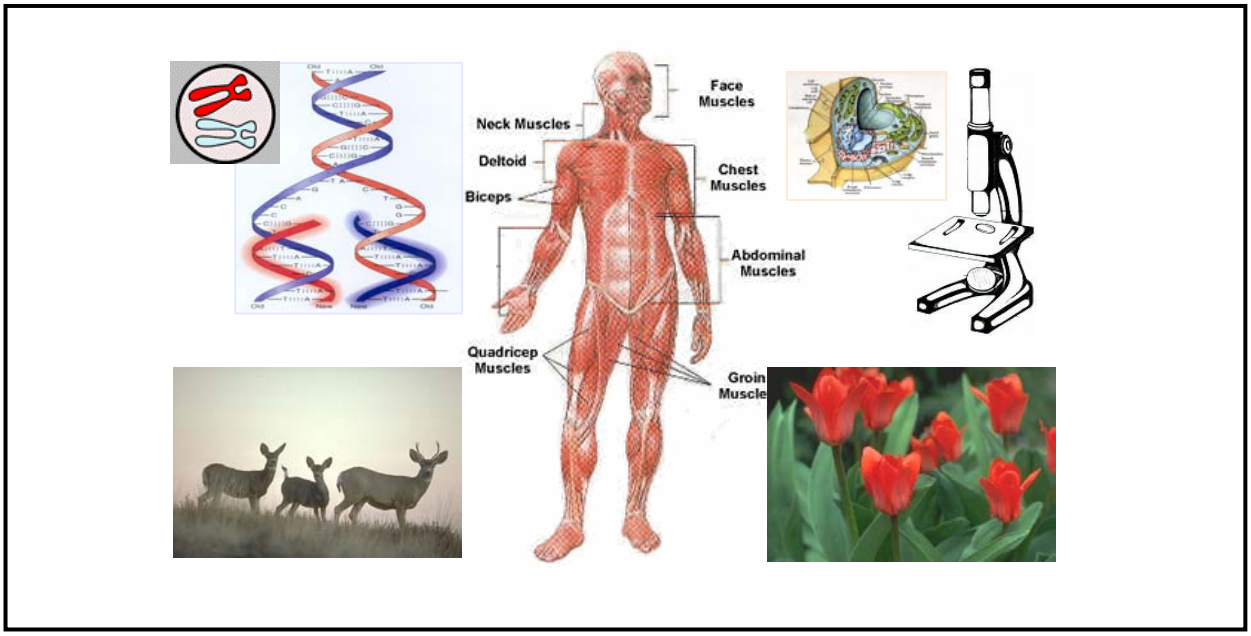
Project EASE

(Effective Alternative Secondary Education)

BIOLOGY



MODULE 1

Nature of Biology

BUREAU OF SECONDARY EDUCATION
Department of Education
DepED Complex, Meralco Avenue
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Module 1
Nature of Biology

What this module is about

This module was designed and written with you in mind. It is here to help you master the nature of Biology. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

The module is divided into three lessons, namely:

- **Lesson 1 – Biology: The Science of Life**
- **Lesson 2 – Biological Concepts as Applied in Technology**
- **Lesson 3 – Tools Used in the Development of Biology and Biotechnology**

What you are expected to learn

After going through this module, you are expected to:

1. identify the unifying ideas in biology;
2. explain the different life processes;
3. explain biological concepts in a given technology;
4. identify the parts and function of the microscope;
5. name special tools used in research and technology; and
6. describe the contributions of Filipino and foreign scientists in the field of biology and technology.

How to learn from this module

This may be a new type of instructional material for you. Its subject matter has been broken down into a series of manageable blocks. The given activities are important because they are programmed to help you learn more efficiently.

Some topics present new information; others review materials that you may already know. Every block presents a learning task that requires some response from you.

When you have written or marked your answer, you will want to find out whether your answers were right. The module provides you with important feedback by giving you easy access to the answers. Do not look at the correct answer until after you have marked your own answers. If you look before answering, you will only impair your own learning process.

If your answer is wrong, reread the lesson until you understand your error. Then go on.

What to do before (Pretest)

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. The process by which animals take in foods that have already been manufactured from raw materials is
   a. digestion
   b. ingestion
   c. nutrition
   d. photosynthesis

2. The process by which digested foods are passed into different parts of a plant or an animal is
   a. digestion
   b. ingestion
   c. nutrition
   d. absorption

3. The process by which oxygen is taken into an organism and carbon dioxide is eliminated from the organism is called
   a. excretion
   b. secretion
   c. circulation
   d. respiration

4. The building-up and breaking down processes occurring in animals is
   a. excretion
   b. secretion
   c. metabolism
   d. assimilation

5. Learning the bones of the human body would be a part of
   a. anatomy
   b. cytology
   c. embryology
   d. physiology

6. The process by which food is broken down into simpler substances is called
   a. digestion
   b. excretion
   c. ingestion
   d. respiration

7. Growth occurs due to a (an)
    a. increase in the metabolism
    b. increase in the size of cells
    c. increase in number of cells
    d. lowering in the rate of cell division

