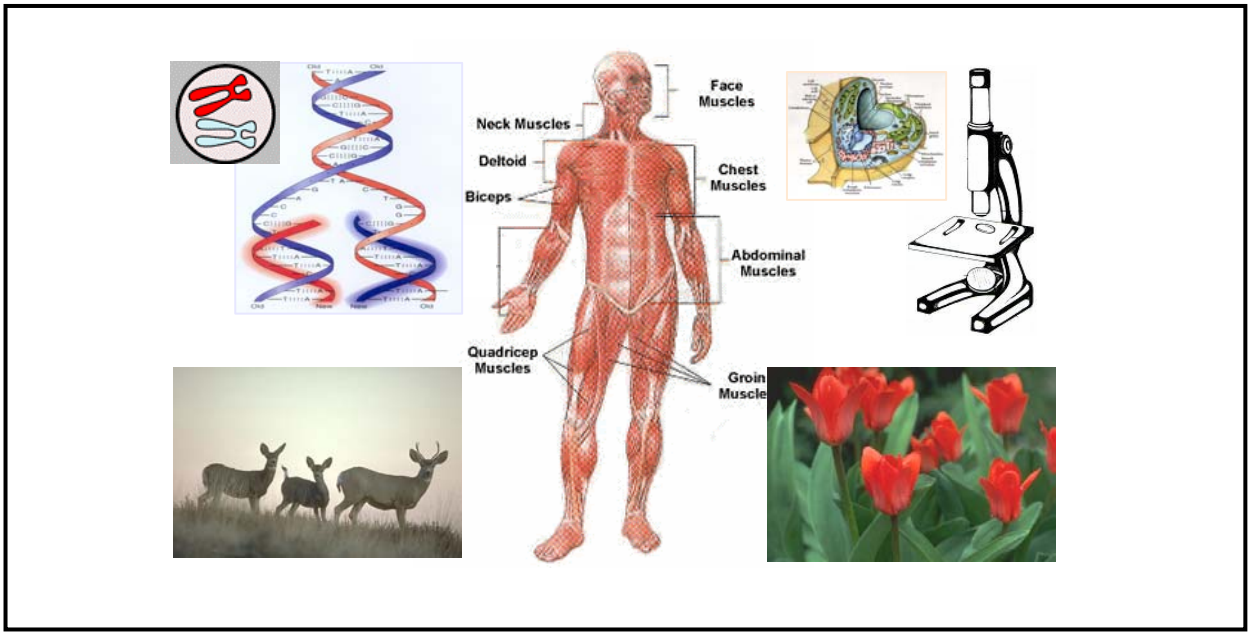
Project EASE

(Effective Alternative Secondary Education)

BIOLOGY



MODULE 6

The Levels of Biological Organization

BUREAU OF SECONDARY EDUCATION
Department of Education
DepED Complex, Meralco Avenue
Pasig City

Module 6
The Levels of Biological Organization

What this module is about

Living systems demonstrate a unique and complex hierarchical organization. You find a hierarchical level that includes simple molecules, macromolecules, cells, tissues, organs, organ system, organisms, population and species. Each level builds on the level below it and has its own internal structure, which is often hierarchical. These hierarchical levels are in ascending order. You are the best example of a living thing. Your body is composed of many parts. Each part has its own function. You use your eyes to see what is around you. You have ears to collect sound waves. You have your feet for walking. All the parts of living things are interrelated. They do not work alone but as a whole. One part interacts with another part. Have you ever asked yourself " what is inside these body parts that enable them to carry out their function?

In this module, we shall discuss the organization of organisms that enables them to survive despite the ever changing environment. The following lessons are included:

- **Lesson 1 – The Molecular Organization**
- **Lesson 2 – The Cellular Level of Biological Organization**
- **Lesson 3 – Tissue, Organs and Organ System: Other Biological Level of Organization**
- **Lesson 4 – The Characteristics of Living Things.**

What you are expected to learn

After reading the module, you are expected to do the following:

1. Illustrate the coordinated function of cell, tissues and organ systems for maintaining life of plants, animals and human beings.
2. Recognize the necessity of an organized system for proper growth, development and survival of an organism.

How to learn from this module

1. Read the instructions carefully.
2. Before you study the concepts in this module, take the pretest.
3. Check your pretest against the answer key on page 26.
4. Study the lessons included in this module until you gain mastery of the topics.
5. Do all the activities and answer the questions in each activity.
6. Take the self-test that accompanies each lesson.
7. After mastering all the lessons, take the posttest and check you answers against the answer key on page 26.
8. If your posttest score does not reflect mastery, go over the module again.

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 smallest level of organization where the characteristic of life emerges is
   a. atomic level
   b. cellular level
   c. molecular level
   d. population level

2. Which of the following is a compound?
   a. calcium
   b. hydrogen
   c. sodium chloride
   d. oxygen

3. Which of the following is an organic compound?
   a. CO_2
   b. $CaHCO_3$
   c. $CaCO_3$
   d. CH_3CH_2OH

4. Which of the following is a macromolecule?
   a. ethyl alcohol present in wines and liquor
   b. acetic acid in vinegar
   c. urea in urine
   d. protein

5. Energy is important to non-living and living things. Which of the following sources of energy powered the formation of organic compounds in the early days of primitive earth?
   a. electrical discharges from lightning
   b. nuclear power plant
   c. solar radiation
   d. solar cell

6. Which of the following does **NOT** characterize a living thing?
    a. ability to respond
    b. classification
    c. organization
    d. reproduction and development

7. Which of the following is the forerunner of the living cell?
    a. protocell
    b. cell membrane
    c. macromolecules
    d. coacervate droplet

8. Which of the following characteristics of living things is associated with responsiveness?
    a. All cells came from pre-existing cells.
    b. Penguin can swim in icy Antarctica sea.
    c. Beetle is a very tiny animal.
    d. Plant bends toward source of light.

9. Which of the following is important to the continuation of a functioning cell/ organism?
    a. Constant body temperature
    b. Constant blood sugar level
    c. Constant pH
    d. All are important

10. Which of the following cells serves as body cover?
    a. fat cell
    b. neuron
    c. muscle cell
    d. cells of the inner lining of check

11. Which of the following tissues are present in ducts of glands?
    a. parenchyma
    b. vascular tissue
    c. nervous tissue
    d. epithelial tissue

12. What is the organ system responsible for food procurement?
    a. nervous system
    b. muscular system
    c. digestive system
    d. respiratory system

13. Which of the following parts of the plant traps energy from the sun?
    a. The leaves of cactus that became spines
    b. The brightly-colored leaves of the bougainvilla plant
    c. The epidermis of the leaves of plants
    d. The stem of the cactus

14. What is the substance present in the first protocell?
    a. ribonucleic acid
    b. protein
    c. lipid
    d. carbohydrate

15. 15, What is the organ system responsible for gaseous exchange?
    a. nervous system
    b. muscular system
    c. digestive system
    d. respiratory system

