

# Science

## Learner's Material

### Unit 3

This book was collaboratively developed and reviewed by educators from public and private schools, colleges, and/or universities. We encourage teachers and other education stakeholders to email their feedback, comments, and recommendations to the Department of Education at [action@deped.gov.ph](mailto:action@deped.gov.ph).

We value your feedback and recommendations.

**Science – Grade 10**  
**Learner’s Material**  
**First Edition 2015**

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Published by the Department of Education  
Secretary: Br. Armin A. Luistro FSC  
Undersecretary: Dina S. Ocampo, PhD

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**Printed in the Philippines by REX Book Store, Inc.**

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# UNIT 3

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## Living Things and Their Environment



# UNIT 3: Living Things and Their Environment

## Overview

In the past years, you have studied about the coordinated functions of the digestive, respiratory, and circulatory systems. You have learned that nutrients enter the bloodstream and combine with oxygen taken in through the respiratory system. You have also understood the structure of genes and chromosomes, and the functions they perform in the transmission of traits from parents to offspring. You have discovered that some species that once existed are now extinct, and that they become extinct when they fail to adapt to changes in the environment. You have become familiar about how plants capture energy from the sun and store energy in sugar molecules through photosynthesis, and learned that stored energy is used by cells during cellular respiration. You have found out that these two processes are interrelated.

All modules in **Grade 10 Unit 3 Living Things and Their Environment** present mental and hands-on activities that will enable you to apply science concepts and inquiry skills in addressing real-world problems through scientific investigations. These instructional activities are designed to enhance your knowledge, understanding, skills, and ability to transfer learning. There are four modules in this quarter, namely:

Module 1: Coordinated Functions of the Nervous, Endocrine, and Reproductive Systems

Module 2: Heredity: Inheritance and Variation

Module 3: Biodiversity and Evolution

Module 4: Ecosystems: Biodiversity

At the end of Grade 10, you should have already developed scientific, technological, and environmental literacy that will lead you to rational choices on any issue that you will face in life.

Unit 3  
MODULE

1

# COORDINATED FUNCTIONS OF THE NERVOUS, ENDOCRINE, AND REPRODUCTIVE SYSTEMS

## I. Introduction

The human body is made up of different systems that coordinate with one another in order to perform their functions well. If any part of these organ systems malfunctions, the body will become unbalanced. The instability caused by the malfunctioning of one system cannot be made stable by other systems because each system has its own function in the body. You have studied in the past that human body systems are the combined functional units composed of various organs that work in full coordination with one other. In Grade 9, you have already studied how the circulatory and respiratory systems work together and how lifestyle affects these systems. Now you will learn about the coordinated functions of the reproductive, endocrine, and nervous systems.

As you go through this module, you will be able to understand organisms having feedback mechanisms, are coordinated by the nervous and endocrine systems. You will also learn how these feedback mechanisms help organisms maintain homeostasis to reproduce and survive.

## II. Learning Competencies/Objectives

At the end of this module, you are expected to:

1. Describe the parts of the nervous, endocrine, and reproductive systems, along with their functions.
2. Explain the role of hormones involved in the female and male reproductive systems.
3. Describe the feedback mechanisms in regulating processes in the female reproductive system.
4. Describe how the nervous system coordinates and regulates feedback mechanisms to maintain homeostasis.





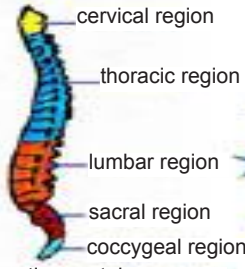

In Module 1, you will answer the following key questions:

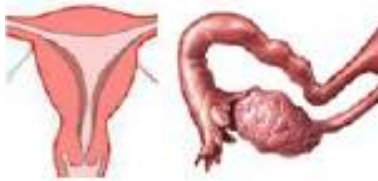



- How do the nervous, endocrine, and reproductive systems perform coordinated functions?
- How do hormones work to regulate various mechanisms inside the human body?
- How do feedback mechanisms help organisms to maintain homeostasis in order to reproduce and survive?

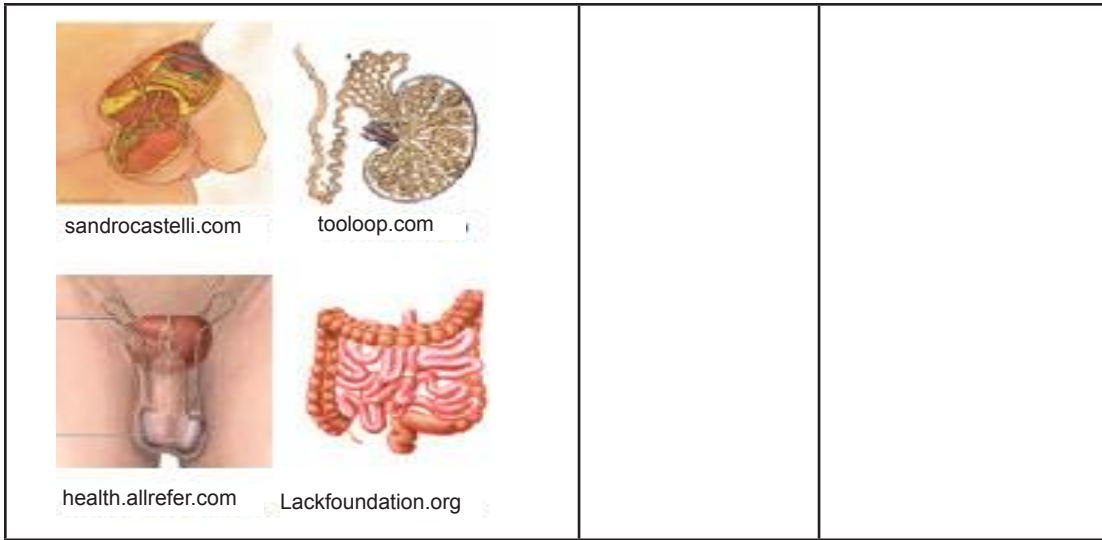
### III. Pre-Assessment

#### Odd Organ Out

Directions: Study each set of diagrams showing different organs of the human body. Then, determine which organ does not belong to the group by naming it on the space provided, on the second column of the table. Lastly, write your explanation on the third column why the organ should not be included in the group.

Group of Organs	Odd-One Out	Reason
<div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>good-health-guide.blogspot.com</p> </div> <div style="text-align: center;">  <p>eweb.furman.edu</p> </div> </div> <div style="display: flex; justify-content: space-around; align-items: flex-start; margin-top: 20px;"> <div style="text-align: center;">  <p>education-portal.com</p> </div> <div style="text-align: center;">  <p>ninds.nih.gov</p> </div> </div>		

Group of Organs	Odd-One Out	Reason
 <p data-bbox="389 464 756 493"> <a href="http://medindia.net">medindia.net</a>    <a href="http://myoptumhealth.com">myoptumhealth.com</a> </p>  <p data-bbox="389 733 756 762"> <a href="http://wisegeek.org">wisegeek.org</a>    <a href="http://academymedical.com">academymedical.com</a> </p>		
 <p data-bbox="383 1044 756 1073"> <a href="http://globehealingcenter.com">globehealingcenter.com</a>    <a href="http://hormone.org">hormone.org</a> </p>  <p data-bbox="386 1317 746 1346"> <a href="http://tooloop.com">tooloop.com</a>    <a href="http://facstaff.gpc.edu">facstaff.gpc.edu</a> </p>		



You have studied that cells make up a tissue, then tissues make up an organ, and organs make up a system. Now, you will first try to understand the organ system before you go to the cellular level to know how the individual cells of the nervous system work.

#### IV. Reading Resources and Instructional Materials

### The Nervous System The Structure of the Nervous System



Figure 1. The human nervous system

Your nervous system connects all your body parts and transmits signals from one part to another. It is a system of cells, tissues, and organs that regulates the body's responses to internal and external stimuli. Each part of the nervous system has a specific role as it functions as an important part of a system.

## **Major Divisions and Parts of the Nervous System**

### 1. **Central Nervous System (CNS)**

The CNS serves as the main processing center for the entire nervous system. It consists of two main components, namely the:

#### **a. Brain**

This is an organ located within the skull that functions as organizer and distributor of information for the body.

It has three main parts:

**Cerebrum** – large, upper part of the brain that controls activity and thought.

**Cerebellum** – the part under the cerebrum that controls posture, balance, and coordination.

**Brain Stem** – the part that connects the brain to the spinal cord and controls automatic functions such as breathing, digestion, heart rate, and blood pressure.

#### **b. Spinal Cord**

This serves as a channel for signals between the brain and the rest of the body, and controls simple musculoskeletal reflexes without input from the brain.

### 1. **Peripheral Nervous System (PNS)**

The PNS connects the central nervous system to the organs and limbs. It has two main divisions:

#### **a. Somatic Nervous System**

This system is associated with the voluntary control of body movements and has two main parts:

**Spinal Nerves** – the nerves that carry motor and sensory signals between the spinal cord and the body.

**Cranial Nerves** – the nerve fibers that carry information into and out of the brain stem

**b. Autonomic Nervous System**

This system is associated with the involuntary control of body movements and has two subdivisions:

**Sympathetic** - it is activated when the body is in a dynamic role or stress. (e.g., increased heart rate and breathing, dilation of pupil, sweating, etc.)

**Parasympathetic** - it maintains body functions and restores the body to normal or relaxed mode.

Now, test your understanding of the basic organization of the nervous system by doing Activity1.

**Activity 1**

**Break it Down!**

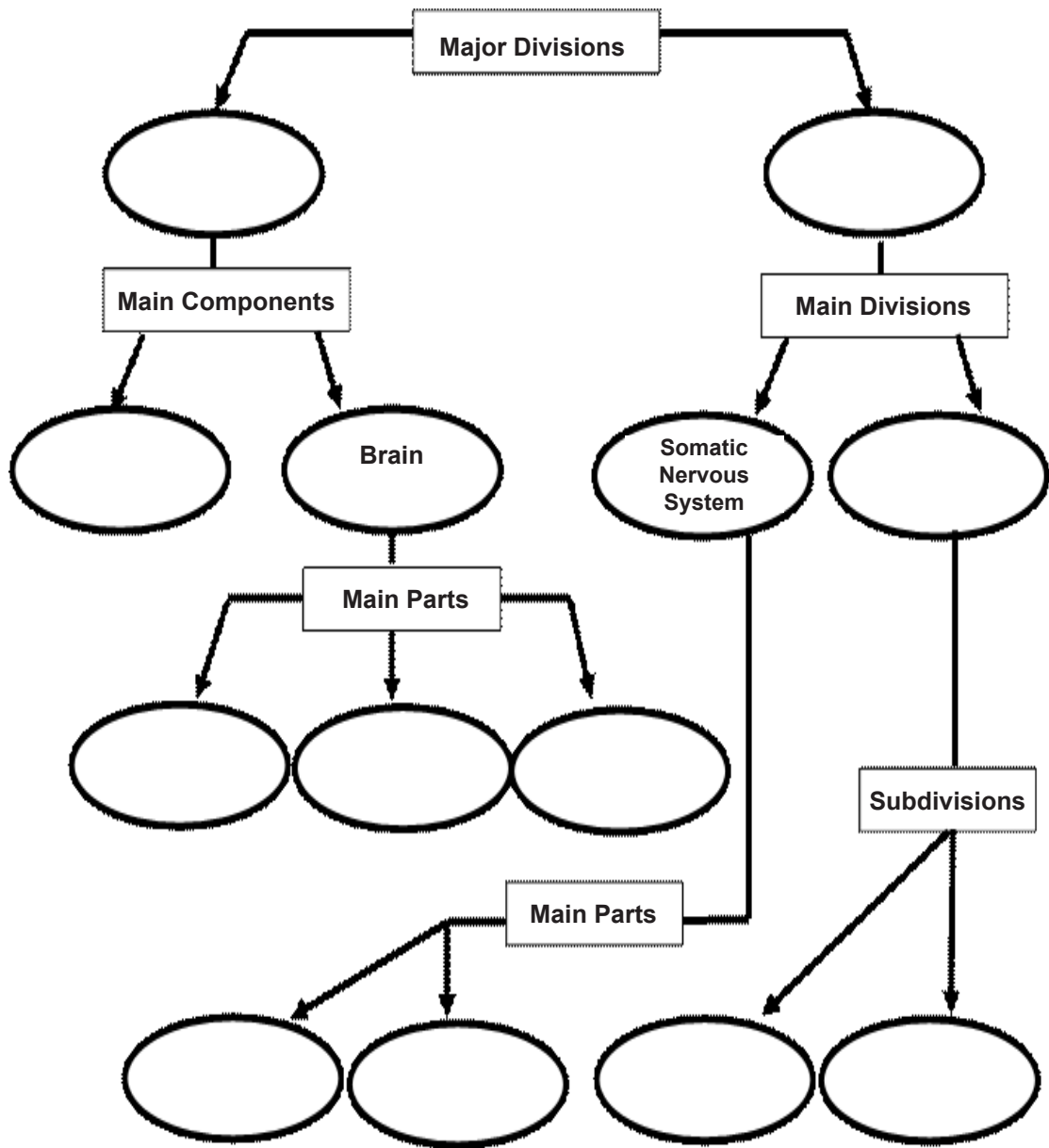
(Adapted from DepEd Project EASE, Module 9: Life Support Systems, pp. 4-6)

**Objective:**

Identify the parts of the nervous system

**Procedure:**

Using the given graphic organizer, fill in the missing parts to complete the entire concept showing the structure of the nervous system.



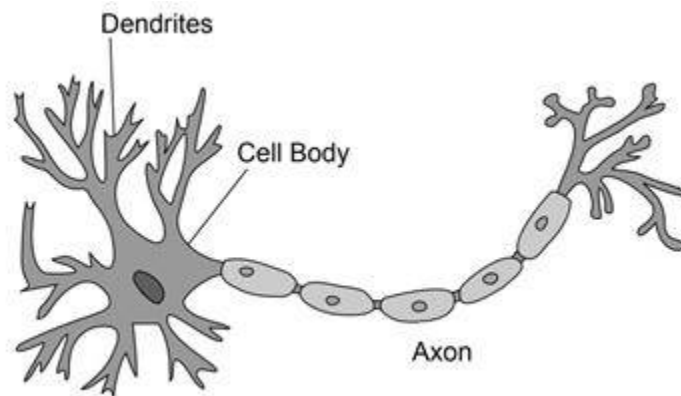
**Guide Questions:**

- Q1. How will you differentiate the Central Nervous System (CNS) and the Peripheral Nervous System (PNS) in terms of their functions?
- Q2. What might happen to the human body if one part of the nervous system fails to carry out its function properly?

