Microbiology: An Introduction, 12e **(Tortora)**
Chapter 2 Chemical Principles

2.1 Multiple Choice Questions

1) Which of the following statements about the atom $^{12}_{6}C$ is FALSE?

A) It has 6 protons in its nucleus.
B) It has 12 neutrons in its nucleus.
C) It has 6 electrons orbiting the nucleus.
D) Its atomic number is 6.
E) Its atomic weight is 12.
Answer: B
Section: 2.1
Bloom's Taxonomy: Comprehension
Learning Outcome: 2.1
Global Outcome: 2

2) Table 2.1

$^{16}_{8}O$ $^{12}_{6}C$ $^{1}_{1}H$

Using the information in Table 2.1, calculate the molecular weight of ethanol, C_2H_5OH.
A) 96
B) 46
C) 34
D) 33
E) The answer cannot be determined.
Answer: B
Section: 2.1
Bloom's Taxonomy: Application
Learning Outcome: 2.1
Global Outcome: 2

3) Antacids neutralize acid by the following reaction. Identify the salt in the following equation:

$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + H_2O$

A) $Mg(OH)_2$
B) HCl
C) $MgCl_2$
D) H_2O
E) None of the answers is correct.
Answer: C
Section: 2.4
Bloom's Taxonomy: Comprehension
Learning Outcome: 2.5

4) Which of the following statements is FALSE?
A) Salts readily dissolve in water.
B) Water molecules are formed by hydrolysis.
C) Water freezes from the top down.
D) Water is formed as a part of a dehydration synthesis reaction.
E) Water is a polar molecule.
Answer: B
Section: 2.4
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.4

5) Which of the following is the type of bond holding K^+ and I^- ions in KI?
A) ionic bond
B) covalent bond
C) hydrogen bond
Answer: A
Section: 2.2
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.2

6) Which of the following is the type of bond between molecules of water in a beaker of water?
A) ionic bond
B) covalent bond
C) hydrogen bond
Answer: C
Section: 2.2
Bloom's Taxonomy: Comprehension
Learning Outcome: 2.2
Global Outcome: 7

7) What is the type of bond holding hydrogen and oxygen atoms together in a single H_2O molecule?
A) ionic bond
B) covalent bond
C) hydrogen bond
Answer: B
Section: 2.2
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.2

8) Identify the following reaction: Glucose + Fructose → Sucrose + Water
A) dehydration synthesis reaction
B) hydrolysis reaction
C) exchange reaction
D) reversible reaction
E) ionic reaction
Answer: A
Section: 2.5
Bloom's Taxonomy: Analysis
Learning Outcome: 2.7

9) Identify the following reaction: Lactose + H_2O → Glucose + Galactose
A) dehydration synthesis reaction
B) hydrolysis reaction
C) exchange reaction
D) reversible reaction
E) ionic reaction
Answer: B
Section: 2.5
Bloom's Taxonomy: Analysis
Learning Outcome: 2.7

10) Identify the following reaction: $HCl + NaHCO_3 \rightarrow NaCl + H_2CO_3$
A) dehydration synthesis reaction
B) hydrolysis reaction
C) exchange reaction
D) reversible reaction
E) ionic reaction
Answer: C
Section: 2.3
Bloom's Taxonomy: Analysis
Learning Outcome: 2.7
Global Outcome: 2

11) Identify the following reaction: $NH_4OH \rightleftharpoons NH_3 + H_2O$
A) dehydration synthesis reaction
B) hydrolysis reaction
C) exchange reaction
D) reversible reaction
E) ionic reaction
Answer: D
Section: 2.3
Bloom's Taxonomy: Analysis
Learning Outcome: 2.7
Global Outcome: 2

12) Which type of molecule contains the alcohol glycerol?
A) carbohydrate
B) phospholipids
C) DNA
D) protein
Answer: B
Section: 2.5
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.9

13) Which type of molecule is composed of (CH_2O) units?
A) carbohydrate
B) lipid
C) nucleic acid
D) protein
Answer: A
Section: 2.5
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.8

14) Which type of molecule contains $-NH_2$ (amino) groups?
A) carbohydrate
B) triglycerides
C) nucleic acid
D) protein
Answer: D
Section: 2.5
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.10