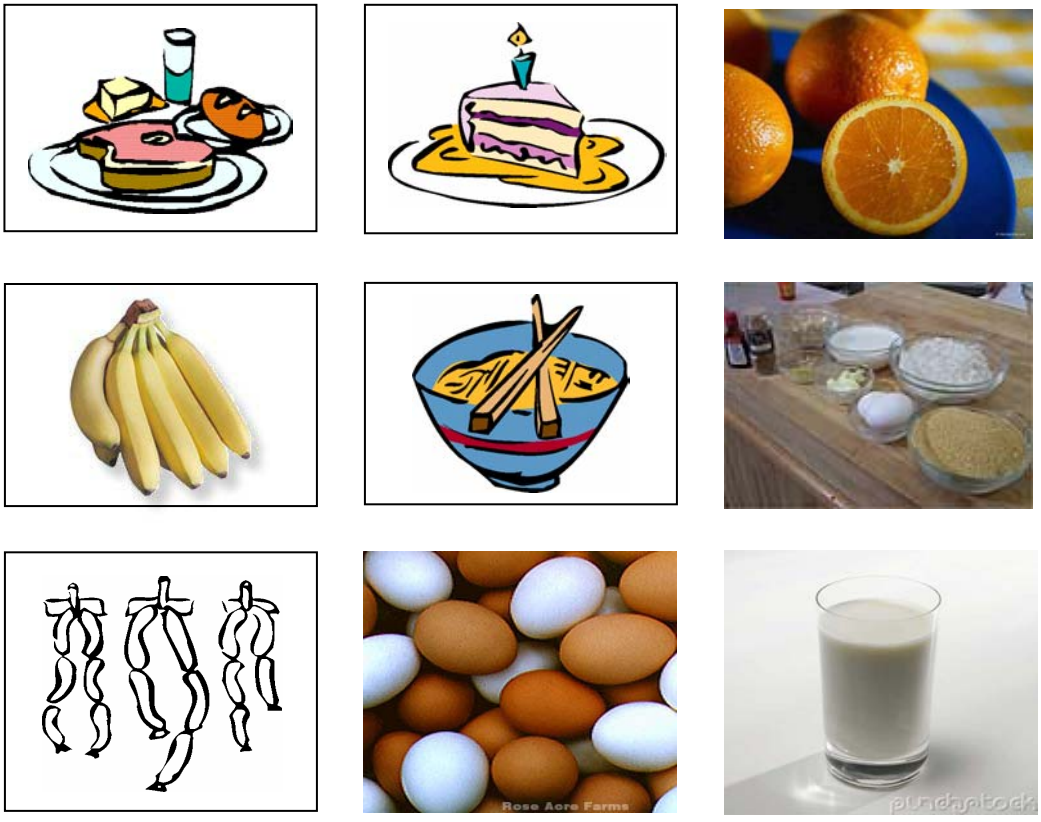
Key to answers on page 26.

Be familiar with the following terms:

Protocell	The forerunner of true cell
Coacervate droplets	An aggregate of organic compounds found in newly formed oceans of primitive earth
Cell	Basic unit of living organism
Tissues	Group of cells performing the same/similar function
Organs	Group of tissues doing the same function
Organ system	Association of organs of similar function

Lesson 1. The Molecular Organization

Your breakfast may consist of:



All these foods are important to our health. Milk, egg and meat are food for growth. Rice is an energy-giving food. Banana, strawberry and orange give minerals and vitamins which make us glow. What are the building blocks of foods?

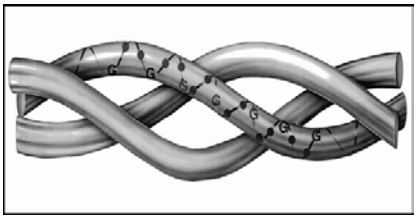
According to Soviet biochemist Alekandr Oparin, gases of the primitive atmosphere dissolved in the rain were carried down into the newly forming oceans. Examples of these gases were hydrogen, ammonia and methane. They interacted with each other to form simple organic molecules in the presence of strong outside energy sources. Examples of simple organic substances are urea in animal urine; formic acid which the ants inject into our skin as they bite us; acetic acid in vinegar; and alcohol in wines. The outside energy sources that powered the production of simple organic substances were volcanoes, meteorites, radioactivity from the earth's crust, powerful electric discharges from lightning, and solar radiation. The idea of Oparin was supported by the work of American chemist Stanley Miller in 1953.

Through time, the ocean became a warm, organic soup full of variety of organic substances such as amino acids, glycerol, simple sugars, nitrogenous bases and short-chained fatty acids. These organic substances joined to form large molecules and then macromolecules. An example is the combination of carbon dioxide and water in the presence of light which is trapped by green pigments of plants.

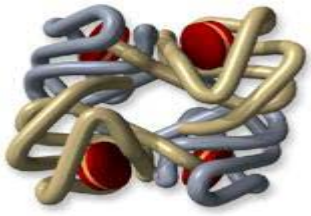
$$CO_2 + H_2O \xrightarrow[\text{Green pigments of plants}]{\text{light}} C_6H_{12}O_6 + O_2$$

This process called **photosynthesis** occurs in the living system. The product of photosynthesis is a sugar called glucose ($C_6H_{12}O_6$), an organic compound. **Macromolecules** include carbohydrates, lipids, proteins and nucleic acid which are substances present in foods. The complex organization of these macromolecules makes them unique. They give living systems both a biochemical unity and diversity. Figure 2 gives the different structures of certain proteins in our body.

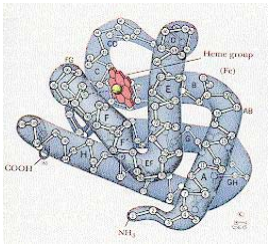
.



Collagen
(protein cartilage)



Hemoglobin
(protein red blood cells)

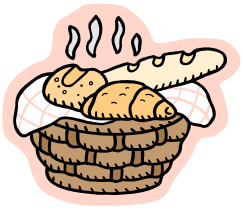


Myoglobin
(protein found in muscles)

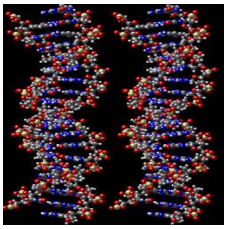
Figure 1. Structures of some Proteins

Collagen is the protein present in the bones and cartilages of our skeletal system. The hemoglobin is the protein in our red blood cells that transport oxygen from the lungs to the different parts of the body and returns carbon dioxide from the different parts of the body to the lungs. Myoglobin is a muscle protein that stores oxygen and makes the muscle red.

What are the macromolecules that make up your body? The collage in Figure 2 shows the four groups of organic compounds mostly present in living organisms.



Carbohydrate



DNA
(molecule)

Soya bean
For protein meal and oil (lipid)

Figure 2. Macromolecules

You can perform Activity 1.1 to prove the presence of these substances in living organisms.

What you will do

Activity 1.1 Biochemical Test

What you need:	ethanol	Benedict solution	sodium bicarbonate
	Distilled water	tincture of iodine	test tubes
	Biuret reagent	dilute hydrochloric acid	test tube rack

What to do:

A. Emulsion test for fats

1. Get two mL of chicken soup and place it in a test tube.
2. Add 2 mL of ethanol and mix well.
3. Pour the mixture into the test tube containing equal volume of distilled water. Describe what you see in the test tube.
4. If lipid is present, a milky layer is found on top of a clear liquid. This is an emulsion of fat.

B. Test for Starch

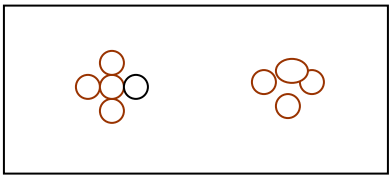
1. Get a cooked sweet potato, mash it and add water.
2. Decant the liquid into a test tube and add a few drops of tincture of iodine.
3. Note the color change.
4. If the mixture turns blue black, then starch is present.

C. Test for Sugars

1. Get 2 mL of sugarcane juice and place it in a test tube. Add 5 drops benedict's solution. If sugarcane is not available, you may use table sugar solution by mixing 5 granules in 10 mL water.
2. Add 1 mL dilute hydrochloric acid. Heat the mixture.
3. Neutralize the mixture with sodium bicarbonate. What is the color of the mixture after adding sodium bicarbonate? This is a test for presence of sucrose in food.

