

SCIENCE

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PHYSICAL SCIENCE - 7
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Physical Science

INSTRUCTIONS

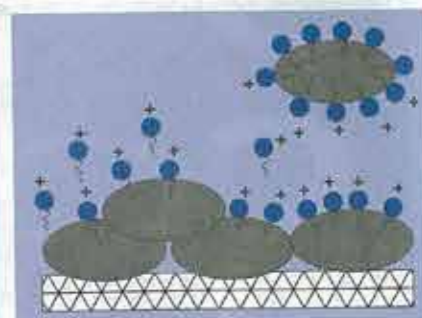
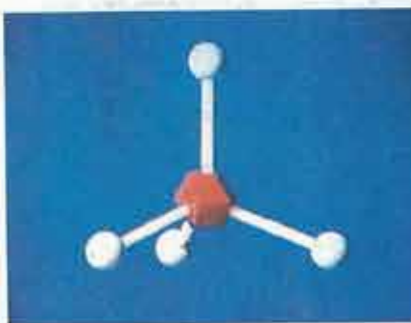
This PACE has a text and a separate Activity Pac that contains the exercises for the text. Follow these steps:

1. Become familiar with the Words to Know at the beginning of each section.
2. Read through the entire text to obtain an overview of the text content.
3. Then reread the text while completing the exercises in the Activity Pac.

Organic Chemistry

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In meekness instructing those that oppose themselves; if God peradventure will give them repentance to the acknowledging of the truth.

II Timothy 2:25

Organic Chemistry

Carefully read these pages. The Objectives tell you what you should learn in this PACE. The Words to Know give the meanings of all terms introduced in this PACE.

Objectives

When you have successfully completed this PACE, you should be able:

- To define and recognize organic and inorganic substances.
- To identify the allotropic forms of carbon and their properties.
- To recognize the structure of common organic compounds.
- To understand the molecular structure of carbohydrates, fats, and proteins in the body.
- To understand the function of enzymes.
- To understand the basic structure of DNA in the body.
- To understand the function of DNA in genetics.

Words to Know

- anticipation* *n.* (ān·tīs'ē·pā'shən) Looking forward to.
- assent* *n.* (ə·sēnt') Acceptance; agreement.
- assert* *v.* (ə·sûrt') To declare positively; to state firmly.
- cyanate* *n.* (sī'ē·nāt') A salt of cyanic acid; a colorless, poisonous liquid.
- incredulously* *adv.* (īn·krēj'ē·lēs·lē) Doubtfully; without believing.
- integral* *adj.* (īn'tē·grəl) Necessary; essential.
- macromolecule* *n.* (māk'rō·mōl'ē·kyūl) A large, complex molecule made up of many smaller molecules.
- tetrahedral* *adj.* (tēt're·hē'drəl) Having four sides, or faces.

I. Carbon and Its Compounds

"I passed! I got it! I can drive now!" Amy Walters shrieked to her mother as she flew in the door.

"Mercy, child, take it easy!" laughed her mother. "Did your father survive your driving test in good health?"

"Of course, Mom. I'm a good driver!" Amy asserted. "Dad's putting the car in the garage, but I couldn't wait to tell you."

After they had eaten supper and washed the dishes, Amy brought her dad his

newspaper and a cup of tea. "Here, Dad, I brought your newspaper and tea. May I get you anything else?" she asked.

"Uh, oh! I know that voice," teased her father. "What do you want this time, Sweetie? Money?"

"Oh, Dad," Amy said, "I just thought that . . . well . . . if you don't need the car Saturday morning, may I go to the mall with Brenda for a while?"

Mr. Walters glanced quickly at his wife

isomers *n.* (i'sə-mərz) Compounds with the same molecular formula but different properties.

polymer *n.* (pōl'i-mər) A chemical compound whose molecules are made of two or more simpler molecules.

preoccupied *adj.* (prē-ōk'yə-pīd') Lost in thought.

pungent *adj.* (pūn'jənt) Referring to a sharp or biting taste or smell.

salve *v.* (sāv) To smooth over or soothe.

II. Organic Compounds

Hydrocarbons

On Saturday morning, Amy was up early and ready to go by nine. "Are you ready yet, Mom?" she called excitedly. "I don't want to be late."

"I'll be just another minute or two, child. Hold your horses!" her mother chuckled.

"Mom, why don't I go out and back the car out of the garage?" Amy asked eagerly. "Then it'll be easier for you to get in."

"Oh, all right," laughed her mother. "I remember how anxious I was to drive for the first time. Just go to the end of the driveway, and no farther. Understand?"

