Microbiology with Diseases by Taxonomy, 5e **(Bauman)**
Chapter 2 The Chemistry of Microbiology

2.1 Multiple Choice Questions

1) Which of the following does not contribute significantly to the mass of an atom?
A) electron
B) neutron
C) element
D) proton
E) isotope
Answer: A
Bloom's Taxonomy: Knowledge
Section: Atoms
Learning Outcome: 2.2

2) Matter composed of a single type of atom is known as a(n)
A) element.
B) mineral.
C) molecule.
D) compound.
E) electron.
Answer: A
Bloom's Taxonomy: Knowledge
Section: Atoms
Learning Outcome: 2.1

3) A stable atom has _____ in its valence shell.
A) 4 electrons
B) 2 neutrons
C) 8 electrons
D) 8 protons
E) 10 electrons
Answer: C
Bloom's Taxonomy: Comprehension
Section: Chemical Bonds
Learning Outcome: 2.5

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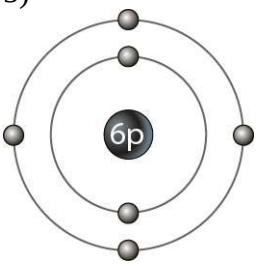
4) Which parts of the atoms interact in a chemical reaction?
A) protons
B) neutrons
C) ions
D) electrons
E) isotopes
Answer: D
Bloom's Taxonomy: Comprehension
Section: Chemical Bonds
Learning Outcome: 2.5

5)



The atomic mass of this stable isotope atom (Figure 2.1) is
A) 4.
B) 6.
C) 10.
D) 12.
E) cannot be determined from the available information
Answer: D
Bloom's Taxonomy: Comprehension
Section: Atoms
Learning Outcome: 2.3

6) The valence of an atom represents its
A) ability to interact with other atoms.
B) electronegativity.
C) radioactivity.
D) ability to attract electrons.
E) ability to interact with water.
Answer: A
Bloom's Taxonomy: Comprehension
Section: Chemical Bonds
Learning Outcome: 2.5

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7) The type(s) of bond produced when atoms share electrons equally is/are
A) a nonpolar covalent bond.
B) a hydrogen bond.
C) an ionic bond.
D) a polar covalent bond.
E) both polar covalent and ionic bonds.
Answer: A
Bloom's Taxonomy: Comprehension
Section: Chemical Bonds
Learning Outcome: 2.7

8) The type(s) of bond produced when atoms with somewhat different electronegativities share electrons is/are
A) a nonpolar covalent bond.
B) a polar covalent bond.
C) an ionic bond.
D) a hydrogen bond.
E) both nonpolar covalent and ionic bonds.
Answer: B
Bloom's Taxonomy: Comprehension
Section: Chemical Bonds
Learning Outcome: 2.7

9) The carbon atoms in organic compounds typically form _____ with other atoms.
A) nonpolar covalent bonds
B) polar covalent bonds
C) ionic bonds
D) hydrogen bonds
E) either ionic or hydrogen bonds
Answer: A
Bloom's Taxonomy: Application
Section: Chemical Bonds
Learning Outcome: 2.7, 2.8

10) Unstable isotopes can be useful
A) catalysts.
B) in medical diagnosis.
C) in vitamins.
D) in the formation of hydrogen bonds.
E) as buffers.
Answer: B
Bloom's Taxonomy: Application
Section: Atoms
Learning Outcome: 2.4

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11) Which of the following is an INCORRECT pairing?
A) electrolytes; anions
B) synthesis; endothermic
C) hydrolysis; hydrogen bonds
D) catabolism; exothermic
E) dehydration; anabolism
Answer: C
Bloom's Taxonomy: Application
Section: Chemical Reactions
Learning Outcome: 2.16

12) A compound that dissociates in water to produce _____ is called a salt.
A) hydrogen ions
B) anions
C) hydroxyl ions
D) cations
E) anions and cations
Answer: E
Bloom's Taxonomy: Knowledge
Section: Water, Acids, Bases, and Salts
Learning Outcome: 2.19

13) Which of the following is a property of water?
A) It has a high capacity for heat.
B) It is not a common reactant in metabolic reactions.
C) It is not a good solvent.
D) It is liquid in a very narrow temperature range.
E) It is a nonpolar molecule.
Answer: A
Bloom's Taxonomy: Comprehension
Section: Water, Acids, Bases, and Salts
Learning Outcome: 2.15