## The Nerve Cell

The basic unit of the nervous system is the nerve cell. Nerve cells are called neurons. Study Figure 2 and look at the different parts of the neuron. There are billions of neurons in the body. Some exist alone. Others are joined together to form organs like the brain and spinal cord.

There are twelve to fourteen billions of neurons in one part of the brain alone. A neuron has a cell body containing the nucleus. Projecting out from the cell body are root-like structures. These are the dendrites and axons. Dendrites carry impulses towards the cell body. A cell may have as many as 200 dendrites carrying impulses toward the cell body. A single dendrite can be over one meter long. Axons carry impulses away from the cell body. Axons pass impulses to the dendrites of other neurons or cell body of muscle cells. Axons can be grouped together into cable-like bundles called nerves.



**Figure 2.** The basic parts of a neuron

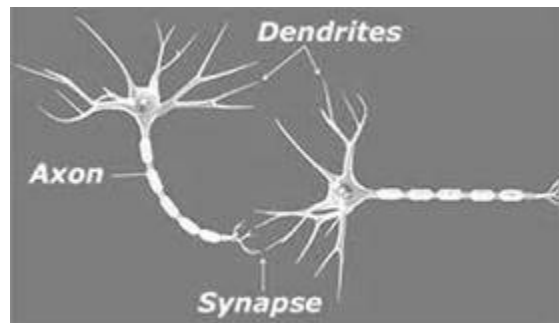
## Control of Body Processes through the Nervous System

### The Nerve Impulse

Neurons are cells with the special ability to carry signals or impulses. Thoughts, emotions, learning, and many body functions are carried by nerve impulses in the neurons. A nerve impulse is a combination of an electrical charge and a chemical reaction. A nerve impulse is not a flow of electricity, but an electrochemical signal moving along a neuron.

Imagine that you have a board with a row of switches. Quickly click each switch in the row on and off. This will give you an idea of how a nerve impulse travels along a neuron.

A nerve impulse cannot jump from one neuron to another. When a nerve impulse comes to the end of an axon, it produces the chemical, called neurotransmitter, to be released. The chemical crosses the space between neurons called synapse and stimulates the nerve impulse to start in the next dendrite.



**Figure 3.** The nerve impulse is sent by neurotransmitters from one neuron to another through a gap called synapse

The nervous system is assisted by five sense organs - the eyes, ears, nose, tongue, and skin. These sense organs are constantly receiving information from the environment and sending messages to the brain. These senses aid in the survival of human beings. A stimulus (plural: stimuli) is any factor in the environment that may trigger a nerve impulse. A response is a reaction to a stimulus. A stimulus is received by the body and a response is made. An organism must be able to respond to a stimulus in order to survive.

Messages do not travel in both directions along the same neuron. Only the axon of the neuron releases neurotransmitters that cross the space between neurons. Reaction time is the length of time between application of a stimulus and detection of a response.

The next activity that you will perform will enable you to understand these concepts better. Use your body's senses to detect the stimuli in your environment and execute the corresponding response.

## **Activity 2**

### **How Fast is Your Reaction?**

(Adapted from DepEd Project EASE, Module 9: Life Support Systems, pp. 7-8)

#### **Objective:**

- Measure the length of time of response to catch a dropped object



**Materials:**

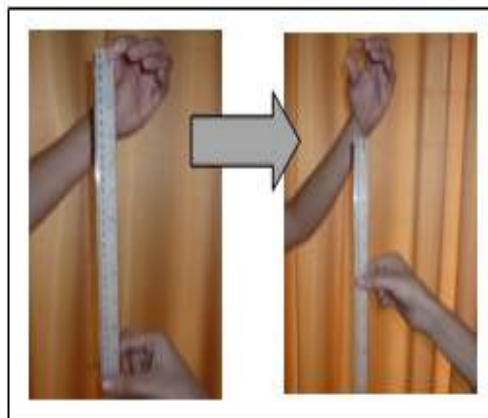
- metric ruler
- data chart

**Procedure:**

1. Construct a table like the one given below, to record your data.

Trials	Centimeters where the ruler fell			
	Eyes open		Eyes closed	
	Left hand	Right hand	Left hand	Right hand
1st				
2nd				
3rd				
4th				
5th				
<b>Average</b>				

2. Have your partner hold a metric ruler at its end with the highest number in cm.
3. Place the thumb and forefinger of your left hand close to, but not touching, the end with the lowest number.
4. When your partner drops the ruler, try to catch it between your thumb and finger.



**Figure 4.** Measuring the reaction time

5. Record where the top of your thumb is, when you catch the ruler. This number gives how many centimeters the ruler fell.
6. Repeat steps 2 to 5 five more times and record the measurements on the data table that you have constructed earlier.
7. Repeat steps 2 to 5 five more times using your right hand to catch the ruler.
8. Repeat steps 2 to 5 five more times using your left hand with your eyes closed. Your partner will signal you by saying “now” when the ruler drops.
9. Repeat steps 2 to 5 five more times using your right hand with your eyes closed. Record your data and observations.
10. Exchange tasks and drop the ruler for your partner.
11. To complete your data chart, change all the centimeters to seconds by multiplying by 0.01.
12. After recording all the data, compute for the average by adding up the measurements of all the trials and dividing it by the number of trials.

**Guide Questions:**

(Answers will depend on whether the person is left-handed or right-handed)

- Q3. With which hand did you catch the ruler faster when your eyes were open?
- Q4. With which hand did you catch the ruler faster when your eyes were closed?
- Q5. Did you catch the ruler faster with your eyes open or closed?
- Q6. Explain why a message moving along nerve pathways takes time.
- Q7. Describe the nerve pathway that the message followed when you saw the ruler fall.

**KEY CONCEPTS:**

Neurons have the special ability to carry signals or impulses. A nerve impulse is an electrochemical signal moving along a neuron. The space between neurons is called synapse. A stimulus is any factor in the environment that influences behavior. A response is a reaction to a condition or stimulus. An organism must be able to respond to a stimulus in order to survive. Reaction time is the length of time between application of a stimulus and detection of a response.

Did you know that your brain works round the clock for as long as you live? Your brain does not only control your thoughts, emotions, and movements but also numerous things that you are less aware of such as your breathing, your heartbeat, and even the stress that you feel.

How does your nervous system work? This system is like a network that relays messages back and forth from the brain to various parts of the body. It transmits information through the spinal cord, which extends from the brain down through the back and consists of fine nerves that branch out to every organ and body part. When a message reaches the brain from any part of the body, the brain commands the body to respond. You can think of your nervous system as a relay team where one runner passes the object to another runner. Relatively, you have nerve cells handing its information to the next cell, which passes the information to another cell. Finally, the information reaches into its destination and a reaction takes place. For instance, if you hold a rose stem and accidentally prick your fingers, the nerves in your skin release a message of pain to your brain. Your brain, in response to the signal, commands the muscles in your hand to pull away. This split second relay inside your body happens in a much shorter period than it took you to read about it.

Neurons are specially intended for information processing and signaling. They relay and receive messages (impulse) between the brain and body, and within the brain and spinal cord. Motor neurons transmit impulses from the brain to muscles, glands, or other neurons in the Peripheral Nervous System (PNS). Sensory neurons transmit impulses from sensory nerves (receptor cells) to the Central Nervous System (CNS).

Do the next activity to understand how the nervous system controls body processes.

### **Activity 3**

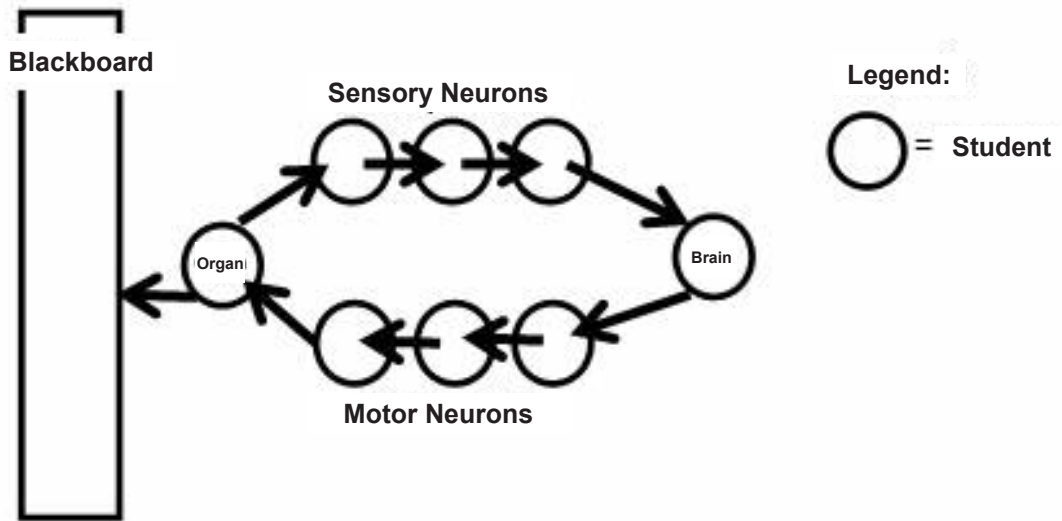
#### **A Nervous Trip**

##### **Objective:**

Explain how the body processes are controlled through the nervous system

##### **Procedure:**

1. Form a team of 8 to 10 students and compete with the other groups in your class.
2. Among the members of the group, assign students who will represent the following parts: Brain, Organ, Sensory Neurons, and Motor Neurons
3. Have the “Brain” stand at one end of the classroom, and the “Organ” at the other end near the blackboard.
4. Let three to four members representing “Sensory Neurons” stand and line up between the “Brain” and the “Organ.” Another set of three to four members representing “Motor Neurons” will stand and line up facing the “Sensory Neurons.”
5. Refer to the following illustration to see how you will position yourselves in the game.



**Figure 5.** The game setup showing the relay course from start to end

6. Your teacher will show a card to the first member of the group, who is the “Organ.” Each card will depict a situation of a stimulus affecting an organ.
7. The “Organ” must pass the message to one “Sensory Neuron” by whispering.
8. Each member who receives the message must relay it to another until it reaches the last “Sensory Neuron.”
9. Let the last person in the “Sensory Neuron” group run to the “Brain” to communicate the message that was transmitted from the “Organ.”
10. The “Brain” must think of a reaction to the stimulus presented and pass this response to the “Motor Neurons.”
11. Each member of the “Motor Neuron” group who receives the response from the brain, must relay it to another until it reaches the last person in the group.
12. The “Organ” will receive this response through the “Motor Neurons” and run quickly to the board to write the response.
13. The team with the most acceptable answer and the shortest time of trip will win the game.

### Guide Questions:

- Q8. How does the brain receive the information from the receptor?
- Q9. What does the brain do as soon as it receives the information?
- Q10. How is the message from the brain sent in response to the stimuli?
- Q11. How will you differentiate the sensory and motor neurons based on their functions?
- Q12. Based on the simulation activity, explain how information travels in the nervous system.
- Q13. Why does the damage in the nervous system cause paralysis of the body?
- Q14. What public health care programs in your locality are geared towards dealing with health issues concerning the nervous system?

#### **KEY CONCEPTS:**

When a receptor such as an organ perceives a stimulus, the impulse is sent to the brain by the sensory neurons, which then transmit information from one nerve cell to another. As the message reaches the brain, it processes the information and commands an effector such as a muscle or an organ to respond. The message coming from the brain is sent through the motor neurons.

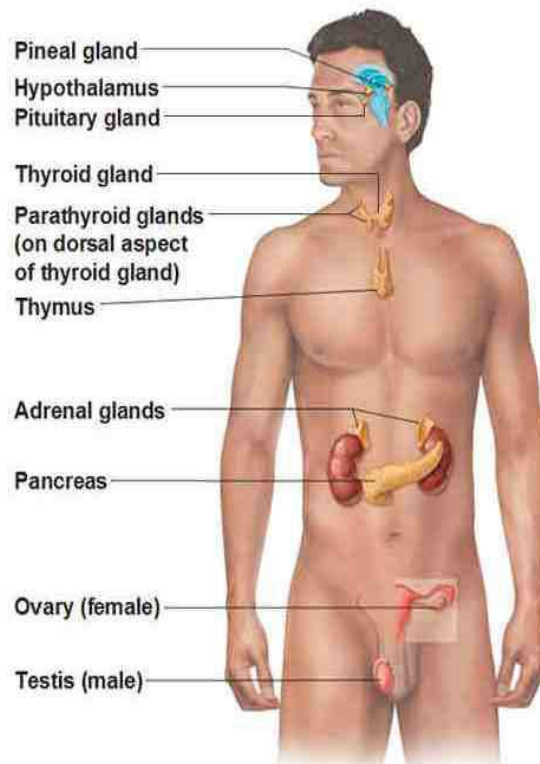
### Suggested Enrichment Activities

1. During the first three years, a child's brain triples in weight and establishes approximately 1,000 trillion nerve connections. Thus, the child's experiences during the first three years of life are crucial to brain development. Gather and write down information about the different ways of stimulating brain development in children.
2. Design a flyer that will disseminate information about the different diseases affecting the human nervous system.

Similar to the nervous system, the endocrine system controls and regulates body processes. Generally, the endocrine system is in control of the mechanisms in the body that slowly take place, such as cell growth. Rapid processes, such as body movement and breathing, are controlled by the nervous system. Although these two systems are different, they work together in a coordinate manner to enable the body to function properly. After studying about the nervous system, now you will learn about the endocrine system, its functions, and the glands that comprise the system.