8. What is the smallest, most basic unit of life?
    a. cell
    b. system
    c. tissue
    d. element

9. Which of these processes produce genetically identical organisms?
    a. cloning
    b. grafting
    c. colchicine
    d. hybridization

10. What is the process that allows millions of copies of DNA to be produced?
    a. PCR
    b. recombinant DNA
    c. DNA fingerprinting
    d. gel electrophoresis

11. Two sections of DNA that are joined together form
    a. a PCR
    b. ligase
    c. a clone
    d. recombinant DNA

12. Exact copies of DNA as a result of asexual reproduction are
    a. clones
    b. splices
    c. complimentary bases
    d. recombinant sequences

13. What do you call the circular pieces of DNA found in bacteria?
    a. clones
    b. ligase
    c. plasmids
    d. endonucleases

14. What chemicals are used to cut DNA into fragments?
    a. clones
    b. ligases
    c. plasmids
    d. restriction enzymes

15. The quality of a microscope is judged by its
    a. light strength
    b. resolving power
    c. magnification power
    d. volumetric capacity

16. Which microscope uses lenses and objectives to magnify?
    a. atomic force microscope
    b. compound light microscope
    c. scanning electron microscope
    d. transmission electron microscope

17. Who was the scientist who gave the name cells to structures?
    a. Hooke
    b. Schwann
    c. Virchow
    d. Schleiden

18. Who developed the modern system of classification?
    a. Hooke
    b. Carson
    c. Darwin
    d. Linnaeus

19. Who was the “founder“ of biology?
    a. Hooke
    b. Darwin
    c. Aristotle
    d. Leeuwenhoek

20. Mendel became famous for his study of
    a. zoology
    b. cytology
    c. heredity
    d. bacteriology

Key to answers on page 20.

Lesson 1. Biology: The Science of Life

Biology Defined

Biology is the science that studies life and living things, including the laws that govern the phenomena of life.

Every aspect of life from the smallest submicroscopic living particle to the largest and most imposing of plant and animal species is included in the study of biology. Biological study encompasses all that is known about any plant, animal, microbe or other living thing of the past or present.

Biology is a *natural* science because it is the study of organic (living) nature. It is the science of fishes and fireflies, grass and grasshoppers, humans and mushrooms, flowers and sea stars, worms and molds. It is the study of life on top of the highest mountain and at the bottom of the deepest sea. Biology is the accumulated knowledge about all living things and the principles and laws that govern life. Those who specialize in biology are known as *biologists* or *naturalists*, and it is through their observations of nature and natural phenomena that the great ideas of biology have been born.

Branches of Biology

The amount of knowledge gained in biology is so large that it has many branches. The following table lists some of the major ones.

Table 1. Some Branches of Biology

Name	Focus
Botany	plants
Zoology	animals
Anatomy	structure of living things
Taxonomy	classification of living things
Cytology	cells, their structure and functions
Genetics	heredity
Physiology	functions of living things
Microbiology	living things at microscopic level

Unifying Ideas in Biology

1. There is an underlying unity in the world of life, for all organisms are alike in key respects. They consist of the same kinds of substances, put together according to the same laws that govern matter and energy. Their activities depend on input of energy, which they must obtain from their environment. All organisms sense and respond to changing conditions in their environment. They all grow and reproduce, based on the instructions contained in their DNA.

2. There is also an immense diversity in the world of life. Millions of different organisms inhabit the Earth. Many millions more lived and became extinct over the past 3.8 billion years. And each kind of organism is unique in some of its traits – that is, in some aspects of its body plan, body functions, and behavior.

3. Theories of evolution, especially the theory of natural selection as first formulated by Charles Darwin, help explain the meaning of biological diversity.

4. Biology is a science. It is based on systematic observations, hypotheses, predictions, and relentless tests. The external world, not internal conviction, is the testing ground for scientific theories.

Life Processes

It is usually easy to recognize life, but it is often much harder to define it. *All living things are made of cells*. Some organisms are *unicellular* and consist of only a single cell. Other organisms are *multicellular* and are composed of many cells. To determine whether an object is living or nonliving, biologists have agreed on several characteristics that define living things. They are referred to as *life processes* or activities. These life processes include such activities as growth, metabolism, movement, and reproduction. Living things also react, or respond, to their environment. The ability to respond to an environment stimulus is called *irritability* (no, this word does not mean cranky in this case).

Living things grow. *Growth* is an increase in size. Most organisms also go through a series of changes called *development*. The beginning form of an organism may not

resemble its adult form. For example, a tadpole does not look the same as an adult frog. Growth in multicellular organisms is due to an increase in the number of cells. Humans begin life as a single cell. However, when they are adults, they consist of even more cells.

Metabolism refers to the chemical activities that are needed for life. Ingestion, digestion, respiration, and excretion are the processes of metabolism. *Ingestion* is taking in food. The process of breaking down food into simpler substances is called *digestion*. The breaking down of food particles to release energy is called *respiration*. For biologists, respiration has two meanings. Respiration occurs at the cellular level when food is broken down to release energy. Respiration is also the process of taking in oxygen and giving off carbon dioxide as a waste gas. In humans, breathing and respiration often refer to the same process. *Excretion* is getting rid of wastes. Excretion usually refers to the removal of solid and liquid metabolic wastes that are produced during respiration.

