## Unit 4 MODULE 1

## BIODIVERSITY

## Overview

From Grades 3 to 7 you have studied some of the different organisms and their easily observable characteristics. You learned about those organisms that you find just around you and other places in the country. You were taught that organisms form the biotic component of an ecosystem. You were introduced to the cells that differ in plants and animals. In addition, you learned about organisms other than plants and animals. Some of these consist only of a single cell while others have many. You may also had a chance to look at organisms that are so small and can be seen only with the microscope.

This module will introduce you to the concept of biodiversity, specifically the variety of organisms living on Earth. This will discuss how they are classified and named. It will also show the similarities and differences of these organisms. It will describe the different groups to which these organisms belong. It will let you discover uses of some not just as food but also in medicine, agriculture, industries and the ecosystems where they are present. In addition, you will know about the harmful effects of some to other organisms.

The module will further show you the advantages of high biodiversity over low biodiversity. It will also help you recognize the value of biodiversity in your community. Most importantly, this hopes to encourage you to start or continue protecting and conserving your community's biodiversity for future generations.

Why is biodiversity important?
What human activities help protect and conserve rare and economically important species?
What human activities destroy or endanger the existence of rare and economicallv important species?

## Levels of Biodiversity

Biodiversity is coined from the words, biological diversity. Usually, scientists would refer to three levels of biodiversity namely: different kinds of organisms (species diversity), genetic information that organisms contain (genetic diversity) and different kinds of places where organisms live and the interconnections that bind these organisms together (ecosystem diversity). If you recall, you have learned about ecosystem diversity in the lower grades. You will know more about genetic diversity in Grade 9.

Species diversity consists of the large number and all different kinds, shapes, colors and sizes of organisms that inhabit the Earth. It includes the smallest and the simplest bacterium (pl. bacteria) to the complex, bigger, brightly colored flower or fish. Add to this the carabao, the tallest acacia, the biggest elephant and a human like you. These organisms are found in various places from the soil, to the rivers, oceans, forests, salty or hot places, in short in every corner of the Earth. Some of them even live in your body. At present, more than a million organisms have been identified and named while many more are being discovered every year. Just recently, foreign and local researchers have found that diversity of reptiles and amphibians in the Northern Philippines is even greater than what has been known and identified.

If there are a lot more of the organisms in the world than you can count, how will you be able to know about them? Does an organism you see in your place, for example, have the same name in another place? Do organisms have to be classified? Why? Try the following activity below.

## Activity 1 <br> What's in a name?

## Objectives:

After performing this activity, you should be able to:

1. give the names of organisms as they are known in yourcommunity
2. recognize the need to have a system of classifying and naming organisms.

## Materials Needed:

pictures of organisms
pencil or ball pen
sheet of paper

## Procedure:

1. Get pictures of organisms from your teacher.
2. With your group discuss how each of these organisms is called in your community. Accept any name which your group mates will give for an organism. If you know other names by which an organism is called in another place, include them. Write these on the sheet of paper.
3. Be ready when your teacher asks you to present your work to the class. Take note of how the other groups named each of the organisms shown.

Q1. Are there organisms that others gave the same name to as your group did? Give examples.

Q2. Are there organisms that others gave a different name to as your group did? What are these organisms?

Q3. What can you say about your knowledge of the organisms before the other groups' presentations and the teacher's discussion?

## Classifying and Naming Organisms


#### Abstract

For organisms to be studied and information about them shared to those who need it, scientists grouped them into meaningful classifications. The different groups are ranked from the largest to the smallest groups. Large groups include many organisms with few similarities. Small groups include few organisms having more similarities. Organisms which have more similarities would then, be closely related than those which have less similarities. These classifications or categories consist of the domain, kingdom, phylum, class, order, family, genus and species.


The domain is the largest category into which organisms have been classified. This is followed by the kingdom category subdivided into various phyla (sing. phylum). A phylum consists of different classes, each class with several orders, an order with different families. Families consist of several genera (sing. genus) and each genus comprise the smallest group of various species.

A species is a group of similar organisms and capable of reproducing their own kind. This means only members of the same species can mate and produce fertile offspring. The dog, waling-waling (an orchid), milkfish (local name, bangus), rice plant and humans like you are examples of a species.

With the information available about organisms from the early studies to the present, scientists came up with the three-domain system of classification. Before, organisms were only grouped into eukaryotes and prokaryotes. Remember in your previous year, you knew about the nucleus in cells that contain DNA in chromosomes having a role in heredity. In eukaryotes, these materials are enclosed in a membrane while in prokaryotes they are not. Most prokaryotes are tiny and unicellular, thus, are referred to as microorganisms. A lot of eukaryotes are multicellular, thus, are larger in size because of the greater number of cells their bodies contain.

Recently, prokaryotes have been divided into two domains, namely: Archaea and Bacteria. The eukaryote group was retained and now consists the third domain (Eukarya) that includes protists, fungi, plants and animals. Table 1 shows an example of how organisms are classified.

Table 1. Sample classification of organisms

| Category | Domesticated <br> Cat | Dog | Bangus | Wolf | Lion |
| :--- | :---: | :---: | :---: | :---: | :---: |
| Kingdom | Animalia | Animalia | Animalia | Animalia | Animalia |
| Phylum | Chordata | Chordata | Chordata | Chordata | Chordata |
| Class | Mammalia | Mammalia | Actinopterygii | Mammalia | Mammalia |
| Order | Carnivora | Carnivora | Gonorynchiformis | Carnivora | Carnivora |
| Family | Felidae | Canidae | Chanidae | Canidae | Felidae |
| Genus | Felis | Canis | Chanos | Canis | Panthera |
| Species | Felis catus | Canis <br> familiaris | Chanos chanos | Canis lupus | Panthera leo |

Q4. Which organisms in Table 1 are similar up to the Order category?
Q5. Which organisms are most closely related? Why do you say so?
Q6. Can a dog and a wolf produce fertile offspring? Explain your answer.

Recall in Activity 1 that local and common names created confusion. So, organisms also need be to given names for easier filing of information and reference by people. How are organisms named?

Q7. Examine the row for species in Table 1. What have you noticed?
For any organism identified, a Scientific Name is given. In this way, every scientist and other people from different places would use the same name for the same organism. This is what you see in the species row for each of the organisms. You must have observed that a scientific name consist of two names.

Q8. What does the first one refer to in the table? What about the second name?

This way of naming organisms is referred to as the binomial system of classification. Also take note that scientific names are in the Latin language and are italicized.

You should know, however, that researchers may differ in classifying organisms. It is important to bear in my mind that with further researches and discoveries this system of classification may change as more information are gathered about organisms found all over the Earth.

Early studies of organisms resulted to only the two-kingdom classification system. Later, with the invention of the microscope and with more evidences gathered about different forms of life, various scientists proposed three, to four, then, five and later to six or even eight-kingdom classification. Here, the six-kingdom classification will be used namely: Archaebacteria, Eubacteria, Protist, Fungi, Plant, and Animal kingdoms.

## Archaea Domain: Kingdom Archaebacteria

Organisms that belong to this kingdom are all microscopic. They live in various places, some even in the most severe environments. Methanogens, halophiles and thermophiles are examples of archaebacteria.

Do you know that methanogens can survive in places where there is no oxygen? Some members of this group inhabit digestive tracts of animals and ponds where animal, human and domestic wastes are treated (Figure 1). Methanogens are also present on bottoms of lakes, swamps and rice fields. An important characteristic of this group is they produce methane gas. If you live near rice paddies and swamps the bubbles that pop at the water surface is methane.

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.243.)

Figure 1. Examples of methanogens. (a) Methanobacterium ruminatum, from cow stomach undergoing division, and (b) Methanospirillum hungatei, from waste treatment ponds (bar scale $=1 \mu \mathrm{~m}$ ). The symbol $\mu \mathrm{m}$ means micrometer. $1 \mu \mathrm{~m}$ is equal to 0.001 m .

