement is TRUE regarding energy sources used by organisms?
- Phototrophs can use carbon dioxide as a carbon source.
 - Phototrophs can use carbon dioxide as an energy source.
 - All phototrophs are autotrophs.
 - All chemotrophs are heterotrophs.
 - All phototrophs are autotrophs that can use carbon dioxide as a carbon source.
35. Which statement is FALSE regarding bacterial and archaeal cells?
- Archaeal and bacterial plasma membranes consist of a thin bilayer of lipid molecules penetrated by proteins.
 - Bacteria and archaea have group specific specializations in their cell envelope.
 - Archaea can have a single- or double-layered membrane.
 - Bacteria can have a single- or double-layered membrane.
 - Both bacteria and archaea have a layer of peptidoglycan in their cell envelope.

36. Which organelle does NOT consist of a double membrane?
- mitochondrion
 - ribosome
 - chloroplast
 - endoplasmic reticulum
 - Golgi body
37. Which method is MOST useful when fractionating cellular organelles?
- centrifugation
 - precipitation
 - chromatography
 - restriction digest
 - peroxidation
38. Which organelle is NOT found in plant cells?
- ribosome
 - lysosome
 - chloroplast
 - vacuole
 - mitochondrion
39. Which reason is MOST probable for why carbon is used in living organisms but not silicon?
- Carbon can make four bonds, whereas silicon can only make three.
 - Carbon can make double bonds, but silicon cannot.
 - Carbon can form more preferred geometries when bonding.
 - Carbon is lighter, and therefore its bonds are stronger.
 - Silicon is heavier, and therefore its bonds are stronger.
40. Which group includes the four most abundant elements in living organisms?
- carbon, hydrogen, oxygen, iron
 - carbon, hydrogen, nitrogen, oxygen
 - carbon, hydrogen, phosphorous, oxygen
 - carbon, nitrogen, phosphorous, oxygen
 - carbon, hydrogen, sulfur, oxygen
41. What did Jacques Monod mean when he wrote, “What is true of *E. coli* is true of the elephant?”
- Bacterial cells are identical to animal cells.
 - Bacterial cells can synthesize ivory under certain conditions.
 - Bacterial cells contain a chromosome similar to animal cells.
 - Bacterial cells contain enzymes similar to those found in animal cells.
 - Bacterial cells contain molecules with complexity similar to molecules found in in the “mineral world.”
42. Which ranking CORRECTLY describes the rigidity of the red bond (the central bond) shown in the figure?



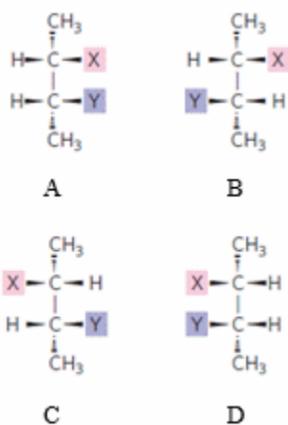
- 2 = most rigid, 3 = least rigid
- 1 = most rigid, 5 = least rigid
- 4 = most rigid, 3 = least rigid
- 2 = most rigid, 1 = least rigid
- 4 = most rigid, 1 = least rigid

43. Which choice CORRECTLY lists the molecular masses from smallest to largest?
- 18 kDa < 15,000 Da < 15,100 amu < 1.8 MDa < 1.8 mDa
 - 1.8 mDa < 15,000 Da < 15,100 amu < 18 kDa < 1.8 MDa
 - 1.8 MDa < 15,000 Da < 15,100 amu < 18 kDa < 1.8 mDa
 - 1.8 mDa < 15,100 amu < 15,000 Da < 18 kDa < 1.8 MDa
 - 1.8 MDa < 18 kDa < 15,100 amu < 1.8 mDa < 15,000 Da
44. Which substance is NOT a secondary metabolite?
- adenine
 - morphine
 - quinine
 - nicotine
 - salicylic acid
45. Which list of descriptive terms for biological molecules is placed in CORRECT order from smallest to largest?
- monomer, oligomer, polymer
 - monomer, multimer, macromer
 - oligomer, monomer, polymer
 - polymer, oligomer, monomer
 - metamer, oligomer, polymer
46. Which answer choice represents the LARGEST percentage, by weight, of an *E. coli* cell?
- RNA
 - DNA
 - protein
 - lipids
 - water
47. Which discipline uses an approach that tries to integrate information to give a molecular picture of all the activities of a cell under certain conditions?
- metabolomics
 - genomics
 - systems biology
 - proteomics
 - lipidomics
48. 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:
- metabolome.
 - lipidome.
 - glycome.
 - proteome.
 - genome.
49. Which types of molecules can serve as informational macromolecules in cells?
- proteins
 - nucleic acids
 - oligosaccharides
 - both proteins and nucleic acids
 - proteins, nucleic acids, and oligosaccharides
50. What is the CORRECT name for the configuration of the molecule shown in the figure?