Catabolism and anabolism are two processes in living things that are involved in metabolism. *Catabolism* is the break down of complex substances into simpler substances. *Anabolism* is the formation of complex substances from simpler substances.

Reproduction is the process of producing new organisms of the same kind. Reproduction of living things can occur asexually, requiring only one parent, or sexually, requiring two parents. Organisms that consist of a single cell reproduce asexually by dividing. Organisms that reproduce sexually contain genetic material contributed from each parent. If a group of living things does not reproduce, extinction of that group occurs.

Living things react to changes in their environment. A *response* is a reaction to a change. Responding to a change in the environment may increase an organism's ability to survive.

Organisms must be able to get and use energy in order to survive. *Energy* is needed to carry out all cellular processes. For example, organisms use energy from food to grow, develop, and reproduce.

Energy flows through individual animals, communities, and the environment. It is passed from one organism to another organism, usually in the form of food. For example, a goat eats the energy from the sun that is contained in the cells of a plant. Man then eats the goat and gets its energy. In this way, energy moves through living systems from one organism to another. The sun is the ultimate source of energy, for most of the organisms that live on Earth, although there are exceptions. Some bacteria for example, are able to use the energy trapped in chemical compounds rather than the energy from the sun as plants do.

Living things are *highly ordered*. A tree grows into a form typical of its species. All humans have the same general form, although there are differences in size. The chemical reactions that occur in living things do not occur randomly. The chemicals that make up living organisms are, in general, more complex than the chemicals found in nonliving things, such as rocks. All living things are complex. All are composed of small units of life called cells. Cells are able to carry out all the life processes that insure their survival.

What you will do

Activity 1.1 Understanding Science Words

There are two ways you can understand science words better. One way is by defining the word in context. The way the word is used gives you a clue as to its meaning. Another way is by looking at the parts that make up the word. Each word part can give you a clue as to the meaning of the whole word.

Learning the Skill: Defining Words in Context

1. First, read to see if the word is defined directly in the sentence.
2. If the word is not defined directly, read several sentences beyond the one in which the word first appears. These sentences may provide information about the definition of the word.
3. If possible, define the word based on your own past knowledge. You may have learned the word in an earlier grade, or you may be familiar with it because you hear it everyday.
4. Figure out the meaning of the word by how it is used in the sentence and by the sentences around it.

Find the definitions of the italicized words.

1. *Biology* is the study of life.
2. A cat is a *mammal*.
3. All living things can *reproduce*
4. Green plants carry out *photosynthesis*.

Learning the Skill: Understanding Word Parts

1. Look at the word to see how many word parts you think it has. The word may have one or more word parts.
2. You may recognize parts of the word from previous lessons. Or, you may recognize parts of the word from other familiar words. Try to define each word part if you can. Then define the whole word.
3. Look for root words and prefixes or suffixes. A root word is the main part of the word. A *prefix* is a word part added to the front of a root word to change its meaning. A *suffix* is a word part added to the end of a root word to change its meaning.

Now try the following:

1. What does the word *microorganism* mean? The word *microorganism* has two word parts, *micro* and *organism*. You remember the word *microscope* and that *micro* means small. You also remember that the word *organism* means a living thing.
2. Examples of root words are:

emia- blood	bio- life
vertebrate- animal with a backbone	zoo- animal

3. The prefixes *an* and *in* mean *without*. What do the words *anemia* and *invertebrate* mean?
4. The suffix *logy* means *the study of*. What is biology? Zoology?

What you will do

Self-Test 1.1

Use a separate sheet of paper to write down your answers.

Matching Type. Write the letter of the item in column B that most closely matches the item in column A.

A	B
1. a child gains four kilograms	a. development
2. heartbeat rate increases during exercise	b. growth
3. a tadpole becomes a frog	c. homeostasis
4. the number of organisms in a community increases	d. reproduction
5. dogs produce dogs	
6. a tree trunk gets thicker as the tree becomes older	
7. a dog pants when it is hot	
8. a seed changes form in becoming a plant	
9. zoology	e. plants
10. anatomy	f. animals
11. physiology	g. structure of the body
12. ecology	h. organisms and their environment
13. botany	i. functions of the body
14. growth	j. forming complex substances
15. cell	k. the smallest unit of life
16. catabolism	l. breaking down complex substances
17. anabolism	m. producing organisms of the same kind
18. reproduction	n. an increase in size

Key to answers on page 20.

Lesson 2. Biological Concepts as Applied in Technology

Biotechnology

One of the new and revolutionary areas of biological research is the field of *biotechnology*. Biotechnology is "applied biological science" such as the use of the genetic material in living organisms to help make useful products or to solve medical problems. The use of biotechnology has affected many practices in agriculture, criminal investigations, and the ways we diagnose and prevent human diseases.

Biotechnology is a combination of several different technologies. Even though biotechnology is a new word, the concept behind biotechnology is very old. Throughout history, people selected strains of bacteria and yeasts that were useful in producing certain food products. For example, they used yeast to make bread. Yeast is a microscopic organism related to mushrooms and the fungi that cause diseases such as athlete's foot and ringworm. Various kinds of bacteria were used to produce cheeses and yogurt. Bacteria are also living organisms. By making observations and through trial and error, these selections could certainly be considered early uses of biotechnology.