Methane is utilized as biogas, a cheap alternative source of energy. There are already communities and industries which obtain energy for their lighting and cooking fuel needs from the biogas technology.

If you live in areas which make salt, have you observed the orange or yellow color in salt ponds? This is due to the presence of halophiles. These archaebacteria are adapted to very salty environments. Examples are Haloccocus dombrowski and Halobacterium salinarum.

Q9. Read about the Dead Sea and the Great Salt Lake of Utah, USA. What do these have in common?

Figure 2 below are examples of thermophiles. This group of archaebacteria can live in places with high temperature. These areas include volcanic hot springs with temperatures from 80 to $110^{\circ} \mathrm{C}$. They also inhabit the small deep sea openings where hot water with temperatures higher than $250^{\circ} \mathrm{C}$ come out. Thermophiles turn hydrogen sulfide $\left(\mathrm{H}_{2} \mathrm{~S}\right)$ released from these openings to food for other organisms and in turn are provided essential nutrients by the former.

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.242).

Figure 2. Electron micrographs of thermophiles (a) Pyrodictium occcultum and b) Pyrococcus furiosus (bar scale $=10 \mu \mathrm{~m}$ ). $10 \mu \mathrm{~m}=0.01 \mathrm{~mm}$.

Some members of archaebacteria also survive acidic and even cold environments.

## Bacteria Domain: Kingdom Eubacteria

Members of eubacteria are unicellular and microscopic. They are referred to as the true bacteria and are usually called the "bacteria" group. Their cell walls are made of peptidoglycan, a carbohydrate.

Q10. What comes into your mind when you hear the word bacteria?
Bacteria consist of a very diverse group. They have varied shapes (Figure 3). They can be found in almost all kinds of places, in soil, water and air. Some are present in raw or spoiled food; others live in or on other organisms including your body. You must have known that they also cause disease and harm to other organisms. But most importantly, bacteria have a variety of uses for the environment and for humans.

(Adapted from: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.246).

Figure 3. Basic shapes of bacteria.

Q11. Study Figure 3. Describe cocci, bacilli, and spirilla.
Bacteria are classified according to shape as shown in Figure 3. Also notice that cocci (sing. coccus), are differently arranged. They can form pairs (diplococcus), chains (streptococcus), or clusters (staphylococcus). Bacilli can also occur in chains (streptobacillus).

Most of the time, you probably think of diseases when bacteria which you refer to as "germs" in the early grades is mentioned.

Are you aware that when your oil glands swell and result to pimples, they are infected with the bacterium Propionibacterium acnes? A lot of human diseases are caused by bacteria. Tuberculosis, one common disease in the Philippines, is caused by bacterium Mycobacterium tuberculosis.

Have you heard about the rise of leptospirosis cases in the recently flooded areas in a number of places in the country? Leptospirosis is a bacterial infection due to exposure to the spirochete bacterium, Leptospira interrogans. These bacteria are present in the urine and tissues of cattle, pigs, horses, dogs, rats, and wild animals. It has been found out that the largest number of leptospira bacteria are in the urine of rats. Anybody can be infected through contact with water, soil, food and vegetables that are contaminated with urine of these animals. The bacteria enter the body through cuts in the skin or surfaces of the eyes or nose. It is important for you to know that the disease is preventable and treatable with antibiotics.

Q12. Can you think of ways by which you can avoid leptospirosis?

Bacteria also cause diseases in animals. Bacillus anthracis is responsible for the disease called anthrax. The bacterium is found in the soil and can survive for many years. The disease affects animals like cows and carabaos but can be transmitted to humans. Skin anthrax occurs in the Philippines through contact with animal tissues or their products. Inhalation and intestinal anthrax caused by inhaling spores and eating of contaminated or undercooked meat, respectively, are more deadly. It is strongly advised to refrain from eating meat of dead animals suspected to have died of anthrax. In the early 2000's there was a worldwide threat of using anthrax spores to kill people in what is termed as "biological" warfare.

Q13. Who do you think are the people who are likely to be infected with anthrax?

Antiobiotics are substances that kill or inhibit disease-causing organisms. Do you know that certain bacteria are used to produce antibiotics? Streptomycin, an antibiotic used to treat tuberculosis and certain types of pneumonia is made by Streptomyces griseus. Streptomyces venezuelae on the other hand produces chloramphenicol used in killing bacteria that cause typhoid fever and skin infections.

Escherichia coli is naturally found in the large intestine of humans. It feeds on partially digested food moving from the stomach to the small intestines. These bacteria meanwhile provide the much needed vitamin $\mathrm{B}_{12}$ that otherwise the human body cannot produce. E. coli however, once present in other areas in the body can produce poisons causing diarrhea or kidney damage and even death.

Do you know that many of these bacteria are also involved in making some of the foods or drink you like?

Some bacteria convert cheap materials into useful products such as food. Examples are Lactobacilli bulgaricus and Streptococcus thermophilus of the lactic acid bacteria group. These are specifically involved in making sour milk or yogurt. Yogurt is made by adding a culture of Lactobacillus bulgaricus present in the starter to skimmed milk powder. Lactase in the bacteria changes the milk sugar into lactic acid. When this occurs, proteins in milk curdle which gives yogurt its semi-liquid texture. Be familiar with these bacteria by doing the following activity.

## Activity 2

## How do bacteria in yogurt look like?

## Objectives:

After performing this activity, you should be able to:

1. identify bacteria present in fermented food or drink
2. describe bacteria observed under the microscope
3. explain the use of bacteria in food or drink making

## Materials Needed:

2 droppers diluted yogurt
coverslip glass slide
microscope methylene blue

## Procedure:

1. Place a drop of diluted yogurt on a slide.
2. Add a drop of methylene blue and cover with a cover slip.

Q14. What is the purpose of adding methylene blue to the specimen?

3. Observe under the LPO and HPO of the microscope.

Q15. Describe what you see under the HPO.
Q16. Which are Lactobacillus bacteria in yogurt? Which are Streptoccus bacteria?
Q17. What are your reasons for saying so?

Have you heard about "oil-eating" bacteria? Some members of eubacteria are able to break down or remove pollutants through the process of bioremediation. Scientists at University of the Philippines-Diliman's Molecular Microbiology Laboratory have identified a number of bacteria which can help solve the problem of oil spills in oceans and seas through this technology. These are Pseudomonas aeruginosa, Acinetobacter baumanii, Paenibacillus thiaminolyticus, Bordetella bronchiseptica and Lysinibacillus sphaericus.

Another group of bacteria (Figure 4), the cyanobacteria are plantlike because they have chlorophyll-containing cells. Most of them are single-celled, some form filaments, while others form spores. Cyanobacteria grow in ditches, esteros, or in moist places like gardens and sidewalls where light is present. In Northern Luzon people eat raw Tab-tab (Nostoc) as salad. Spirulina cells are rich in protein, thus, have been grown to produce Single Cell Protein (SCP). It is used as swine and cattle feed and is also recommended as food for humans.

(Source: Philippines. Department of Education. (2009). Science and Technology II.
Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.249).

Figure 4. Examples of cyanobacteria are (a) Lyngbya, (b) Microcoleus, (c) Oscillatoria, (d) Nostoc, and (e) Spirulina.

Anabaena azollae, another cyanobacterium is important in agriculture. It converts nitrogen in air into compounds usable by plants for growth and development. The same is being done by the Rhizobium group of bacteria. They are present in the root nodules of legumes.

Q18. What is the advantage of planting legumes together with other crops?
Certain bacteria, like Bacillus thuringiensis, have been developed into a microbial pesticide. It is used to control pests and and insects carrying diseasecausing organisms.

## Protists

Earlier you were introduced to protists. Are they prokaryotes or eukaryotes? What can you remember from Grade 7 about algae? How were they classified?