14) An acid dissociates in water to release
A) hydrogen ion(s).
B) cation(s).
C) hydroxyl group(s).
D) anion(s).
E) both anions and hydrogen ions.
Answer: E
Bloom's Taxonomy: Knowledge
Section: Water, Acids, Bases, and Salts
Learning Outcome: 2.19

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15) The reverse of a dehydration synthesis reaction is a(n) _____ reaction.
A) anabolic
B) exchange
C) hydrolytic
D) endothermic
E) metabolic
Answer: C
Bloom's Taxonomy: Knowledge
Section: Chemical Reactions
Learning Outcome: 2.10

16) A weak acid may function as a
A) transfer group.
B) buffer.
C) hydroxyl donor.
D) cation.
E) salt.
Answer: B
Bloom's Taxonomy: Comprehension
Section: Water, Acids, Bases, and Salts
Learning Outcome: 2.19

17) Which of the following is NOT a characteristic of saturated fats?
A) They are usually solid at room temperature.
B) They contain at least one double bond.
C) They are found in animals.
D) Their fatty acids pack tightly together.
E) They are a form of stored energy.
Answer: B
Bloom's Taxonomy: Comprehension
Section: Organic Macromolecules
Learning Outcome: 2.22

18) Which of the following is NOT a characteristic of phospholipids?
A) They are found in cellular membranes.
B) They can form micelles and bilayers.
C) They contain fatty acids that associate with water.
D) They contain a hydrophilic phosphate "head."
E) They contain two fatty acids and a phosphate functional group.
Answer: C
Bloom's Taxonomy: Comprehension
Section: Organic Macromolecules
Learning Outcome: 2.21

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19) Organisms use carbohydrates in all of the following ways EXCEPT
A) as a component of cell walls.
B) as a long-term energy source.
C) as a short-term energy source.
D) to keep membranes flexible at low temperatures.
E) as a building block of DNA and RNA molecules.
Answer: D
Bloom's Taxonomy: Comprehension
Section: Organic Macromolecules
Learning Outcome: 2.23

20) Nucleic acids, proteins, and complex carbohydrates are all produced by
A) hydrolytic reactions.
B) dehydration synthesis.
C) exchange reactions.
D) hydrogen bonding.
E) catabolic reactions.
Answer: B
Bloom's Taxonomy: Application
Section: Organic Macromolecules
Learning Outcome: 2.14

21) Which of the following is an example of a polysaccharide?
A) glycogen
B) glucose
C) fructose
D) deoxyribose
E) sucrose
Answer: A
Bloom's Taxonomy: Comprehension
Section: Organic Macromolecules
Learning Outcome: 2.23

22) Which of the following statements about proteins is FALSE?
A) They are composed of amino acids.
B) They have multiple levels of structural organization.
C) They can be hydrophobic, hydrophilic, or both.
D) Their primary function is energy storage.
E) They are formed by dehydration synthesis reactions.
Answer: D
Bloom's Taxonomy: Application
Section: Organic Macromolecules
Learning Outcome: 2.24

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23) All of the following are components of an amino acid EXCEPT a(n)
A) carboxyl group.
B) pentose group.
C) amino group.
D) α-carbon.
E) R group.
Answer: B
Bloom's Taxonomy: Comprehension
Section: Organic Macromolecules
Learning Outcome: 2.25

24) Which of the following is found in nucleic acids?
A) amines
B) carboxylic acid
C) purines
D) glycerol
E) R group
Answer: C
Bloom's Taxonomy: Comprehension
Section: Organic Macromolecules
Learning Outcome: 2.26

25) Hydrogen bonds are found in all of the following EXCEPT
A) between phosphates in ATP.
B) in α-helices.
C) between water molecules.
D) in the DNA double helix between nucleotides.
E) between the R groups of amino acids in proteins.
Answer: A
Bloom's Taxonomy: Application
Section: Chemical Bonds
Learning Outcome: 2.12

26) Tertiary and quaternary structure of proteins involves _____ bonds.
A) hydrogen
B) ionic
C) polar covalent
D) nonpolar covalent
E) ionic, hydrogen, polar, and nonpolar covalent
Answer: E
Bloom's Taxonomy: Application
Section: Organic Macromolecules
Learning Outcome: 2.25

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27) Which of the following are examples of pyrimidines?
A) uracil and adenine
B) cytosine and guanine
C) thymine and adenine
D) thymine and guanine
E) cytosine and thymine
Answer: E
Bloom's Taxonomy: Comprehension
Section: Organic Macromolecules
Learning Outcome: 2.26