The solutions you used in the activity came from living organisms. Sweet potato contains starch which can be broken down to sugar. A similar process will happen to lipids, proteins, and nucleic acid. Sugar units from starch as well as the small units from proteins, lipids and nucleic acid can be rejoined into other new combinations in other forms of organisms.

The mixture of macromolecules came closer to form complex units called ***coacervate droplets.*** Coacervate droplet is an aggregate of macromolecules which are found in the newly formed oceans of primitive earth.



Coacervate droplets tend to absorb and incorporate substances from surrounding water. The complexity of macromolecules increased and gave rise to units with ability to make copies of themselves.

Through time, semi-permeable boundary surrounded the coacervate droplets. This separated the coacervate from the rest of the ocean. Figure 3 shows the fluid mosaic model of membrane.

As you can see in Figure 3, the cell membrane is made up of protein, lipid and carbohydrate. A cell membrane is an example of cellular organelle or cell part. Ribosome, a non-membrane bound structure in a living system, is another example of cellular part.

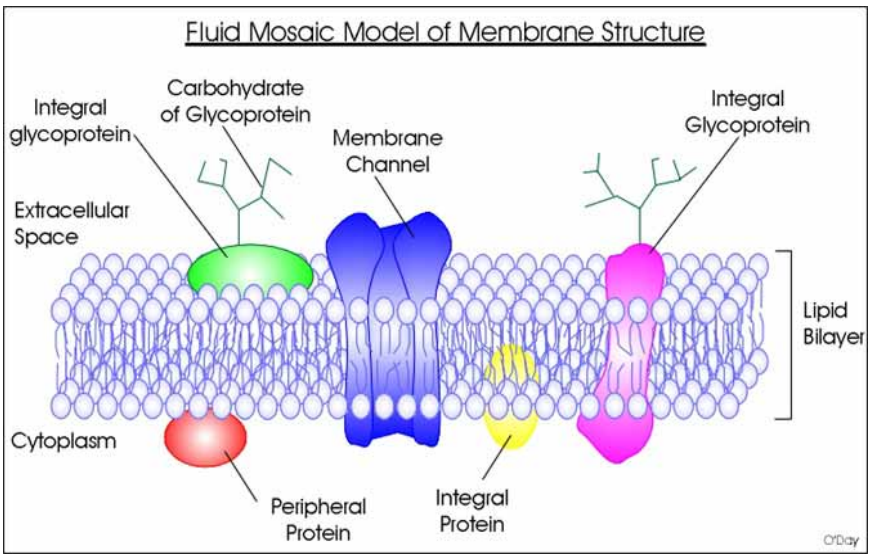


Figure 3. Fluid Mosaic Model of the Cell Membrane

Further modification of the semi-permeable boundary enclosed coacervate droplets resulted to a protocell. Protocell means a beginning cell. A protocell was a structure with lipid-protein membrane that carried out energy metabolism. The substance inside the protocell was ribonucleic acid (RNA). RNA had a dual function. It served both as genetic material and as catalyst.

The protocell was a forerunner of the simplest biological system. It was a heterotroph. It could not make food but it was not hungry. Why? The ocean was full of food. Protocell was supplied with life-support system present in water.

Protocell underwent biological modification to become a true cell. The flowchart in Figure 4 shows the stages that led to the formation of the first form of cell, wherein the macromolecules led to the evolution of cellular organelles.

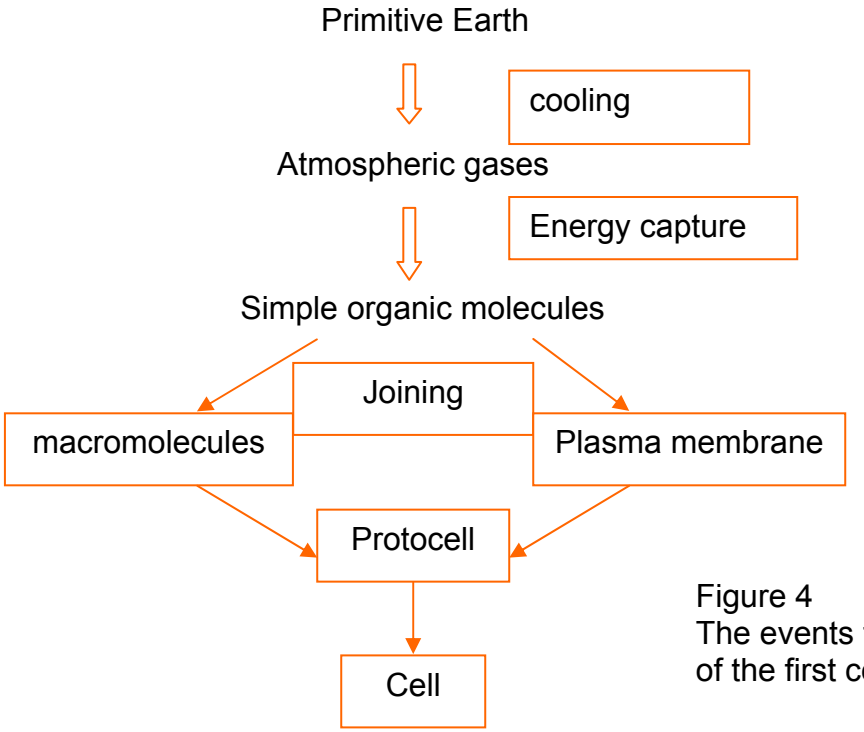


Figure 4
The events that led to the formation of the first cell

What you will do

Self-Test 1.1

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

1. Who said that the interaction of simple inorganic molecules led to the complex formation of biomolecules known in our body today?
   a. Thomas Morgan
   b. Stanley Miller
   c. A.I. Oparin
   d. Charles Darwin

2. Which of the following molecules dissolved in the newly formed oceans?
   a. ammonia
   b. carbon dioxide
   c. oxygen
   d. ozone

3. What powered the interaction of simple gases in the primitive atmosphere?
   a. Lightning
   b. radioactivity in the soil
   c. solar radiation
   d. all of the above

4. What isolated the coacervate droplets that formed in the ocean?
   a. inability to dissolve droplets in the ocean water.
   b. ability to absorb substances from the ocean
   c. semi-permeable boundary
   d. capsule

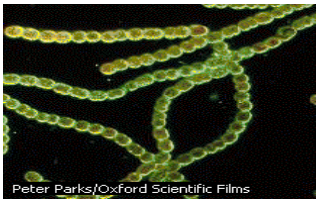
5. What is the test for the presence of starch in food?
   a. alcohol test
   b. emulsion test
   c. iodine test
   d. spot test

Key to answers on page 27.

Lesson 2. The Cellular Level of Organization

The **cell** is the first level of the biological organization. It is the lowest level to have a characteristic of life. It is the basic unit of life. It is made of molecules discussed in Lesson I. The living substance inside the cell is a jelly-like substance called **protoplasm**.

The first cell was a prokaryote and was a heterotroph. Heterotroph can not make its own food. It has no nucleus. Today, there are two groups of prokayotic cell – archaebacteria and eubacteria. Figure 5 shows two prokaryotic cells.