## The Endocrine System

### Function of Endocrine System



**Figure 6.** The major endocrine organs in the body

The endocrine system is composed of glands that secrete different types of hormones that affect almost every cell, organ, and function of our body. It is essential in regulating growth and development, metabolism, as well as reproductive processes and mood.

How does your endocrine system function? Endocrine glands secrete chemicals known as hormones into the bloodstream, which carries them throughout the body. When a hormone in the blood reaches the target organ, it produces a notable effect. The endocrine system sends signals all over the body, much like the nervous system, but unlike the instant responses activated by the nervous system, the effects can take a few hours or even weeks.

## Endocrine Glands and Their Hormones

The endocrine system contains a group of glands that release hormones into the body. The following table lists all the major glands in the body, with their functions, locations, and the hormones they release.

Gland	Location	Hormones Released	Function
Pituitary	at the base of the brain	Oxytocin, Vasopressin, Growth Hormone, Adrenocorticotropic Hormone (ACTH), Prolactin, Luteinizing Hormone, Follicle Stimulating Hormone (FSH)	stimulates growth, and controls the functions of other glands
Thyroid	below the voice box	Thyroxin, Calcitonin	regulates body metabolism, and causes storage of calcium in bones
Parathyroid	in the neck	Parathyromone	controls the calcium levels in your body, and normalizes bone growth
Thymus	in front of the heart	Thymosin	enables the body to produce certain antibodies
Adrenal	on top of the kidneys	Adrenaline	prepares the body for action, controls the heart rate and breathing in times of emergency
Pancreas	between the kidneys	Insulin, Glucagon	regulates blood sugar levels
Reproductive -Testes (Males)  -Ovaries (Females)	lower abdomen  lower abdomen	Androgen, Testosterone  Estrogen, Progesterone	control maturation and male characteristics  influence female traits, and support reproductive function



Now that you are familiar with the different glands in the human endocrine system, you can already perform the following activity.

## Activity 4

### Who's in Control?

#### Objective:

Identify the major endocrine glands in the human body and their functions

#### Procedure:

Study each picture that depicts the involvement of a particular gland in the endocrine system. Write down the name of the endocrine gland and explain its effect, according to its function.

#### Example



Thyroid Gland  
It regulates the metabolism of the body.

1.



2.



Athletes burn up calories during exercise.

A pregnant woman

A boy running away from danger

3.



4.



5.



A kid growing taller

A sick person in bed

A girl eating sweets

### **Guide Questions:**

- Q15. Which gland of the endocrine and nervous system controls the other glands in the body?
- Q16. How will you differentiate thyroid and parathyroid glands in terms of location and function?
- Q17. If a person's blood sugar level becomes unstable, what glands might be involved in the problem?
- Q18. How important is the thymus gland in keeping your body free from diseases?
- Q19. What might happen to a person born without a thymus gland?
- Q20. How will you explain the sudden boost of energy, increased strength and extraordinary ability to lift very heavy objects especially during emergency situations?
- Q21. Why is injecting insulin an essential part of the daily regime for most people with diabetes?
- Q22. Why does the menstrual cycle stop during menopause?
- Q23. How do oral contraceptives, specifically birth control pills, prevent pregnancy?
- Q24. Breastfeeding releases oxytocin and prolactin, hormones that relax the mother and make her feel more nurturing toward her baby. On the other hand, how does the baby benefit from the production of these hormones in the mother's body?

#### **KEY CONCEPTS:**

The endocrine system consists of glands that secrete chemicals called hormones to control various body processes. This control system usually brings about slow changes in the body because chemical messengers move more slowly than nerve impulses. The major glands in the body are the pituitary, thyroid, parathyroid, thymus, adrenal, pancreas, ovaries, and testes.

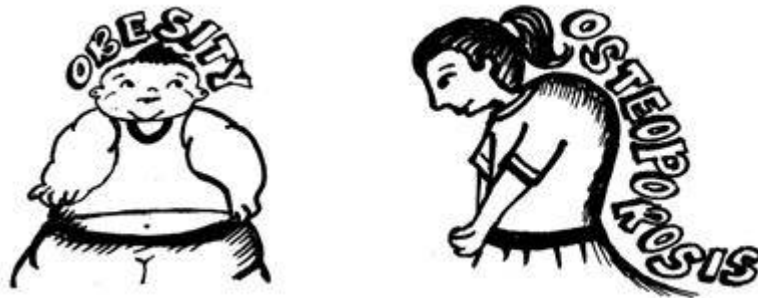
## Effects of Hormones in the Body

Several processes in the body are coordinated by hormones which regulate and balance the working of organs, tissues, and cells. The endocrine system influences how your heart beats, how your bones and tissues develop, and even your capacity to have a baby. It plays an essential role in the occurrence of disorders such as diabetes, thyroid disease, growth disorders, and/or sexual dysfunction.

Both men and women produce hormones in the same areas with one exception, the reproductive glands. Additional male hormones are produced in the testes while female hormones are produced in the ovaries.

Some hormones have short-term effects while other hormones have long-term effects such as those that control our growth and the changes at the onset of puberty. During puberty, there are many hormonal changes that happen in your body. One moment you laugh, and then suddenly you feel like crying. Sudden mood swings are relatively caused by the increasing amount of hormones in the body at this stage. It is therefore important to maintain a positive outlook in life and remember that these changes are only temporary and will stabilize with time.

Hormones act in very small amounts. If the organ and hormones do not produce the regulated amount of chemicals to your body, it may result in an abnormality of your body. This condition is called hormonal imbalance. An increase or decrease in its amount may have a significant effect in the human body.



**Figure 7.** Disorders due to endocrine dysfunction

The next activity will get you acquainted with the different disorders in the endocrine system due to hormonal imbalance and the hormones responsible for them.

## Activity 5

### What Went Wrong?

#### Objective:

Explain the effect of a particular hormone in the body if not properly regulated

#### Procedure:

- A. Identify which gland in the endocrine system is involved in each dysfunction and explain the effect of hormonal imbalance that was observed.

1.



<http://www.picturehistory.com/>

**Dwarfism**

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2.



<http://www.bigfootbuzz.net/>

**Gigantism**

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<http://www.gfmer.ch>

### Goiter

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B. Write a one-paragraph essay about how one of these conditions will affect your life if you have dysfunction due to the effect of hormonal imbalance

#### Guide Questions:

- Q25. What condition may arise if the pituitary gland is not producing enough growth hormones?
- Q26. What will happen to a person with excessive secretion of growth hormones from the pituitary gland?
- Q27. Why is there a noticeable swelling in the front part of the neck of a person who has goiter?
- Q28. How does using iodized salt help in preventing thyroid problems?
- Q29. How does the medical condition of a person with endocrine dysfunction affect his or her way of life?

#### KEY CONCEPTS:

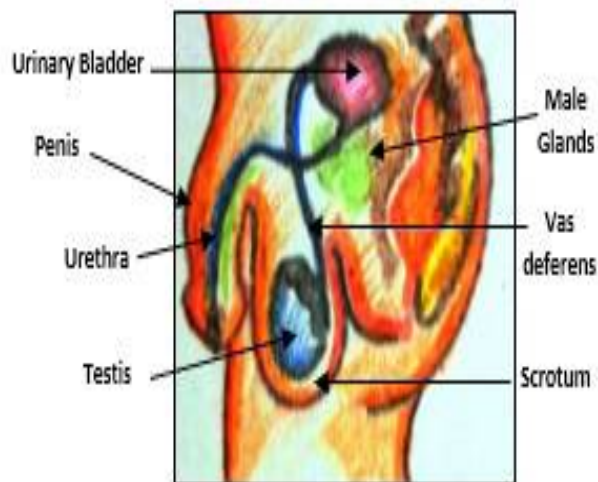
Hormones affect various processes in the body as they regulate and balance the functioning of organs, tissues, and cells. Hormones have great impact on your growth, appearance, emotions, and reproductive functions. These determine whether or not you develop disorders such as diabetes, thyroid disease, growth disorders, or sexual dysfunction. Hormones act in very small amounts. An increase or decrease in hormonal levels may result in body disorder due to hormonal imbalance.

For most living creatures, reproduction is basically a normal process controlled by hormones. Even though human reproduction is also controlled by hormones, the process is rather more complicated. Unlike other organisms such as plants and animals, you can make decisions about reproduction. What influence these decisions are your values, emotions, expectations, and goals. However, like any other living things, humans depend on reproduction for the survival of the species. If people stop to reproduce, the human species would become extinct.

## The Reproductive System

The system involved in sexual reproduction is called the reproductive system. There is a striking difference between the male and the female reproductive systems, although they also share a number of similarities. For example, the reproductive organs of the male and female are developed from the same embryological structures, and some hormones are commonly found in both male and female, in varying quantities and produce different responses

### The Male Reproductive System



**Figure 8.** Parts of the Male Reproductive System

Examine the diagram of the male reproductive system. Figure 8 shows the main parts of the male reproductive system. The cross-sectional side view of the reproductive system shows that certain parts of the male reproductive system are also part of the excretory system.

Be familiar with the specific functions of each basic part using the table below:

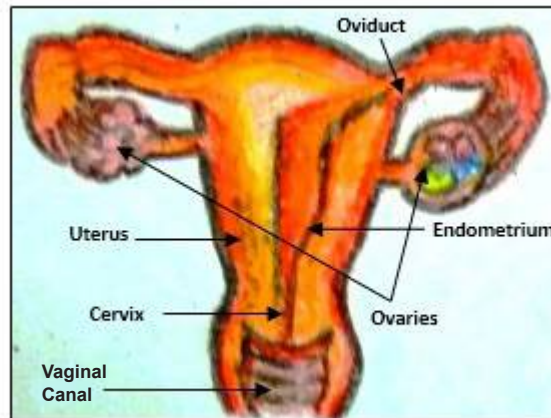
<b>Part</b>	<b>Function</b>
Testis	Produces sperm cells
Scrotum	Sac of skin that holds the testis
Penis	Deposits sperms into the vagina during mating
Vas deferens (tube)	Carries sperm from testes to urethra
Urethra	Carries sperm and urine out of the body
Glands a. seminal vesicle b. prostate gland c. bulbourethral gland	Provide liquid in which sperm can swim - Secretes a fluid that makes up most of the components of the semen - Secretes a slightly alkaline milky fluid that is discharged as part of the semen - Secretes a thick and clear mucus that lubricates and neutralizes the any trace of acidic urine in the urethra

## **The Female Reproductive System**

The female reproductive system has the following functions:

1. Produces female sex cells
2. Receives sperm cells from the male
3. Nurtures the development of and provides nourishment for the new individual

Examine the diagram on Figure 9 which shows the front view of the female reproductive system. The female reproductive system consists of the ovaries, oviducts (Fallopian tubes), uterus, vagina, and external genitalia. The internal reproductive organs of the female are located within the pelvis, between the urinary bladder and rectum. The uterus and the vagina are in the middle part, with an ovary on each side of the uterus.



**Figure 9.** Parts of the Female Reproductive System

Now, study the function of each part.

Part	Function
Ovary	produces egg cells
Oviduct	serves as passageway of eggs from the ovary to the uterus; site of egg fertilization
Uterus	serves as site of egg implantation; is where the fertilized egg develops
Vagina	receives the penis of male during mating

Puberty involves the onset of sexual maturity and the ability to reproduce. When a female reaches puberty, egg cells start to develop in her ovaries that produce the sex cells. It is also the time when the body develops the capacity to conceive.

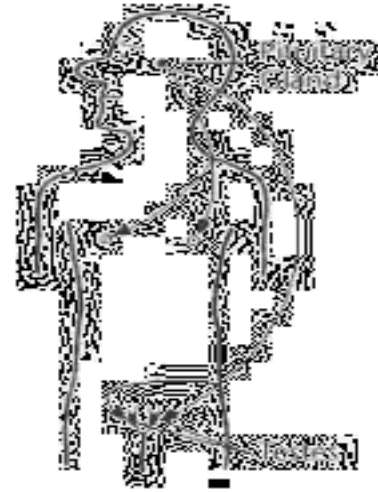


## The Role of Hormones in Female and Male Reproductive Systems

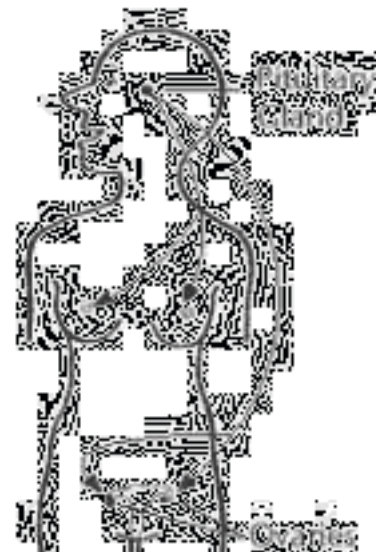
The male reproductive system also has prostate glands. Chemicals from these glands nourish the sperm cells and help them mature.

The production of sperm cells and the release of semen can be regulated by hormones or special chemicals that come from the testis, the brain and the pituitary gland (refer to Figure 10A). These hormones keep the reproductive system properly functioning.

The female reproductive system, just like the male reproductive system, is also regulated by hormones. The follicles produce hormones that control the growth and release of eggs from the ovaries. While other hormones prepare the uterus so a baby can grow in it, other hormones still control the stretching of the uterus during pregnancy.



**Figure 10A.** Pituitary gland controls the function of the testes.



**Figure 10B.** Pituitary gland controls the function of the ovaries.

### KEY CONCEPTS:

Hormones play an important role in both male and female reproductive systems. The pituitary gland controls the functions of both the testes and the ovaries. These hormones keep the reproductive system properly functioning.

# Feedback Mechanisms Involved in Regulating Processes in the Female Reproductive System

## The Menstrual Cycle

We have learned that, on average, an ovary releases only one egg every 28 days. Now, what controls this timing? Hormones control many of the changes in the reproductive system. Remember that hormones are chemicals that affect certain body organs. The monthly changes that take place in the female reproductive system are called menstruation. This cycle occurs every month from the first onset which could happen when a female is between 10 to 13 years old. The monthly cycle continues for about 40 years. Refer to Figure 11 for a clearer explanation of the different events that take place in the cycle. Just follow numbers 1-10 in proper order.