28) All of the following bases are found in RNA molecules EXCEPT
A) adenine.
B) thymine.
C) uracil.
D) cytosine.
E) guanine.
Answer: B
Bloom's Taxonomy: Knowledge
Section: Organic Macromolecules
Learning Outcome: 2.27

29) The double-strands of DNA result from the formation of _____ between the bases.
A) covalent bonds
B) peptide bonds
C) ionic bonds
D) hydrogen bonds
E) α−1,4 bonds
Answer: D
Bloom's Taxonomy: Application
Section: Organic Macromolecules
Learning Outcome: 2.27

30) Which of the following would NOT normally be found as a component of a cell's nucleic acids?
A) adenine deoxyribonucleotides
B) thymine deoxyribonucleotides
C) uracil deoxyribonucleotides
D) cytosine ribonucleotides
E) adenine ribonucleotides
Answer: C
Bloom's Taxonomy: Application
Section: Organic Macromolecules
Learning Outcome: 2.27

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31) All of the following are associated with ATP molecules EXCEPT
A) a long-term energy supply.
B) high-energy bonds.
C) a recyclable energy supply.
D) formation of coenzymes.
E) three phosphate groups.
Answer: A
Bloom's Taxonomy: Knowledge
Section: Organic Macromolecules
Learning Outcome: 2.28

32) Which of the following statements concerning nucleic acids is CORRECT?
A) Nucleic acid strands are held together by hydrogen bonds between adjacent carbohydrates.
B) Cellular DNA is double stranded.
C) All viruses have DNA genomes.
D) The nucleic acid polymer is composed of peptide bonds.
E) There are three naturally occurring purines in nucleic acids.
Answer: B
Bloom's Taxonomy: Application
Section: Organic Macromolecules
Learning Outcome: 2.27

33) Which of the following is an INCORRECT pairing?
A) primary structure; amino acid sequence
B) secondary structure; disulfide bridges
C) tertiary structure; covalent bonds
D) quaternary structure; two or more polypeptides
E) secondary structure; β-pleated sheets
Answer: B
Bloom's Taxonomy: Application
Section: Organic Macromolecules
Learning Outcome: 2.25

34) Proteins contain both acidic and basic R groups and can, therefore, function as
A) energy storage macromolecules.
B) structural macromolecules.
C) buffers.
D) catalysts.
E) genetic material.
Answer: C
Bloom's Taxonomy: Application
Section: Organic Macromolecules
Learning Outcome: 2.16, 2.24

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35) A(n) _____ is a compound that dissolves into anions and cations in water.
A) acid
B) buffer
C) base
D) salt
E) catalyst
Answer: D
Bloom's Taxonomy: Comprehension
Section: Water, Acids, Bases, and Salts
Learning Outcome: 2.19

36) Cell walls containing _____ provide the best protection from drying.
A) polysaccharides
B) triglycerides
C) waxes
D) peptidoglycan
E) sterols
Answer: C
Bloom's Taxonomy: Application
Section: Organic Macromolecules
Learning Outcome: 2.21

37) A(n) _____ is an arrangement of atoms found in a variety of macromolecules.
A) buffer
B) isotope
C) salt
D) stereoisomer
E) functional group
Answer: E
Bloom's Taxonomy: Comprehension
Section: Organic Macromolecules
Learning Outcome: 2.20

38) Decomposition reactions are commonly _____ reactions.
A) endothermic
B) exchange
C) exothermic
D) anabolic
E) dehydration
Answer: C
Bloom's Taxonomy: Knowledge
Section: Chemical Reactions
Learning Outcome: 2.13

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39) Lipids found in the cytoplasmic membranes of all eukaryotic cells are
A) polyunsaturated fats.
B) phospholipids.
C) steroids.
D) waxes.
E) triglycerides.
Answer: B
Bloom's Taxonomy: Knowledge
Section: Organic Macromolecules
Learning Outcome: 2.21

40) A protein is a _____ of amino acids.
A) monomer
B) polymer
C) bilayer
D) solution
E) decomposition product
Answer: B
Bloom's Taxonomy: Knowledge
Section: Organic Macromolecules
Learning Outcome: 2.25

41) DNA is composed of repeating units of sugars, phosphates, and nucleic acids. This is an example of a
A) polymer.
B) monomer.
C) salt.
D) micelle.
E) lipid.
Answer: A
Bloom's Taxonomy: Knowledge
Section: Organic Macromolecules
Learning Outcome: 2.27

