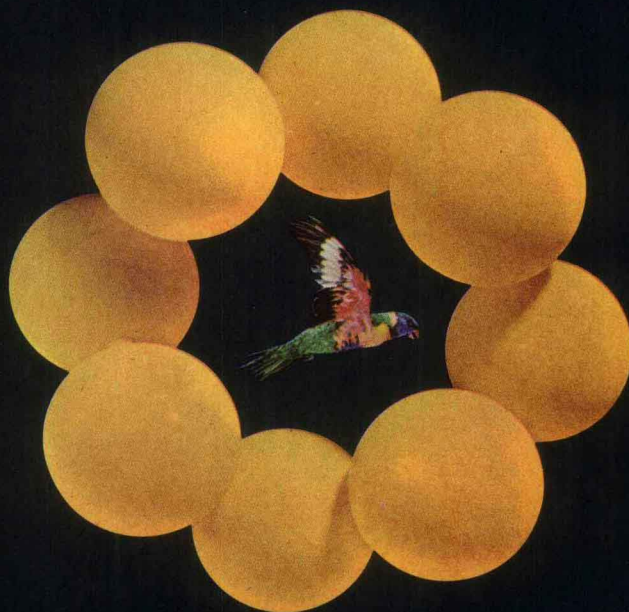




California State Series

## TODAY'S BASIC SCIENCE



### The Molecule and the Biosphere

*A developmental science  
program with experiments and  
observations for the pupil*