Members of Kingdom Protista come from unrelated ancestors. This grouping is referred to by biologists as an artificial grouping. The inclusion of the large number of unicellular organisms under this kingdom is just for convenience.

Protists differ in size, movement and method of obtaining energy. Though most of protists are microscopic, some can grow to as high as several meters.

In terms of method in obtaining energy, protists are classified into three groups. Phototrophs produce their own food. Heterotrophs feed on other organisms. This group is also divided into a group with no permanent part for movement, those with cilia, and those with limited movement. Others which are nonmotile and form spores belong to the sporozoan group. Members of this group are all parasitic.

Phototrophs are like plants in that they have chlorophyll. This group includes the algae, dinoflagellates, and euglenoids.

Algae may be green, golden, brown or red. The chlorophyll in green algae is not masked in contrast to the other members of the group. The carbohydrate that green algae produce is stored as starch. They grow on wet, humid rocks or bark of trees, in non-flowing canals, in seas, freshwater bodies and even polluted waterways. Green algae differ in size and shape. Some are unicellular; others form colonies, sheets, filaments, tubes and ribbons (Figure 5). Some green algae are edible. The marine green alga Caulerpa lentillifera is eaten fresh as salad.

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.255).

Figure 5. Examples of green algae (a) Chlorella, (b) Draparnaldia, (c) colonial Pediastrum, and (d) filamentous Spirogyra

Golden algae (Figure 6) cells also contain chlorophyll but is masked by yellow pigments. Members of this group are mostly microscopic. They store food in the form of leucosin oil or chrysolaminarin.


Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.256).

Figure 6. Diversity in shape of diatoms, a golden algae.

In one of your trips to the seashore, did you notice something like one of those shown in Figure 7? If your answer is yes, you have seen brown algae! Most members of this group are marine so you can see them just lying around on the beach. Brown pigments mask their chlorophyll.

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.257).

Figure 7. Some common brown algae found in the marine waters of the Philippines

Brown algae are the largest of the algae species. Giant kelps, a member of this group can grow to more than 30 meters in length. This group of algae store carbohydrate in the form of laminarin.

Do you know that brown algae have something to do with your favorite ice cream or toothpaste? Some members of the group contain alginic acid used as an ingredient in making these two, including candy and cream cosmetics.

Leaflike and bubblelike structures called bladders are present in brown algae. They float near the water surface where light is present.

Q19. What is the importance of bladders in brown algae?

Have you heard eaten gozo? Eucheuma muricatum (Figure 8) or kanot-kanot, another name for gozo, is a member of the red algae group. The group differs from the rest of the algae by storing food in the form of floridean starch. As their name suggests, red pigments mask their chlorophyll.

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.257).

Figure 8. Examples of red algae.

Red algae can change color depending on whether they are exposed or hidden from light. When they are exposed to light, they are bright green in color. If they grow without much light, they are colored red. Members of the group consist of both microscopic and large multicellular organisms. Most of them are found in marine waters.

There are species in the group that help form coral reefs because of their ability to produce calcium carbonate. Economically, E. muricatum is useful being a source of agar and carageenan. If you are fond of eating gulaman, note that it comes from agar. Eucheuma farming has become a source of livelihood in certain areas in Central Visayas and Mindanao. Likewise, Gracilaria salicornia (Figure 8) is an agar source and edible too.

Q20. Why is light important to algae?
Most members of dinoflagellates live in oceans and seas. They are mostly unicellular. Some occur as single organisms, while others form colonies. An important dinoflagellate to know is Pyrodinium bahamense var. compressum (Figure 9). They are the ones that cause "red tide" when present in large numbers. During red tide, people should not eat clams and mussels in the affected areas. This is because these organisms might have fed on the dinoflagelates which produce toxins and cause paralysis of the diaphragm that can lead to death.

(Adapted from: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.255).

Figure 9. Pyrodinium bahamense var. compressum, the red-tide causing dinoflagellate.

Q21. What is the danger of eating clams when red tide occurs?
The euglenoids are microscopic and unicellular. Euglena belongs to this group. It lives in freshwater bodies. Organisms of this group have a whiplike flagellum for movement. Some euglenoids have chlorophyll.

Euglena has an interesting characteristic of getting food. When light is available to, it makes food utilizing chlorophyll. In the absence of light, it absorbs nutrients from dead organic matter.

Heterotrophs with no permanent structure for movement include the radiolarians, foraminiferans and amoeba (Figure 10). They move by means of the pseudopods or pseudopodia. Notice the extensions at the sides of these organisms. These temporary extensions are formed when changes in the cytoplasmic concentration occur within the cell. This change causes the cell membrane to contract and enable the organism to make a creeping movement. Pseudopods may form as they are needed.

Q22. Compare pseudopods of foraminiferans, radiolarians and amoeba.

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.259).

Figure 10. Examples of heterotrophs using pseudopodia for movement.

Entamoeba histolytica is a harmful species of amoeba living in freshwater bodies. If present in underground water, it can contaminate drinking water. Once this happens, the gastrointestinal tract is infected causing amoebiasis. If the protist invades the intestinal lining it leads to amoebic dysentery. Proper sanitation must be practiced to ensure clean and safe drinking water.

Another heterotroph, the paramecium, moves using the cilia attached to parts or all over its body. The ciliate group are free-living and present in both fresh and salt water. They also use the cilia to get food. Other examples are the Didinium and Vorticella.

Slime and water molds are motile in a certain stage in their life cycles. Thus, they are considered to be heterotrophs with limited movements. Slime molds are usually the colored yellow, orange, or whitish growths that you may see on damp rotting logs. They feed on bacteria and decaying plant material in the same manner as an amoeba does. Water molds are white cottony growths on dead fish or plant parts that you might see floating in water. Certain species of water molds are parasitic on corn, grapes cabbage and many other important crops.

Members of the sporozoan group as mentioned earlier cannot move on their own. They may be free-living and parasitic. Some like four species of Plasmodium are harmful for they cause malaria, a serious disease in humans. This malaria-causing sporozoan is transmitted to humans by Anopheles mosquito. In the Philippines malaria is still constantly present in certain areas.

Another group of heterotrophs include the flagellates. They are unicellular and they use one or many of their threadlike flagella to move. Some of them exist as single organisms though others form colonies. There are parasitic and free-living flagellates. Two important species to study are Giardia lamblia and Trypanosoma gambiense (Figure 11a) because they affect humans. G. lamblia cause severe diarrhea, while T. Gambiense is responsible for Gambian sleeping sickness.

Trichonympha (Figure 11b) is beneficial to other organisms. It lives in the intestine of termites. Since termites cannot digest the wood that they eat, Trichonympha do it for them. Termites in turn give them a home and food to eat.

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.259).

Figure11. (a) Harmful and (b) beneficial flagellates

## Q23. Give at least five uses of protists.

## Fungi

You must have seen the orange colored growth on spoiled corn, the gray to black or white spots on a three-day old bread left in a warm and humid or moist place. Or the kabuti, that your father gathered from the woods and yeast used in making bread. All these are fungi.

You first encountered the eukaryotic fungi in Grade 7. You have also learned that they have no chlorophyll thus, cannot produce their own food. Some are parasites, because they survive by living on a host organism. Others feed on decaying matter and are called saprophytes. Fungi also have cell walls but are made up of chitin.

Fungi undergo asexual reproduction by forming buds and many spores. Actually, the black thing you see in fungi are spores in large numbers. These spores are abundant in the environment as they are carried easily by wind, water, animals, or humans. When spores land in areas suitable for their growth, new fungus develops.

Fungal bodies consist of hyphae with rootlike rhizoids that attach them to the substrate on which they grow. Hyphae absorb and provide nutrients to the fungi by extending downward into the substrate. Fungi also reproduce sexually when male and female hyphae join together.

Fruiting structures extend upward where spores are produced. Fungi are classified according to the kind of fruiting structures they form (Figure12). In bread mold Rhizopus, spores are produced in the sporangium.

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.264).