42) An unbranched polymer composed of simple sugars is a(n)
A) protein.
B) triglyceride.
C) starch.
D) glycoprotein.
E) amino acid.
Answer: C
Bloom's Taxonomy: Knowledge
Section: Organic Macromolecules
Learning Outcome: 2.23

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43) Anna is conducting an experiment using a pH indicator that is red at low pH, green at neutral pH and purple at high pH. She starts with a green solution. When she adds compound X to her solution it turns purple. Then she adds compound Z to the solution and it turns green. She adds more Z, the solution remains green. These observations suggest X is _____ and Z is _____.
A) a base; a buffer
B) an acid; a base
C) a base; a strong acid
D) an acid; a buffer
E) a buffer; a base
Answer: A
Bloom's Taxonomy: Analysis
Section: Water, Acids, Bases, and Salts
Learning Outcome: 2.19

44) Two molecules react to produce two products, one of which is water. What type of reaction is likely to be involved?
A) a decomposition reaction
B) a hydrolysis reaction
C) an exchange reaction
D) a synthesis reaction
E) The answer cannot be determined from the available information.
Answer: D
Bloom's Taxonomy: Application
Section: Chemical Reactions
Learning Outcome: 2.13

45) Which of the following is an organic compound?
A) adenine
B) carbon dioxide
C) molecular oxygen
D) sodium chloride
E) water
Answer: A
Bloom's Taxonomy: Comprehension
Section: Chemical Bonds
Learning Outcome: 2.8

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46) Which of the following is found in RNA but not DNA?
A) adenine
B) cytosine
C) deoxyribose
D) guanine
E) uracil
Answer: E
Bloom's Taxonomy: Knowledge
Section: Organic Macromolecules
Learning Outcome: 2.26

2.2 True/False Questions

1) The smallest chemical units of matter are elements.
Answer: FALSE
Bloom's Taxonomy: Knowledge
Section: Atoms
Learning Outcome: 2.1

2) The side groups of amino acids can interact with each other and with other molecules.
Answer: TRUE
Bloom's Taxonomy: Comprehension
Section: Organic Molecules
Learning Outcome: 2.25

3) A molecule composed of carbon and hydrogen is a compound.
Answer: TRUE
Bloom's Taxonomy: Knowledge
Section: Chemical Bonds
Learning Outcome: 2.6

4) The electron shells of atoms hold eight electrons each.
Answer: FALSE
Bloom's Taxonomy: Knowledge
Section: Atoms
Learning Outcome: 2.5

5) Hydrogen bonds are stronger then covalent bonds.
Answer: FALSE
Bloom's Taxonomy: Comprehension
Section: Atoms
Learning Outcome: 2.12

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6) An organic molecule with the chemical formula $C_4H_5O_1N_3$ is probably a pyrimidine.
Answer: TRUE
Bloom's Taxonomy: Application
Section: Organic Macromolecules
Learning Outcome: 2.26

7) Denaturation of a protein is always permanent.
Answer: FALSE
Bloom's Taxonomy: Comprehension
Section: Organic Macromolecules
Learning Outcome: 2.25

8) The long-term chemical energy storage molecules in plants are steroids.
Answer: FALSE
Bloom's Taxonomy: Knowledge
Section: Organic Macromolecules
Learning Outcome: 2.23

9) Dehydration synthesis is a common feature of polymer production in cells.
Answer: TRUE
Bloom's Taxonomy: Knowledge
Section: Organic Macromolecules
Learning Outcome: 2.25

10) Salts are produced from exchange reactions in which acids and bases neutralize each other.
Answer: TRUE
Bloom's Taxonomy: Comprehension
Section: Water, Acids, Bases, and Salts
Learning Outcome: 2.19

2.3 Short Answer Questions

1) Radioactive iodine is sometimes used to treat thyroid cancer. This is an example of the use of (isotopes/elements/radiation) in medical treatment.
Answer: isotopes
Bloom's Taxonomy: Knowledge
Section: Atoms
Learning Outcome: 2.4

2) A(n) (nonpolar/polar/ionic/hydrogen) bond is one in which electrons are shared equally between atoms.
Answer: nonpolar
Bloom's Taxonomy: Knowledge
Section: Chemical Bonds
Learning Outcome: 2.7

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3) Cell surface markers composed of both carbohydrate and lipid molecules are known as (glycoproteins/glycolipids/LPS).
Answer: glycolipids
Bloom's Taxonomy: Knowledge
Section: Organic Macromolecules
Learning Outcome: 2.23