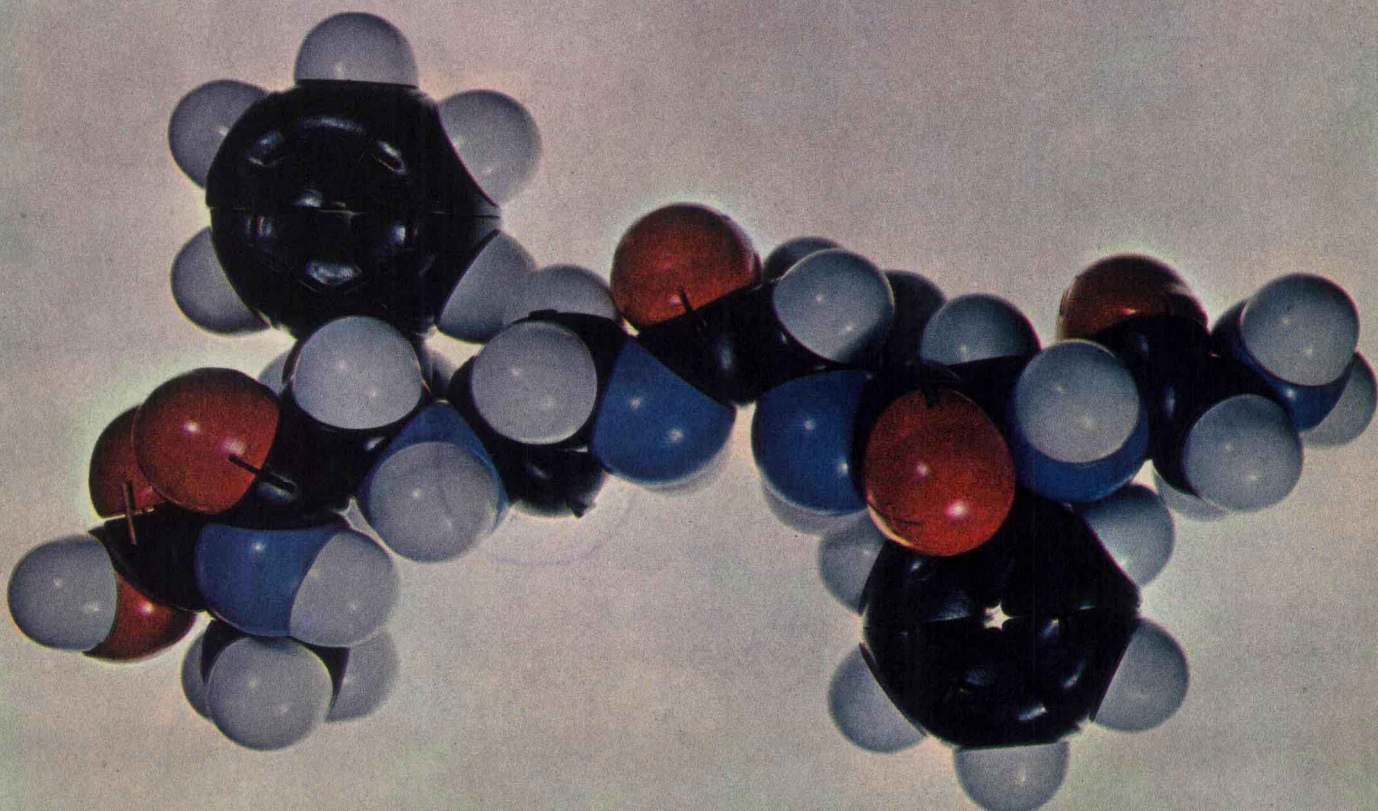
*Kindergarten through grade 8*



## California State Series

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John Gabriel Navarra Joseph Zafforoni John E. Garone



**TODAY'S BASIC SCIENCE** The Molecule and the Biosphere





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# Preface

*Today's Basic Science: The Molecule and the Biosphere* explains fundamental concepts and basic principles that have long been known to scientists. In addition, the book goes into theories and discoveries that have been around for scarcely a decade. Thus, in your study of this book, you will explore both the foundations of science and the frontiers of modern science.

You will see that science is more than a single subject or one specialized field of interest. Science, strictly speaking, is not merely biology, chemistry, physics, geology, astronomy, medicine, or mathematics. Instead, it is all of these things. To understand the life sciences, for example, you must comprehend the basic principles of energy and matter. Matter, energy, life—each is a part of the other.

The interrelationships come together in a compelling story of man's search for knowledge and for an understanding of his environment. Within this story are the excitement and intrigue of orbiting satellites, whirling electrons, coded molecules (DNA), revealing formulas, and unresting cells. Here, too, are the historic findings of Leeuwenhoek, Mendel, Schwann, Kepler, *et al.*

Look for things that are both amazing and comfortably satisfying in your study of this book. Above all, become an informed citizen. Science is a part of every person's life in this remarkable era of enquiry, investigation, advancement, and progress.

John Gabriel Navarra

Joseph Zaffaroni

John E. Garone

# Contents

<b>Unit 1 Perception and Science</b>	9
Chapter 1 <i>Perceiving Things</i>	11
<b>Unit 2 Life in a Physical World</b>	49
Chapter 2 <i>Substance and Matter</i>	51
Chapter 3 <i>Living Matter</i>	77
Chapter 4 <i>The Living Cell</i>	97
Chapter 5 <i>Cell Organization</i>	123
<b>Unit 3 From Life to Life</b>	151
Chapter 6 <i>Classifying Living Things</i>	153
Chapter 7 <i>Genetics, The Study of Heredity</i>	163
Chapter 8 <i>Embryology, The Beginning of Life</i>	185
<b>Unit 4 The Chemistry of Living Things</b>	209
Chapter 9 <i>Solutes and Solvents</i>	211
Chapter 10 <i>Solutions in the Body</i>	237
Chapter 11 <i>The Digestion of Foods</i>	249