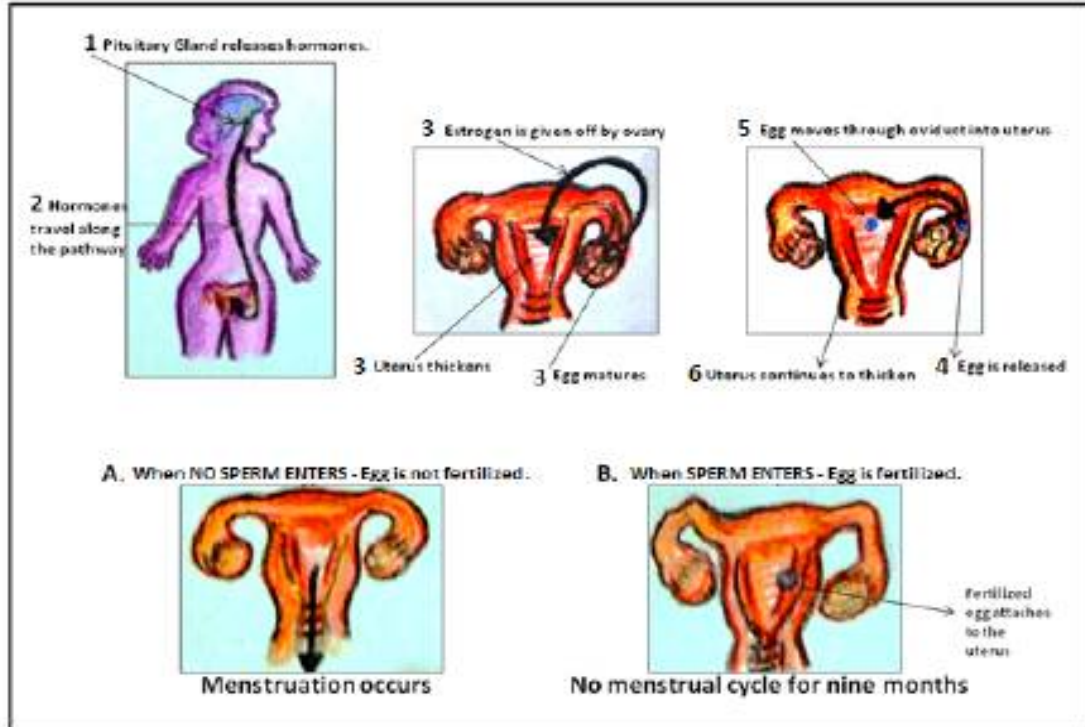


Figure 11. The menstrual cycle

To summarize, the important events during the menstrual cycle are as follows:

1. The pituitary gland controls and starts the cycle.
2. The pituitary gland releases hormones that cause the egg in the ovary to mature. The luteinizing hormone (LH) initiates the maturation of the follicles, converts ruptured follicles into corpus luteum and causes the secretion of progesterone. The follicle stimulating hormone (FSH) assists in the maturation of the follicles and causes the secretion of estrogen from the follicles.

3. Meanwhile, the ovary itself releases a hormone called estrogen, which causes the uterine lining to increase in thickness. The uterine lining becomes thicker so that the fertilized egg can attach to it.
4. The ovary releases an egg on day 14. Assume that no sperm is present.
5. The egg moves through the oviduct and enters the uterus.
6. Meanwhile the uterine lining continues to thicken.
7. The egg has not been fertilized, therefore, it will not attach to the uterus.
8. The thick uterine lining is no longer necessary, so the cells of the thickened uterine lining break off and leave the vagina. The unfertilized egg is lost and some blood is lost too. This loss of cells from the uterine lining, blood, and egg is called menstruation.
9. After menstruation, the cycle starts again.

Did you know that menstrual cramps are the results of the strong contractions of the uterine wall that occur before and during menstruation? The cramps can be caused by excessive secretion of prostaglandins. Shedding of the endometrium of the uterus results in the inflammation in the endometrial layer of the uterus and prostaglandins are produced as a consequence of the inflammation.

As you perform Activity 6, you'll be able to understand the feedback mechanisms in the female reproductive system.

## **Activity 6**

### **Mark My Calendar!**

#### **Objective:**

Describe the feedback mechanisms involved in regulating processes in the female reproductive system

#### **Materials:**

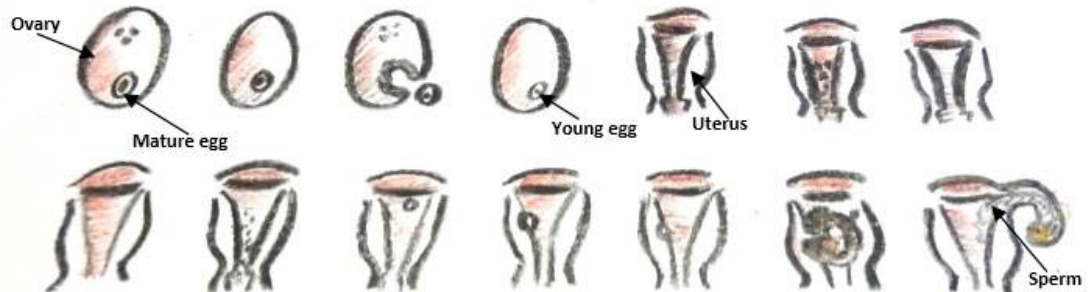
- 2 calendar charts
- diagrams of the male and female reproductive system
- scissors
- tape or glue

#### **Procedure:**

Part A - For no fertilization:

1. Get a calendar, with an approximate size of 8 x 11 inches. It must be marked by the day-to-day changes in the menstrual cycle.
2. Note that certain events are marked on certain days.

3. Make a copy of the diagrams of the menstrual cycle like in Figure 12. Some of the diagrams will show events in the ovary, and some will show events in the uterus. They are not in proper order. Cut out each square.



**Figure 12.** Unsequenced events in the menstrual cycle

4. Place the diagram in the space to the right of the corresponding description.
5. Tape or glue your diagrams in right places/dates where they occur.
6. Make sure that they are correctly placed.

#### Part B – With fertilization of the egg

1. Get another calendar marked by the day-to-day changes in the menstrual cycle.
2. You will be given a set of diagrams to place on the calendar. The diagrams will not be in proper order. You may not need all the diagrams that show the uterus.

#### **Guide Questions:**

- Q30. How long does a regular menstrual cycle last?
- Q31. Describe what happens to an egg during the first 14 days of the cycle in Part A.
- Q32. Describe what happens to the egg if fertilization occurs.
- Q33. Explain what takes place in the uterus after fertilization.
- Q34. Why is it important to study the menstrual cycle?

A feedback mechanism is the process through which the level of one substance influences the level of another substance. A negative feedback affects the production of hormones in the menstrual cycle. High levels of one hormone may inhibit the production of another hormone.

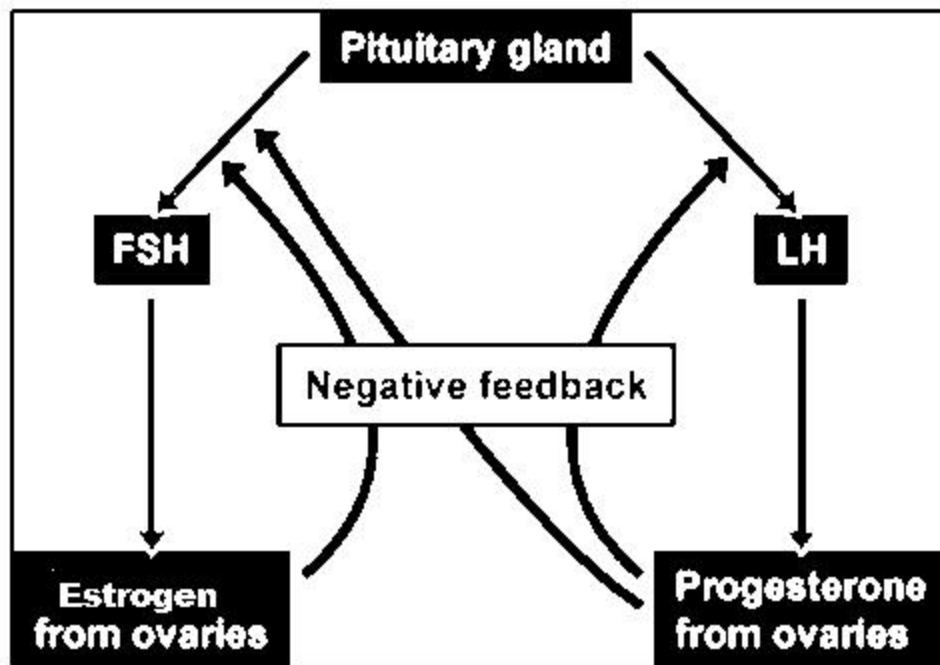


Figure 13. Negative feedback mechanisms in the menstrual cycle

Feedback mechanisms in menstrual cycle:

1. Follicle stimulating hormone (FSH) stimulates the ovaries to release estrogen. High levels of estrogen then prevent the further production of FSH.
2. Estrogen also stimulates the release of luteinizing hormone (LH) from the pituitary gland, which in turn controls the production of progesterone. High levels of progesterone then inhibit the further release of LH.

## Nervous System Working Together with Endocrine System to Maintain Homeostasis

Both the nervous system and endocrine system are important in enabling the body to maintain homeostasis. **Homeostasis** is the state reached when each part of the body functions in equilibrium with other parts. This is attained through the regulation of the bodily functions by the endocrine and nervous systems.

Most body systems maintain homeostasis by using feedback mechanisms. When the brain receives messages from the body about an internal change in one of its systems, it works to restore the system to its normal state. The levels of hormones in the body are controlled by feedback. It is important that the amount of hormones in our body is kept at the right level. The endocrine system plays an important part in homeostasis. To achieve homeostasis, the nervous and endocrine systems maintain a normal range of the following variables:

- Body temperature
- Amount of water in the body
- Amount of metabolic wastes in the cell
- Blood calcium level
- Hormones in the blood

- Q35. What might happen to a person whose nervous and endocrine systems fail to maintain homeostasis?
- Q36. Suppose a boy skipped his lunch for the day. How will the hormones (glucagon) from his pancreas help his body to cope when his blood sugar level drops below normal?
- Q37. Suppose a girl ate too many sweets such as candies and chocolates. How will the hormones (insulin) from her pancreas help her body cope with a possible blood sugar level rise above normal?
- Q38. How do the nervous and endocrine systems respond to an increase in environmental temperature to achieve homeostasis?
- Q39. How do the nervous, endocrine, and reproductive systems perform their coordinated functions in various functions such as pregnancy and childbirth, menstrual cycle, breastfeeding, and sexual intercourse?

## Performance Task: Video Making

### Topic: Contraceptive Measures

**Goal:** Your objective is to present information to the public about the common and effective contraceptive measures used in family planning, in line with the Reproductive Health Law. The video that you will create must be in persuasive form. The challenge is how you will be able to convince people about the benefits of various contraceptive measures using gathered facts and scientific evidences.

**Role:** Assume the role of a professional video production team. You are tasked to produce a promotional video that will be used in campaign advertising about various contraceptive measures used in family planning.

**Audience:** Your voice, as part of the youth, will be heard through your campaign advertising. You will present the finished video in front of your class. After that, you may also opt to use social media advertising to let other people view your multimedia presentation. It is important to clearly communicate your purpose from the beginning of the video.

**Situation:** Campaign advertising is often accomplished by combining a short message with a catchy tune that people are likely to remember. Since one of the most powerful means of communicating information today is through music, you may persuasively share your thoughts and ideas on the topic using a chosen melody. After studying the coordinated functions of the reproductive, endocrine, and nervous systems, you will be able to use scientific and logical explanations in promoting various contraceptive measures. There are challenges to overcome in accomplishing the task such as the conflicting judgments of people on the issue that may cause various controversies. Therefore, it is important to be objective in presenting ideas rather than being subjective.

**Product/Performance:** Produce a campaign advertising video that presents common and effective contraceptive measures used in family planning. The maximum video duration is three (3) minutes. You may seek assistance from your teacher in MAPEH regarding the tune, rhythm and beats of the music. For the rhyme and wordplay to be used, you may consult your teacher in English.

**Standards:** You will be given two (2) days to conceptualize and execute your ideas through video-making. Once the video is finished, you may already present it in front of the class for evaluation. Your multimedia presentation will be assessed according to the rubric that will be given to you by your teacher.

## V. Summary/Synthesis/Feedback

- The nervous system is composed of cells, tissues, and organs that regulate the body's responses to internal and external stimuli. Each component of the nervous system has a specific role to do as an important part of a team.
- The nervous system has two main divisions, which are the Central Nervous System (CNS) and the Peripheral Nervous System (PNS).
- The Central Nervous System (CNS) serves as the main "processing center" for the entire nervous system. It has two main parts, which are the brain, and the spinal cord.
- The Peripheral Nervous System (PNS) contains all nerves that extend outside the brain and spinal cord. It has two main divisions, which are the Somatic Nervous System and the Autonomic Nervous System.
- The basic unit of the nervous system is the nerve cell. Nerve cells are called neurons. Neurons have dendrites and axons that aid in transmitting message.
- Neurons have the special ability to carry signals or impulses. A nerve impulse is an electrochemical gradient moving along a neuron. The space between neurons is called synapse. A stimulus is any factor in the environment that may induce a nerve impulse that initiates physiological and behavioural changes. A response is a reaction to a condition or stimulus. To survive, an organism must be able to respond to a stimulus. Reaction time is the length of time between application of a stimulus and detection of a response.
- When a receptor such as an organ perceives a stimulus, the impulse is sent to the brain by the sensory neurons, transmitting information from one nerve cell to another. As the message reaches the brain, it processes the information and commands an effector such as a muscle or an organ to respond. The message coming from the brain is sent through the motor neurons.
- The Endocrine System consists of glands that secrete chemicals called hormones which control various body processes. This control system usually brings about slow changes in the body because chemical messengers move more slowly than nerve impulses. The major glands in the body are the pituitary, thyroid, parathyroid, thymus, adrenal, pancreas, ovaries and testis.