"Yes, Mother," Amy meekly replied as she grabbed the car keys off the kitchen table and dashed out the back door. When she was seated behind the wheel, she went through a mental check list. "Garage door open; seat and mirror adjusted; seat belt fastened; car in 'park'; key in ignition; foot on brake; start engine; check mirror; reverse gear; let off brake; gently press gas pedal. . . . So far, so good! I can handle this just fine!" she asserted.

Just as Amy was beginning to feel confident, she heard an alarming "CRUNCH!" from behind and under the car. She quickly stopped, shifted gears, pulled forward, and stopped the car. When she got out to check, she found the mangled shape of a little red tricycle.

"Oh, no!" Amy felt her face grow pale. "That's Joey's tricycle. How did it get in our driveway?" Looking around to see if she were being watched, Amy thought, "I'll just return it—they won't know who did it anyway." She picked up the tricycle and carefully placed it on the curb in front of her neighbor's house.

When Amy's mother joined her in the car a few minutes later, Amy seemed *preoccupied* and strangely quiet. Although she felt her mother's puzzled looks in her direction, Amy said nothing about the ruined tricycle. Somehow the trip to the mall was not nearly as much fun as Amy had anticipated.

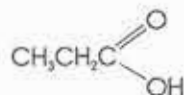
For the rest of the day, Amy was preoccupied with questions and fears: "Did I do the right thing?" (She knew she had not.) "What if someone saw me run over the tricycle? What will my parents do if they find out about the accident? How will Joey feel about his tricycle being smashed? How can I ever face Joey or his parents again?"

Because she had tried to hide her deed, Amy was becoming overwhelmed with feelings of guilt and anxiety. Any student trying to study the more than 3.5 million different organic compounds will be likewise overwhelmed unless he has a systematic means of classifying them.

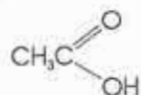
Classification of organic compounds is based on specific groupings of atoms known as functional groups. A functional group is a chemically reactive group of atoms and bonds. A functional group gives certain physical and chemical properties to the compound in which it is found. For example, the functional group



has certain *distinctive* properties and will react in a certain way whether it is found in the molecule



or in the molecule



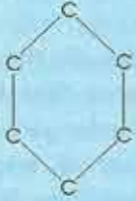
We will limit our discussion to the more common functional groups: alkanes (ä'l'känz), alkenes (äl'kēnz), alkynes (äl'kīnz), *aromatic* hydrocarbons, hydroxyls (hī-drök'selz), aldehydes (äl'dē-hīdz'), and carboxyls (kär-bök'selz).

Many organic compounds are composed only of carbon and hydrogen. These compounds, called hydrocarbons, include the following functional groups: alkanes, alkenes, alkynes, and aromatic hydrocarbons.

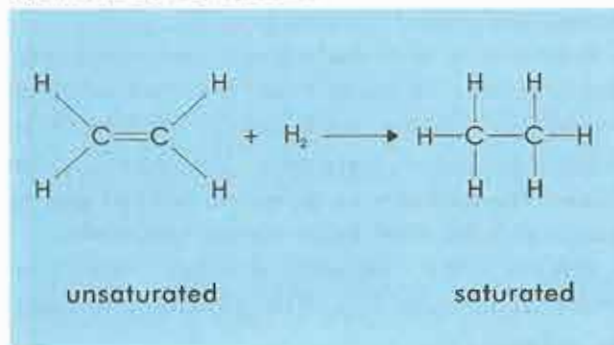
Hydrocarbons that contain only single carbon-carbon bonds are called saturated hydrocarbons. In a saturated hydrocarbon, each carbon atom is bonded to four other atoms (the maximum possible number) by covalent bonds. Additional atoms cannot be added to a saturated compound because it is impossible for the carbon atoms to react and form bonds with any additional atoms.

An unsaturated hydrocarbon contains at least one carbon-carbon multiple bond. If a multiple bond is broken, the carbon atoms involved in the multiple bond can then react and form new bonds with additional atoms.