Genetic Engineering

To date, more than one hundred fifty products produced by biotechnology are being used in medicine and agriculture. Another hundred or more new products are in various stages of development. So you can see that biotechnology may soon influence your life more than any other technology will. As you read on, you will discover some of the other contributions of biotechnology.

Scientists use biotechnology in much more sophisticated ways today. Scientists can actually use microorganisms to make many biologically important substances. For example, most genetic research is done at the molecular level. Scientists are now able to manipulate genes of living organisms. This technique is usually called *genetic engineering.* Many times, genes are actually moved from one DNA molecule and inserted into another. The new DNA molecule is called *recombinant DNA*.

Scientists are able to combine two different DNA fragments through the use of *restriction enzymes.* Using restriction enzymes like a pair of chemical scissors, scientists cut a strand of DNA at particular point in the sequence of bases. The point where the sequence is cut by the restriction enzyme is called the *restriction site*. Scientists then

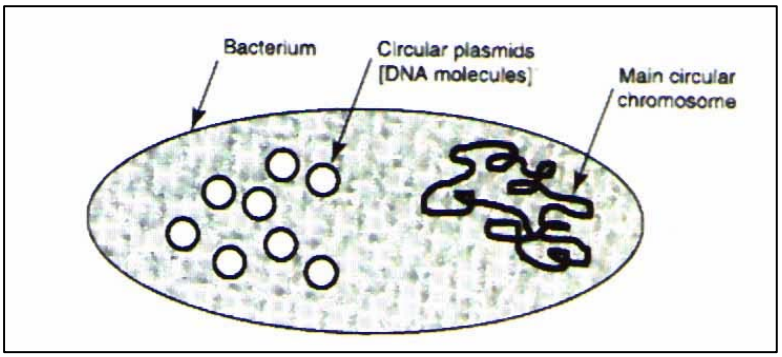

Figure 2.1 Bacterium with plasmids

remove the fragment of DNA that contains a specific gene and insert that section into a new DNA molecule. The DNA fragment cannot function by itself; it must be inserted into the DNA of an organism. After insertion, the open areas of the DNA have to be closed. *Ligases* are enzymes used to join the pieces of DNA.

The process by which a section of DNA from one organism is inserted into the DNA of another organism is called *gene splicing.* It is easiest to insert the DNA fragments into the DNA material present in bacterial cells. *Plasmids*, or circular pieces of DNA in bacteria, usually serve as the site of insertion for sections of DNA. Since bacteria reproduce very quickly, many copies of the recombinant gene can be made in a short time. *Cloning* is asexual reproduction that produces identical copies of the DNA.

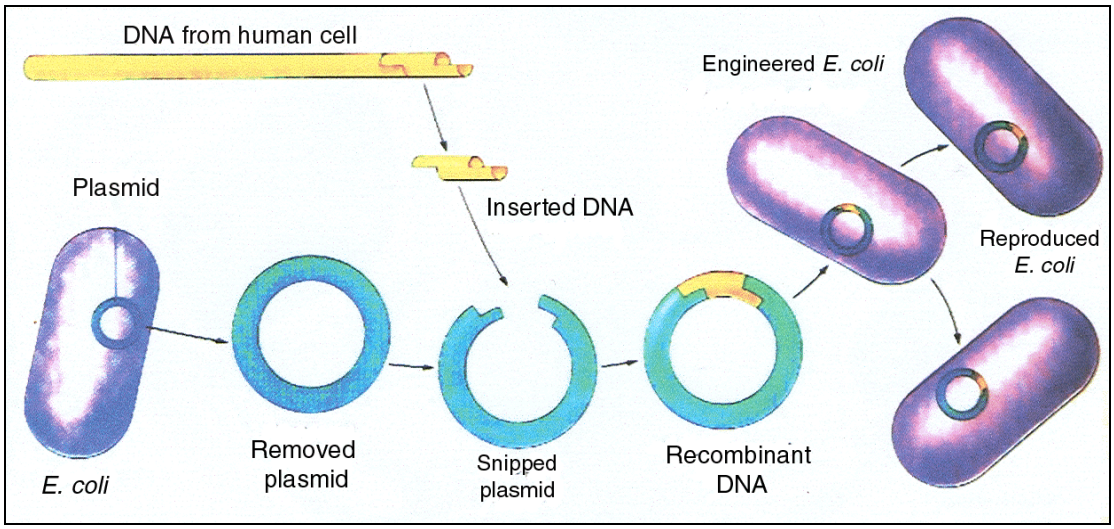

Figure 2.2

During the formation of recombinant DNA, a plasmid from a bacterium, such as E. coli, is snipped open. A short piece is then removed from the DNA of a human cell. This human DNA is inserted to the snipped bacterium plasmid. Then the plasmid is placed back into the bacterium.