15) Which type of molecule NEVER contains a phosphate group?
A) triglycerides
B) phospholipid
C) nucleic acid
D) ATP
Answer: A
Section: 2.5
Bloom's Taxonomy: Comprehension
Learning Outcome: 2.9

16) Based upon the valence numbers of the elements magnesium (2) and hydrogen (1), predict how many covalent bonds would form between these atoms to achieve the full complement of electrons in their outermost energy shells.
A) one
B) two
C) three
D) four
Answer: B
Section: 2.2
Bloom's Taxonomy: Analysis
Learning Outcome: 2.2
Global Outcome: 2

17) Table 2.1

$^{16}_{8}\mathrm{O}$ $^{12}_{6}\mathrm{C}$ $^{1}_{1}\mathrm{H}$

Using the information in Table 2.1, calculate the number of moles in 92 grams of ethanol, C_2H_5OH.
A) 1
B) 2
C) 3
D) 4
E) The answer cannot be determined.
Answer: B
Section: 2.2
Bloom's Taxonomy: Analysis
Learning Outcome: 2.2
Global Outcome: 4

18) Which of the following statements regarding protein structure is FALSE?
A) The primary structure is formed by covalent bonding between amino acid subunits.
B) Secondary structures are formed only from hydrogen bonds.
C) Tertiary structures are formed only from covalent bonds.
D) Quaternary structures involved multiple polypeptides.
Answer: C
Section: 2.5
Bloom's Taxonomy: Comprehension
Learning Outcome: 2.10

19) Which of the following pairs is mismatched?
A) $NaOH \rightleftharpoons Na^+ + OH^-$ — base
B) $HF \rightleftharpoons H^+ + F^-$ — acid
C) $MgSO_4 \rightleftharpoons Mg^{2+} + SO_4^{2-}$ — salt
D) $KH_2PO_4 \rightleftharpoons K^+ + H_2PO_4^-$ — acid
E) $H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{2-}$ — acid
Answer: D
Section: 2.3
Bloom's Taxonomy: Analysis
Learning Outcome: 2.3
Global Outcome: 2

20) Table 2.2

$NaOH \rightleftharpoons Na^+ + OH^-$ — base
$HF \rightleftharpoons H^+ + F^-$ - acid
$MgSO_4 \rightleftharpoons Mg^{2+} + SO_4^{2-}$ — salt
$KH_2PO_4 \rightleftharpoons K^+ + H_2PO_4^-$ — acid
$H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{2-}$ — salt

Which of the following statements about the reactions in Table 2.2 is FALSE?
A) They are exchange reactions.
B) They are ionization reactions.
C) They occur when the reactants are dissolved in water.
D) They are dissociation reactions.
E) They are reversible reactions.
Answer: A
Section: 2.3
Bloom's Taxonomy: Analysis
Learning Outcome: 2.3
Global Outcome: 2

21) What is the type of weak bond between the hydrogen of one molecule and the nitrogen of another
molecule, where the two don't actively share an electron?
A) ionic bond
B) covalent bond
C) hydrogen bond
D) disulfide bond
E) hydrophobic bond
Answer: C
Section: 2.3
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.2
Global Outcome: 7

22) What is the type of strong chemical bond between carbon, hydrogen, and oxygen atoms in a single organic molecule?
A) ionic bond
B) covalent bond
C) hydrogen bond
Answer: B
Section: 2.3
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.2
Global Outcome: 7

23) What is the type of bond between ions in salt?
A) ionic bond
B) covalent bond
C) hydrogen bond
Answer: A
Section: 2.3
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.2
Global Outcome: 7

24) A scientist wants to perform a test that will indicate whether a nucleic acid sample is composed of RNA or DNA. Testing for the presence of which of the following is most appropriate in this situation?
A) phosphate
B) nitrogen
C) guanine
D) uracil
E) thymine
Answer: D
Section: 2.5
Bloom's Taxonomy: Comprehension
Learning Outcome: 2.11
Global Outcome: 2

25) Structurally, ATP is most like which type of molecule?
A) carbohydrate
B) lipid
C) protein
D) nucleic acid
Answer: D
Section: 2.5
Bloom's Taxonomy: Comprehension
Learning Outcome: 2.12