Cyanobacteria

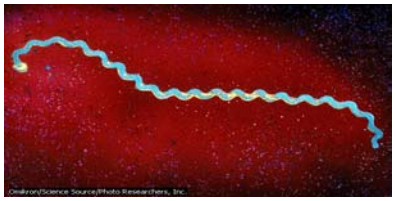
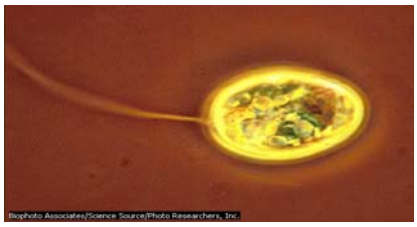

spiral bacteria

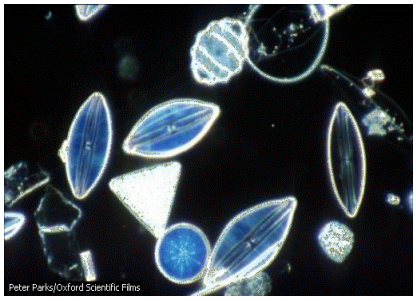
Figure 5. Prokaryotic cell

The prokaryotic cell went through many changes till it gave rise to eukaryotic cell, a cell with true nucleus. The eukaryotic cell may be plant-like or animal-like. You can see these eukaryotic cells in Figure 6. They have true nucleus and other cellular parts.

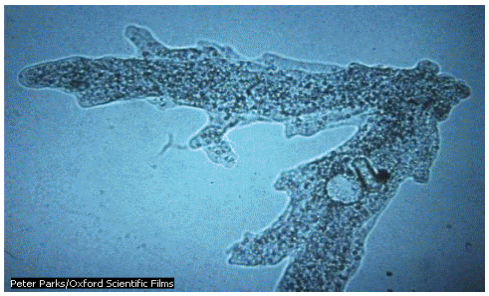


Euglena

paramecium



Diatoms



Amoeba

Figure 6. Eukaryotic cells

The cells shown in Figures 5 and 6 are organisms by themselves. We call them **single-celled organisms**. **Euglena** has a green pigment, a characteristic of plants. It also has a **flagellum**, a charactersitic of an animal. Euglena, paramecium and amoeba are grouped as protist. From them came the fungi, plants and animals. Fungi (except yeast), plants and animals are made up of many cells. Thus, they are called **multi-celled organisms**. You are a multi-celled organism. Do you know how many cells you have in your body? Well, you are composed of around 60-100 trillion cells.

Cells have different shapes and sizes because they do different jobs and are found in different parts of the body. Do Activity 2.1 to view the cell of a plant and an animal.

What you will do

Activity 2.1 Viewing a Plant and Animal Cell

What you need:

- onion bulb
- cotton swab/toothpick
- Methylene blue
- Tincture of Iodine
- microscope
- glass slide
- cover slip
- distilled water

What to do:

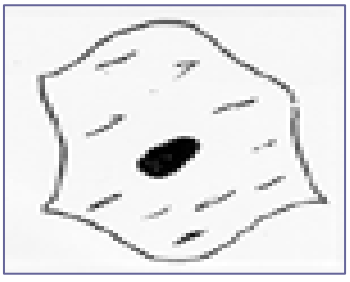
A. Plant Cell

1. Strip off a piece of epidermis from the inner lining of one of the fleshy scales of an onion.
2. Mount a small piece on a slide, add a small drop of water, and stain the cells with tincture of iodine.
3. Cover the specimen with a cover slip.
4. Observe and draw one cell under low and high power. Observe the granular cytoplasm surrounding the clear vacuole. The nucleus is located in the cytoplasm close to the cell wall. Draw a diagram of the features you can see.
5. Repeat this step but without staining the onion with iodine. What difference does this make to how much you can see? What does this tell you about the need for staining cells before looking at them under a microscope?

B. Animal Cell

1. Gargle with water.
2. Get a cotton swab and move the cotton swab over your cheek.
3. Smear the swab on a clean microscope slide. Dispose of the cotton swab in the container provided.
4. Put 3 drops of methylene blue stain onto the slide with a teat pipette and cover with a coverslip.
5. Observe the cells under low and high power.
6. The cytoplasm will be stained blue and the nucleus a darker blue. Draw a diagram of the cell under high power.

The cells you have observed serve as cover of a surface. They are packed closely, leaving no spaces between cells. The cells you observed in the onion skin are epidermal cells while those of the inner lining of your mouth are called **squamous epithelial cells**. The cell that serves as cover is flat and can be found on surfaces. The cells are shown in Figure 7.



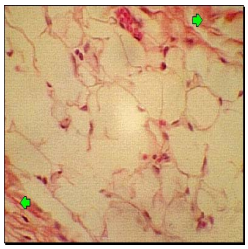
Cell of the inner lining of mouth

Cell of the onion skin

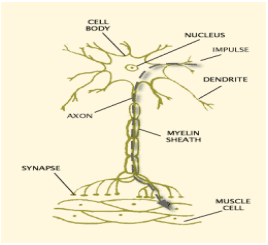
Figure 7. Cell you saw in your activity

These cells vary in shapes. Look at the cells shown in Figure 8. Some bacterial cells are short cylindrical objects. Nerve cells have complex shapes with many long thin extensions and may reach lengths of several meters. Most plant cells are polygonal surrounded by rigid cell walls. Most cells in animals are compact in shape with a deformable and often richly folded surface. Why do cells come in different shapes? The shapes of cells are associated with location and function.

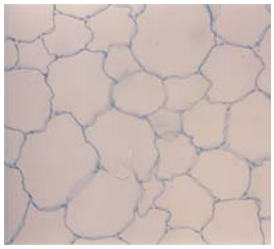
Red blood cell is discoidal, carries respiratory gases - O_2 and CO_2



Fat cells store fat and serve as insulator



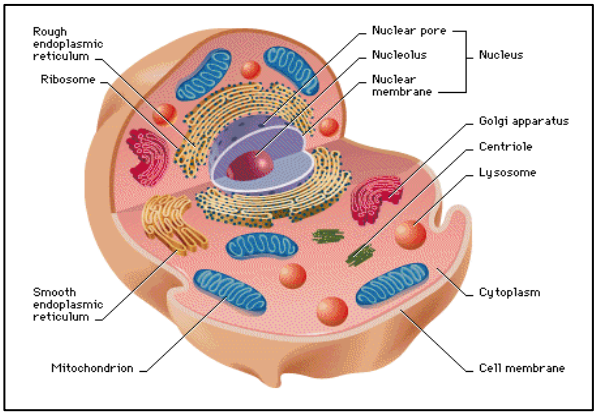
Neuron that conducts nerve impulses



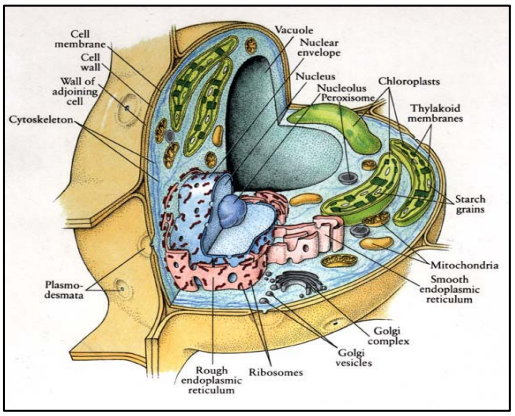
parenchyma cells of plants that store food and water

Figure 8. Varying shapes of cells

Cells may have different shapes and sizes but they all have something in common as you can see in Figure 9.