Figure 12. Differences in the fruiting structures of three groups of fungi. (a) occurs in bread mold, (b) in yeasts and (c) in mushrooms.

Q24. Where are spores of yeasts produced? How are yeast spores called?
Q25. Where are mushroom spores produced?
Q26. What is the advantage of the large numbers of spores produced by fungi?

Examples of fungi used as food are Volvariella sp. and Pleurotus sajor-caju (oyster mushroom). Others utilized in soy sauce making include the yeast, Saccharomyces rouxii and the mold, Aspergillus oryzae. Yeast is an ingredient in making bread.

Fungi are involved in decomposing organic materials. Decomposition is made faster using Trichoderma harzianum. An important mold to mention is Penicillium notatum. It is used in making penicillin, a drug that kills disease-causing bacteria.

Some fungal species however, can be harmful to other organisms and humans. The mold Aspergillus flavus produces aflatoxin, a poisonous substance. If large amounts of aflatoxin in moldy corn, garlic or peanuts are ingested, both poultry and humans can be poisoned. The parasitic fungi Trichophyton mentagrophytes and $T$. rubrum, cause athlete's foot. T. rubrum can also cause ringworm.

Q27. From what you know and have observed about fungi, in what conditions do they grow?

## The Plant Kingdom

Recall what you know about plant cells. Do they have chloroplasts? What are their cell walls made of?

You knew earlier that plants belong to the eukaryote group. They are multicellular and because they have chlorophyll, they can make their own food. Plants consist of two big groups: those which do not have tissues to transport water and food (nonvascular) and those that have this transport system (vascular).

## Nonvascular Plants

Have you noticed green patches attached to stones or cement walls especially during the rainy season or in moist, wet and shady areas?

Liverworts, mosses and hornworts (Figure 13) are nonvascular plants. They are attached to the places where they live by means of their root-like rhizoids. These rhizoids absorb water and nutrients instead of true roots. They also do not have true
stems and leaves so they grow very close to damp grounds, stone walls or tree trunks.


Figure 13. Example of nonvascular plants (a) liverworts, (b) mosses, and (c) hornworts.

Q28. How do liverworts, mosses and hornworts differ in appearance?

When nonvascular plants mature, they also form different reproductive structures. Liverworts develop "umbrella-like" structures that produce eggs and sperms. Notice in Figure 13b the capsules at the tip of thin stalks in mosses. These capsules contain the spores. In hornworts, you see them as thin "thorn-like" structures.

Nonvascular plants may seem very small but they play an important role in the environment. They provide oxygen to many organisms. Their "carpetlike" growth covering large areas in hilly grounds prevent erosion and increase the capacity of soil to hold water. Dried Sphagnum or peat moss is used to wrap plants and breakable items during transport. Gardeners use them to retain more water in the soil for important crops. Old, dead sphagnum form thick deposits called peat, which is used as fuel in some places.

Q29. Why do you think nonvascular plants cannot grow very large or tall?

## Vascular Plants

From studying water-dwelling organisms, you now will deal with ferns which thrive on land with true roots, stems and leaves. Ferns also reproduce by spores. More than 900 species of ferns can be found in moist, shaded and mountainous areas in the country. They exhibit diversity in size from a few millimeters to about 12
meters. Some ferns still inhabit freshwaters (Figure 14b), while others grow on tree trunks. The Anabaena cyanobacterium you studied earlier are present in the underside of azolla, a water fern.

Q30. Examine Figure 14a. Can you explain how it earned its name?
Have you heard of tree ferns (Figure 14c)? At first glance, you may think it is a tree with a sturdy trunk. You should know that they are not strong as woody plants.


Photo by: Alvin J. Encarnacion Giant fern, Angiopteris sp.
(a)

Photo by: Karina Luth Discaya
Cyathea sp. (tree fern)
(c)



Photo courtesy of Michael Anthony B. Mantala Salvinia sp.
(b)

Figure 14. Examples of Philippine ferns (a) Giant fern, (b) water fern and (c) tree fern.

Q31. How will Azolla help rice if they are grown together in fields?

With the fern's ability to make food, they too provide other organisms with food and oxygen. You are also familiar with the use of ferns as plant decoration. Some Philippine handicrafts are made from fern fibers like nito.

Q32. Give other uses of ferns in your locality.

## Gymnosperms

Seed plants consist of those which bear seeds contained in cones and those inside a protective layer of tissue. Plants whose seeds are borne in cones (Figure 15a) are called gymnosperms. Examples of gymnosperms are the conifers, cycads, ginkgoes, and gnetophytes. Many conifers like pine trees grow in cold countries and in elevated places in warmer climates. They are woody trees and have tough needlelike leaves.

male cone


Photo by Rodolfo S. Treyes
(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.264). (a)
(b)

Figure 15. (a) Benguet pine cones and (b) a Ginkgobiloba tree growing in Tokyo, Japan.

Q33. Where in the Philippines would pine trees likely grow?
Cycads are short, palm-like plant growing in tropical and subtropical areas. In the Philippines they are seen in well-landscaped hotels and parks. Gnetopytes are represented by Welwitschia which can be found in Namibia, Southwestern Africa.

Gymnosperms are sources of quality wood for making plywood and furniture. They also supply pulp to paper-producing factories. Other species provide resin, used in making perfumes and varnishes. Pine cones are popular Christmas decoration items.

Q34. How would uncontrolled cutting of pine trees, for example, affect the forest ecosystem?

## Angiosperms

You are most familiar with members this group as you may have played with their flowers even at an early age. In the earlier grades, you have learned how varied they are in terms of parts and habitat. You also studied about what parts are involved in reproduction and ways by which they reproduce. They are also called flowering plants since flowers, as well as fruits, are involved in their reproduction and development.

Angiosperms can be classified according to their lifespan. Annuals live for a year or one growing season and die like rice and corn. Biennials develop roots, stems and leaves during the first year, produce seeds on the second year, then die. Perennials live for many years, usually producing woody stems like tsitsirika, bamboo, and trees.

Leaves of angiosperms also differ in their arrangement in the stem. Study Figure 16.


Coffea arabica (coffee)


Allium sativum (garlic)


Anacardium occidentale (cashew)
(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.276).

Figure 16. Differences in arrangement of leaves in plant stems

Q35. Which plant leaves are arranged alternately, radially and opposite each other?

Flowering plants are also classified as to the number of cotyledons present in their seeds. Monocotyledons or monocots have only one cotyledon present, while dicotyledons or dicots have two. Coconut and grasses are examples of monocots. Gumamela and mango are dicots. Other differences among the two are exhibited in characteristics of some of their parts as shown in Figure 17.

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook
(Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.276).
Figure 17. Characteristics of monocots and dicots

Q36. In terms of leaf venation, is santan a dicot or a monocot?
Q37. How about bamboo?
Recall the structure of the flower you studied in Grade 7. Angiosperms can also be differentiated by means of their flower parts. A flower may have both petals and sepals or may have sepals or petals only. Others have stamens, petals and sepals attached to the ovary. Some have their petals separated, others are united. You can observe several flowers from different plants and you may see other differences or similarities among them.

## Importance of Angiosperms

Look around you. Think of what you have eaten or what you have used earlier. Were there any from this group of plants mentioned that you have eaten, or in any way used?

Angiosperms of importance worth mentioning are Filipinos' staple food: rice for most of us, corn in some areas; vegetables like camote tops, malunggay, cabbage, carrots, saluyot and squash.

Q38. Make a list of the uses of coconut that you know.

Many of our agricultural products, both fresh and processed are exported. Examples are banana from Davao, mango from Guimaras, coffee from various provinces, pineapple from Bukidnon and tobacco from provinces in Northern Luzon. Furniture made from rattan are also sold to various countries abroad. Sugar cane from different provinces is also another grown for export.

Many angiosperms have been developed to prevent and cure some diseases. Lagundi, sambong, ampalaya, and banaba to name a few are now commercially available for specific ailments.