In order to manipulate DNA, scientists need to study the individual fragments of DNA they are working with. *Gel electrophoresis* is a method used to separate DNA fragments. This technique uses agarose gel and an electric current. DNA is placed in the gel, and an electric current is run across the gel. Because DNA fragments are negatively charged, they move towards the positively charged areas in the agar. Small fragments of DNA move faster than larger fragments. Thus, based on its rate of migration, the size of the DNA fragment can be calculated.

Many copies of a specific segment of DNA can be made through a process called a *polymerase chain reaction* (PCR). In cloning techniques, PCR is used to increase the amount of DNA. It has also been used to help diagnose human genetic disorders. When only small amounts of DNA are available, PCR is used to increase the size of the sample for easy analysis.

DNA Fingerprinting

One aspect of biotechnology deals with DNA that is used to identify a person. Traditionally, identification has been made by identifying fingerprint patterns. Since no two people (except identical siblings) have exactly the same DNA sequence, it is possible to use these unique sequences as a means of identifying a person. This new technique has become known as *DNA fingerprinting*. This process is often used to compare a sample of DNA found in tissues collected at a crime scene with the DNA of the suspect.

Many people are concerned that certain applications of biotechnology will lead to possible abuses of individual rights. Decisions about the use of biotechnology often involve value judgments that will have to be decided by society. While we debate the uses and consequences of biotechnology, many benefits to society have already been achieved using these techniques, and new discoveries are being made daily.

What you will do

Self-Test 2.1

Use a separate sheet of paper to write down your answers.

A. Matching Type

Direction: Write the letter of the item in column B that most closely matches the item in column A.

A	B
1. genetic engineering	a. determining order of bases in DNA
2. DNA fingerprinting	b. process to separate DNA fragments
3. gel electrophoresis	c. making copies of DNA
4. PCR	d. manipulating the genes of living organisms
5. DNA sequencing	e. allow scientists to compare DNA sequences

B. Fill in the blanks

1. Gel electrophoresis works because DNA has a _____ charge.
2. Using gel electrophoresis, the size of a DNA fingerprint can be calculated by its rate of _____.
3. The process that takes a section of DNA from one organism and inserts it into the DNA of another organism is called gene _____.
4. _____ is the use of living organisms to help solve problems or make useful products.
5. The specific point where a restriction enzyme cuts a DNA sequence is called its _____.

Key to answers on page 21.

Lesson 3. Tools Used in the Development of Biology and Biotechnology

The subject of this lesson is the MICROSCOPE. *The microscope is a tool used to study objects too small to be seen with the unaided eye*. You will be using the microscope to discover a whole world of life too small to be seen with the eye alone. The study of the diversity of life will begin with microscopic organisms and progress to the largest organism.

The microscope enlarges the image of a small object. In your biology class, you will be using the compound microscope. It consists of two lenses, each fitted into the end of a tube within a tube.

How to Prepare the Microscope

The word *microscope* comes from the Greek word *micro* meaning "small" and *scopein* meaning "to see or view." *The purpose of a microscope is to magnify small objects so that they can be seen.*

The microscope that you will be using is both a light and a compound microscope. The light for your microscope will come from sunlight. The word *compound* refers to a microscope with two lenses or a set of lenses. There are two sets of lenses in a microscope, one at each end of the body tube. The two sets of lenses are called the EYEPIECE and the OBJECTIVE.

How to Focus the Microscope

*The purpose of adjusting or focusing the microscope is to produce a magnified image that is sharp***.** That is where the problem begins. Do not be surprised if you do not get sharp images at once.

The scientific word for focusing to get a sharp image is RESOLUTION. MAGNIFICATION is the enlarging of an image. Resolution and magnification are two different things. The problem is that you cannot get good resolution and good magnification at the same time.

A microscope may have to be continually adjusted to get a sharp picture. This is especially true when you are viewing living things. They swim up and down in a drop of water. As an organism moves in a drop of water, it will go out of focus. Turn the adjustment knob to bring the image back into focus.

The Limitations of a Microscope

1. Resolution limits magnification.
2. Continual focusing is necessary if the object moves.
3. Image will be upside-down and reversed.

Microscope Parts and Their Functions

1. *Arm*. Supports the body tube.
2. *Eyepiece*. Contains the magnifying lens you look through.
3. *Body tube*. Maintains the proper distance between the eyepiece and objective lens.
4. *Nosepiece*. Holds objective lens.
5. *Objective lens*. A lens which usually provide a 10x or a 20x magnification.
6. *Stage clips*. Hold the slide in place.
7. *Stage*. Supports the slide being viewed.
8. *Diaphragm*. Regulates the amount of light let into the body tube.
9. *Mirror*. Reflects the light upward through the diaphragm, the specimen, and the lenses.
10. *Base*. Supports the microscope.
11. *Adjustment knob*. Moves the body tube up and down for focusing.