- orthogonal*
- trans*
- cis*
- zis*
- chiros*

51. Which statement CORRECTLY describes the molecules shown in the figure?



- A) A and D are enantiomers, and B and C are diastereomers.
 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.

52. It is possible to separate a racemic mixture by:

- A) combustion.
 B) crystallization.
 C) centrifugation.
 D) distillation.
 E) magnetism.

53. Which factor can be changed WITHOUT breaking covalent bonds?

- A) conformation
 B) configuration
 C) chirality
 D) stereochemistry
 E) None of the answers is correct.

54. 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.

55. Which statement about living systems is NOT true?

- A) Living organisms can be described as an open system.
 B) Living systems maintain a more-or-less constant composition.
 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.

56. When energy is used by a system, can it be “used up”?

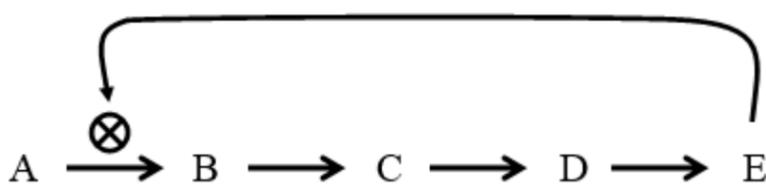
- A) Yes, it is used up when the energy source is depleted.
 B) Yes, it is used up when all energy is converted into chemical energy.
 C) No, all energy is converted into potential energy.
 D) No, all energy is converted into kinetic energy.
 E) No, energy can be converted into kinetic and potential energy.

57. 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) order

58. In an oxidation-reduction reaction, the oxidized reagent _____, and the reduced reagent _____.

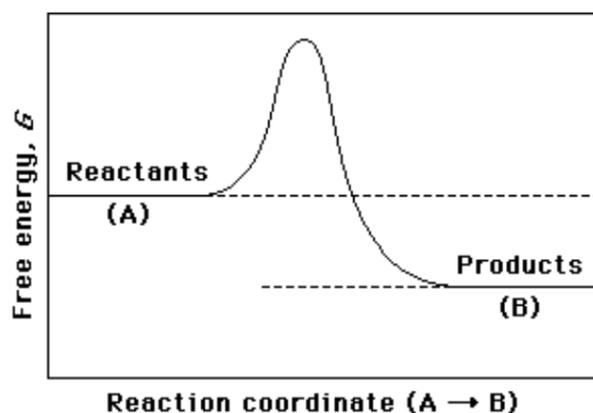
- A) is energized; is deenergized
 B) is deenergized; is energized
 C) loses electrons; gains electrons
 D) gains electrons; loses electrons
 E) maintains the same number of electrons; loses electrons