Q39. Describe how birds, butterflies and spiders benefit from members of the angiosperms.

Q40. What is the greatest contribution of plants to living things on Earth?

## Harmful Plants

Some plants can be harmful to animals, humans, and even to other plants. Care must be taken that cows and other livestock should not graze in areas where sorghum grow. It is known to cause cyanide poisoning in livestock as young leaves contain a poisonous substance.

Jatropha curcas (tuba-tuba/tubang bakod) is popular due to its being an alternative source of bio-fuel. Although known to have medicinal properties, its seed is poisonous. The fruits which are usually eaten by children cause stomach pain, burning sensation in the throat and vomiting. Manihot esculenta (cassava) if boiled with its bark on it can be poisonous. The bark contains hydrocyanic acid. It is advised that during cooking, the pot cover should be removed for the cyanogas to escape. A word of caution: do not eat any part of a plant which you are not familiar with.

Echinochloa crus-galli (dawa-dawa) and Digitaria sanguinalis (saka-saka) are weeds which are alternative hosts to abaca and corn mosaic viruses.

Q41. What harm can weeds do to crops if they grow together?

## The Animal Kingdom

What can you remember about the characteristics of animal cells? How do animals differ in size, shape or habitat? How do they respond to their environment?

Animals differ in size and shape. In Grade 7, you learned that small ones have few cells while big ones can have up to trillions! Some animals can live inside other animals. Others are found in fresh or marine waters and some in every habitat on land. They reproduce either sexually or asexually.

Despite their differences, animals share basic characteristics. By now you must have known that this group are eukaryotic and multicellular. Some get nourishment from other animals, others eat plants while others feed on protists. You knew that animal cells have no cell walls. But they have cells involved in movement though some species are nonmotile. Animals also have cells that transmit messages throughout their body.

Q42. In your observation, how are animals distinguished from the other groups as to their reaction to stimuli?

Animals consist of two major groups, the invertebrates and vertebrates. Invertebrates lack backbone which is present in vertebrates. In this section, you will discover the diverse characteristics, uses and roles in the environment of nine in about thirty five animal phyla.

## Sponges

Sponges, the simplest animals, belong to Phylum Porifera. They live in shallow and deep oceans. The young of sponges are motile, while adults are attached to solid materials like rocks. The body of a hard sponge is supported by a "skeleton" called spicules, made of either glasslike silica or calcium carbonate. A network of protein fibers supports soft sponges. This is the one used for bathing and washing.

(Source: Philippines. Department of Education. (2009). Science and Technology II.
Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.285).
Figure 18. Structure of a sponge showing how water and food and waste materials move in and out of its body, respectively.

Water and food enter through the pores into the sponge body (Figure 18). Food is brought to the collar cells with the beating of flagella. Waste water and materials go out of the sponge through the osculum.

## Cnidarians

Members of Phylum Cnidaria consist of animals whose tentacles contain stinging cells called nematocysts. These poison-filled structures are used for defense and to capture their prey or food. Once released, this can be painful and even fatal like an attack by jellyfishes.

Corals form colonies of various colors and secrete a hard skeleton. These accumulate to form coral reefs which are of great importance as they are one of the
world's most productive ecosystems. A coral reef is where fishes and other marine organisms breed. At present however, coral reefs are destroyed by pollution from oil spills and dynamite fishing. Add to these the silt and sediments that flow down from the mountains because of farming, mining and logging activities.

Hydra represent freshwater cnidarians. Other marine cnidarians are shown in Figure 19.

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.287).

Figure 19. Variety in marine cnidarians.

Q43. Which cnidarians are attached? Which are free-swimming?

## Flatworms

The flatworm group belongs to Phylum Platyheminthes (in Greek platys means flat, helmins means worm). As their name suggests, they are flat and ribbonlike organisms. Flatworms are found in freshwater, in wet places and marine waters. They include the free-living or nonparasitic worms, the parasitic flukes, and the tapeworm group. Planaria is an example of a free-living flatworm. It lives in moist surfaces, under rocks in ponds, rivers and even aquariums. Flukes are parasites that live in other animals including humans.

Tapeworms are also parasitic flatworms like flukes without a digestive system. It can have fish, cows and pigs as hosts. Humans can be infected with tapeworms if they eat uncooked fish, beef or pork.

Q44. Why do you think parasitic flatworms do not have a digestive system?

## Roundworms

Roundworms are members of Phylum Nematoda. Compared to flatworms, roundworms also known as nematodes have long, cylindrical and slender bodies. Some roundworms are free-living while others are parasites of animals and plants. The free-living ones are important as they are decomposers in the soil in both marine and freshwaters. A lot of them are found in decaying organic matter. Parasitic roundworms can be found in moist tissues of plants and animals. Heartworms for example can infect dogs and cats. Humans can be infected with parasitic roundworms such as trichina worms, hookworms and the more common pinworms and Ascaris (Figure 20) afflicting children.

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p.288).

Figure 20. A male and female Ascaris with its internal parts shown. Digested food is taken in the mouth and exit in the anus.

Q45. Study Figure 20. How many openings does an Ascaris body have?

## Segmented Worms

The third group of worms among the animal phyla belongs to Phylum Annelida. Also known as annelids, these animals are characterized by a segmented or repeated body parts. This makes them move easily and with flexibility. Annelids are mostly found crawling in moist soil or swimming in sea and freshwaters. Examples of annelids are earthworms, polychaetes and leeches. Most polychaetes are marine living in tubes attached to rocks or sand. They get floating food through the feathery gills. Sandworms are examples of polychaetes.

Annelids have nervous, circulatory, digestive and excretory systems. Each segment contains most of the internal structures of these systems. Gas exchange only occurs by diffusion through their skin. This is why earthworms need to be in moist places like under rocks or stay buried in the soil. As they feed and burrow through the soil, they get nutrients and eliminate wastes (castings) through the anus. In this way they aerate the soil and the castings serve as fertilizer.

Leeches are blood-sucking annelids. They have suckers in both ends of their bodies that are also used to attach themselves to their hosts. They secrete an anticlotting chemical that has been used in medicine.

## Mollusks

Mollusks (Phylum Mollusca) are soft-bodied invertebrates with most of them covered by a shell. They have complex respiratory, reproductive, circulatory, digestive and excretory systems functioning together for their survival. The mollusk's body has three parts: a muscular foot for locomotion, a mantle that produces the shell, and the visceral mass that contains their internal organs. Mollusks consist of three classes: the Gastropods, Bivalves and Cephalopods.

Q46. Study Figure 21. How would you describe univalves? bivalves?


Univalves


Bivalves
(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City:Instructional Materials Development Corporation. p. 291.)

Figure 21. Examples of mollusks

Gastropods, also called univalves, as you have observed, has only one shell. They are mostly marine with freshwater and terrestrial members. Those living in seas have gills for breathing and those on land use the lining of their mantle as lungs. Sea and land slugs, as well as nudibranchs are examples of gastropods.

You may be most familiar with the bivalves as you see them on your dining table more often. These molluscs as you have observed consist of two shells attached to each other. Some bivalves are attached to rocks while others remain in the sand or mud. They use their mantle cavity to feed by trapping suspended particles in water and for gas exchange. Mussels, oysters, and clams are bivalves.

The cephalopod group include the squid and cuttlefish with internal skeleton. The chambered nautilus has external skeleton while the octopus is shell-less. All cephalopods are described as the most active molluscs, moving very fast using arms and tentacles in catching prey.

Q47. Into which group would you classify halaan? the giant African snail?Tridacna (taklobo)?

Many mollusk species are utilized as food like tahong (mussels), talaba (oyster), halaan (clam), scallops, and kuhol or suso to name some. Other species are made into decorative items.

Golden kuhol, however, has become a pest to rice and other crops. They eat a lot of plant leaves and reproduce rapidly. The giant African snail Achatina fulica was found to be an intermediate host to a rat lungworm that causes meningitis.