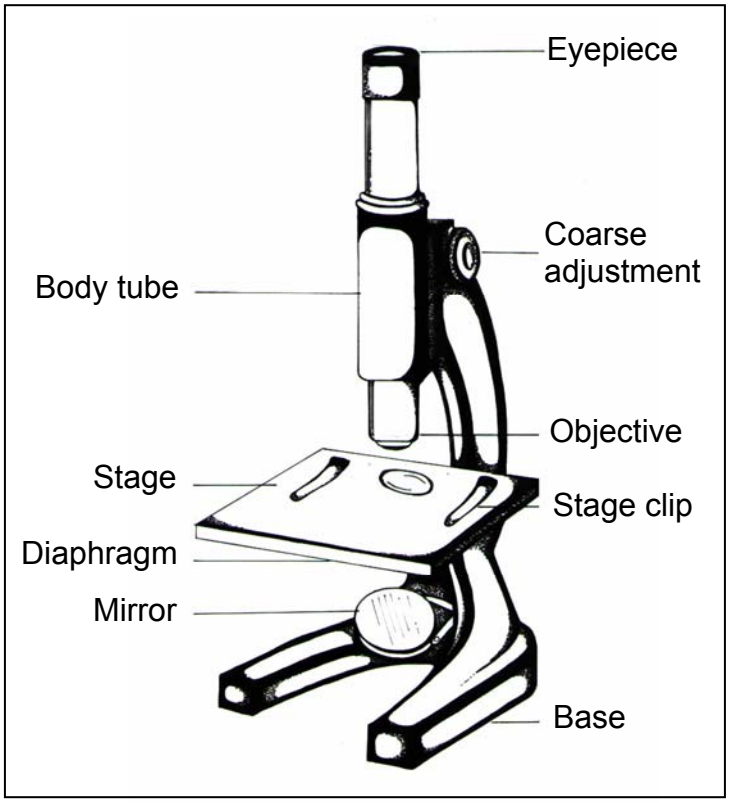

Figure 3.1
Compound Light Microscope

Other Tools of the Biologist

In the 1930s, scientists developed the first *electron microscope*. This type of microscope used beams of electrons, instead of light, to make an image. Today, there are two types of electron microscopes, the *transmission electron microscope* (TEM) and the *scanning electron microscope* (SEM). In the TEM, electrons actually pass through the object being viewed. The biologist sees a thin, flat view of the structures of a specimen. The SEM gives the biologist a surface view of a specimen by coating the specimen with metal, causing the electrons to bounce off the surface. Special detectors pick up the electrons and convert them on a television screen.

Computers have also increased our knowledge by storing and processing great quantities of data.

Biologists at Work

The following is a brief list of people who made contributions to the body of biological knowledge.

Anton van Leeuwenhoek, a Dutch lens maker, is credited with making the first microscope. Leeuwenhoek was the first person to observe microscopic organisms.

Robert Hooke was an Englishman who observed cork – the protective layer of cells produced by trees – under a microscope. He noticed that the cork sample was divided into small chambers. He called these chambers cells. Supposedly, they reminded him of the cells, or rooms, in a monastery. Today, the word cell describes the smallest structural unit of all living things.

Carolus Linnaeus was a Swedish botanist who developed the system for naming organisms used by biologists. Known as binomial nomenclature, this system links a unique genus and species name to every type of living thing. These two names are used by scientists all over the world to describe particular organisms. Before this system was developed, people used many different names for the same organism. Linnaeus's work brought order to what was previously a chaotic situation.

Charles Darwin was the British scientist who developed the idea of *natural selection*, which led to his famous theory of evolution. Darwin's theory recognizes that life has existed on Earth for a very long time, and has changed over time to produce the many types of living things we observe today.

Gregor Mendel was an Austrian monk whose work formed the basis for the modern science of genetics. Mendel's work with pea plants enabled him to develop the basic laws that are used to explain the inheritance of traits.

Matthias Schleiden, a botanist, and **Theodor Schwann**, a zoologist, made observations that led to the "cell theory". The cell theory states that: all living things are made up of cells; cells are the basic unit of structure and function of all living things; and all cells come from preexisting cells.

James Watson, an American biologist, and **Francis Crick**, a British physicist, discovered the structure of DNA. DNA is the nucleic acid that stores information needed for all cellular activities. Their work was based, in part, on the brilliant X rays of DNA taken by biochemists Rosalinda Franklin and Maurice Wilkins.

Rachel Carson, an American writer and biologist, warned of the danger of the increased use of pesticides and the damage it was doing to nature. This brilliant scientific writer attracted a large audience. Her book *Silent Spring* made Americans aware of ecology and the concept that all living things are important because their lives are interconnected in many ways.

Jacques-Yves Cousteau, a French ocean explorer, is the co-inventor of the aqualung. This device revolutionized underwater exploration by making it easier for people to explore the world of ocean life. He introduced the general public to life in the sea through his books and films.

The following are outstanding Filipinos who have made a large contribution to biological knowledge.

Lourdes J. Cruz. Her researches have contributed to the understanding of the biochemistry of toxic peptides from the venom of fish-hunting Conus marine snails. The characterization of over fifty biologically active peptides from the snails' venom had been made possible, in part, by her studies. Also, her work led to the development of conotoxins used as tools for examining the activity of the human brain. For instance, w-Conotoxin is widely used for studying neural calcium channels and m-Conotoxins is used when muscular activity must be controlled to examine events at the synapse.