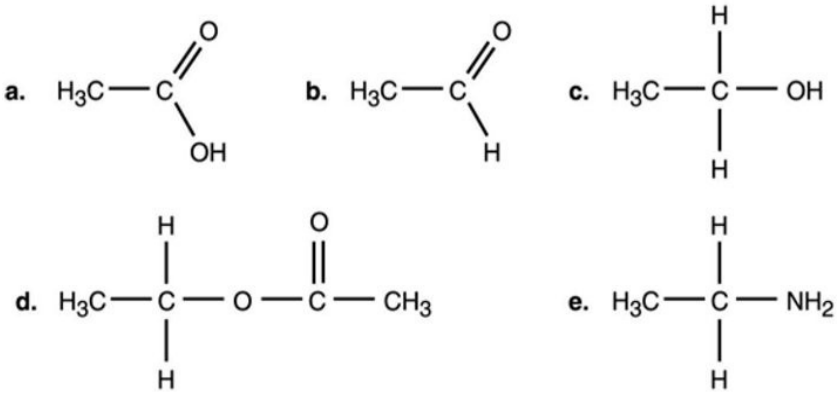
26) What do genes consist of?
A) carbohydrates
B) lipids
C) proteins
D) nucleic acids
Answer: D
Section: 2.5
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.11
Global Outcome: 7

27) Which molecule is composed of a chain of amino acids?
A) carbohydrate
B) lipid
C) protein
D) nucleic acid
Answer: C
Section: 2.5
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.10

28) Which are the primary molecules making up plasma membranes in cells?
A) carbohydrates
B) lipids
C) proteins
D) nucleic acids
Answer: B
Section: 2.5
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.9
Global Outcome: 7

29) The antimicrobial drug imidazole inhibits sterol synthesis. This would most likely interfere with
A) bacterial cell walls.
B) fungal cell walls.
C) eukaryotic plasma membranes.
D) prokaryotic plasma membranes.
E) genes.
Answer: C
Section: 2.5
Bloom's Taxonomy: Analysis
ASMcue Outcome: 3.4
Learning Outcome: 2.9
Global Outcome: 2

Figure 2.1



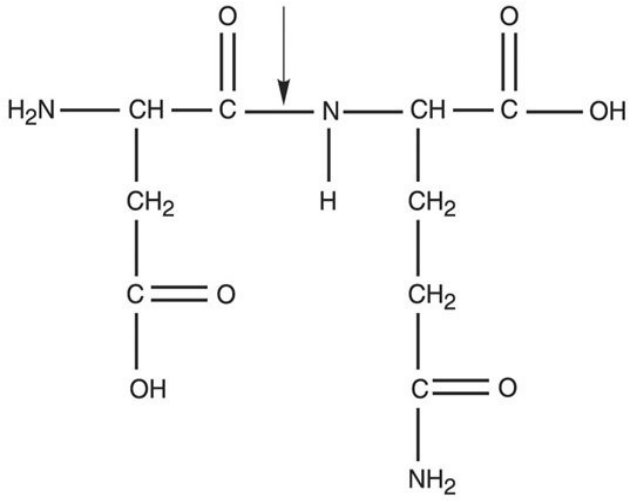
30) In Figure 2.1, which is an alcohol?
A) a
B) b
C) c
D) d
E) e
Answer: C
Section: 2.5
Bloom's Taxonomy: Analysis
Learning Outcome: 2.7
Global Outcome: 3

31) Which compound in Figure 2.1 is an ester?
A) a
B) b
C) c
D) d
E) e
Answer: D
Section: 2.5
Bloom's Taxonomy: Analysis
Learning Outcome: 2.7
Global Outcome: 3

32) Which compound in Figure 2.1 is an organic acid?
A) a
B) b
C) c
D) d
E) e
Answer: A
Section: 2.5
Bloom's Taxonomy: Analysis
Learning Outcome: 2.6
Global Outcome: 3

33) Most amino acids found in cells demonstrate what type of chirality?
A) L-isomers
B) D-isomers
C) C-isomers
D) B-isomers
E) A-isomers
Answer: A
Section: 2.5
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.10

34) Figure 2.3



What kind of bond is at the arrow in Figure 2.3?
A) disulfide bridge
B) double covalent bond
C) hydrogen bond
D) ionic bond
E) peptide bond
Answer: E
Section: 2.5
Bloom's Taxonomy: Analysis
Learning Outcome: 2.10
Global Outcome: 3