## Echinoderms

You can be fascinated by the star-shaped sea star or the spine-studded sea urchin and the appearance of the sand dollar. Along with the brittle star and the sea cucumber, they belong to Phylum Echinodermata. All echinoderms are found in a marine environment. Sea lily, another echinoderm, is rooted in the sand at the bottom of the sea, while sea cucumber burrows in mud of deep or shallow waters.

Parts of most echinoderms radiate from the center of the body. They also have spines which are extensions made of hard calcium. Under the skin, these form an internal skeleton called the endoskeleton.

Sea stars have the ability to regenerate. A cut arm can easily regrow into a new sea star.

Unique to echinoderms is the presence of the water-filled tubes that spread out to form the tube feet (Figure 22). Tube feet are used for getting food, moving around and gas exchange.

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p. 294.)

Figure 22. Sea star showing (a) arms radiating from the center of the body, (b) spines, and (c) tube feet.

Echinoderm species which are edible include the sea urchin and sea cucumber. Holothuria edulis, a sea cucumber, is dried and used as ingredient for chopsuey and soups.

Remember the role of coral reefs in the environment? Sea urchins are important to coral reefs because they consume algae that otherwise overgrow and can kill the corals. In contrast, the sea star, crown of thorns, are predators of coral polyps posing a threat to the existence of the reefs.

## Arthropods

Have you observed what grasshoppers, spiders, crabs and centipedes have in common? If you take a look at each of these you will notice that they have jointed legs. These animals belong to Phylum Arthropoda. The group is considered the most successful of all animal phyla as they are present in almost all types of habitats. There are arthropods that walk or crawl, some can fly, while others swim in salty and freshwaters.

Recall in Grade 6, you learned that arthropods have an exoskeleton. This is made of chitin and varies from thin and flexible to thick and hard exoskeletons. These animals grow a new skeleton many times in their life to give way to growth, specifically, increase in size through the process of molting.

Q48. How do arthropods differ from echinoderms?
Q49. What could be the function of the exoskeleton in arthropods?
Arthropods are grouped based on the type of exoskeleton, the number of body sections and the kind of appendages like mouth parts present. Appendages may be used for avoiding predators, getting food, walking or swimming. Crustaceans form one group of arthropods which includes water fleas, crabs, shrimps, lobsters and barnacles. They have hard exoskeletons and have mandible to bite and grind food. All crustaceans live in water with the exception of the pill bug. You see it in the soil as the small creature that rolls into a tiny ball when disturbed. Aquatic crustaceans have gills for breathing. Many crustaceans are food to humans. The small ones are eaten by fishes and even whales.

Arachnids have two body sections, most with four pairs of legs and mouthparts called chelicerae and pedipalps. They use book lungs to respire. Spiders with thin and flexible exoskeleton are the largest members of the group. Mites and ticks are parasitic arachnids. They cause itching to some mammals,
including humans. Scorpions have a poisonous sting. The horsehoe crab, a close relative of arachnids, is considered the oldest living arthropod.

Millepedes and centipedes, close relatives of insects have long, wormlike segmented bodies. They have a pair of antenna and each segment bear a pair or two legs. These animals live in the soil, under rocks or rotting logs and leaves. Millipedes have two pairs of legs per segment and roll up when disturbed. They feed on decaying matter. Centipedes have a pair of legs in a segment. They have venomcontaining claws and feed on earthworms, even other arthropods and small animals.

Insects form the largest group among arthropods. They have three body sections, three pairs of legs, a pair of antenna and one to two pairs of wings. Insects are more adapted for flying and have tracheal tubes for respiration. They are present in great numbers in all kinds of environments except in marine waters. Exoskeleton of insects as that of a fly is thin. Insects are also successful animals because they reproduce rapidly. Dragonflies, grasshoppers, aphids, and butterfies are some examples of insects.

Q50. Which arthropod group has no antenna?
Q51. How do legs of insects and arachnids differ?
An important insect that you should learn about is the mosquito. A species of this group, Aedes aegypti pose a danger to people of all ages. It carries and transmits through its bite the virus that causes dengue. The following activity will describe how this species reproduce and teach you how to control dengue.

## Activity 3 <br> What can you do to prevent dengue?

## Objectives:

After performing this activity, you should be able to:

1. describe and classify Aedes aegypti,
2. discuss the life cycle of $A$. aegypti,
3. identify breeding places of $A$. aegypti,
4. explain the role of $A$. aegypti in spreading dengue, and
5. suggest ways of preventing dengue.

## Materials Needed:

sheet of paper<br>illustration of life cycle of Aedes aegypti

## Procedure:

1. Study the different stages in the life cycle of Aedes aegypti below.

## Life Cycle of Aedes aegypti

The adult Aedes mosquito comes out of the pupal case and waits in a protected area for its wings to dry. It can then fly as far as one hundred metres to one kilometre away to mate and look for food. The male mosquitoes feed on flower nectar and are usually found near breeding sites. It is the female mosquito that bites animals and people to feed itself with blood. It continues the cycle by laying eggs.

The third stage consists of the commashaped pupa which continue to stay at the water surface. The pupa breathes through two small tubes called "trumpets." It dives downwards quickly when disturbed. It stops eating and grows shorter, then encases itself with a hard covering. Inside the pupal case, it continues to change and grow. This stage only takes about two to three days. If the water dries up before the next stage, the organism dies.


Female mosquitoes lay eggs in clean, standing or non-flowing water. Examples are rainwater that has accumulated in old unused tires and those in flower vases. A mosquito can lay an egg or a group of up to one hundred at a time. Eggs are whitish or yellowish in color but later turn brownish. Usually, this stage may last for only minutes to two or three days or for about a week depending on the climate and environmental conditions. Some however, remain as eggs even for a year and are hatched during the rainy season.

Mosquito eggs hatch into larva (plural: larvae). It is the second and the most easily seen stage of mosquito development. A larva always lives in water and eats a lot of floating algae and organic matter. It dies if taken out of the water. The larva stays at the surface and breathes through an air tube called siphon. When disturbed, it dives or wriggles down to the bottom, that is why it is also called a "wriggler." It returns to the surface to breathe. This stage usually lasts for about five to seven days.

Q52. How does the adult of this mosquito look?
Q53. Describe the breeding place of $A$. aegypti.
Q54. In which places in your home, school or surroundings can this mosquito breed? Name at least 5.

Have you heard about "kiti-kitt"? These are the larvae or wrigglers.

Q55. What do you think will happen to a larva that is removed from water?
Q56. Based on your study of the life cycle of Aedes aegypti, how important is water to the mosquito?
2. Review your answers to Q54.

Q57. What can you do to stop the reproduction of the dengue virus-carrying mosquito? Name at least 5 .

Q58. Into what group of arthropods would you classify the mosquito and why?

## Chordates

Animals belonging to Phylum Chordata have four characteristics that are present in any of the stages in their life cycle. These are the notochord, the dorsal hollow nerve cord, gill slits and a post-anal tail. In many chordates, the notochord later becomes the backbone. Humans being a member of the chordate group have the notochord, tail and gill slits only in the embryo stage.

However, there are lower chordates that do not have a backbone. Examples are the tunicates and lancelets. The adult tunicates have only the gill slits present but the larva stages have all the four features. Tunicates attach to solid materials like rocks or coral reefs. They are filter feeders, taking in food particles suspended in water.

Lancelets have the four chordate characteristics present in the adult stage. They live in the sandy ocean bottom. They are also suspension feeders. Lancelets move in a fishlike motion using the muscles on both sides of their body.

## Vertebrates

Most vertebrates are sea and land dwellers forming the large group of chordates. The vertebrates' notochord is replaced by the backbone or the vertebral column (vertebra, plu. vertebrae)). The nerve cord is enclosed by the projections of the vertebrae. The protected nerve cord enlarges at the anterior end to develop into the brain. The tail can be the bone and muscle that animals use for swimming in
aquatic species. For some vertebrates, the gill slits remain till the adult stage. In others, these are modified into structures for gas exchange.