Clare R. Baltazar is the author of *Philippine Insects,* the first authoritative text on Philippine insects. Her numerous works on insects, especially on the *Philippine Hymenoptera,* are significant in laying down the framework of insect control in the future. She also discovered one subgenus of Hymenoptera and one hundred eight new species of the Philippine parasitic wasp.

Magdalena C. Cantoria. Dr. Cantoria's researches focused particularly on the morphology, physiology, and biochemistry of drug plants. She has also done basic study on the pharmacognosy (or the study of the therapeutic substances) of agar, raulfia, datura, mint, and piper species.

Filomena F. Campos is recognized for her work on cotton research in the Philippines. Her contribution led to the development of a package of technology on cotton production achieved in relatively short period of three years. She was also deeply involved in the research on sunflower, which is a potential source of edible oil and livestock feed.

Benjamin D. Cabrera. Most of Dr. Cabrera's works are on medical parasitology and public health. Parasitology is concerned with parasitism and the parasites, like intestinal parasites, its causes and possible prevention.

Because of his work on epidemiology and life cycle of filarial parasites, preventive measures through the development of drugs, can now be implemented on humans especially against mosquito carriers. With the model he proposed, ascariasis or soil-transmitted helminthes can now be reduced.

Eduardo A. Quisumbing is widely known in botany, especially for his work on taxonomy, systematics and morphology. His researches on Philippine medicinal plants and orchids are pioneering. He is the author of *Medicinal Plants of the Philippines*, which is considered a forerunner on the subject in our country today. He has also written one hundred twenty-nine scientific articles.

Francisco M. Fronda. Dr. Fronda's most significant contribution is the development of poultry industry in the Philippines as well as in the Asian region. His title as the "Father of Poultry Science in the Philippines" is but fitting to his share in the development of the poultry and livestock industry. He spent over six decades – virtually a lifetime – teaching, doing researches and extension work, and he truly deserves the honor.

Emerita V. de Guzman. The outstanding contribution of Dr. de Guzman is the development of the makapuno embryo inside a test tube (in vitro development). This discovery has dramatically changed the ratio of the makapuno-bearing nuts in the tropics which ranges only three to five makapuno nuts in every raceme or cluster of fourteen to nineteen nuts. Dr. de Guzman successfully produced one hundred per cent all makapuno-bearing nuts in a cluster.

Emil Q. Javier. Dr.Javier has been known for his practical and realistic approaches to the problems confronting the small farmers, especially in a tropical and developing country like the Philippines. Keenly aware of the limited resources of the small farmers, Dr. Javier directed his researches towards developing practical methods to improve crop production using cheap, indigenous materials.

Jovenito D. Soriano. Some of Dr. Soriano's studies on plant cytogenetics (or the study dealing with the cells and their processes) and researches on mutations have been published in international journals. He shed light on the understanding of the mutation process (mutation is the process of cell transformation or cell change).

What you will do

Activity 3.1 Calculating Magnification

Objects viewed under the microscope appear larger than their normal size because they are magnified. Total magnification describes how much larger an object appears when viewed through the microscope.

Learning the Skill:

1. Look for a number marked with an X on the following:
    a. eyepiece
    b. objective

    The X stands for how many times the lens of the microscope magnifies an object.
2. To calculate total magnification, multiply the number on the eyepiece by the number on the objective.

Now try the following:

a. If the eyepiece magnification is 5x, and the objective magnification is 10x, then the total magnification is?
b. If the eyepiece magnification is 5x, and the objective magnification is 20x, then the total magnification is?

What you will do

Self-Test 3.1

Use a separate sheet of paper to write down your answers.

Free Response

1. What is a microscope?
2. What is a compound microscope?
3. What are the lenses on a microscope called?
4. How should a microscope be carried?
5. How is the total magnification of a microscope determined?
6. What is the purpose of the mirror and diaphragm?
7. What is the purpose of the adjustment knob?
8. What do the clips hold?
9. What is magnification? resolution?
10. Why may it be necessary to continually focus a microscope?

Key to answers on page 21.

Let's Summarize

1. The basic characteristics of living things include movement, metabolism, growth, response, and reproduction.
2. Metabolism is the sum of all chemical activities essential to life. Ingestion, digestion, respiration, and excretion are metabolic activities that occur in all organisms.
3. Life span is the maximum length of time a particular organism can be expected to live.
4. A living thing reacts to a stimulus, which is a change in the environment, by producing a response.
5. Reproduction is the process by which organisms produce offspring.
6. Asexual reproduction requires only one parent while sexual reproduction requires two parents.
7. Living things need energy for metabolism. The primary source of energy for all living things is the sun.
8. Oxygen in the air or dissolved in water is used by all organisms during respiration. Carbon dioxide is used by plants to make food.
9. Homeostasis is the ability of an organism to keep conditions constant inside its body when the outside environment changes.