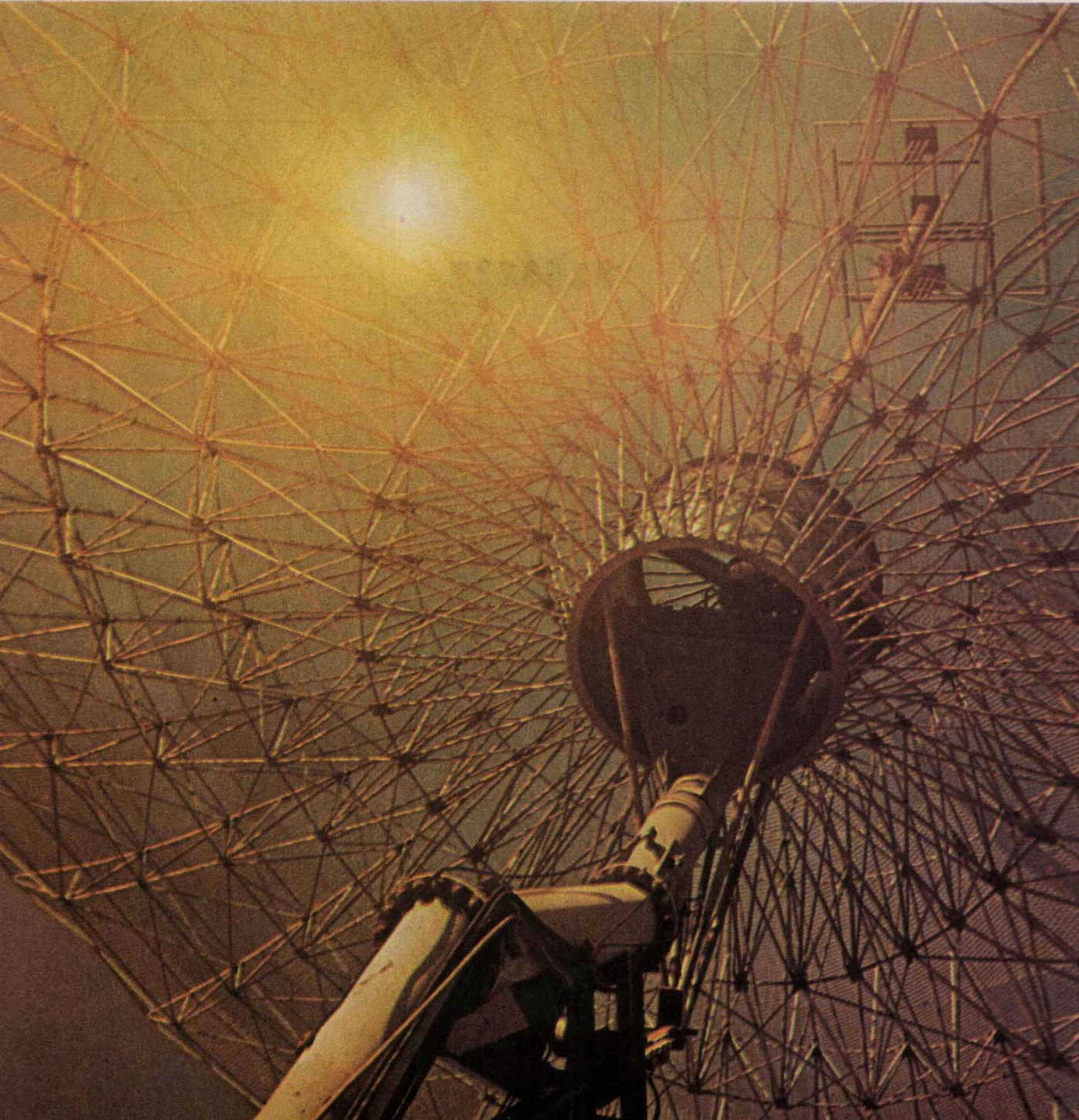




<b>Unit 5 The Biophysics of Sound</b>	277
Chapter 12 Acoustics, The Study of Sound	279
Chapter 13 Producing Sound	299
Chapter 14 Hearing Sound	319
<b>Unit 6 The Living Biosphere</b>	347
Chapter 15 Basic Elements of Ecology	349
Chapter 16 The Biotic Community	371
<b>Unit 7 Biology in Space</b>	399
Chapter 17 Space and Ecology	401
Chapter 18 Life and Survival	415
<b>Glossary</b> The Language of Science	431
<b>Acknowledgments</b>	439
<b>Index</b>	440

