

## Chapter 2: Concepts of Chemistry

### Overview

Chemistry is the study of matter and how it undergoes change. Regardless of the field you have chosen to go into, an understanding of chemistry can make life more satisfying. Everything we come into contact with is made up of chemicals. Even our bodies are made up of chemicals.

### Learning Outcomes

After completing this chapter, the student should be able to:

- 2.1 Identify matter and its characteristics.
- 2.2 Classify important inorganic substances.
- 2.3 Classify important organic substances.
- 2.4 Explain how chemical changes impact lifespan.


### Lecture Outline


- **Case Study (LO 2.4)**
  - **Dehydration:** Adam Rooke, a 74-year-old man, was working on his car on a hot summer day. He became dizzy and had to sit down to rest. His pulse was weak but he was not perspiring.
- **Introduction (LO 2.1)**
  - **Chemistry is the study of matter and how it undergoes change. Biochemistry is a branch of chemistry that deals with the chemistry of life or biological chemistry.**
  - **When two or more atoms are chemically combined, a molecule is formed. Molecules are the basic units of compounds. A compound is formed when two or more atoms of more than one element are combined.**
  - **Atoms are held together by chemical bonds. Energy is stored in chemical bonds. When the bonds are broken, energy is released that can be used by the body. When bonds are formed, energy is required. Two of the more important chemical bonds we see in cells are covalent bonds and hydrogen bonds. Covalent bonds are when two atoms share the same electrons. A hydrogen bond is an attractive intermolecular force between two partial electric charges of opposite polarity.**

- **Metabolism is the sum of all the chemical reactions that take place in our body. The two processes of metabolism are anabolism and catabolism. In anabolism, small molecules combine to form larger ones. In catabolism, larger molecules are broken down into smaller ones.**
- **PPT slide 2-3 to 2-7**
- **Matter and Atomic Structure (LO 2.1)**
  - **Matter is anything that takes up space and can be a gas, liquid, or solid. Matter is made up of substances called elements that are made up of the same atom.**
  - **An atom consists of a nucleus which is at the center of the atom. The nucleus may contain a number of neutrally charged particles called neutrons and positively charged particles called protons. Neutrons and protons have approximately the same mass.**
  - **Surrounding the nucleus, we find a number of negatively charged particles called electrons. Their mass is so small compared to protons and neutrons we say they have no mass. Electrons farthest from the nucleus are called valence electrons. Valence electrons are gained or lost to make a molecule more stable or may be shared as in covalent bonds.**
  - **The atomic number of an element is the number of protons in the element. The atomic weight is the sum of the number of protons plus neutrons.**
  - **Matter can be divided into two large categories: organic and inorganic matter.**
  - **PPT slides 2-8 to 2-16**
- **Inorganic Substances (LO 2.2)**
  - **Water is the most abundant inorganic compound in the body and is an essential component of our cells, our blood and many other body fluids. Because it takes a lot of energy to change the temperature of water, it helps to regulate our body temperature.**
  - **Oxygen is another essential inorganic molecule. We inhale oxygen, and then it is transported through our blood attached to hemoglobin within red blood cells to all the cells and tissues of our body. It helps to convert glucose to needed energy.**

- Carbon dioxide is exchanged in the cells for oxygen. The carbon dioxide is then exhaled. Although carbon dioxide is considered a waste product for us and other animals, it is essential for most plants and is used to make oxygen.
- Inorganic salts are the fourth major category of inorganic substances that are important to life. They consist of ions such as sodium ( $\text{Na}^+$ ), chloride ( $\text{Cl}^-$ ), phosphate ( $\text{PO}_4^{-2}$ ), potassium ( $\text{K}^+$ ), calcium ( $\text{Ca}^{+2}$ ), magnesium ( $\text{Mg}^{+2}$ ), carbonate ( $\text{CO}_3^{-2}$ ), sulfate ( $\text{SO}_4^{-2}$ ), and bicarbonate ( $\text{HCO}_3^-$ ). They are involved in many important metabolic functions.
- PPT slides 2-17 to 2-19
- Organic Substances (LO 2.3)
  - Carbohydrates are our body's main source of energy. Sugars are one category of carbohydrate and they are soluble in water. Sugars can be classified as simple or complex depending on their size. The most common carbohydrate is glucose which contains 6 carbon atoms, 12 hydrogen atoms, and 6 oxygen atoms in every molecule. Besides being an energy source, carbohydrates are used to build some structural units.
  - Lipids are fats and are insoluble in water. The three types of lipids found in the body are triglycerides, phospholipids, and steroids. Triglycerides are used to store energy for cells. A major function of phospholipids is to make cell membranes. Steroids are very large lipid molecules used to make cell membranes and some hormones.
  - Proteins have many functions in the body. Many proteins act as structural materials for the building of solid body parts. Other proteins act as hormones, enzymes, receptors, and antibodies.
  - Nucleic Acids or DNA (deoxyribonucleic acid) and RNA (ribonucleic acid) are two examples of nucleic acids. Nucleic acids are large complex molecules made up of carbon, hydrogen, oxygen, nitrogen, and phosphorus. DNA contains genes, or the genetic information of cells, and RNA is used to synthesize proteins.
  - PPT slides 2-20 to 2-24
- Life Span (LO 2.4)
  - Chemical changes occur as we get older and also when we become ill.
  - PPT slide 2-25