- Hormones affect various processes in the body as they regulate and balance the functioning of organs, tissues, and cells. Hormones greatly influence growth, appearance, emotions, and reproductive functions. These chemicals play an essential role in the occurrence of disorders such as diabetes, thyroid disease, growth and/or sexual dysfunction. Hormones act in very small amounts. An increase or decrease in the said amount may result in a body disorder due to hormonal imbalance.
- The Reproductive System is a collection of organs in an organism that function together for sexual reproduction. The male reproductive organs are the penis, the testicles, the epididymis, the vas deferens, and the prostate gland. The female reproductive organs are the vagina, uterus (womb), Fallopian tubes, and ovaries.
- Hormones play an important role in both male and female reproductive systems. The pituitary gland controls the functions of both the testes and the ovaries. These hormones keep the reproductive system properly functioning.
- Hormones secreted by the ovaries and a small gland in the brain called the pituitary gland control the menstrual cycle.
- Feedback mechanism is the process through which the level of one substance influences the level of another substance. A negative feedback affects the production of hormones in the menstrual cycle. High levels of one hormone may inhibit the production of another hormone.
- Homeostasis is the state reached when each part of the body functions in equilibrium with other parts. This is attained through the regulation of the bodily functions by the endocrine and nervous systems.

## VI. Summative Assessment

I. Answer briefly the following questions. (2 pts. each)

1. How does the Central Nervous System (CNS) function similarly to the Central Processing Unit (CPU) of a computer?  
\_\_\_\_\_
2. Why are there significant changes in the body at puberty stage?  
\_\_\_\_\_
3. In what way do the nervous and endocrine systems differ in the way they communicate messages throughout the body?  
\_\_\_\_\_
4. Why is it important to maintain homeostasis in the body?  
\_\_\_\_\_

II. Match each gland in column A with its corresponding function in column B. (1 pt. each)

A	B
a. Stimulates growth, and controls the functions of other glands	1. Thymus
b. Controls the calcium levels in your body, and normalizes bone growth	2. Pancreas
c. Regulates body metabolism, and causes storage of calcium in bones	3. Adrenal
d. Enables the body to produce certain antibodies	4. Thyroid
e. Prepares the body for action, and controls the heart rate and breathing in times of emergency	5. Parathyroid
f. Controls maturation and male characteristics	6. Pituitary
g. Regulates blood sugar levels	7. Testis
h. Influence female traits and support reproductive function	8. Ovaries

III. Draw and label the parts of a neuron. (4 pts.)

## Glossary of Terms

<b>Axon</b>	the part of the neuron that transmits impulses away from the cell body
<b>Dendrite</b>	the branchlike structure of the neuron that extends from the cell body to receive an impulse
<b>Embryo</b>	an organism in its early stages of development, especially before it has reached a distinctively recognizable form
<b>Endocrine Gland</b>	an organ that produces chemical secretions released directly into the bloodstream
<b>Egg Cell</b>	also called ovum (plural: ova); the female gamete
<b>Fertilization</b>	a process that occurs when the sperm and egg combine to produce an embryo
<b>Homeostasis</b>	the ability or tendency of an organism to maintain internal equilibrium by regulating its processes
<b>Hormone</b>	a chemical substance produced in the body that controls and regulates the activity of certain cells or organs
<b>Impulse</b>	an electrochemical gradient moving along a neuron
<b>Neuron</b>	the basic unit of the nervous system, also called nerve cell, that transmits messages to and from the central nervous system
<b>Semen</b>	the ejaculated fluid containing sperm cells and secretions from the seminal vesicle, prostate gland, and bulbourethral gland
<b>Sperm</b>	shorter term for spermatozoon (plural: spermatozoa); the male gamete
<b>Stimulus</b>	any factor in the environment that influences the behavior of an organism
<b>Synapse</b>	the space between neurons where electrochemical signals pass

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(DepEd Materials)

BEAM: Biology – Organ System – Endocrine and Nervous Systems

EASE, Module 9: Life Support Systems

EASE, Module 13: Reproductive Systems

APEX Biology – Unit IV, The Organ Systems

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# HEREDITY: INHERITANCE and VARIATION

## I. Introduction

You learned in Grade 9 that many genes in plants and animals behave differently than the genes that Mendel studied in peas, where traits are not entirely controlled by dominant and recessive genes. You also learned how the genes in your deoxyribonucleic acid (DNA) influence your characteristics.

Now, you will work on activities to assess your understanding on the structure of the DNA, explain how DNA replication takes place, how ribonucleic acid (RNA) is made using the information from DNA, how information in some genes is translated into proteins, and explain how mutations may cause changes in the structure and function of a protein.

Many investigations of how the genes control cells were done even before scientists first knew that genes were made of DNA. The American geneticists George Beadle and Edward Tatum established the connection between genes and enzymes. The experiments of Beadle and Tatum linked genes to actual products of cells and showed the importance of genes to cellular activity. In other words, a gene is a portion of DNA that contains the instructions for the synthesis of specific RNA or protein.

Building a house usually requires a blueprint, or a plan of the structure of the house to determine how it would look like after construction. Organisms have blueprints which contain information that will determine their physical and chemical characteristics. This blueprint is DNA.

## II. Learning Competencies/Objectives

In this module, you are expected to:

1. explain how a protein is made using information from DNA.
  - a. identify the role of DNA and RNA in protein synthesis
  - b. describe DNA replication
  - c. relate DNA replication to its complementary structure
  - d. describe transcription and translation.
2. Explain how mutations may cause changes in the structure and function of a protein.
  - a. Compare the different types of mutations and their possible results.

Answer the following questions as you work on the activities in this module.

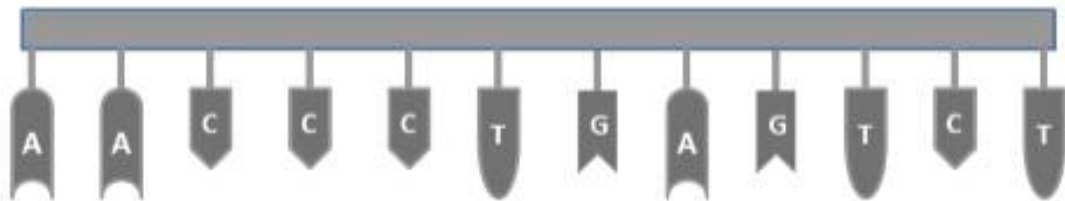
### Key questions for this module:

1. How is DNA made out of a DNA template?
2. How is RNA made out of a DNA template?
3. How is protein made out of a RNA template?
4. How does mutation result to change in the structure and function of a protein?

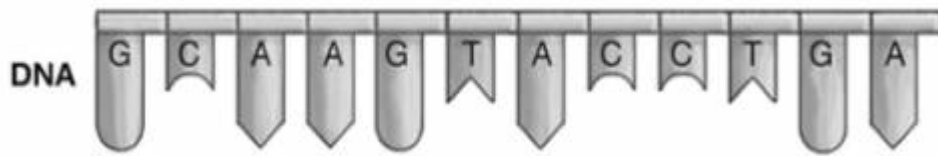
## III. Pre-Assessment

Directions: Answer the following questions:

1. The sequence of bases in one DNA strand is given below. Identify the complementary sequence of bases in the other strand of DNA.

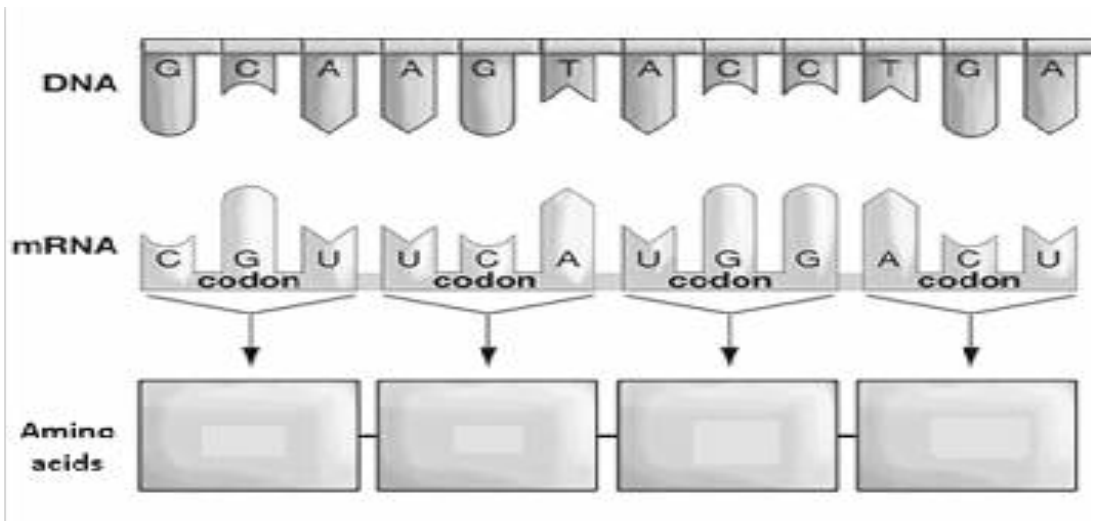


2. Show how the DNA code translates into RNA code by placing the sequence of bases of the DNA and RNA side by side.



RNA \_\_\_\_\_

3. Each combination of three nitrogenous bases on the mRNA molecule is a codon, a three letter code for a specific amino acid. Use the table below to identify the specific amino acid for each mRNA codon.



### THE GENETIC CODE

		Second letter								
		U		C		A		G		
First letter	U	UUU	Phenylalanine	UCU	Serine	UAU	Tyrosine	UGU	Cysteine	U
		UUC		UCC			UAC			UGC
	UUA	Leucine	UCA	Proline	UAA	Stop codon	UGA	Stop codon	UAG	A
	UUG		UCG		UAG		UGG		Tryptophan	G
	C	CUU	Leucine	CCU	Threonine	CAU	Histidine	CGU	Arginine	U
		CUC		CCC		CAC		CGC		C
		CUA		CCA		CAA	Glutamine	CGA		A
	CUG	CCG	CAG	CGG	G					
	A	AUU	Isoleucine	ACU	Alanine	AAU	Asparagine	AGU	Serine	U
		AUC		ACC		AAC		AGC		C
		AUA	ACA	AAA		Lysine	AGA	Arginine	A	
		AUG	ACG	AAG			AGG		G	
	G	GUU	Valine	GCU	Threonine	GAU	Aspartic acid	GGU	Glycine	U
		GUC		GCC		GAC		GGC		C
		GUA		GCA		GAA	Glutamic acid	GGA		A
		GUG		GCG		GAG		GGG		G



4. Look at the four DNA sequences of bases below.

A	A	A	C	C	G	G	G	G
T	T	T	G	G	C	C	C	C

Original sequence

A	A	A	C	C	G	G	G	G
T	T	T	G	G	C	C	C	C

Base pair removed

A	A	A	C	T	C	G	G	G	A
T	T	T	G	G	G	C	C	C	T

Base pair replaced

A	A	C	C	C	T	G	G	G
T	T	G	G	G	A	C	C	C

Base pair replaced

How does each of these errors change the DNA sequence? What do you call these changes? \_\_\_\_\_

Now, you will work on the initial assessment activity to measure your understanding of DNA and RNA structures.

#### IV. Reading Resources and Instructional Activities

##### Activity 1

##### Getting to Know the DNA and RNA Structure

**Objective:**

Compare the structures of the DNA and RNA molecule

**Material:**

Activity sheets

## Procedure:

1. Read the given information carefully about DNA and RNA.

### Component molecules

1. The DNA molecule is composed of three types of component molecule: phosphate group, the sugar deoxyribose, and the bases adenine, thymine, cytosine, guanine (A, T, C, G).

### Nucleotides

2. There are three molecules that form the basic building block of DNA, the nucleotides. Each nucleotide is composed of one phosphate group, one sugar molecule, and one of the four bases – in the example. Across the strands of the helix, A always pairs with T, and G with C.

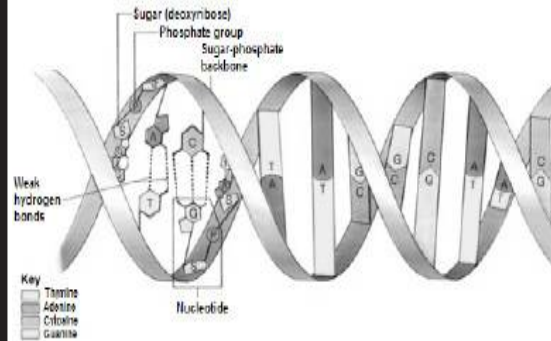


Figure 1. DNA Structure

Ribonucleic Acid, like DNA, is a nucleic acid. However, RNA structure differs from DNA structure in three ways, shown in Figure 2. First, RNA is single stranded – whereas DNA is double stranded. Second, the sugar in RNA is ribose; DNA has deoxyribose. Finally, both DNA and RNA contain four nitrogenous bases, but instead of thymine, RNA contains a similar base called uracil (U). The uracil pairs with adenine. The major types of RNA include: messenger RNA (mRNA), ribosomal RNA (rRNA), and transfer RNA (tRNA).

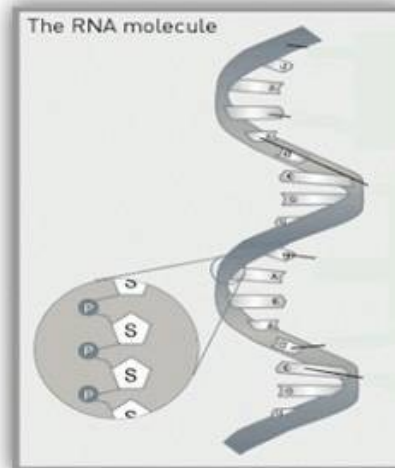


Figure 2. RNA Structure

2. Fill in the comparison table below.

<b>Basis of Comparison</b>	<b>DNA</b>	<b>RNA</b>
1. Number of strands		
2. Location in the cell		
3. Type of sugar		
4. Nitrogenous base pair		

**Guide Questions:**

Q1. What are the components of the DNA and RNA molecule?

Q2. What is the structural difference between DNA and RNA?

Q3. What nitrogenous base is found in RNA but not in DNA?