Animal cell



Plant cell

Figure 9. The cell

Both cells have many parts or **organelles**. The most prominent is the **plasma membrane**. Plasma membrane enclosed the cytoplasm. The cytoplasm is rich in water. Among prokaryotes, there is a nuclear area in the cytoplasm but it is not enclosed by a nuclear envelope. Among eukaryotes, a membrane enclosed-nucleus is embedded in the cytoplasm. Plant cells have cell wall, a vacuole and may have chloroplast. Plant and animal cells are eukaryotic cells because they each have a true nucleus. Some cells do not have nucleus and most cell parts that are present in eukaryotic cells. A good example is the

cell of bacterium as shown in Figure 10. Bacterium is a prokaryotic cell. The cell has cytoplasm with nuclear zone where the simple chromosome is present. A chromosome is a coiled/folded deoxyribonucleic acid, the genetic material.

The cytoplasm is surrounded by a membrane. Cell wall is present in bacteria but its chemical composition is different from that of a plant cell. Some bacteria may have a capsule, cilia (hair-like structure) and flagellum (tail-like). The cilia and flagellum are present in some eukaryotic cell, but of a different structure.

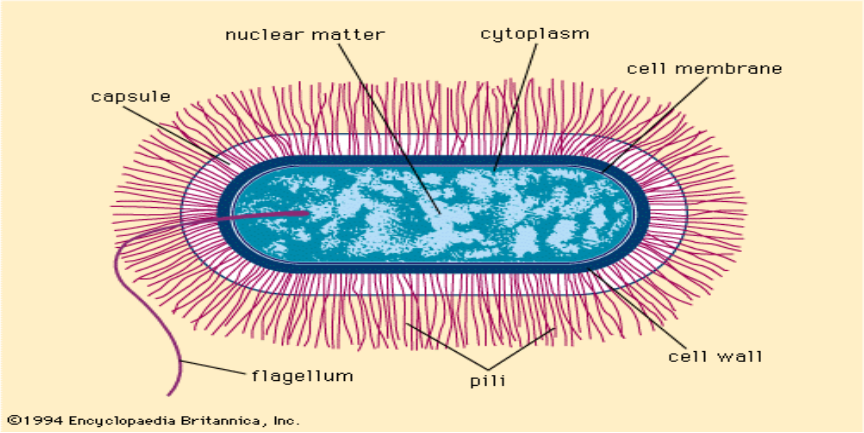


Figure 10. Bacterium

Cells also differ in size. Some are big like a chicken egg. Others are very small like a bacterium. Table 1 lists some cells present in plants and animals. Their function and location are also indicated.

Table 1. Some cells present in plants and animals

Organism	Cell	Location	Function
Plant	Meristematic cell	Root tips, apex, buds	To increase the height of plants, etc.
	Parenchyma cell	Cortex of stem, roots	Food storage
Animal	Columnar cell	Inner lining of the intestine	Absorption of nutrients
	Cuboidal cell	Ducts of glands	Secretion of substances
	Skeletal muscle cell	Skeletal muscles attached to bones	Muscle contraction which moves body parts

What you will do

Self-Test 2.1

1. From the illustrations and discussion in Lesson 2, label the specified parts of the cell shown in Figure 11.
   - 1.1. part marked m
   - 1.2. part marked f
   - 1.3. part marked j
   - 1.4. part marked n

2. Is the cell in Figure 11 a prokaryotic cell or eukaryotic cell? Explain your answer.

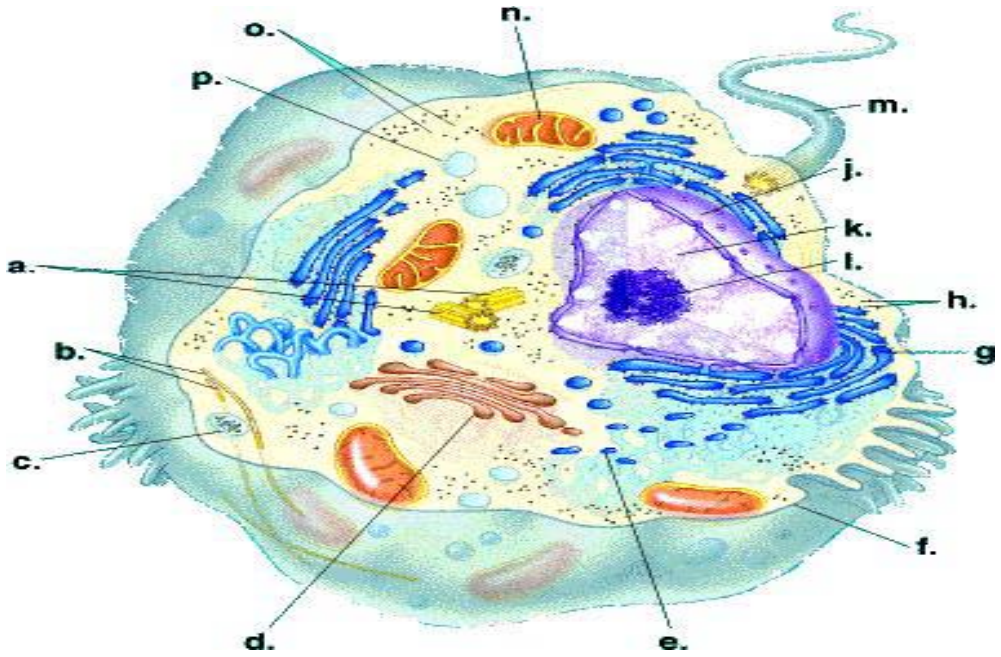
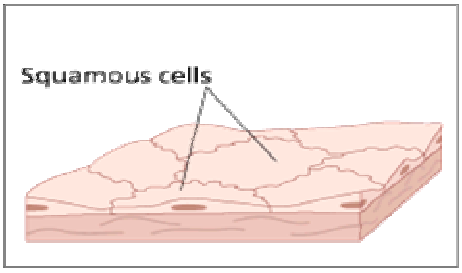


Figure 11. The Cell

Key to answers on page 27.

Lesson 3. Tissue, Organs and Organ System: Other Biological Level of Organization

Cells come together to do certain functions. We call this association as **tissue**. Tissue is a group of associated, similarly structured cells that perform specialized functions for the survival of the organism. Neurons or nerve cells form nervous tissue; muscle cells forms muscular tissue; blood cells form vascular tissue; fat cells form adipose tissue; etc.



Many squamous cells form squamous epithelial tissue. This is found in the outer layer of the skin and serves as covering of our body.

Figure 12. Squamous epithelial tissue

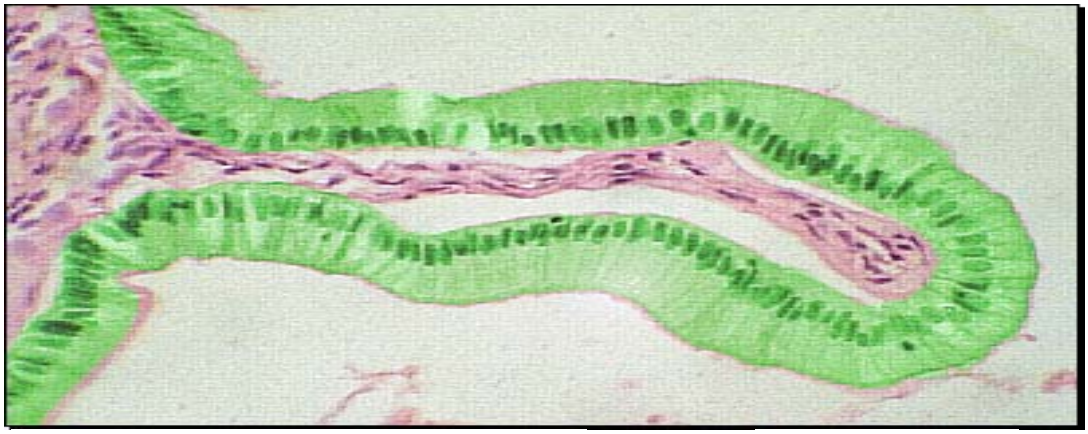
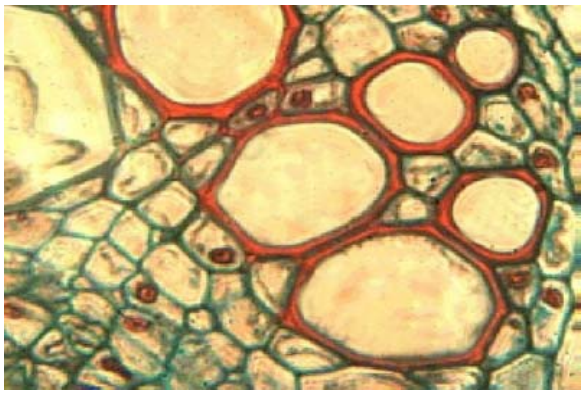