59. The joining of two amino acids via a peptide bond (the process of protein synthesis) has a positive ΔG value. What does this imply?
- Forming a peptide bond is endergonic and must be coupled to another reaction.
 - Forming a peptide bond is exergonic and must be coupled to another reaction.
 - Forming a peptide bond is spontaneous and does not need to be coupled to another reaction.
 - Forming a peptide bond is spontaneous and can sometimes be coupled to another reaction.
 - Forming a peptide bond increases the entropy of a system.
60. Reaction 1 has a ΔG° of -12.3 kJ/mol, and Reaction 2 has a ΔG° of 23.4 kJ/mol. Which statement is TRUE of these two reactions?
- Reaction 1 occurs faster.
 - Reaction 2 occurs faster.
 - Both reactions occur at the same rate.
 - Reaction 2 will not occur.
 - It is impossible to know which reaction occurs faster with this information.
61. Fructose-1-phosphate can be hydrolyzed into fructose + inorganic phosphate (P_i) with a ΔG° of -16.0 kJ/mol. If ATP can be hydrolyzed into ADP + P_i with a ΔG° of -30.5 kJ/mol, what is the free energy change for the reaction of fructose + ATP \rightarrow fructose 1-phosphate + ADP?
- -46.5 kJ/mol
 - -14.5 kJ/mol
 - 46.5 kJ/mol
 - 14.5 kJ/mol
 - -1.4 Genetic Foundations5 kJ/mol
62. In general, increasing the temperature of a reaction will have what effect, based on the relationship between standard free energy change and the equilibrium constant?
- The reaction will be inhibited.
 - The reaction will go faster.
 - The reaction will become more spontaneous.
 - The reaction will become less spontaneous.
 - There will be no effect on the reaction.
63. _____ pathways _____ large molecules, _____ energy.
- Catabolic; break down; releasing
 - Anabolic; break down; releasing
 - Catabolic; break down; storing
 - Anabolic; break down; storing
 - Anabolic; build up; releasing
64. The diagram below is a generic example of what process?
- 
- A \rightarrow B \rightarrow C \rightarrow D \rightarrow E
- A feedback loop arrow starts from E and points back to A, with a circled 'X' at the arrowhead.
- systems biology
 - feedback inhibition
 - positive feedback
 - equilibrium
 - catabolism
65. In double-stranded DNA, the two strands are held together by _____ bonds.
- covalent
 - ionic
 - polypeptide
 - hydrogen
 - phosphodiester
66. The precise three-dimensional structure, or _____ conformation, is critical to a protein's function.
- native
 - molecular
 - chaperone
 - macromolecular
 - high-affinity

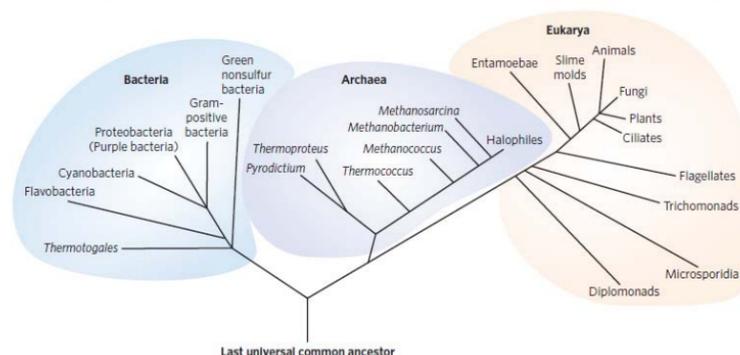
67. Accurate folding of a protein does NOT depend on:
- proper pH.
 - correct ionic strength.
 - correct temperature.
 - correct metal ion concentration.
 - All of the conditions listed are important for correct folding of a protein.
68. The similarities of gene sequences and metabolic pathways across the three domains of life are evidence for:
- evolution.
 - a common ancestor.
 - cross-species genetic transfer.
 - both evolution and a common ancestor.
 - both a common ancestor and cross-species genetic transfer.
69. Which statement is NOT true about genetic mutations?
- Mutations arise from an unrepaired mistake in DNA replication.
 - Mutations arise from incorrectly repaired damage to one of the DNA strands.
 - Mutations in reproductive cells can be passed on to offspring.
 - Mutations may better equip an organism or cell to survive in its environment.
 - All of the statements are true.
70. 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.
- amino acids
 - aldehydes
 - ribonucleotides
 - both amino acids and aldehydes
 - amino acids, aldehydes, and ribonucleotides
71. Which present-day observable piece of evidence supports the "RNA world" hypothesis?
- RNA molecules participate in biologically significant reactions.
 - RNA can serve as an information-carrying molecule.
 - RNA nucleotides catalyze peptide bond formation.
 - RNA molecules participate in biologically significant reactions, and RNA nucleotides catalyze peptide bond formation.
 - RNA molecules participate in biologically significant reactions, RNA can serve as an information-carrying molecule, and RNA nucleotides catalyze peptide bond formation.
72. Which statement is NOT true about the formation of early organisms?
- The first organisms were anaerobic because the atmosphere was devoid of oxygen.
 - The original electron donor for photosynthetic processes was probably H₂S.
 - Oxygen, a powerful oxidant, was probably welcomed by anaerobic organisms as a preferable choice for metabolic reactions.
 - The transfer of electrons to O₂ releases more energy than transferring electrons to SO₄²⁻
 - Cyanobacteria are modern descendants of early photosynthetic oxygen-producers.
73. Which organelle probably originated as an endosymbiotic engulfing of an aerobic bacterium by a eukaryotic cell?
- ribosome
 - mitochondrion
 - Golgi body
 - nucleus
 - endoplasmic reticulum
74. Which statement is NOT true regarding orthologous genes?
- They share similar sequences.
 - They usually have the same function.
 - They usually have a similar three-dimensional structure.
 - They presumably arose from a gene duplication event.
 - All of the statements are true.
75. The _____ of homologous proteins can be used to estimate the degree of evolutionary divergence.
- three-dimensional structure
 - expression profiles
 - sequence similarity
 - endosymbiotic nature
 - chromosomes