35) An *E. coli* culture that has been growing at 37°C is moved to 25°C. Which of the following changes must be made in its plasma membrane to help it cope with the decrease in temperature?
A) The number of phosphate groups must increase.
B) The viscosity must increase.
C) The number of saturated chains must increase.
D) The number of unsaturated chains must increase.
E) No changes are necessary.
Answer: D
Section: 2.5
Bloom's Taxonomy: Comprehension
Learning Outcome: 2.9

36) Radioisotopes are frequently used to label molecules in a cell. The fate of atoms and molecules in a cell can then be followed. Assume *Saccharomyces cerevisiae* is grown in a nutrient medium containing the radioisotope ^{35}S. After a 48-hour incubation, the ^{35}S would most likely be found in the *S. cerevisiae's*
A) carbohydrates.
B) nucleic acids.
C) water.
D) lipids.
E) proteins.
Answer: E
Section: 2.5
Bloom's Taxonomy: Comprehension
Learning Outcome: 2.10
Global Outcome: 2

37) Radioisotopes are frequently used to label molecules in a cell. The fate of atoms and molecules in a cell can then be followed. Assume *Saccharomyces cerevisiae* is grown in a nutrient medium containing the radioisotope ^{32}P. After a 48-hour incubation, the majority of the ^{32}P would be found in the *S. cerevisiae's*
A) plasma membrane.
B) cell wall.
C) water.
D) proteins.
E) carbohydrates.
Answer: A
Section: 2.5
Bloom's Taxonomy: Comprehension
Learning Outcome: 2.9
Global Outcome: 2

38) Starch, dextran, glycogen, and cellulose are polymers of
A) amino acids.
B) glucose.
C) fatty acids.
D) nucleic acids.
E) acids.
Answer: B
Section: 2.5
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.8

39) Which of the following is a base?
A) $C_2H_5OCOOH \rightarrow H^+ + C_2H_5OCOO^-$
B) C_2H_5OH
C) $NaOH \rightarrow Na^+ + OH^-$
D) $H_2O \rightarrow H^+ + OH^-$
E) H_2CO
Answer: C
Section: 2.4
Bloom's Taxonomy: Analysis
Learning Outcome: 2.6
Global Outcome: 2

40) Two glucose molecules are combined to make a maltose molecule. What is the chemical formula for maltose?
A) $C_3H_6O_3$
B) $C_6H_{12}O_6$
C) $C_{12}H_{24}O_{12}$
D) $C_{12}H_{22}O_{11}$
E) $C_{12}H_{23}O_{10}$
Answer: D
Section: 2.5
Bloom's Taxonomy: Comprehension
Learning Outcome: 2.8
Global Outcome: 3

41) If an amino acid contained a hydrocarbon (a group of multiple carbons and hydrogens linked together) as its side group, in which of the following categories could it be appropriately designated?
A) hydrophilic
B) polar
C) nonpolar
D) basic
E) acidic
Answer: C
Section: 2.5
Bloom's Taxonomy: Analysis
Learning Outcome: 2.10
Global Outcome: 2

2.2 True/False Questions

1) Elements only achieve the full complement of electrons in outermost energy cells by donating away or sharing electrons.
Answer: FALSE
Section: 2.1
Bloom's Taxonomy: Comprehension
Learning Outcome: 2.1

2) Covalent bonds are always shared equally.
Answer: FALSE
Section: 2.1
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.2
Global Outcome: 7

3) Individual covalent bonds are stronger than individual ionic bonds.
Answer: TRUE
Section: 2.1
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.2

4) All chemical reactions are, in theory, reversible.
Answer: TRUE
Section: 2.3
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.3

5) The formation of ADP from ATP can be defined as a hydrolytic reaction.
Answer: TRUE
Section: 2.3
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.12

6) The density of liquid water is greater than the density of ice.
Answer: TRUE
Section: 2.4
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.4

7) A basic solution is expected to contain more hydrogen ions than hydroxyl ions.
Answer: FALSE
Section: 2.4
Bloom's Taxonomy: Comprehension
Learning Outcome: 2.5
Global Outcome: 7

8) All forms of life function optimally at a pH of 7.
Answer: FALSE
Section: 2.4
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.5