Figure 13. Columnar epithelial tissue Columnar cells

Cells of columnar epithelial tissue are taller than wide as shown in Figure 13. The nucleus is located at the base. The cells making this tissue may have tiny projections called **villi** and microscopic projections called **microvilli**. Columnar epithelial tissues are associated with secretion and absorption of substances. They are found in stomach, intestines and ducts of glands.



Those big spaces shown in Figure 14 are the conducting vessels of the water-conducting xylem tissue of the plant. Xylem makes up the wood of trees.

Figure 14. Xylem of plants

The tissues of animals are grouped into four types. Table 2 lists the four groups of animal tissues while those of plants are listed in Table 3.

Table 2. Animal tissues

Type of tissues	Function
epithelial tissues	Cover and protect organs
connective tissues	Connect one organ to another
muscle tissues	Contract to produce movement
nervous tissues	Respond to changes in the environment

Table 3. Plant tissues

Type of tissues	Function
Meristematic tissues	Actively dividing cells to replace damaged and old cells
Collenchyma tissues	Support tissue of herbaceous plants and temporary support tissue of young woody plants
Schlerenchyma tissues	Support tissue of woody plant
Vascular tissues Xylem phloem	Transport water from roots to leaves Conducts food from leaves to other parts of the plant

What becomes of tissues? They form organs. Let us take the heart as an example. Your heart is as big as your fist. It is located at the midsection of your upper body and is oriented towards the left side of your body.

Your heart is a dual pump because it circulates blood through two separate closed systems. Oxygen-carrying blood leaves the left ventricle through the aorta and is distributed throughout the body. The deoxygenated blood is returned to the right auricle via the superior and inferior venae cavae. The right ventricle pumps the deoxygenated blood through the pulmonary artery to the lungs, where it exchanges carbon dioxide for oxygen.

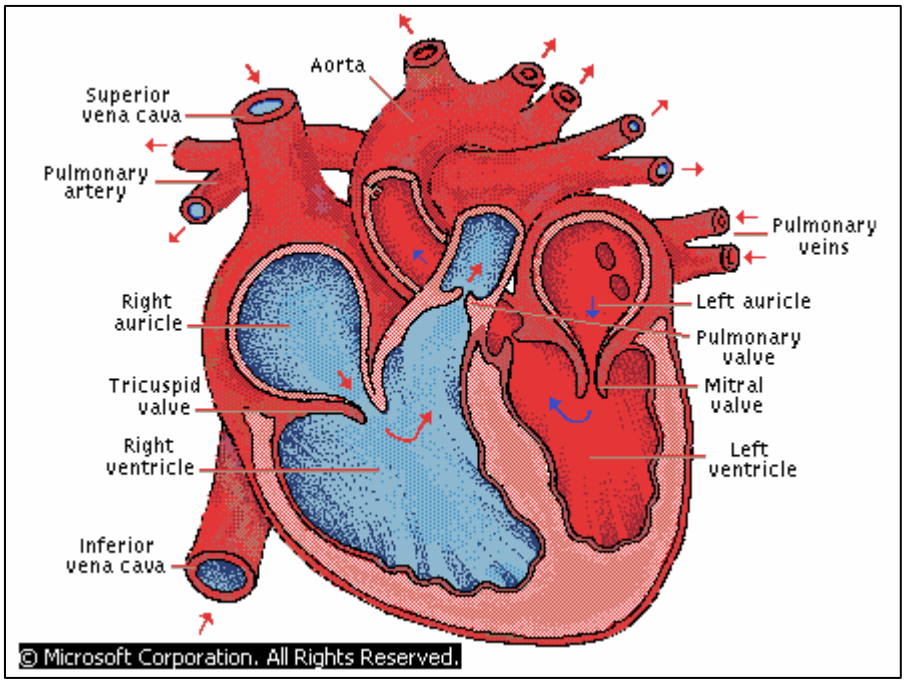


Figure 15. The human heart

Oxygenated blood from the lungs then returns to the left auricle of the heart, ready for arterial circulation, through the pulmonary veins. The tissues that make up the heart are cardiac tissue, nervous tissue, epithelial tissue, adipose tissue and connective tissue. These tissues enable the heart to do its job – to pump blood to the different parts of your body.

Organs work together with other organs to form a system. The heart works with the blood vessels – arteries, veins, capillaries, to form the circulatory system. It is not only the humans that posses the circulatory system but also other multi-celled animals such as frogs, horses, pigs, and rodents.

What will you do

Activity 3.1 Do you know that...

1. the small intestine is a part of the digestive organ system?
2. Small intestines are made up of the following tissues:
    a. epithelial tissue that covers the outermost part of the small intestine;
    b. epithelial tissue that lines the inside of the small intestine;
    c. circular smooth muscle tissue to constrict or dilate the intestine;
    d. longitudinal smooth muscle tissue to shorten or lengthen the small intestine;
    e. vascular tissue to supply the small intestine with oxygen and nutrients as well as to eliminate waste products; and
    f. nervous tissue to respond to changes in the environment.

Different organ systems form organisms. Figure 16 shows the summary of the hierarchy of the biological organization.