76. _____ are typically expressed under all conditions and are not subject to regulation.
- Housekeeping genes
 - Homologous genes
 - Bacterial genomes
 - Eukaryotic genomes
 - Endosymbiotic genes
77. What six characteristics distinguish living organisms from inanimate objects?
78. All cells are surrounded by a plasma membrane composed of lipid and protein molecules. What is the function of the plasma membrane?
79. *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?
80. Most cells of higher plants have a cell wall outside the plasma membrane. What is the function of the cell wall?
81. 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?
82. What is the difference, if any, between cytosol and cytoplasm?
83. Provide a brief explanation for the observation that macromolecules diffuse at a slower rate in the cytosol than they do in dilute solution.
84. Draw the structures of the following functional groups in their un-ionized forms:
(a) hydroxyl, (b) carboxyl, (c) amino, (d) phosphoryl.
85. 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?
86. Explain the difference, if any, between a proteome and a proteasome.
87. Name two functions of (a) proteins, (b) nucleic acids, (c) polysaccharides, (d) lipids.
88. Why is an asymmetric carbon atom called a chiral center?
89. Differentiate between configuration and conformation.
90. What is optical activity? (b) How did Louis Pasteur arrive at an explanation for the phenomenon of optical activity?
91. A chemist working in a pharmaceutical lab synthesized a new drug as a racemic mixture. Why is it important that she separate the two enantiomers and test each for its biological activity?
92. Explain why living organisms are able to produce *particular* chiral forms of different biomolecules while laboratory chemical synthesis usually produces a racemic mixture.
93. 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?
94. Describe the relationship between a living organism and its surroundings in terms of both matter and energy.
95. 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?
96. 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 .

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



98. What is meant by feedback inhibition and why is it important in a living organism?
99. How is the genetic information encoded in DNA and how is a new copy of DNA synthesized?
100. Hereditary transmission of genetic information can be viewed as a balance between stability and change. Explain.
101. Discuss how a mutation in DNA could be harmful or beneficial to an organism.
102. Describe Stanley Miller's experiment (1953) and its relevance.
103. Describe the “RNA world” hypothesis.
104. Describe how the rise of O_2 -producing bacteria might have led to the eventual predominance of aerobic organisms on earth.
105. 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?
106. List and explain the factors that limit the dimensions of living cells on both the lower and upper limits.
107. Briefly, compare and contrast the three domains of life.
108. A) What is the diagram below? B) Describe what it illustrates about the relationship between animals, halophiles, slime molds, and gram-positive bacteria. C) Explain the evidence used in construction of this diagram.



109. What is meant by the term “in vitro”? What are the challenges and benefits to studying enzymes “in vitro”?
110. Why is the use of the expression “ $M_r = 18,000$ daltons” incorrect?

Answer Key

1. C
2. E
3. B
4. C
5. B
6. B
7. D
8. B
9. A
10. E
11. B
12. B
13. D
14. D
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16. C
17. E
18. A
19. C
20. D
21. C
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23. B
24. A
25. C
26. E
27. D
28. E
29. D
30. E
31. C
32. B
33. D
34. A
35. C
36. B
37. A
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41. D
42. C
43. B
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46. E
47. C
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66. A
67. E
68. D
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72. C
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75. D
76. A

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