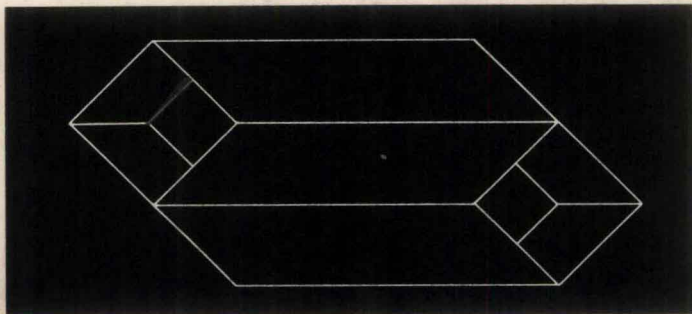
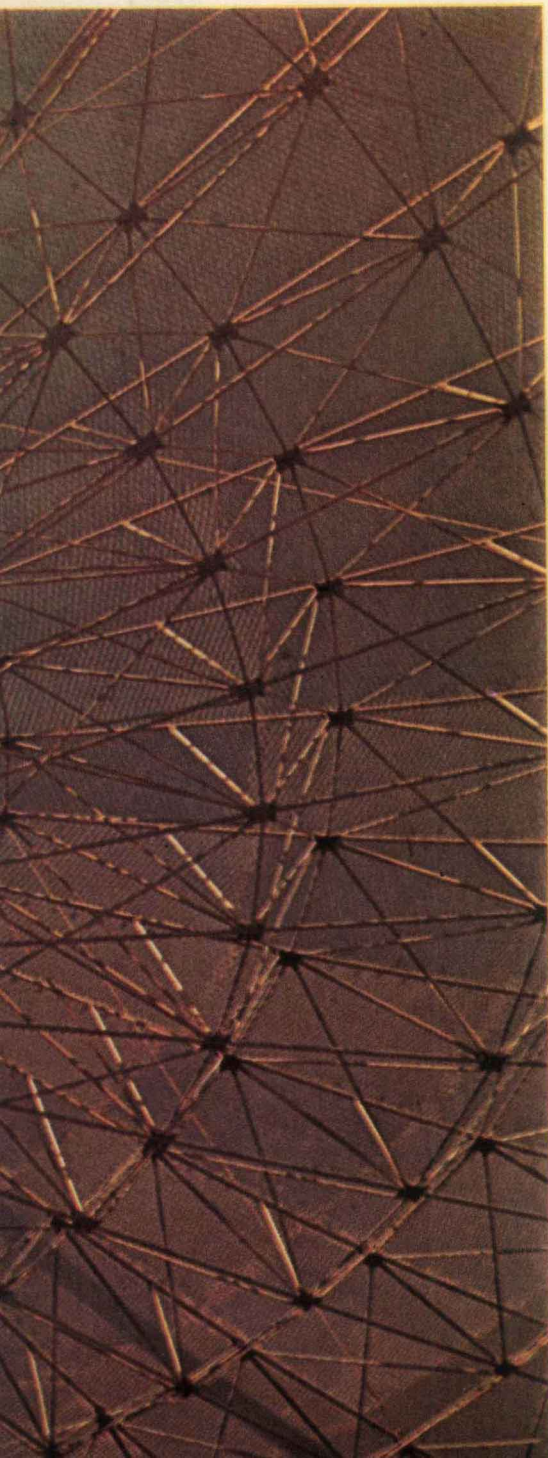


# UNIT ONE





# PERCEPTION AND SCIENCE



There are in space many stars and galaxies that not even the most powerful optical telescope can bring into view. These astronomical wonders cannot be seen. Yet, we know they are there. Radio waves from distant galaxies tell us of their existence.

The dish-shaped antennas of radio telescopes gather in these waves. To the untrained ear, the incoming bursts of energy are meaningless. But to the radio astronomer they are a means of mapping the sky. These waves lead to *perception*, or to awareness and understanding.