**KEY CONCEPTS:**

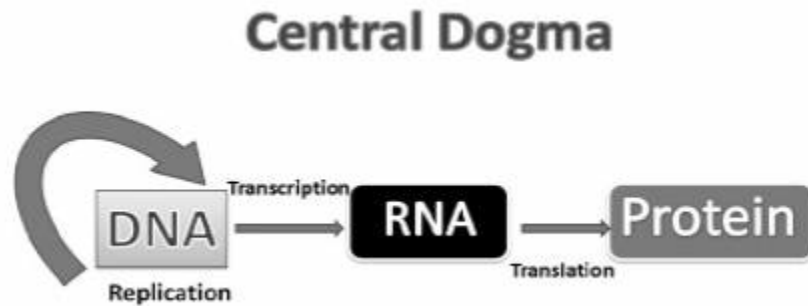
- A DNA is a double helix molecule composed of complementary strands of deoxyribonucleotides units. The complementary base pairs of the DNA are held by hydrogen bonds.
- RNA is single stranded.
- Examples of RNA types include: mRNA, rRNA and tRNA.
- In DNA, adenine always bonds with thymine, and cytosine bonds with guanine. In RNA, adenine bonds with uracil, and cytosine bonds with guanine.

## Replication

In 1953, James Watson and Francis Crick worked out that DNA is double helix like a twisted staircase. The two sugar-phosphate backbones make up the sides and the base pairs make up the rungs or steps of the twisted staircase.

Deoxyribonucleic acid is copied during interphase prior to mitosis and meiosis. It is important that new copies are exactly like the original molecule. The structure of the DNA provides a mechanism for making accurate copies of the molecule. The process of making copies of DNA is called replication. When DNA replicates, two identical copies of DNA molecules are produced, which are exactly the same as the original.

The central dogma of the transfer of genetic information is outlined below.



**Figure 3.** Transfer of genetic information

You will work on the next activity to demonstrate the replication of the DNA molecule and the specificity of base pairing in the nitrogenous bases.

## Activity 2

### DNA Makes DNA

#### Objective:

- Make a model of a DNA template to determine the sequence of bases in the new DNA strand.

#### Materials:

- crayons
- scissors
- paste/tape
- 1/4 size illustration board or long size folder

#### Procedure:

1. Use the patterns of the components of the DNA provided by your teacher. Color code phosphate = blue, deoxyribose sugar = green and nitrogenous bases as follows: adenine = yellow, thymine = pink, guanine = violet and cytosine = red.
2. Cut out the shapes of each nucleotide.
3. Build a model of a strand of a DNA molecule. The strand should contain 6 base “rungs” following the given order of the nucleotides below.
  - Guanine
  - Adenine
  - Cytosine
  - Thymine
  - Cytosine
  - Guanine

4. Tape the cut out pattern to form the nucleotides.
5. Let this arrangement represent the left half of your DNA molecule.
6. Make a complementary strand for the first strand that you made in step 3.
7. Tape the cut-out pattern forming nucleotides for the second strand of the DNA molecule.
8. Match the bases of the first strand and the second strand. Do not tape across bases.
9. Once you have made your DNA model, separate the two strands of the DNA model down the middle so that there are now two single strands of DNA.
10. Create new double-stranded DNA by matching complementary nucleotides to the bases on each single strand.
11. Tape and then cut out the pattern forming the nucleotides for each of the single nucleotides.
12. When you are finished, mount the original DNA model and the DNA model with its complementary strand in the illustration board or folder.

**Guide Questions:**

- Q4. Compare the two new strands of DNA. Are they the same or different? Why?
- Q5. How do the nucleotides in DNA pair?
- Q6. How do you compare a DNA molecule to a zipper?
- Q7. How is information from the DNA passed on from one cell to another?
- Q8. How does the structure of a DNA molecule help account for the great variety of life that exists on earth?

Do you understand the process by which DNA copies itself? The following are the events while DNA copies itself:

- Step 1. An enzyme called helicase breaks the bond between nitrogenous bases. The two strands of DNA split.
- Step 2. The bases attached to each strand then pair up with the free nucleotides found in the cytoplasm.
- Step 3. The complementary nucleotides are added to each strand by DNA polymerase to form new strands. Two new DNA molecules, each with a parent strand and each with a new strand are formed. The DNA replication is known as semi-conservative replication, because one of the old strands is conserved in each new molecule. Figure 4 illustrates the semi-conservative replication of DNA.

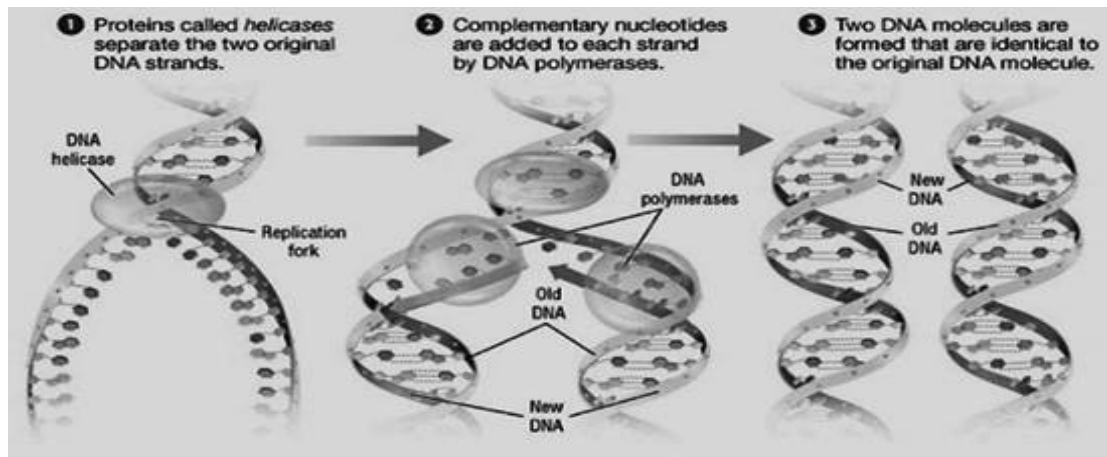


Figure 4. DNA Replication

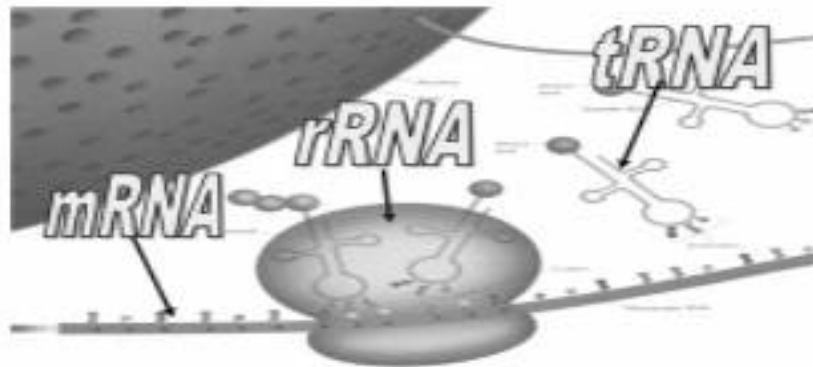
**KEY CONCEPTS:**

- DNA is made up of sugars, phosphate groups, and nitrogenous bases and its shape is a double helix. The complementary structure the two strands of DNA allow each strand to serve as a template during replication.
- The specificity of base pairing in DNA, adenine with thymine, and cytosine with guanine, allows DNA to replicate itself with accuracy.

What do you think is the role of RNA in making proteins in the cell? Can you imagine a car being assembled in a car factory? By way of analogy, different cars are being built in many simple steps. Engineers tell workers how to make cars, and the workers follow directions to build the cars. Suppliers bring parts to the factory so they can be installed in the car. Protein production is similar to car production. It is the role of the DNA to provide workers with the instructions for making the proteins, and the workers build the proteins. Other workers known as amino acids, bring parts to the factory. RNA molecules or the workers for protein synthesis get the instructions from the DNA on how the protein should be assembled.

Moreover, do you know that there are three types of RNA that help build proteins? You can consider these RNA molecules to be the workers in the production of protein.

- One type of RNA, messenger RNA (mRNA) brings information from the DNA in the nucleus to the protein manufacturing area, the cytoplasm. In the cytoplasm, the mRNA becomes the template of information to make proteins.
- Ribosomes, made of ribosomal RNA (rRNA), and ribosomal proteins hold tightly into the mRNA using its information to assemble the amino acids in correct order.



Source: [internalcampaignschools.org](http://internalcampaignschools.org)

**Figure 5.** Types of RNA

- Transfer RNA (tRNA) supplies amino acids to the ribosome to be assembled as protein.

Did you find this car-making analogy helpful? But, how does the information in DNA, which is found in the nucleus, move to the ribosome in the cytoplasm?

## TRANSCRIPTION

In the next activity, you will demonstrate the process of transcription through the use of paper DNA and mRNA models.

### Activity 3

#### What's the Message

##### Objectives:

- Make a model to show how the order of bases in DNA determines the order of bases in mRNA.
- Infer why the structure of DNA enables it to be easily copied.

##### Materials:

- crayons
- 1/4 illustration board or long folder
- scissors
- paste/tape

##### Procedure:

1. Use the patterns of the components of the DNA provided by your teacher. Color code phosphate = blue, deoxyribose sugar = green, ribose sugar = brown and nitrogenous bases as follows: adenine = yellow, thymine = pink, guanine = violet and cytosine = red and uracil = orange.
2. Cut out the shapes of each nucleotide.
3. Using the given order of the nucleotides below, construct a double stranded DNA molecule.  
Guanine  
Adenine  
Cytosine  
Thymine  
Cytosine  
Guanine
4. Fasten your molecule together using a clear tape. Do not tape across base pairs.
5. Step 1, use the patterns of the components of the RNA provided by your teacher. Color code phosphate = blue, ribose sugar = brown and nitrogenous bases as follows: adenine = yellow, uracil = orange, guanine = violet and cytosine = red.



6. Cut out the shapes of each nucleotide.
  7. With your DNA model in front of you, demonstrate the process of transcription by first pulling the DNA model apart between the base pairs.
  8. Using the right strand of the DNA model in step 3, begin matching complementary RNA nucleotides with the exposed bases on the DNA model to make mRNA.
  9. Tape the RNA nucleotides.
  10. When you are finished, tape your new mRNA molecule together.
- Q1. Does the mRNA model more closely resemble the DNA strand from which it was transcribed?
- Q2. Explain how the structure of DNA enables the molecule to be easily transcribed. Why is this important for genetic information?
- Q3. Why is RNA important to the cell?
- Q4. How does a mRNA molecule carry information from DNA?

Do you know how the information in DNA, which is found in the nucleus, move to the ribosome in the cytoplasm? The following events can help you understand the process of transcription:

- Step 1. Ribonucleic Acid polymerase enzyme binds and opens the DNA molecule that will be transcribed.
- Step 2. As the DNA molecule opens, the RNA polymerase slides along the DNA strand and links free RNA nucleotides that pair with the nitrogenous bases of the complementary DNA strand. Hence, if the sequence of bases on the DNA strand were CCG TTA CAT, the sequence of bases on the RNA strand would be GGC AAU GUA.
- Step 3. When the process of base-pairing is completed, the RNA molecule breaks away as the DNA strands rejoin. The RNA leaves the nucleus and goes to the cytoplasm. Figure 6 shows the transcription process.

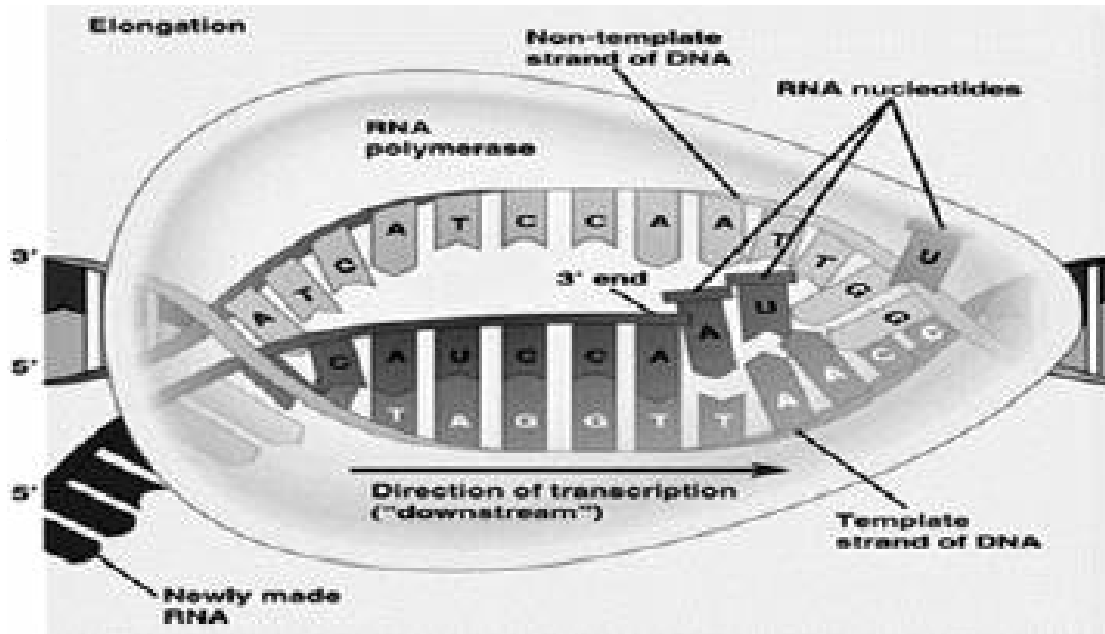


Figure 6. Transcription

**KEY CONCEPTS:**

- The sequence of nucleotides in DNA directs the order of nucleotides in messenger RNA in a process called transcription.
- There are three major types of RNA that help build proteins: mRNA, rRNA, and tRNA.
- The mRNA carries the information in DNA to the ribosomes found in the cytoplasm.

**TRANSLATION**

The DNA directs the production of proteins and determines the formation of mRNA. The order of bases of mRNA determines the protein synthesized.

Proteins control the activities of the cell, as well as so the life of the entire organism. But how does DNA make a unique protein that will perform a special function? Would you like to find out how the message of the mRNA is translated to proteins?