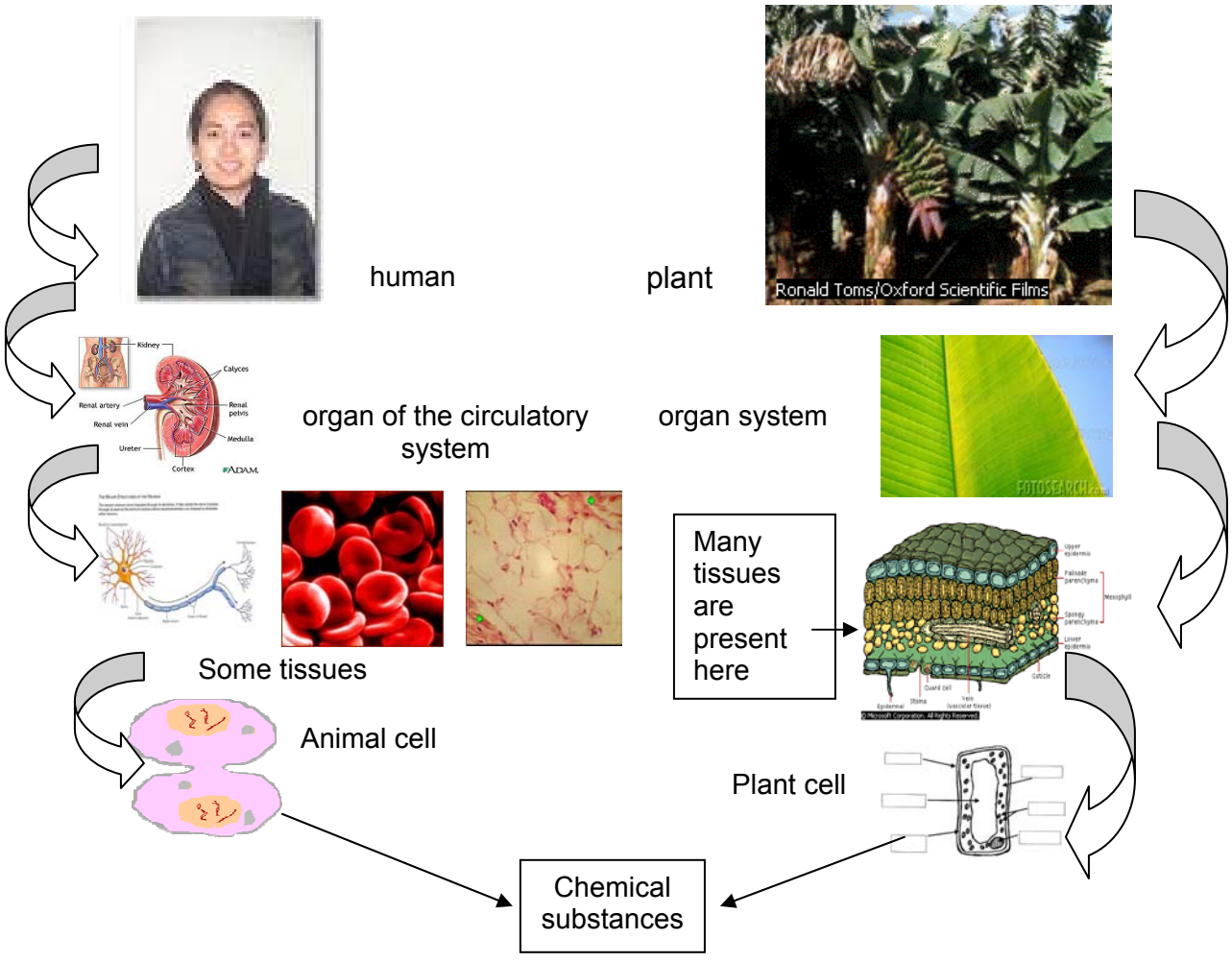


Figure 12. Summary of level of organization

What you will do

Self-Test 3.1

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

1. Which of the following units is the lowest level of biological system?
   a. cell
   b. tissue
   c. molecule
   d. macromolecule

2. Which of the following substances is/are present in a protocell?
   a. ribonucleic acid
   b. deoxyribonucleic acid
   c. both ribonucleic acid and deoxyribonucleic acid

3. What is/are responsible for the unique shape of a cell?
   a. Its size
   b. Its location
   c. Its function
   d. Its function and location

4. How do we call the association of similar cells doing the same function?
   a. organ
   b. tissue
   c. organisms
   d. organ system

Key to answers on page 27.

Biological organization does not end in just the individual. There are biological organizations beyond you as an individual. You shall look at them as well. The first organization outside the individual is ***population.*** A population is composed of all organisms of one type occupying a paticular area. Figure 17 shows the population of African elephants. The African elephants live in grassy regions south of the Sahara Desert.

Figure 17. African elephants

Figure 18 shows another population. This is a flock of sheep domesticated in New Zealand. In this country, the sheep population outnumbers the human population.

Figure 18. Sheep

Figure 19 shows grasses. You are familiar with different kinds of grasses. The area occupied dominantly by grasses is called a ***grassland***. In the grassland, you will find other plants and animals. The population of various plants including grasses and animals in the grassland make up a ***community.*** A community is an assemblage of many populations occupying a given area at a given time interval. Figures 20 and 21 give more examples of community.

Figure 19. Grassland Community

Figure 21 is a typical kind of mountain community. The human population occupying the area is engaged in agriculture. The populations interact among themselves and with the physical environment such as soil, water, atmosphere, etc to form an ***ecosystem***. An ecosystem is a relatively self-contained, dynamic system composed of a natural community along with its physical environment.

Figure 20
Community dominated by trees

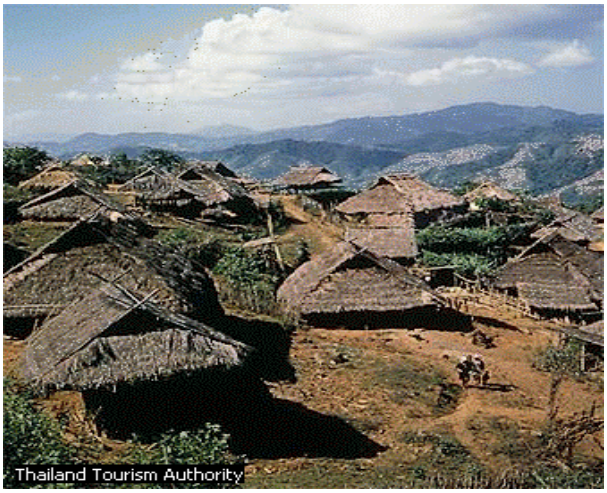


Figure 21
Mountain community

Ecosystem may be small or big, natural or artificial. Examples of natural ecosystems are rivers, lakes or oceans. Terrarium and aquarium are examples of artificial ecosystem. The biggest ecosystem is the entire biosphere.

What you will do

Activity 3.2 Name Me…

1. Do you know your place very well?
2. Name an example of a community found in your place.
3. Why do you consider it a community?
4. Name an ecosystem in your place.
5. What are the organisms found in such ecosystem?

What you will do

Self-Test 3.2

Use the following terms to identify the term being described by the word/phrase:

cell	organ system	ecosystem
tissue	population	
organ	community	

_____ 1. muscle in the heart
_____ 2. yeast
_____ 3. mosquitoes in the forest
_____ 4. forest
_____ 5. root of the mango tree
_____ 6. respiratory system

Key to answers on page 27.

Lesson 4. Characteristics of Living Things

In Lesson 2, we learned one important characteristic of living things, that is, that living things are organized. We shall learn more characteristics of living things in this lesson. To start the lesson, you can do activity 4.1.

What you will do

Activity 4.1 Life or no Life

1. You are given two objects. One is a marble, the other one is a 2-week old dog.
2. You are told to make two boxes. In Box 1, put your description about the marble. In Box 2, place the description about the dog.

Box 1 The marble	Box 2 The dog

What did you say about the marble? One thing a marble has is calcium carbonate. This is a chemical organization. It is not a biological organization. Therefore, marble is a non-living thing.

Now, what did you say about the dog? You could say that a dog is composed of cells. You just described a living thing because cell is the basic unit of a living organism. To maintain this organization and carry on the activities of living things, it needs outside sources of ***materials and energy***. A plant needs light energy from the sun to allow water and carbon dioxide to produce food and oxygen through the process called **photosynthesis**. How did the plant get the raw materials for photosynthesis? Well, it has the following parts:

a. roots to get water and nutrients from soil
b. xylem to bring up the water and plant nutrients to the leaves where photosynthesis occur
c. stomata to get carbon dioxide from the air
d. chloroplast that contain chlorophyll traps energy from the sun

The dog needs food. Through **cellular respiration,** the energy stored in the food is being harvested. Cellular respiration is the breakdown of food to release energy. How does a dog use food as a source of energy? Like the plant, it has parts to carry out the process. The dog uses the digestive system to get the food and digest it, the circulatory system to bring the product of digestion to cells where cellular respiration occurs, and the respiratory system to obtain oxygen from air into the lungs. From the lungs, the oxygen is carried to the heart. The heart pumps it to the different cells of the body. Cells have mitochondrion where digested food is degraded to harvest energy.