Perception is a goal of science. Through experimentation and observation, the scientist explores the nature of things. He makes comparisons, sees relationships, notes differences, observes likenesses, asks questions, obtains answers, and forms conclusions. He *perceives*.



## INVESTIGATION 1

*Do you see things as they really are? Investigate and find out. For your investigation, use a piece of paper two inches wide and twenty inches long. A strip of wrapping paper will do.*

*Hold one end of the strip in one hand. With your other hand give the free end a half twist. Now, bring the two ends together and fasten them with paste or transparent tape. A ribbon of paper twisted in this way is known as a Möbius strip. Does the Möbius strip have unexpected properties? Experiment and see.*

*Grasp the paper strip between your thumb and index finger. Move your finger along the entire piece of paper. Do you return to the starting point? On the basis of this experiment, how many surfaces does the band have? Run your finger along one edge. How many can you trace?*

*Cut through the middle of the Möbius strip with a pair of scissors. Cut lengthwise, and return to your starting point. What do you expect to get? Will you get two bands? Does the cut add another edge and another side, or surface? Cut and see. Make two complete trips around the band with one continuous cut. What do you predict will happen?*

*Try these experiments with your friends and relatives. Ask each person to tell you how many edges the strip has. Then have the person trace one edge. Ask each person to predict what will happen when the strip is cut through the center. Then have him cut the strip. Keep a record of how well your friends' predictions agree with their findings.*





## Chapter 1

# Perceiving Things

Look at the chapter title on this page: *Perceiving Things*. What do you see? Do you see a set of printed words, a block of type? Can you single out the curved lines, the straight lines, and the general shape of the letters? Do you *perceive* something?

To perceive is to become aware of the things around you. The act of perceiving is known as perception. In perceiving, you are engaging in an on-the-spot experience. You are experiencing an event or situation within your body or outside your body.

You perceive through your senses. Your sense of sight enables you to read the title of this chapter. The block of type is outside your body, but it reaches your brain through sight. A sense of sight, in turn, is dependent upon something else. To see, you must have light. Light is a form of energy.

Some form of energy is always necessary before you can perceive. Energy must

reach a part of your body. It must go into your eyes, your ears, your skin, your nose, or your tongue. Energy, you see, activates your senses—your sense of sight, your sense of hearing, your sense of touch, your sense of taste, and your sense of smell.

Perception provides you with the raw materials needed for thinking and learning. You cannot see the type on this page without first perceiving the individual words and letters. The letters go together to make words. The words form sentences. The sentences have meaning. You can perceive the meaning of these sentences.

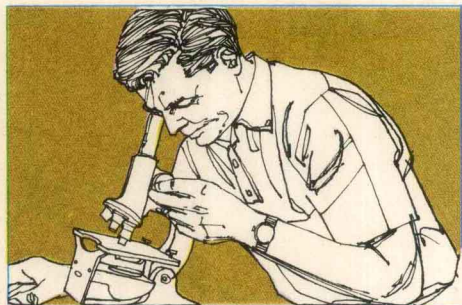
To perceive things is an important goal of science. Perception is essential to you and to anyone else who works in science. The scientist is a careful observer. He acquires knowledge and makes discoveries by means of perceptive observations and meaningful experimentation.



## The Stimulus of Energy

Perception can be thought of as a chain of activities. There are many links in this chain. Each link helps to channel a message to the brain. If any link is broken or missing, there can be no perception. No message gets to the brain.

The first link is a contact. Perception begins when the perceiver makes contact with an object, a situation, or an event. In making contact, the perceiver reacts to some form of energy. He may respond to light, heat, sound, or chemical energy.