Work on the next activity to demonstrate the process of translation.

## Activity 4

### Relay the Message

#### Objectives:

- Make a model of the translation process
- Simulate the steps in translation

#### Materials:

- crayons
- 1/4 size illustration board or long size folder
- scissors
- paste/tape

#### Procedure:

1. Use the patterns of the components of the DNA and RNA provided by your teacher. Color code phosphate = blue, deoxyribose sugar = green, ribose sugar = brown and nitrogenous bases as follows: adenine = yellow, uracil = orange, guanine = violet, cytosine = red and amino acid = green.
2. Cut out the shapes of each nucleotide.
3. Using the given order of the nucleotides below, construct a double stranded DNA molecule.

Guanine  
Adenine  
Cytosine  
Thymine  
Cytosine  
Guanine

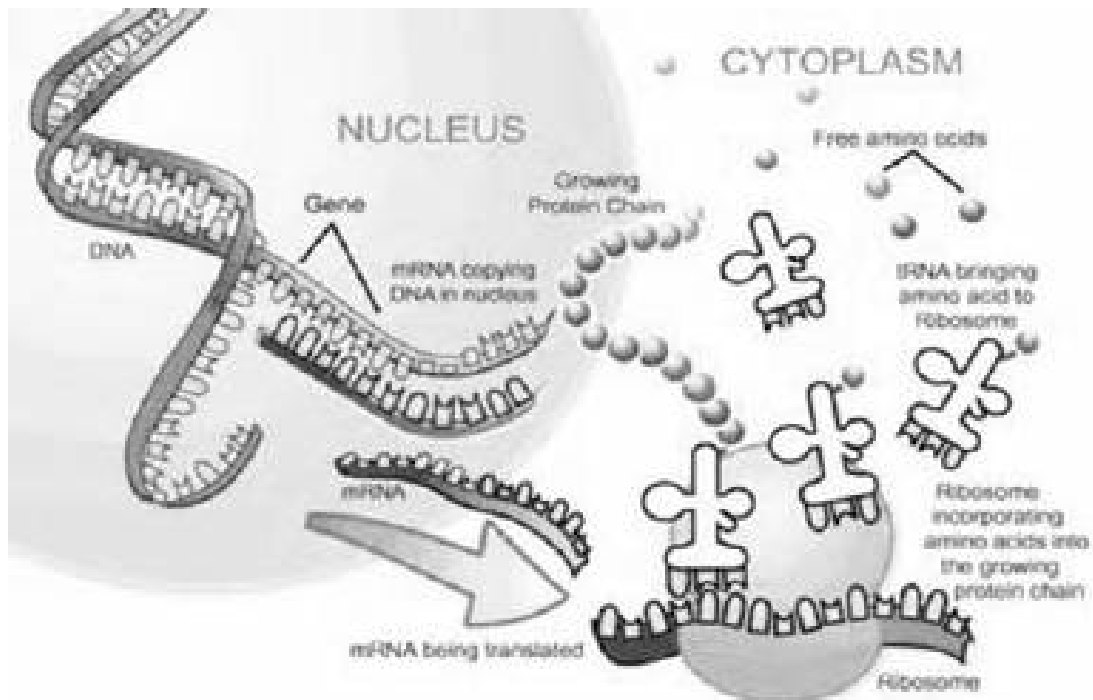
4. Fasten your molecule together using a clear tape. Do not tape across base pairs.
5. Step 1, use the patterns of the components of the RNA provided by your teacher. Color code phosphate = blue, ribose sugar = brown and nitrogenous bases as follows: adenine = yellow, uracil = orange, guanine = violet and cytosine = red.
6. Cut out the shapes of each nucleotide of RNA.
7. With your DNA model in front of you, pull apart the DNA model.

8. Using the right strand of the DNA model in step 3, begin matching complementary RNA nucleotides with the exposed bases on the DNA model to make mRNA.
  9. Tape the RNA nucleotides.
  10. Fasten your molecule together using a clear tape. Imagine that mRNA leaves the cell nucleus and moves out to the cell's ribosomes. Meanwhile, transfer RNA (tRNA) is present in the cell cytoplasm. tRNA has a three –base sequence (a triplet) that can match with the bases of mRNA.
  11. Cut out the two models of tRNA only along solid lines.
  12. Join the tRNA molecules to the mRNA model.
  13. When you are finished, tape your model of the translation process on the illustration board or folder.
- Q13. What are the four nucleotide bases present in tRNA? Do these bases differ from those found in mRNA?
- Q14. What base in mRNA can only join with the adenine base of RNA? uracil base of tRNA?
- Q15. What is a codon? What does it represent?
- Q16. What is the role of tRNA in protein synthesis?
- Q17. How does a tRNA molecule carrying its amino acid recognize which codon to attach?
- Q18. You have learned that there is a stop codon that signals the end of an amino acid chain. Why is it important that a stop codon be part of protein synthesis?
- Q19. A construction worker brings hollow blocks to build a wall. What part of translation resembles the construction worker's job? What do the hollow blocks represent?

In translation, each set of three nucleotides in an mRNA molecule codes for one amino acid in a protein. This explains why each set of three nucleotides in the mRNA is called a codon. Each codon specifies a particular amino acid. For example, the first codon which is, cytosine-guanine-uracil (CGU), instructs the ribosome to put the amino acid arg (arginine) in the protein. The sequence of codons in the mRNA determines the sequence of amino acids in the protein.

But how are the right amino acids added in the right sequence to match the sequence of codons in the mRNA? The following events in translation can help you understand the process:

- Step 1. As translation begins, mRNA binds to a ribosome. Then, tRNA molecules, each carrying a specific amino acid, approach the ribosome. The tRNA anticodon pairs with the first mRNA (start) codon argenine-uracil-guanine (AUG), to form the initiation complex. The two molecules temporarily join together.
- Step 2. Usually, the first codon on mRNA is AUG, which codes for the amino acid methionine. AUG signals the start of protein synthesis. Then, the ribosome slides along the mRNA to the next codon.
- Step 3. A new tRNA molecule carrying an amino acid pairs with the second mRNA codon.
- Step 4. When the first and second amino acids are in place, an enzyme joins them by forming a peptide bond between them.
- Step 5. As the process continues, a chain of amino acids is formed until the ribosome reaches a stop codon (e.g., UAA,UAG,UGA) on the mRNA strand. The polypeptide chain is released. Protein synthesis is complete. Figure 7 summarizes the translation process.



Source: [www.scq.ubc.ca](http://www.scq.ubc.ca)

**Figure 7.** Translation

**KEY CONCEPTS:**

- The process of converting the information in messenger RNA into a sequence of amino acids that make a protein is known as translation.
- The role of transfer RNA (tRNA) is to bring the amino acids in the cytoplasm to the ribosomes to make proteins.

Proteins such as enzymes are mostly amino acids chained together in a certain order. Each group of three nucleotide bases represents a codon in a DNA or mRNA that corresponds to a specific amino acid or a start/stop signal. This code is picked up by the mRNA and is carried from the nucleus to the cytoplasm. The codon has its complement anticodon in tRNA. Each amino acid that will form the protein molecule to be synthesized is determined by the triplet code or codon on the mRNA.

In this activity, you will apply what you have learned about DNA and mRNA, and the use of the information in the Genetic Code Table.

## Activity 5

### Trace the Code

#### Objective:

- Identify the amino acids coded for by the mRNA codon using the Genetic Code Table.

#### Materials:

- Genetic Code Table
- activity sheets

#### Procedure:

1. Copy and fill in the table.
2. Refer to the Genetic Code Table to identify the amino acid.

Order of bases in DNA	Order of bases in mRNA (codon)	Order of bases in tRNA	Amino Acid Coded into Proteins
<b>TAG</b>	<b>AUC</b>		
<b>CAT</b>			
	<b>GUC</b>		
	<b>CCA</b>		
			<b>Methionine</b>
			<b>Valine</b>
	<b>ACU</b>		
<b>ACA</b>	<b>UGU</b>		
<b>AAA</b>			
<b>GAA</b>	<b>CUU</b>		

3. To determine the order of bases in the first column (DNA), second column (codon), and third column (anticodon), consider the complementary base pairs in DNA: adenine pairs with thymine and guanine pairs with cytosine. While in RNA, adenine pairs with uracil and guanine pairs with cytosine.
4. To identify the amino acid, look at the bases in the mRNA codon, e.g., AUG using the **Genetic Code Table**. Look for the first letter of the mRNA codon on the left side of the genetic code table (A), the second letter of the mRNA on the second letter column (U), and the third letter on the right side column (G). AUG codes for the amino acid -methionine.
5. Do the same with the other codons in the chart.

## Genetic Code Table

		Second letter				
		U	C	A	G	
First letter	U	UUU Phenylalanine UUC Phenylalanine UUA Leucine UUG Leucine	UCU Serine UCC Serine UCA Serine UCG Serine	UAU Tyrosine UAC Tyrosine UAA Stop codon UAG Stop codon	UGU Cysteine UGC Cysteine UGA Stop codon UGG Tryptophan	U C A G
	C	CUU Leucine CUC Leucine CUA Leucine CUG Leucine	CCU Proline CCC Proline CCA Proline CCG Proline	CAU Histidine CAC Histidine CAA Glutamine CAG Glutamine	CGU Arginine CGC Arginine CGA Arginine CGG Arginine	U C A G
	A	AUU Isoleucine AUC Isoleucine AUA Methionine, initiation codon AUG Methionine, initiation codon	ACU Threonine ACC Threonine ACA Threonine ACG Threonine	AAU Asparagine AAC Asparagine AAA Lysine AAG Lysine	AGU Serine AGC Serine AGA Arginine AGG Arginine	U C A G
	G	GUU Valine GUC Valine GUA Valine GUG Valine	GCU Alanine GCC Alanine GCA Alanine GCG Alanine	GAU Aspartic acid GAC Aspartic acid GAA Glutamic acid GAG Glutamic acid	GGU Glycine GGC Glycine GGA Glycine GGG Glycine	U C A G

Q20. Why is specific base pairing essential to the processes of transcription and translation?

Q21. How many codon/s codes for one amino acid?

## MUTATION: Changes in the Genetic Code

When you copy from the blackboard, sometimes you may make mistakes. In a similar way, mistakes may occur when DNA is replicated. Look at Figure 8 to see some common mistakes in replication. Changes in the DNA sequence may delete such protein or change its structure.

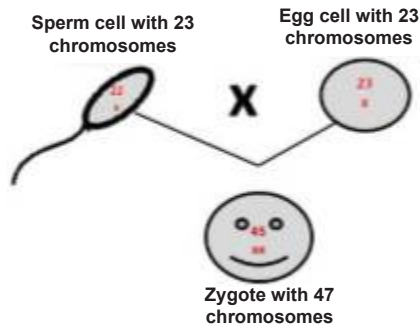


Source: www.shmoop.com

Figure 8. Common Mistakes in Mutation



When the code in a gene is changed, a different message may result. Any change in the sequence of nitrogenous bases in the DNA, any mistake in the transcription of genetic information from DNA to RNA or pairing of the codon and anticodon, may cause changes in the kind, sequence and number of amino acids of proteins synthesized by cells. Changes in the protein structure or level of expression may lead to changes in cellular properties and behavior, as a result, the organism is affected. Changes in the genes can occur for a variety of reasons. Mutation may be induced by factors called mutagens. Mutagens are commonly in the form of toxic chemicals, and harmful radiation. Sometimes, mistakes occur in DNA replication, mitosis, and meiosis. All of these can alter the DNA sequence and length.



**Figure 9.** Diagram of a cross with mutated chromosomes

Mutations can occur in two different types of cells: reproductive cells and body cells. Only mutations in sex cells pass on to offspring. Mutations affect the reproductive cells of an organism by changing the sequence of nucleotides within a gene in a sperm or an egg cell. If these cells are fertilized, then the mutated gene becomes a part of the genetic makeup of the offspring as shown in Figure 9. If mutation is severe, the resulting protein may be nonfunctional, and the embryo may not develop. There are two types of mutations that can occur in gamete cells:

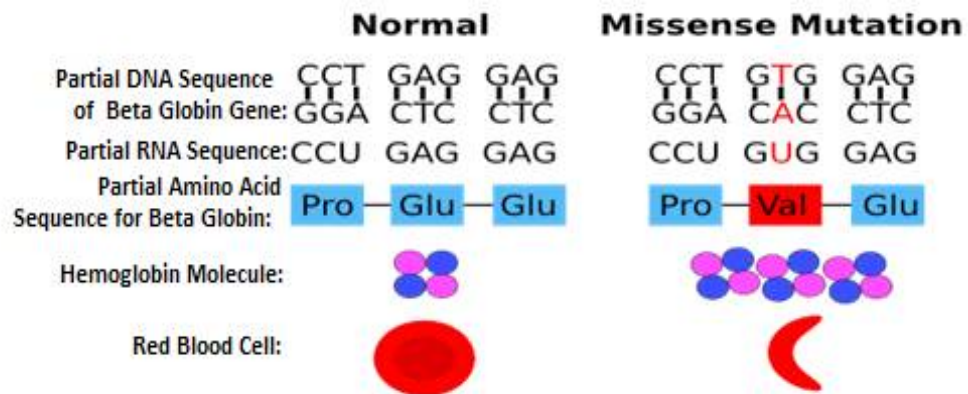
- Gene mutation is a permanent change in the DNA sequence that makes up a gene.
- Chromosomal mutation occurs at the chromosome level resulting in gene deletion, duplication or rearrangement that may occur during the cell cycle and meiosis. It maybe caused by parts of chromosomes breaking off or rejoining incorrectly.

Most mutations are harmful. Some mutations in a body cell are known to cause cancer, while mutations in sex cells can cause birth defects. A severe mutation may lead to cell death and may have no effect on the body. Sometimes mutations may be useful for the species. For example, a mutation in blood proteins prevents viruses or parasites to thrive in host organisms.

- When is mutation inherited? Why are mutations in sex cells heritable?