Photosynthesis and **cellular respiration** are chemical reactions carried out by living things, but these are not the only chemical reactions that occur in living things. There

are many other processes. The sum of all these chemical reactions in a cell is called ***metabolism.***

For these metabolic processes to continue, there are conditions to be met. What are these? All living things need to maintain a stable temperature, moisture level, acidity, and other physiological factors. This is called ***homoestasis***. Homeostasis means the maintenance of internal conditions within certain boundaries. How do living things do this? Let us take the body temperature. Some organism regulate the body through behavior. Typical example of this is demonstrated by marine iguana. Iguana raises its temperature by staying in the sun on a hot rock. When its body temperature becomes high, it dives into the sea to cool down. You do not have to do what iguanas do. Why? You have organ systems such as the excretory system to keep your body temperature at an average of 37 ^{o}C.

Metabolism supports growth. Growth may be in the form of increase in mass, size, or organization that is different from simple addition of more particles of matter. Aside from growth, living things also develop. You were once a single-celled fertilized egg called zygote. Zygote divides many times and undergoes many changes to become a miniature adult, and eventually becoming a full grown adult.

Once mature, living things generate offspring through reproduction. The offspring is a look-alike of parents but there are differences or variation. The variation is due to the rearrangement of hereditary information. Variation is both bad and good. Good variation gives offspring a better chance of survival.

The environment is ever changing but living things get used to it. We call this adaptation. **Adaptation** is the result of evolutionary change. It is the accumulation of inherited variations over time. In Figure 22 you see several adaptations.

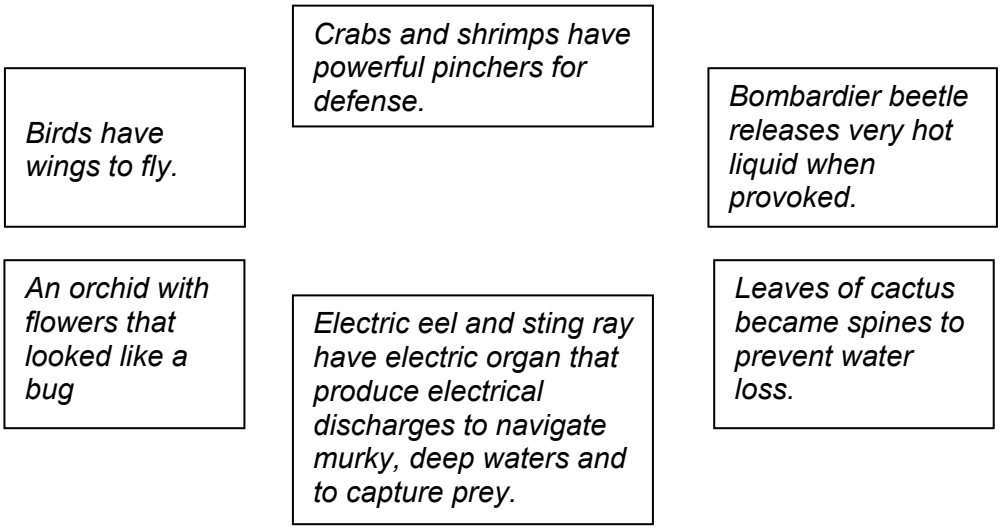


Figure 22. Adaptations

Living things are sensitive to changes in the internal and external environment. Makahiya or “touch me not “ folds its leaves as soon as you disturb it. Dama de noche

releases its fragrance by nightfall. You withdraw your fingers without thinking as soon as you touch a hot or cold object.

What you will do

Self-Test 4.1

Which characteristics of living things justify the statement (numbers 1-5). Choose from letters a - e.

a. Living things are organized.
b. Living things carry out metabolism.
c. Living things respond.
d. Living things reproduce.
e. Living thing evolve.

_____ 1. Hereditary units are passed from parents to child.
_____ 2. Cat runs away from an approaching dog.
_____ 3. Cells use materials and energy for growth and repair.
_____ 4. There are many different kinds of living things.
_____ 5. Adaptation to a way of life best explains why living things display homeostasis, are diverse, began as single cells, are classified into three domains, and mate with their own kind.

Key to answers on page 27.

Living things come in diverse forms. Look at the organisms in Figure 23. They are all beautifully colored.

Figure 23. Different life forms

Let's Summarize

1. Molecular organization starts from atoms to protocell.
2. Cell is the lowest level of biological organization.
3. Cells differ in shapes due to their function and location.
4. Cell is either a prokaryotic cell or eukaryotic cell.
5. Tissue is a group of similarly structured cells that perform the same function.
6. Tissues form organs, and organs into organ systems.
7. Living things have different characteristics.

Posttest

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

1. Which one does **NOT** belong to the group?
   a. ecosystem
   b. community
   c. population
   d. tissue

2. What is the substance present in the first protocell?
   a. ribonucleic acid
   b. carbohydrates
   c. protein
   d. lipid

3. What is common to both prokyotic cell and eukaryotic cell?
   a. mitochondrion
   b. chloroplast
   c. cytoplasm
   d. nucleus

4. Metabolism refers to
   a. chemical and energy transformations
   b. maintenance of internal conditions
   c. ability to respond to stimulus
   d. the lack of reproduction

5. Living things can adapt to a changing environment because
   a. they are highly organized
   b. they possess a nervous system
   c. they have a way of getting food
   d. they have a way of getting respiratory gases

Which of the following statements characterizes items 6 and 7?

a. Living things evolve.
b. Living things are organized.
c. Living things respond.
d. Living things reproduce.

_____6. Hereditary units passed from parents to children
_____7. Zebras run away from the cliff

8. Plants are unique among living things in that they are

a. multicellular and absorb food
b. unicellular and ingest food
c. multi-cellular and photosynthetic
d. all of these are correct

Which of the following terms describes items 9 and 10?

a. community
b. population
c. ecosystem

____ 9. tilapia in muddy river
____10. monkey eating eagles in the virgin forest in Mindanao

11. Which of the following systems integrates the activities of the human body?

a. skeletal system
b. muscular system
c. excretory system
d. endocrine system

12. Which of the following constricts the large and small intestines?

a. smooth muscle
b. skeletal muscle
c. cardiac muscle
d. nervous tissue

13. Which of the following is storage cell?

a. Collenchyma
b. Parenchyma
c. schlerenchyma
d. vascular cambium

Key to answers on page 28.

Key to Answers

Pretest

1. b	6. b	11. d
2. c	7. a	12. c
3. d	8. d	13. d
4. d	9. d	14. a
5. a and c	10. d	15. d

Lesson 1

Self-Test 1.1

1. c
2. a
3. d
4. c
5. c

Lesson 2

Self-Test 2.1

1. 1.1 flagellum
   1.2 cell membrane
   1.3 nucleus
   1.4 mitochondrion
2. eukaryotic cell because it has true nucleus

Lesson 3

Self-Test 3.1

1. a
2. a
3. d
4. b

Self-Test 3.2

1. tissue
2. cell
3. population
4. ecosystem
5. organ system
6. organ system

Lesson 4

Self-Test 4.1

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

Posttest

1. d
2. a
3. c
4. a
5. b
6. d
7. c
8. c
9. b
10. b
11. d
12. a
13. b

References

Campbell, N. (2000). *Biology*. Englewood Cliffs, New Jersey: John Wiley and Sons.

Mader, S. (2003). *Biology*. Englewood Cliffs, New Jersey: John Wiley and Sons.

Pickering, W.R. (2000). *Complete biology*. Oxford, New York: Oxford University Press.

_____. (2000). *Microsoft Encarta.*