### ***For Perceiving and Learning***

*Perception is an awareness of things; it is an awareness of an object, situation, or an event.*

*Discoveries in science come about through perception.*

*Energy makes perception possible.*

*We perceive through our sense organs.*

*Sense organs are a part of, or a link to, the human nervous system.*





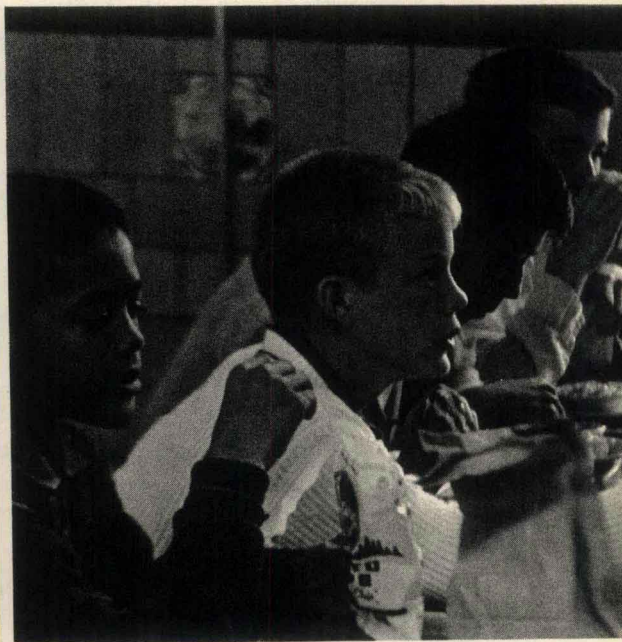
Did you gaze at the moon last night? Did you look at the stars? If so, you made contact with the nighttime sky through the energy of light. Light entered your eyes. It formed an image on the retina of each eye. The optic nerve transmitted the message of sight to your brain. You perceived. You saw the moon and the stars.

Probably at this moment you have little thought of twinkling stars and a glowing moon. Instead, let's say that you are beginning to feel hungry. Hunger pangs are reminding you that lunchtime is approaching. Already you are savoring a tasty bowl

of soup and a hearty roast beef sandwich.

Again you have a contact. The energy changes within your stomach causes you to perceive. You perceive that you are hungry. With this perception, you begin to think of the foods you will eat for lunch. You are even recalling the taste of roast beef and the flavor of a delicious hot soup.

Energy that activates a part of your body is known as a *stimulus*. The light from a star is a stimulus that causes you to see the star. The forms of energy within your stomach give birth to hunger pangs. You know that it is time for lunch.





## EXPERIMENT

Select three colorless liquids. Water, ammonia, and white vinegar will do. Put the liquids into capped bottles. Can you identify the three liquids by looking at them? Remove the bottle caps. Can you tell the liquids apart by their odors? What can you conclude about the odorless liquid? Your ability to perceive odors has been compared to a chemical laboratory. What is the reason for this comparison?

The energy of light is an external stimulus. It originates outside the body. Energy of all forms can be external. The chemical energy of a steak on a charcoal broiler, for example, reaches your nose. You smell the steak. Sound from a phonograph moves out in waves. The sound waves strike your ears, and you can hear the phonograph.

Energy also functions internally, as in the case of hunger pangs. The contact with energy from within enables you to know what is going on inside your body. Such knowledge is important to your health and well-being. Suppose you never felt hungry and were too busy to eat. Starvation might overtake you, slowly but surely.

A stimulus from within causes you to perceive a headache, a stomach-ache, or a sore throat. An internal stimulus tells you of hunger, thirst, fatigue, and anxiety. You may be sleepy, listless, alert, or wide-awake. Whatever your condition, internal stimuli will keep you informed on the state of your body.

## EXPERIMENT

Cover your ears. Plug them with your fingers. Then read a paragraph from this book aloud. Is your voice distinct? Are the tones resounding and clear? Or do the tones seem muffled and distorted? Now, uncover your ears. Read aloud. Is the sound the same? Is there a difference in your perception? Is it possible to perceive from without and from within at the same time?

The stimuli from within can originate in many parts of your body. Very frequently they arise in muscles, tendons, and joints. They can also arise within the inner ear and in centers of touch. Most of these stimuli result from some irritation within the body or from some movement of the body.

These stimuli from within are the first step in informing the brain as to the state of your body, as to the required movements of your muscles, as to the needs of individual organs, and as to the location of different parts of your body at any particular time.

