

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

2.1 Multiple Choice Questions

1) Which of the following is an atomic particle that has no electrical charge?

- A) electron
- B) neutron
- C) element
- D) proton
- E) isotope

Answer: B

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

4) Which parts of the atoms interact in a chemical reaction?

- A) protons
- B) neutrons
- C) ions
- D) electrons
- E) isotopes

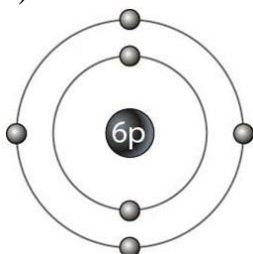
Answer: D

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: E

Bloom's Taxonomy: Comprehension

Section: Atoms

Learning Outcome: 2.3

6) The number of \_\_\_\_\_ of an element determines its atomic number.

- A) protons
- B) neutrons
- C) electrons
- D) valence electrons
- E) isotopes

Answer: A

Bloom's Taxonomy: Knowledge

Section: Atoms

Learning Outcome: 2.3

7) The type(s) of bond(s) 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(s) 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

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) The chemical formula of the oxygen we require is O<sub>2</sub>. It is

- A) a compound.
- B) an isotope.
- C) an element.
- D) a molecule.
- E) both an element and a molecule.

Answer: E

Bloom's Taxonomy: Knowledge

Section: Chemical Bonds

Learning Outcome: 2.3, 2.6

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: 2.18

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

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: 2.16

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

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, 2.27

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

23) All of the following are components of an amino acid EXCEPT a(n)

- A) carboxyl group.
- B) pentose group.
- C) amino group.
- D)  $\alpha$ -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  $\alpha$ -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: Organic Macromolecules

Learning Outcome: 2.12, 2.28

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

27) All amino acids contain what functional group(s)?

- A) aldehyde
- B) amino
- C) ester
- D) carboxyl
- E) both amino and carboxyl

Answer: E

Bloom's Taxonomy: Comprehension

Section: Organic Macromolecules

Learning Outcome: 2.25

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)  $\alpha$ -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



- 31) Which of the following is an accurate description of ATP?
- A) ATP is a form of long term energy storage.
  - B) ATP is a compound formed of ionic bonds.
  - C) ATP does not readily react with other cellular macromolecules.
  - D) ATP serves as a recyclable energy for cells.
  - E) ATP is a structural component of DNA.

Answer: D

Bloom's Taxonomy: Knowledge

Section: Organic Macromolecules

Learning Outcome: 2.28

- 32) Which of the following is NOT characteristic of RNA?
- A) It is a helical polymer.
  - B) It is usually double-stranded.
  - C) Its "backbone" is composed of pentoses and phosphates.
  - D) It contains both purines and pyrimidines.
  - E) It can function as a catalyst.

Answer: B

Bloom's Taxonomy: Knowledge

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;  $\beta$ -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: 2.19, 2.24

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) Synthesis reactions are commonly \_\_\_\_\_ reactions.

- A) endothermic
- B) exchange
- C) exothermic
- D) anabolic
- E) hydrolytic

Answer: A

Bloom's Taxonomy: Knowledge

Section: Chemical Reactions

Learning Outcome: 2.15

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

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) A reaction requires water as a reactant and produces heat. What type of reaction is likely to be involved?

- A) an endothermic reaction
- B) a dehydration 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: 2.15

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

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: 2.27

## 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 than covalent bonds.

Answer: FALSE

Bloom's Taxonomy: Comprehension

Section: Atoms

Learning Outcome: 2.12

6) A nucleotide with a single cyclic ring structure is a pyrimidine.

Answer: TRUE

Bloom's Taxonomy: Application

Section: Organic Macromolecules

Learning Outcome: 2.27

7) Denaturation of a protein is always permanent.

Answer: FALSE

Bloom's Taxonomy: Comprehension

Section: Organic Macromolecules

Learning Outcome: 2.25

8) The valence of an atom is determined by the total number of electrons it contains.

Answer: FALSE

Bloom's Taxonomy: Knowledge

Section: Chemical Bonds

Learning Outcome: 2.5

9) Dehydration synthesis is a common feature of polymer production in cells.

Answer: TRUE

Bloom's Taxonomy: Knowledge

Section: Organic Macromolecules

Learning Outcome: 2.14

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/ isomers) 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

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/endergonic/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

9)

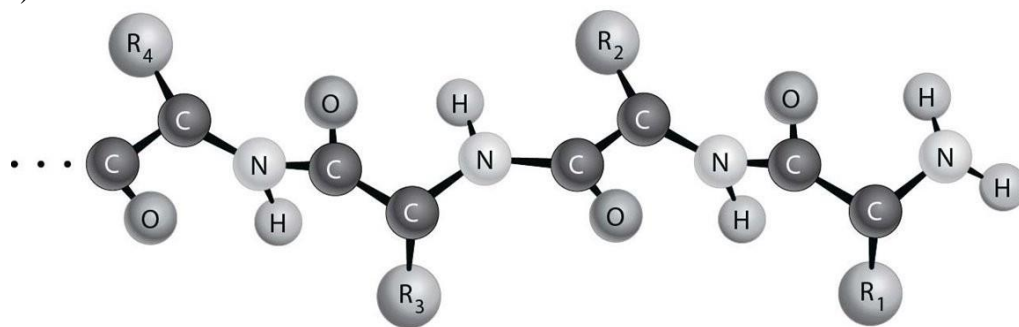


Figure 2.2 depicts the (primary/secondary/tertiary) structure of a protein.

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

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 isotopes of an element vary in the number of (electrons/neutrons/protons) in the atom.

Answer: neutrons

Bloom's Taxonomy: Knowledge

Section: Atoms

Learning Outcome: 2.4

## 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

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 (L, M, and N) 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

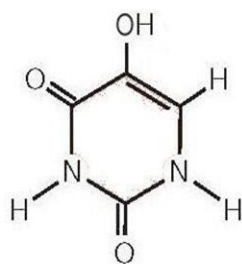
Section: Organic Macromolecules

Learning Outcome: 2.21

5)



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