## Lesson Plan

	Time 	Activity & Instructions	Materials	Learning Outcomes
<b>Introduction</b>	<b>5 min</b>	<p><b>Ask students to Infer why an understanding of chemistry is important to the study of anatomy and physiology.</b></p> <p><b>Introduce the topics for chapter 2.</b></p>		<b>2.1</b>
<b>Lecture</b>	<b>40 min</b>	<p><b>Utilize lecture outline and PPTs.</b></p> <p><b>Identify matter and its characteristics.</b></p> <p><b>Discuss inorganic substances and organic substances relevant to the study of anatomy and physiology.</b></p> <p><b>Explain how chemical changes affect lifespan.</b></p>	<p><b>Lecture outline</b></p> <p><b>PPT slides</b></p>	<b>2.1-2.4</b>

	Time 	Activity & Instructions	Materials	Learning Outcomes
		Using the case study, summarize how knowledge of chemistry affects health and wellness.		
Active Learning and Practice	20 min	Any activity below		
Review	5 min	Review new terminology.	Learning outcomes	2.1-2.4
Assignment		Complete questions at the end of the chapter.	Textbook	2.1-2.4

### Discussion Topics

- Ask students why it is important to have a basic understanding of chemistry when studying anatomy, physiology, and metabolism. Explain that all functioning relates to chemical and physical processes. (LO 2.1)
- Begin a discussion regarding the difference between organic and inorganic materials, including the fact that water is the most common inorganic compound in the body. Instruct students to list four major classes of organic matter. (carbohydrates, lipids, proteins, and nucleic acids) (LO 2.2-2.3)

### Written Assignments

- Ask students to draw/depict an atom of oxygen, including the appropriate number of protons, neutrons, and electrons. (LO 2.1)

- Provide students with a couple of commonly found molecules in the body (e.g., carbon dioxide, oxygen, glucose, water) and ask them to determine the type(s) of chemical bonds between the atoms of each molecule. (LO 2.1)

### Group Activities

- Ask a group of students to explain to the class the concept of metabolism. The explanation should include the fact that the sum total of all the body's chemical reactions is known as metabolism and that metabolism also includes the processes of catabolism and anabolism. (LO 2.1)
- Have students, either singly or in small groups, create a chart consisting of the organic and inorganic materials. In the organic column, information should be included regarding each of the four classes of organic material. (LO 2.2-2.3)

### Internet Activity

- Students who wish to do further study of the importance of chemistry to the study of anatomy and physiology may enjoy reviewing *NIH News in Health*, a monthly newsletter from the National Institutes of Health, <http://newsinhealth.nih.gov>. As the name implies, this newsletter contains practical health information based on research conducted either by NIH's own scientists or NIH grant recipients at universities and medical schools around the country. Invite students who visit this site to search and download an article which demonstrates the importance of chemistry to the understanding of human anatomy and/or physiology.

### Case Study

- A five year old child is brought in by his parents after suffering with nausea, abdominal pain and severe diarrhea for a day. Which of these symptoms is of greatest concern and why?
- Answers to the Case Study: Diarrhea causes loss of body fluids and salts leading to dehydration of varying severity. Severe dehydration may cause death, especially in children.

### Answer Key

#### Case Study 1

1. Sodium chloride and water may be a factor in Adam's situation.
2. c. 60%
3. Adam should drink water and rest indoors in a cool location.

### Review Questions

1. c. water
2. a. nucleic acids
3. c. It is a source of ATP.
4. d. Synthesis of ATP

### Critical Thinking Questions

1. Cholesterol is necessary to produce the sex hormones, androgens, estrogens and progestins; therefore, too little cholesterol may cause infertility, decreased sex drive, amenorrhea, decreased libido, etc.
2. An atom consists of a nucleus, which is at the center of the atom. The nucleus may contain a number of neutrally charged particles called neutrons and positively charged particles called protons. A hydrogen atom contains a proton, but does not contain any neutrons. Neutrons and protons have approximately the same mass.
3. Carbohydrates are our body's main source of energy. Sugars are one category of carbohydrate, and they are soluble in water. Sugars can be classified as simple or complex depending on their size. The most common carbohydrate is glucose which contains 6 carbon atoms, 12 hydrogen atoms, and 6 oxygen atoms in every molecule. Besides being an energy source, carbohydrates are used to build some structural units. Lipids are fats and are insoluble in water. The three types of lipids found in the body are triglycerides, phospholipids, and steroids. Triglycerides are used to store energy for cells. A major function of phospholipids is to make cell membranes. Steroids are very large lipid molecules used to make cell membranes and some hormones. Proteins have many functions in the body. Many proteins act as structural materials for the building of solid body parts. Other proteins act as hormones, enzymes, receptors, and antibodies.

### **Patient Education**

**Patient knowledge about organic substances may help with maintaining a balanced diet.**

### **Applying What You Know**

- 1. Water accounts for the greatest percent mass in the body.**
- 2. Cholesterol, phospholipids, and triglycerides are the three main types of lipids.**
- 3. Each gram of fat can provide over twice the energy as a gram of carbohydrate or protein.**