Perceptions from within provide guides to such actions as walking, maintaining your balance, and searching for objects in complete darkness. They tell you when it is best to eat food or to drink water. These perceptions, in fact, have much to say about your daily activities. Inner perceptions also help you to link yourself with the outside world.



## EXPERIMENT

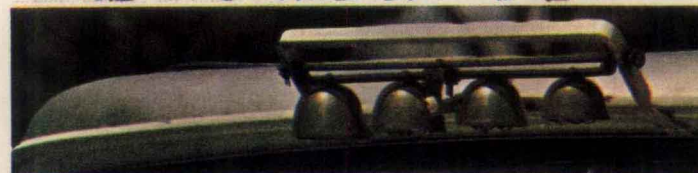
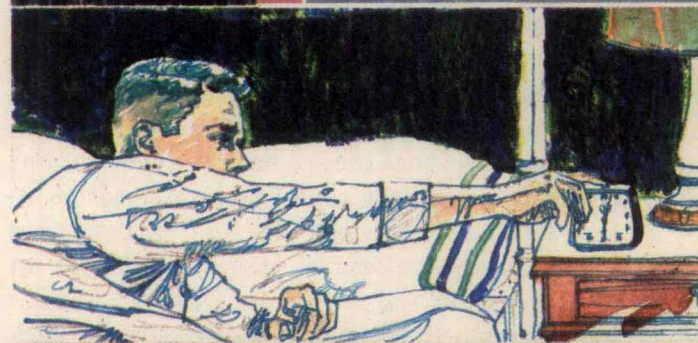
Breathe in deeply, and then hold your breath for twenty seconds. Can you detect any stimuli that arose within your body? What are your perceptions? From what part of the body did these stimuli arise? What forms of energy gave rise to the stimuli?

Every one of us requires perception from without as well as perception from within. Making contact with the world through energy only initiates perceiving. It does not enable us to perceive. It is, however, a necessary link.

## Detecting Energy

Energy must be detected when it makes contact with a part of the body. Otherwise, there is no perception. The parts of your body that can detect energy, or pick up stimuli, are called *receptors*. In general, receptors are sense cells or sense organs. The taste cells in your tongue are sense cells. Your eyes and ears are sense organs.

Each sense cell or sense organ is particularly sensitive to a specific kind of energy. The ear is sensitive to sound energy; the eye to light energy; the nose and mouth to chemical energy; and the skin to heat energy and pressure. The sense cells and organs contain millions of receptors. There are more than four million pain receptors in the human skin!





You are probably familiar with our five senses—the senses of sight, hearing, smell, taste, and touch. This idea of five senses is somewhat misleading. In reality, the human body responds to more than twenty sensations, or senses.

The sense of touch actually is rather complex. Tickling, for example, can be looked upon as a distinct sensation. The receptor that responds to tickling is not the same receptor that feels a pin prick. A pain receptor differs from a heat receptor. Additional receptors respond to pressure and cold.

### THE EYE, A RECEPTOR

Scientists who study perception have learned much about the structure and function of the receptors. They have found, for example, that the screen of the eye contains many receptor cells that are sensitive to light. This screen is the *retina*. Light passes through the lens of the eye and puts an image on the retina, just as light passes through the lens of a motion-picture projector and puts an image on a screen.

The retina of the eye contains many receptor cells. These cells are of two kinds. One kind is known as a *rod*. The other is a *cone*. The rod cells are sensitive to dim light. In addition, they help us to detect motion. The cone cells are sensitive to bright light. They enable us to detect color. A person who is color blind has defective cone cells on the retinas of his eyes.

Rod cells are constantly bringing about a chemical reaction. The rods put vitamin A and a protein together to make a chemi-

cal known as *visual purple*. Once this chemical is made, however, it soon disintegrates. When bright light comes in contact with visual purple, the visual purple splits into vitamin A and a protein. The splitting releases energy. This energy sets up an impulse in the optic nerve that goes to the brain.

### THE HUMAN EYE