10. Biotechnology is the application of technology to the study and solution of problems of living things.
11. When DNA from one organism is removed and inserted into another organism, the new piece of DNA is known as recombinant DNA. The technique by which recombinant DNA is made is called genetic engineering.
12. In genetic engineering, scientists remove a plasmid from a bacterium. Next a short piece of DNA is removed from another cell such as a human cell. The short piece of DNA is joined to the plasmid after it is opened. Then, the plasmid is returned to the bacterium.
13. The products of recombinant DNA are used to produce vaccines, insulin, interferon, and human growth hormone.
14. Genetic engineering is also used to protect plants from the tobacco mosaic virus and to prevent the development of frost on plants.
15. Microscopes magnify small objects and produce enlarged images of them.
16. Lasers and computers have important applications in life sciences.

Posttest

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which is **NOT** one of the basic characteristics of life?
   a. air
   b. response
   c. metabolism
   d. reproduction

2. Life activities such as ingestion and digestion are parts of the process of
   a. growth
   b. response
   c. metabolism
   d. respiration

3. Organisms combine oxygen with other materials to produce energy during
   a. digestion
   b. excretion
   c. ingestion
   d. respiration
4. The maximum length of time an animal can be expected to live is its
   a. growth
   b. life span
   c. development
   d. spontaneous generation
5. A signal to which an organism reacts is called a (an)
   a. action
   b. response
   c. stimulus
   d. environment

6. All organisms directly or indirectly obtain energy from
   a. plants
   b. animals
   c. the sun
   d. excretion

7. The process by which complex foods are broken down into simple usable materials is
    a. digestion
    b. ingestion
    c. absorption
    d. photosynthesis

8. The distribution of digested materials and oxygen to all parts of the body and the removal of wastes produced by normal body activities occur in the process of
    a. excretion
    b. circulation
    c. respiration
    d. assimilation

9. The life process in which certain chemicals are produced by an animal is
    a. digestion
    b. excretion
    c. secretion
    d. metabolism

10. The life process involved with the elimination of waste products of an animal is
    a. digestion
    b. excretion
    c. secretion
    d. metabolism

11. The study of the structure of organisms is called
    a. anatomy
    b. ecology
    c. physiology
    d. biochemistry

12. A method used to separate DNA fragment is
    a. PCR
    b. recombinant DNA
    c. DNA fingerprinting
    d. gel electrophoresis

13. The application of technology to the study and solution of problems involving living things is known as
    a. inbreeding
    b. hybridization
    c. biotechnology
    d. genetic engineering

14. In genetic engineering, the new pieces of combined DNA are called
    a. inbreeding
    b. hybridization
    c. recombinant DNA
    d. selective breeding

15. A plasmid is a (an)
    a. enzyme
    b. growth hormone
    c. nitrogen base in DNA
    d. ring-like form of DNA

16. Which of the following has been genetically engineered to produce proteins made by other organisms?
    a. mice
    b. plants
    c. bacteria
    d. human beings

17. Which of the following is **NOT** produced as a result of genetic engineering?
    a. insulin
    b. square tomatoes
    c. ice-minus bacteria
    d. human growth hormone

18. A microscope with a 10x objective and a 50x occular magnifies
    a. 40 times
    b. 60 times
    c. 150 times
    d. 500 times

19. A microscope that magnifies parts inside a cell three hundred thousand times or more is the
    a. stereoscopic microscope
    b. compound light microscope
    c. scanning electron microscope
    d. transmission electronic microscope

20. Which scientist found that cells are the basic units of function and structure of all living things?
    a. Hooke
    b. Janssen
    c. Leeuwenhoek
    d. Schleiden, Schwann, Virchow, et al.

Key to answers on page 21.

Key to Answers

Pretest

1. b	6. a	11. d	16. b
2. d	7. c	12. a	17. a
3. d	8. a	13. c	18. d
4. c	9. a	14. d	19. c
5. a	10.a	15. b	20. c

Lesson 1

Self-Test 1.1

1. b	6. b	11. i	16. l
2. c	7. c	12. h	17. j
3. a	8. a	13. e	18. m
4. d	9. f	14. n	
5. d	10. g	15. k	

Lesson 2

Self-Test 2.1

A.
1. d
2. e
3. b
4. c
5. a

B.
1. negative
2. migration
3. splicing
4. biotechnology
5. restriction site

Lesson 3

Self-Test 3.1

1. A microscope is a tool used to study objects too small to be seen with the naked eye. The purpose of the microscope is to magnify small objects so that they can be seen.
2. The compound microscope consists of two lenses, each fitted into the end of a tube within a tube.
3. The two sets of lenses are called the *eyepiece* and the *objective.*
4. A microscope should be carried with one hand under the *base* and one hand around the *arm.*
5. The total magnification of a microscope can be determined by multiplying the magnification of the eyepiece and the magnification of the objective.
6. The *mirror* bounces light up through the hole in the stage to the eye. Adjusting the *diaphragm* regulates light.
7. The *adjustment knob* moves the *body tube* up and down.
8. The *clips* hold the slide in place.
9. Magnification is the enlarging of an image. Resolution is the scientific word for focusing to get a sharp image.
10. It is necessary to re-focus a microscope in order to get a sharp picture. This is especially true when you are viewing living things because they move from one point to another.

Posttest

1. a	6. c	11. a	16. c
2. c	7. a	12. d	17. b
3. d	8. b	13. c	18. d
4. b	9. c	14. c	19. d
5. c	10. b	15. d	20. d

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