4) An atom or molecule becomes a(n) (anion/ion/cation) when it loses an electron to a more electronegative molecule.
Answer: cation
Bloom's Taxonomy: Comprehension
Section: Chemical Bonds
Learning Outcome: 2.10

5) A chemical reaction in which a water molecule is a reactant is known as a (dehydration/hydrolysis) reaction.
Answer: hydrolysis
Bloom's Taxonomy: Comprehension
Section: Chemical Reactions
Learning Outcome: 2.16

6) When a base dissolves in water it releases a(n) (electron/cation/hydrogen ion).
Answer: cation
Bloom's Taxonomy: Knowledge
Section: Water, Acids, Bases, and Salts
Learning Outcome: 2.19

7) The folding of a polypeptide into a three-dimensional shape is its (secondary/tertiary/quaternary) structure.
Answer: tertiary
Bloom's Taxonomy: Comprehension
Section: Organic Macromolecules
Learning Outcome: 2.25

8) The DNA double helix is held together by (covalent/ionic/hydrogen) bonds.
Answer: hydrogen
Bloom's Taxonomy: Knowledge
Section: Chemical Bonds
Learning Outcome: 2.12

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9)

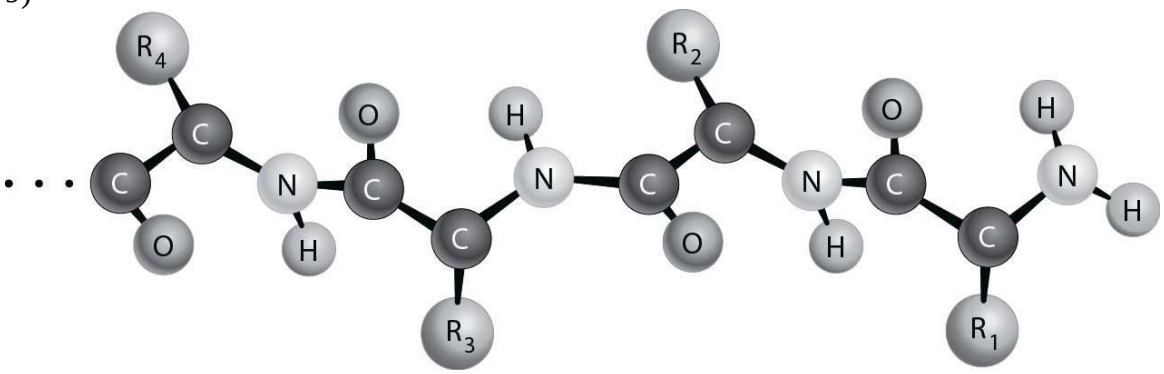

Figure 2.2 depicts the (primary/secondary/tertiary) structure of a protein.
Answer: primary
Bloom's Taxonomy: Knowledge
Section: Organic Macromolecules
Learning Outcome: 2.25

10) A(n) (catalyst/enzyme) is any molecule that speeds up a chemical reaction.
Answer: catalyst
Bloom's Taxonomy: Comprehension
Section: Organic Macromolecules
Learning Outcome: 2.24

11) The monomer of a nucleic acid is called a (nucleoside/nucleotide/base).
Answer: nucleotide
Bloom's Taxonomy: Knowledge
Section: Organic Macromolecules
Learning Outcome: 2.27

12) A nitrogenous base composed of two rings is a (purine/pyrimidine/ribose).
Answer: purine
Bloom's Taxonomy: Comprehension
Section: Organic Macromolecules
Learning Outcome: 2.26

13) Jim adds an acid to a solution, but finds the pH has not changed afterward. This suggests the solution contains a(n) (anion/buffer/salt).
Answer: buffer
Bloom's Taxonomy: Comprehension
Section: Water, Acids, Bases, and Salts
Learning Outcome: 2.19

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14) A saturated fatty acid contains (no/one/multiple) double bonds.
Answer: no
Bloom's Taxonomy: Knowledge
Section: Organic Macromolecules
Learning Outcome: 2.22

15) The (atoms/isotopes/stereoisomers) of an element vary in the number of neutrons in the nucleus.
Answer: isotopes
Bloom's Taxonomy: Knowledge
Section: Atoms