## Fishes

Fishes are vertebrates found in salty, fresh, cold or even hot water. Most have scales for protection, paired fins for movement and gills for gas exchange. Fishes may lay eggs to reproduce or give birth to live young. They are cold bloodied because their body temperature changes when environment temperature changes. Certain fishes do not have true teeth or may be jawless as compared to the others.

Jawless fishes belong to Class Agnatha. Examples are the lampreys and hag fish. Lampreys, being parasites, have tooth-like structures in their mouth that can attach to bodies of other fishes and feed on their tissues and blood. The hagfish is wormlike and use a toothlike tongue to eat dead organisms.

Cartilaginous fishes include the rays, skates and sharks. They have a skeleton made of the soft, flexible protein material called cartilage. Most cartilaginous fishes are covered with a tough, sandpaperlike skin due to the presence of toothlike scales. Skates and rays have winglike fins and move in a gliding motion through the water. Some of them eat floating planktons while others feed on invertebrates at the bottom of seas and oceans.

Sharks may feed on small fishes or on floating algae. The whale shark (Rincodon typus), the largest fish, and locally known as butanding is found in marine waters of Cebu, Sorsogon and Dumaguete.

The diverse groups of bony fishes belong to Class Osteichthyes. These are the fishes that have an endoskeleton made of hard, calcium material called bone. Bony fishes are more familiar to you like bangus (milkfish), tuna, goldfish, and tilapia. The non-familiar lungfish breathes through the lungs in addition to having gills also for respiration. Eels are wormlike fishes. Figure 23 shows some of the members of the bony fishes.

(Adapted from: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p. 301.)

Figure 23. Examples of unique bony fishes

Q59. Compare the skeleton of the shark and the tilapia.

As food of humans and other animals, you will learn more about the role of fishes in food chains and food webs which you will study in the next module.

## Amphibians

Amphibia means "double life" from which amphibians got their name. This refers to animals that live part in water and part on land. Most lay small, shell-less eggs surrounded by jellylike substance in moist places or in water. These hatch into tadpoles with gills and tails. They lose the tail to develop lungs as well as legs and
move to land but close to water or damp habitats. They also have moist skin to help the lungs for gas exchange while in dry land. Amphibians are divided into three groups, the caecilians, salamanders, and frog and toads. Ceacilians live in water or bury themselves in moist soil. Salamanders live in forest floors under rocks and decaying logs.

Both frogs and toads jump. Some frogs can leap and attach to tree trunks and branches. Toads are terrestrial and can even survive in hot places or desert. Frogs have smooth skin while toads have rough or warty skin. Frogs and toads eat worms, insects or small animals.

(d)
(Adapted from: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p. 302.)

Figure 24. Amphibians include (a) the mud puppy, (b) a tree frog,
(c) caecilian, and (d) toad

Q60. Refer to Figure 24. Which amphibian(s) is/are tail-less?
Q61. Which of them do not have legs?

## Reptiles

Reptiles are animals that exhibit more adaptations for living on land. They lay eggs with shells to protect them from drying. They also have smooth or rough scales for protection from loss of body water.

Lizards and snakes have smooth scales. Examples of lizards are the house lizard, gecko (tuko), monitor lizard (bayawak), chamleleon and horned toad. Snakes are legless and have flexible jaws to enable them to swallow their prey whole. A common snake species is the reticulated python seen in zoos. Poisonous species include the cobra and the rattle snake. Snakes however, avoid people and do not attack unless provoked or hurt.

Crocodiles and alligators are also reptiles. They are predators of fish, deers, small cows or carabaos, and even attack humans. Alligators live in freshwater and are only found in North and South America. Crocodiles live in fresh and salty waters in tropical and subtropical regions. In the Philippines, two species are present, the endemic Crocodylus mindorensis (Philippine Crocodile) and the saltwater Crocodylus porosus. The Philippine crocodile is considered a critically endangered crocodile species in the world.

Bodies of turtles and tortoises are enclosed in a shell. The head, legs and tail are pulled inside this shell as protection from predators. Tortoises live on land while turtles live mostly in water. Pawikan (marine turtles) live in the sea and females come to shore only to lay eggs. There are species of marine turtles which are at present in danger of extinction.

## Birds

If reptiles are adapted to land life, most birds are adapted to fly. Characteristics of birds that enable them to fly include: presence of wings and feathers, large flight muscles in the breast bone and reduced weight. Birds weigh less because their bones are light and hollow filled with air. Birds also have eggs with shells and the legs are covered with scales. Their body temperature remains the same despite varying environmental temperature due to the insulation provided by feathers.

Birds have bills or beaks (Figure 25), and in coordination with the type of wings and feet they have, are adapted to where they live and the kind of food they eat.

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p. 305.)

Figure 25 Different beaks of birds.

Q62. Examine the beak of the Philippine eagle. If it is for cutting, what do you think does this bird eat?

Examples of birds that do not fly are the kiwi, penguin and ostrich.
Q63. Compare the legs of amphibians and reptiles with birds that you are familiar with.

You often eat chicken during meals or even merienda. Or maybe balut and salted eggs from ducks are your favourites! Snakes and big animals also prey on smaller birds. You enjoy the relaxing chirping or singing of some birds and their varied colors. Although certain birds feed on rice or corn grains, they have a role in dispersing seeds to various places, resulting to perpetuation of many plant species.

The Philippine Eagle, which is found only in our country, has been declared as a critically endangered species. It means that there is a possibility that the species will disappear or be lost. The main reason is the loss of their habitat-- the forests -due to logging and their conversion to farmlands.

Q64. If you live somewhere in eastern Luzon, Samar, Leyte or Mindanao where the Philippine eagles specifically live, suggest ways to protect their habitat.

## Mammals

Mammals differ from other animals because they have mammary glands that produce milk to nourish their young and most have hair or fur. They breathe in air, have four-chambered hearts and are warm-bloodied. Most of them also give birth to live young and care for them.

The first group of mammals, called monotremes, lay eggs similar to those of birds. The spiny anteater (echidnas) living in Australia, New Zealand and New Guinea as well as the duck-billed platypus are monotremes (Figure 26).

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p. 306).

Figure 26. Examples of Monotremes.

Marsupials or the pouched mammals also give birth to live young. After birth, the young are kept inside pouches and are nourished with the milk from the mammary glands within these pouches. Some marsupials are found in Central and South America. The opossum lives only in North America. Others, such as the more familiar koalas, kangaroos and wombats and flying phalangers, are found in Australia and New Zealand.

The eutherians comprise the largest group of mammals. Known as the placental mammals, they bear fully developed young inside the mother's uterus. These young are attached to the placenta through which they receive nourishment until they are born. After birth, they continue to be cared for and nourished by milk from the mammary glands. Table 2 presents the different groups of placental mammals and their representatives.

Table 2 Placental Mammals

| Order | Characteristics | Examples |
| :--- | :--- | :--- |
| Insectivora | insect-eating | shrews, moles |
| Chiroptera | flying | bats |
| Rodentia | gnawing | rats, mice, squirrels |
| Lagomorpha | rodentlike | rabbits, hares |
| Edentata | toothless | armadillos |
| Cetacea | aquatic | whales, dolphins |
| Sirenia | aquatic | dugong, manatee |
| Proboscidea | trunk-nosed | elephants |
| Carnivora | flesh-eating | dogs, cats, bears, seals, walruses |
| Ungulata | hoofed foot | horses, zebras, rhinoceros, giraffes, <br> carabaos, goats, pigs |
| Primates | large brain <br> relative to body <br> size | lemurs, monkeys, apes, humans |

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City:Instructional Materials Development Corporation. p. 307.)