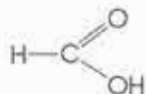
Table 1: MAJOR FUNCTIONAL GROUPS

Name of Group	Structure
hydrocarbons	alkane $\text{C}-\text{C}$
	alkene $\text{C}=\text{C}$
	alkyne $\text{C}\equiv\text{C}$
	aromatic hydrocarbon 
hydroxyl (alcohol)	$-\text{OH}$
aldehyde	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C} \\ \\ \text{H} \end{array}$
carboxyl	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C} \\ \\ \text{OH} \end{array}$

The following diagram begins with the structural formula for ethylene (ēth'ē-lēn), an unsaturated hydrocarbon. Each carbon atom in ethylene is bonded to three atoms. A double bond joins the two carbon atoms, and each carbon atom is bonded to two hydrogen atoms with a single bond. When hydrogen is added to ethylene, the double bond between the two carbon atoms is broken, and each of the carbon atoms then bonds with one of the additional hydrogen atoms. At this point, the hydrocarbon becomes ethane, a saturated hydrocarbon compound.



with a carboxyl group (refer to Table 1 on page 9), replacing three of its hydrogen atoms. The structural formula of methanoic acid is

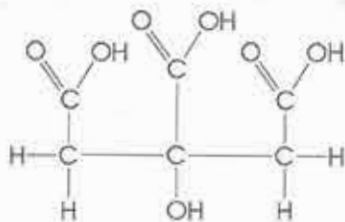


If you have ever been bitten by a red ant or a fire ant, you have had first-hand experience with methanoic (formic) acid. After biting its victim, the ant injects formic acid into the wound. This often causes painful swelling and itching in the area surrounding the bite.



Red ants

Citric acid contains three carboxyl groups. The structural formula of citric acid is



Citric acid, which gives citrus fruits their sour taste, is used as a flavoring in medicines

and soft drinks and is added to canned and frozen fruits to preserve color and flavor. Living cells also form citric acid during metabolism, the process by which cells transform food into energy.

Under the proper conditions, carboxylic acids will react with alcohols to form organic compounds known as esters (*ēs'tērz*). When acetic acid (a carboxylic acid) combines with ethyl alcohol, an ester, methyl acetate (*ās'e-tāt'*), is formed. Methyl acetate may not sound very familiar to you, but you will immediately recognize its familiar flavor and scent if we call it by its common name, peppermint oil. Oil of wintergreen, another popular flavoring, is also an ester.

Most esters have pleasant floral or fruity odors. The distinctive smell and flavor of apples, oranges, pineapples, apricots, pears, and bananas are a result of esters.

Other products made from esters include aspirin, soaps and detergents, and benzocaine (*bēn'zō-kān*), a local anesthetic.

Esters containing long hydrocarbon chains are called waxes. Floor wax, car wax, and shoe polish are examples of ester waxes.



Ester waxes

Words to Know

complement *v.* (*kōm'plə-mēnt'*) To complete by supplying something that is lacking.

cyclic *adj.* (*sī'klīk*) Containing a ring of atoms; referring to atoms arranged in a ring.

helix *n.* (*hē'līks*) An object with a spiral or coiled shape.

lipid *n.* (lĭp'ĭd) An organic compound that feels oily and is insoluble in water.

nucleotide *n.* (nōō'klē-ē-tĭd) A compound which contains sugar and is an integral component of nucleic acid.

pyruvic acid *n.* (pī-rōō'vĭk' ās'ĭd) A colorless acid that is an important product of the metabolism of proteins and carbohydrates.

resolutely *adv.* (rēz'ē-lōōt'lē) With determination.

substrate *n.* (süb'strāt) The material upon which an enzyme acts.

subtle *adj.* (süt'el) Very fine; delicate; hard to recognize.

transcription *n.* (trān-skrip'shən) The process by which a nucleic acid molecule is formed by using the pattern of another molecule.

III. Biochemical Compounds

Carbohydrates

In the morning, Amy awoke more exhausted than she had been the night before. She was determined, however, to delay admitting what she had done. In fact, she hoped it would not be necessary to confess at all.

As her father backed the car out of the driveway on their way to church, Amy's mother remarked, "Look at that! That looks like Joey's little red tricycle out by the curb. I wonder what happened. Just the other day he was proudly washing and polishing it."

Amy sat in shamed silence and **resolutely** repeated her excuses in her mind.

Amy found it difficult to pay attention during the Sunday morning service. She didn't remember later why the pastor had used it, but one statement made during the sermon was painfully clear in its application to her. The pastor stated, "The Bible tells us that we should always have a clear conscience without any offense toward God or man."

Because of the lie that Amy was trying to live, her relationship with God, with her parents, and with her neighbors was strained. Relationships are a way of life—there is no way to avoid them. For a while you might

be able to avoid relationships with other people, but even if you lived alone on an island or in a cave, you have a relationship with God that must be maintained. When relationships are strained, they must be restored, or your conscience—that inner voice that God uses to guide you—will torment you. The Holy Spirit uses your conscience to convict you of wrongdoing and causes you to restore your relationship with God and with other people.