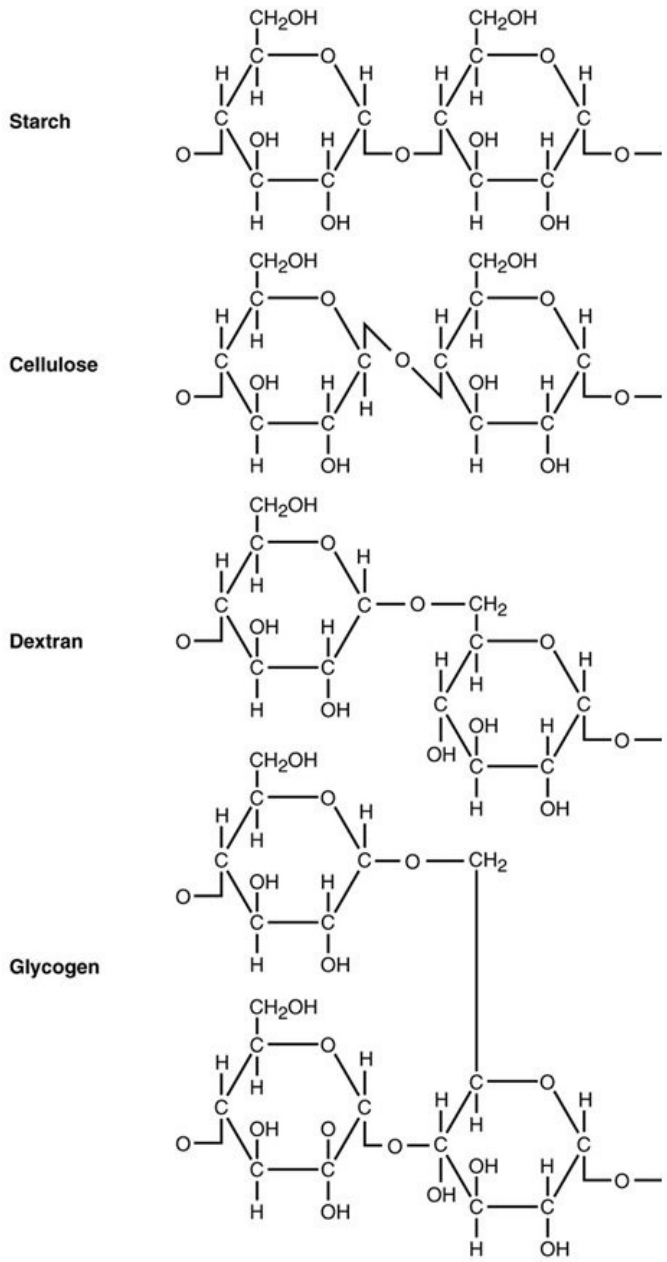
9) There are some forms of life on Earth that can survive without water.
Answer: FALSE
Section: 2.4
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.4
Global Outcome: 2

10) Any compound that contains carbon is considered to be strictly organic.
Answer: FALSE
Section: 2.4
Bloom's Taxonomy: Knowledge
Learning Outcome: 2.6
Global Outcome: 2

2.3 Essay Questions

1) Describe how the properties of phospholipids make these molecules well suited for plasma membranes.
Section: 2.5
Bloom's Taxonomy: Synthesis
Learning Outcome: 2.9
Global Outcome: 8

2) Figure 2.5



Use Figure 2.5 to answer the following. Starch, cellulose, dextran, and glycogen are polysaccharides. How are they similar? To what are their different properties due? Why can't an enzyme that hydrolyzes starch degrade cellulose?
Section: 2.5
Bloom's Taxonomy: Synthesis
Learning Outcome: 2.8
Global Outcome: 8

3) Compare a molecule of a nucleotide to ATP. Could a cell simply insert ATP into DNA without altering it? Explain.
Section: 2.5
Bloom's Taxonomy: Synthesis
Learning Outcome: 2.12
Global Outcome: 8

4) A scientist claims that when a protein is denatured, it can be expected that its secondary structure will more likely be retained when compared to all other levels of protein structure structures. Do you agree? Explain.
Section: 2.5
Bloom's Taxonomy: Evaluation
Learning Outcome: 2.10
Global Outcome: 8

5) A bacterium that grows at a temperature of 37°C transports both glucose and NaCl into its cytoplasm. Which is most easily dissolved in the cytoplasm? Explain how the bonds of these molecules impact disassociation rate.
Section: 2.5
Bloom's Taxonomy: Analysis
Learning Outcome: 2.6
Global Outcome: 8