Q65. Which of the eutherians live in water?
Q66. In your observation, how do humans differ from other primates?
Primates are the most highly developed of all animals. They are able to walk erect, with fingers and toes adapted to grasp or hang on branches and hold things or manipulate food. They also have a high degree of intelligence. Primates exhibit social behavior like living in organized groups or communities. They take care of orphaned individuals or even fight with competing groups. Scientists would like to believe that the care given by females to their young contribute to their ability to survive.

Q67. What characteristics differentiate mammals from other animals?
Mammals are present in various places, from the very cold to the warmest regions and in salt waters. Many live among humans. Mammals have become an important part of ecosystems. In grasslands, zebras eat plants and in turn are killed and eaten by lions. In forests, bats eat insects and compete with monkeys for fruits. Seeds are then spread for plants to grow in other areas. Wastes of these mammals serve as fertilizers to plants. In human communities, rats carry bacteria and dogs virus that cause diseases. In farmlands, carabaos work for people, while cows, sheep and goats provide meat and milk. Rats destroy crops and compete with humans for rice grains. In whatever way, good or bad, mammals affect the ecosystems where they live.

You have just gone through all the different groups of organisms on Earth known to science at present. You have learned about their similarities and differences. The discussions and activities also showed how they are useful to one another and the whole ecosystem or how some harm others.

## Low and High Biodiversity

In the earlier grades you learned that among different ecosystems, the rainforest has the highest biodiversity. This means that it has the greatest number of species living in it. Rainforests have a high rainfall, thus, have lots of plants in them. This condition provides shelter, water and food to many species that can survive drought or disasters as well as competition with other species. This results to a stable ecosystem with lesser rate of species loss. Tropical rainforests are located in places near the equator, while temperate rainforests are found in the temperate regions.

Q68. Based on the discussion above, how will you describe an ecosystem with low biodiversity?

## Activity 4 <br> What is the importance of biodiversity to ecosystems?

## Objectives:

After performing this activity, you should be able to:

1. differentiate low from high biodiversity,
2. give advantages of high over low biodiversity,
3. identify ecosystems with low and high biodiversity, and
4. predict what will happen to an ecosystem with low biodiversity.

## Materials Needed:

photos of different ecosystems
pencil/ballpen

## Procedure:

1. Get photos of various ecosystems from your teacher.
2. Together with your groupmates, identify which of them have high or low biodiversity.

Q69. Which ecosystem/s have high biodiversity? low biodiversity?
3. Study the photo below.


Photo by MD Sebastian
Figure 27. A banana plantation.

Q70. Does it have a high or low biodiversity?
Q71. What will happen if a pest will attack banana plants?
Q72. What will happen if a strong typhoon comes and heavy flooding occurs?
Q73. How will this affect the helpers and owner of the plantation?
4. Examine the photo below.

(Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p. 339).

Figure 28. A coral reef ecosystem.

Q74. What biotic components are present in this ecosystem?
Q75. Describe some relationships and interactions that occur among these biotic components.

Q76. Predict the effect of the presence of many crown of thorns sea star to the ecosystem and its biotic components.

Q77. Why is high biodiversity advantageous over low biodiversity?
Q78. What is the importance of biodiversity to ecosystems?

The North Pole and certain deserts are examples of ecosystems with low biodiversity.

Q79. Give other examples of familiar ecosystems with low biodiversity.

## Protecting and Conserving Biodiversity

You have seen that organisms in an ecosystem are interdependent upon each other for survival and harmonious existence. This interdependence among them demonstrates the importance of biodiversity to an ecosystem. You must know however, that as more species are discovered every year, others previously known and identified have decreased in number or have disappeared. A good way to remember the causes of species decline is through the acronym HIPPO*:

H - Habitat destruction
I - Invasion of introduced species
P - Population increase
P - Pollution
O-Overcollection/overharvesting of resources

Think of the biodiversity in your community at present. What would it look like in the future?

In the following activity, you are going to make a list of conditions that you want to see in your world in the future. Prioritize them, suggest ways and take action to make them happen.
*Threats to Biodiversity. Retrieved from http://www.e-education.psu.edu/geog030/node/394

## Activity 5 I create the future ${ }^{1}$

## Objectives:

After performing this activity, you should be able to:

1. Make a personal and group vision for the future in relation to biodiversity

[^0]2. Analyze the different ways that government, groups, and individuals are doing in order to arrive at the envisioned future, and
3. Take personal action towards conserving biodiversity.

## Materials Needed:

copies of "Priority Pyramid" worksheet and "Making it Happen" handout for each student and for each small group pencil or ballpen notebook or sheet of paper for the "future log"

## Procedure:

## Part I. My Future World

1. As a class, you are going to make a list of conditions that you want to see in your world in the future and then, suggest ways and take action to make it happen. Ask yourself this question: What do you want the future world to be? What things or conditions do you want to see in the world, say, 50 years from now? Make a list of at least five such conditions.
2. Be ready to share your ideas when your teacher will ask the class. Your classmates will be sharing their ideas as well, so listen carefully. Your teacher will write all the ideas on the board. Look at what visions of the future you and your classmates have come up with.

Q80. What conditions do you and your classmates want to see in your future world?
3. Get a copy of the "Priority Pyramid" from your teacher. Complete this pyramid with the conditions that you want your future world to have, ranking them from the most important to the least. Write what for you is the most important condition at the topmost box of the pyramid, the next two conditions on the next level, and so on.
4. You will next share your personal pyramid in a small group. When it is your turn, show your group your pyramid and explain how you chose your top three conditions. When it is the turn of your groupmates to share, be sure to listen to their explanations as well.
5. Now, discuss with your groupmates and create a group pyramid that will represent your group's priorities for the future. Each one should make a copy of your group pyramid. Decide who among you will present to the class your group's top three priorities.
6. Compare your personal pyramid to the pyramid that your group came up with.

Q81. Why are there similarities and differences?
Q82. How do you feel about the final result, that is, the group pyramid?
Q83. How do you feel about the process you went through to come up with the group pyramid?

## Part II. Making it Happen

Q84. Will our dreams for the future come true by simply thinking about them?

1. Look at the different blocks (conditions) on your group pyramid. Are you aware of anything that you or other people are already doing to ensure that these will happen in the future? Make a list and discuss these with your groupmates.

Q85. Do you know of any ongoing programs, initiatives and legislations related to these priorities?

Q86. What government agencies, organizations, groups and individuals are responsible for or are working on the conservation of biodiversity, either locally or on a global scale?
2. Obtain a copy of the "Making it Happen" handout from your teacher. Read about each of the projects and choose those that you think are making or will make significant contributions to meeting the top three priorities in your group pyramid. For each project that your group will choose, write a sentence or two to describe ways it is working to achieve the identified priority. You can also add what your group thinks as the project's strongest and weakest points.

## Part III. I Can Make a Difference!

Q87. What can you do to create a positive future?

1. Keep a "future log" for a week. Your log should list in bullet form, all your activities, behaviors, speech and thoughts for each day. At the end of each day, think about and write down how each bullet item affects the world around you, either positively or negatively, and what consequences it could have for the future.
2. Each day, add ways that you can do more to help preserve the earth's biodiversity.

Q88. What changes in your daily actions can you carry out to contribute to conserving biodiversity?

Remember that the biodiversity found in your community, are what you need to live and survive. As students, start right by taking seriously your learning and understanding of your community's biodiversity, the organisms' importance to and interactions with each other. Use them wisely and conserve biodiversity. It is only when you understand all of these will you realize that you cannot afford to lose any of these, for all of you and your future, will be affected. "ACT NOW, NO ONE CAN DO THIS FOR YOU NOR FOR US!"

In the next module, you will be introduced to more ways by which these organisms affect and interact with each other as well as with the environment they live in.

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[^0]:    ${ }^{1}$ Adapted from Illinois Biodiversity Basics, a biodiversity education program of the Illinois Department of Natural Resources, Chicago Wilderness, and the World Wildlife Fund