2.4 Essay Questions

1) Compare and contrast synthesis reactions with decomposition reactions.
Answer: Synthesis and decomposition reactions are often the reverse of each other. Synthesis reactions consume energy (are endothermic), whereas decomposition reactions release energy (are exothermic). Synthesis reactions often release water molecules in a process called dehydration synthesis, whereas decomposition reactions often consume water molecules in a process called hydrolysis. Finally, decomposition reactions break large macromolecules into their component monomers, which can then be used in synthesis reactions to build new macromolecules for use by the cell, whereas synthesis reactions utilize component monomers to build larger molecules.
Bloom's Taxonomy: Application
Section: Chemical Reactions
Learning Outcome: 2.16

2) Discuss the importance of hydrogen bonds in the chemistry of the cell.
Answer: The chemistry of the cell would basically be impossible without hydrogen bonds. Water, which is required by all cellular reactions, would not have its unique properties of cohesiveness and polarity without hydrogen bonds. Hydrogen bonds hold the double helix of DNA together and contribute to the overall shape of protein molecules. However, unlike covalent bonds, hydrogen bonds are low energy bonds, so they can easily and temporarily be broken, a characteristic that is important at certain points in the cell's life cycle (such as during DNA replication).
Bloom's Taxonomy: Application
Section: Chemical Bonds
Learning Outcome: 2.12

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3) Max is exploring the properties of various compounds. Some of his explorations involve the use of a pH indicator that is red at low pH, yellow-green at neutral pH and blue to purple at high pH. He sets up several tubes containing water and the pH indicator and then begins to add some of the compounds he is characterizing in various combinations. His results are shown on the following table.

Compound	None	1 × L	1 × M	2 × M	5 × M	1 × N	1 × L + 1 × M	1 × L + 5 × M	1 × L + 1 × M + 1 × N
Color	Green	Red	Green	Blue	Purple	Green	Red	Green	Green

What can Max conclude about his compounds based on these results? Describe the likely events in terms of hydrogen and hydroxyl ions.
Answer: Max's results are consistent with L being an acid and M being a weak base. Compound N appears to be a buffer. The green color of the indicator is seen when the concentrations of hydroxyl and hydrogen ions are equal. The red color of the solution indicates the concentration of hydrogen ions is greater than the hydroxyl ion concentration. The data does not provide information for calculating the concentrations. Blue and purple indicator colors show the hydroxyl ion concentrations exceed the hydrogen ion concentrations. The results with the mixes of L and M suggest that L dissolves to release five times more hydrogen ions than the concentration of hydroxyl ions produced by the ionization of M. Compound N accepts or releases ions with changing hydrogen ion concentrations to maintain equal concentrations of cations and anions.
Bloom's Taxonomy: Analysis
Section: Water, Acids, Bases, and Salts
Learning Outcome: 2.19

4) Describe the chemical properties of phospholipids that account for their behavior in water.
Answer: Phospholipids have polar phosphate "heads" and nonpolar fatty acid "tails," which interact in different ways with water molecules. The phospholipid heads are attracted to polar water molecules, but the nonpolar tails of the phospholipid are repelled by water. As the tails are driven away from the water molecules, they congregate together, either in the interior of a ball of lipid (called a micelle) or within the interior of a double layer of phospholipids (called a bilayer). This leaves the phosphate heads "outside," where they can easily interact with the water molecules.
Bloom's Taxonomy: Application
Section: Organic Macromolecules
Learning Outcome: 2.21

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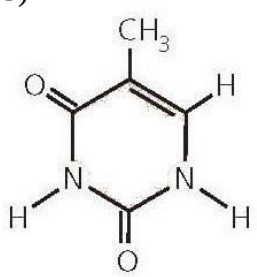
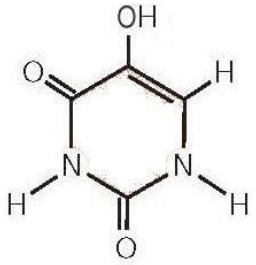


Thymine (T)



Pyrimidine X

Consider the structure of thymine, shown on the left in Figure 2.3 above, and compare to the structure of pyrimidine X on the right. What would be the impact if X is incorporated into the structure of a DNA strand in place of thymine?
Answer: Where thymine has a nonpolar group, pyrimidine X has a polar functional group. If incorporated into a DNA strand pyrimidine X would not form the proper hydrogen bonds with either A or G, resulting in mismatches between DNA strands or, more seriously, disruption of the DNA strand. This type of alteration can lead to mutations in the DNA.
Bloom's Taxonomy: Application
Section: Organic Macromolecules
Learning Outcome: 2.26

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