Many diseases are caused by the effects of inherited genes. In most cases, there is only a small difference between DNA sequences in the defective gene and a normal one. This difference is enough to cause serious and often fatal diseases. These disease-causing genes are the result of a mutation. They may be passed from one generation to the next if present in gametes.

Figure 10 shows changes in the sequences of bases in normal hemoglobin and the one affected by mutation. A recessive gene causes sickle-cell anemia, where most of the red blood cells stiffen and become sickle shape in affected people. These diseased cells carry less oxygen than normal cells. People affected by the disease eventually die.



Source: education-portal.com

**Figure 10.** Hemoglobin Gene Mutation

Consider what might happen if an incorrect amino acid was inserted in a growing protein chain during the process of translation. Do you think this will affect the structure of the entire molecule? This can possibly happen in point mutation where a change in a single base pair occurs. Read the two sentences below. What happens when a single letter in the first sentence is changed?

**THE DOG BIT THE CAT.**

**THE DOG BIT THE CAR.**

Did you see that changing a single letter also changes the meaning of the sentence? A change in nitrogenous base in a protein may yield a different amino acid and a corresponding change in the protein structure and function.

What will happen if a single base is deleted from a DNA strand? You learned in Activity 3 and 4 that an mRNA corresponds to a DNA sequence translated by ribosomes into proteins. If the new sequence with a deleted base was transcribed, then every codon after the deleted base would be different. Deletion or insertion of a base may change the reading frame of the codon leading to frameshift mutation. Read again the two sentences below.

**THE DOG BIT THE CAT.  
THE DOB ITT HEC AT.**

What was deleted? Would the result be the same if there would be an addition of a single base?

Mutations in chromosomes may occur in a variety of ways. Sometimes parts of chromosomes are broken off and lost during mitosis or meiosis.

Now, you will work on an activity that will help you visualize some chromosomal mutations using models.

## **Activity 6**

### **Chromie Change**

#### **Objective:**

- Illustrate the kinds of chromosomal mutations
- Differentiate the kinds of chromosomal mutations

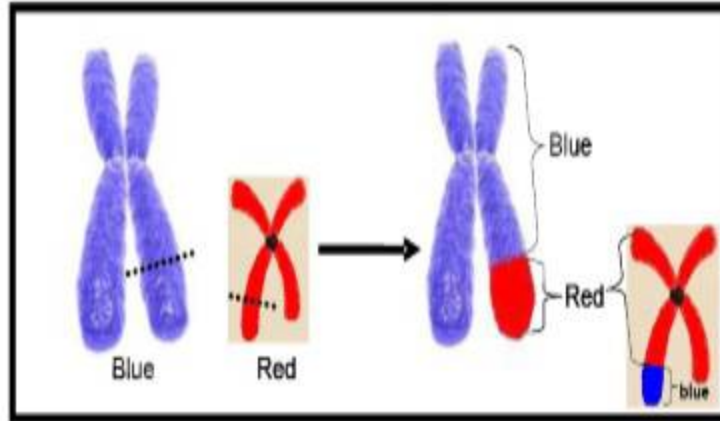
#### **Material:**

Modeling clay of varied color

#### **Procedure:**

##### **A. Translocation**

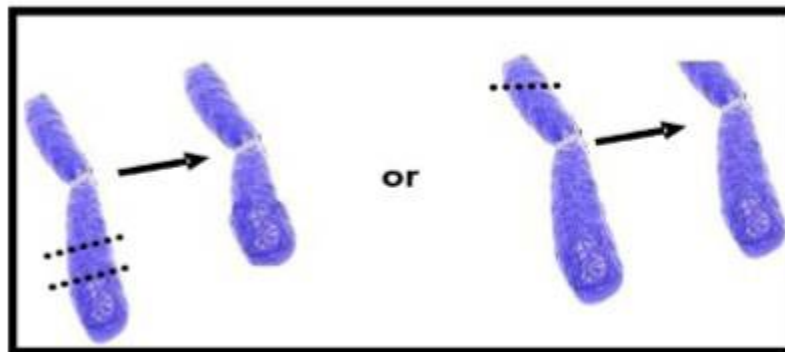
1. Using modeling clay make models of two (2) chromosomes. One should have a different color and size from the other.
2. Break one part of each of the chromosomes. Exchange the parts and attach them to each of the other chromosomes. See illustration below.



3. Fill in the second column (translocation) of the table.

### B. Deletion

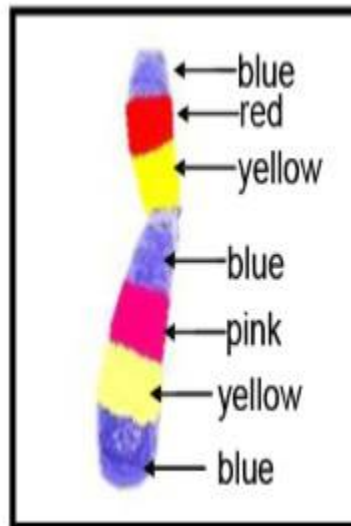
1. Make a model of a chromatid (one of the duplicated copies of a chromosome).
2. When done, remove a portion of it (close to either end of the chromosome or within the long arm or short arm). If you choose to remove a part within the arms, be sure to join back the bottom part. See sample illustration.



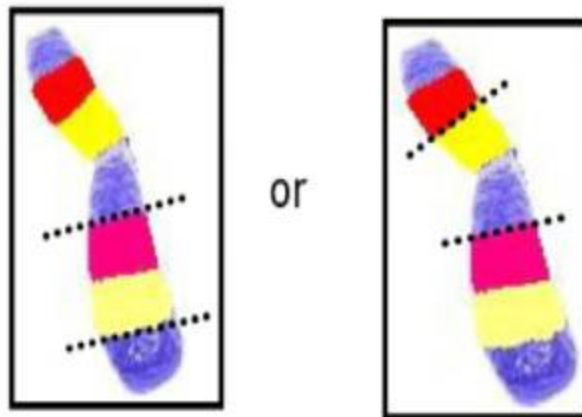
3. Fill in the third column (deletion) of the table.

### C. Inversion

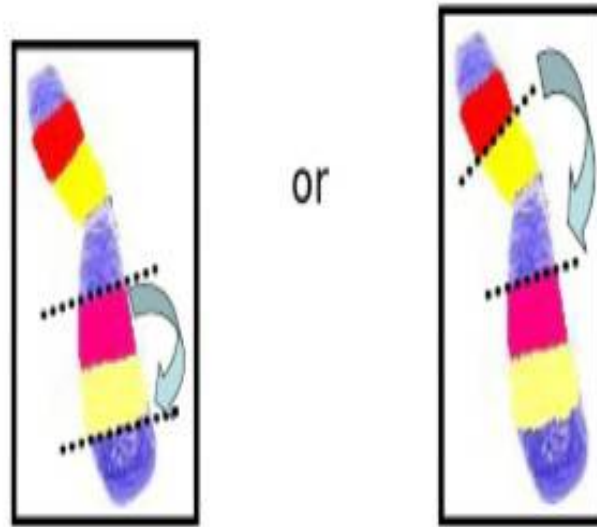
1. Make a colored chromatid as shown below.



2. This time break a portion (with 2 colors) of it. Refer to the illustration below.



3. Reinsert it to the chromatid in reverse manner.



4. Fill in the fourth column (inversion) of the table.

	<b>Chromosomal Mutations</b>		
	<b>Translocation</b>	<b>Deletion</b>	<b>Inversion</b>
1. How many chromosomes are involved?			
2. How did you change the original structure of the chromosomes?			
3. Which condition/s do you think result/s to change/s of chromosome material? Please indicate using the words loss, gain, either loss or gain of genetic material.			

Q22. How are the three chromosomal aberrations different from each other?  
How are they similar?

Q23. Do you think the normal genetic content of the chromosome is affected?

Q24. Which condition results to gain of chromosome material? Loss of chromosome material?

Q25. What are some possible effects of these chromosomal mutations?

(Activity adapted from BEAM – DepEd Material)

Abnormalities in chromosomal structure may occur during meiosis. The normal process of crossing-over and recombination may be affected, such that chromosomes break and reunite the wrong segments. If there is a loss or gain of chromosomal material, there can be significant clinical consequences.

Changes that affect the structure of chromosomes can cause problems with growth, development, and function of the body's systems. These changes can affect many genes along the chromosome and disrupt the proteins made from these genes. Structural changes can occur during the formation of egg or sperm cells in fetal development, or in any cell after birth. Pieces of DNA can be rearranged within one chromosome or transferred between two or more chromosomes.

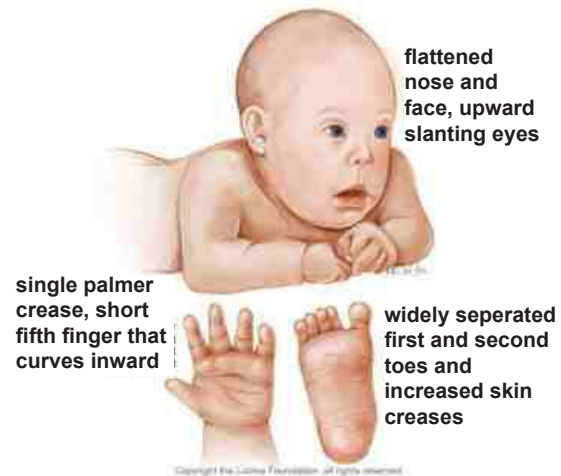
The effects of structural changes depend on their size and location, and whether any genetic material is gained or lost. Some changes cause medical problems, while others may have no effect on a person's health. The gain or loss of chromosome material can lead to a variety of genetic disorders. Human examples are the following on the next page:



Source: player.mashpedia.com  
**Figure 11.** Cri du chat

(a) “*Cri du chat*” is caused by the deletion of part of the short arm of chromosome 5. “*Cri du chat*” is French, and the condition is so named because affected babies make high-pitched cries that sound like a cat. Affected individuals have wide-set eyes, a small head and jaw, are moderately to severely mentally retarded, and very short.

(b) Down’s syndrome is usually caused by an extra copy of chromosome 21 (trisomy 21). Characteristics include decreased muscle tone, stockier build, asymmetrical skull, slanting eyes and mild to moderate mental retardation.



Source: www.healthtap.com  
**Figure 12.** Down’s Syndrome



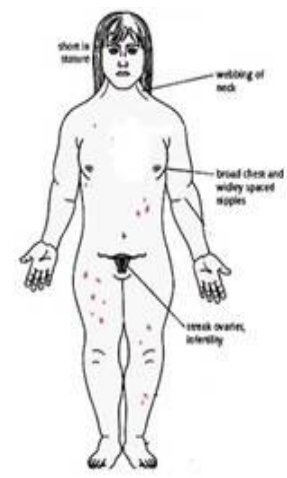
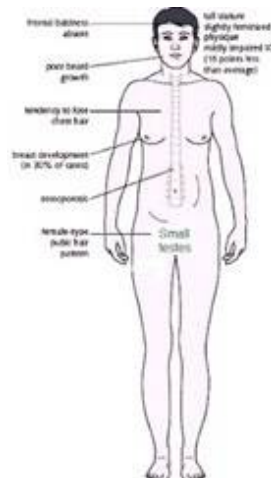
Source: healthtap.com  
**Figure 13.** Edward Syndrome

(c) Edwards syndrome, which is the second most common trisomy after Down’s syndrome, is a trisomy of chromosome 18. Symptoms include mental and motor retardation and numerous congenital anomalies causing serious health problems. About 99% die in infancy. However, those who live past their first birthday, usually are quite healthy thereafter. They have a characteristic hand appearance with clenched hands and overlapping fingers.



- (d) Jacobsen syndrome is also called terminal 11q deletion disorder. This is a very rare disorder. Those affected have normal intelligence or mild mental retardation, with poor or excessive language skills. Most have a bleeding disorder called Paris-Trousseau syndrome.

e) Klinefelter's syndrome (XXY). Men with this condition are usually sterile and tend to have longer arms and legs and to be taller than their peers. They are often shy and quiet and have a higher incidence of speech delay.



Source: <http://chengmoh.blogspot.com/2012/08/genetic-diseases.html>

(f) Turner's syndrome (X instead of XX or XY). Female sexual characteristics are present but underdeveloped. They often have a short stature, low hairline, abnormal eye features and bone development and a "caved-in" appearance to the chest

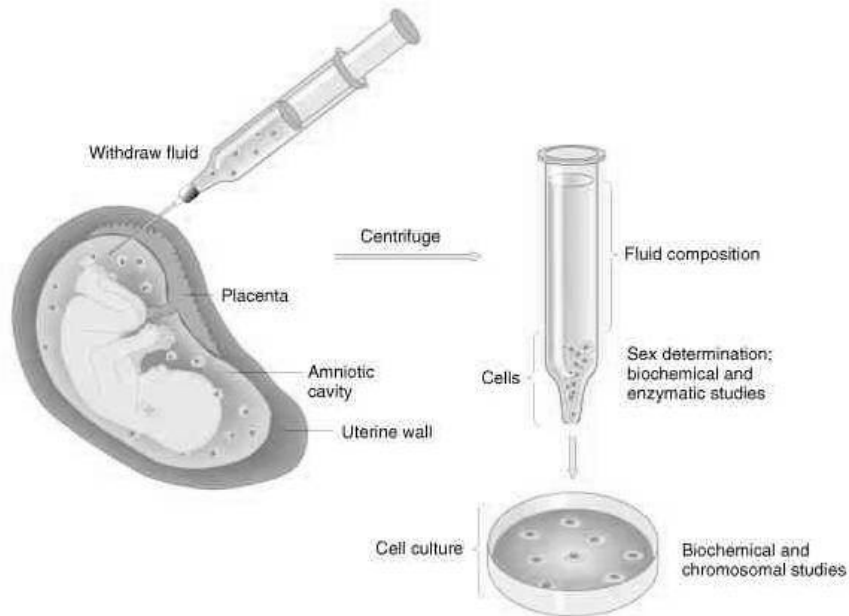
Figure 14. E. Klinefelter Figure 14. F. Turner

Sources: <http://ghr.nlm.nih.gov/handbook/mutationsanddisorders/structuralchanges> <http://www.usd.edu/med/som/genetics/curriculum/1ECHROM3.htm>

## Human Karyotyping

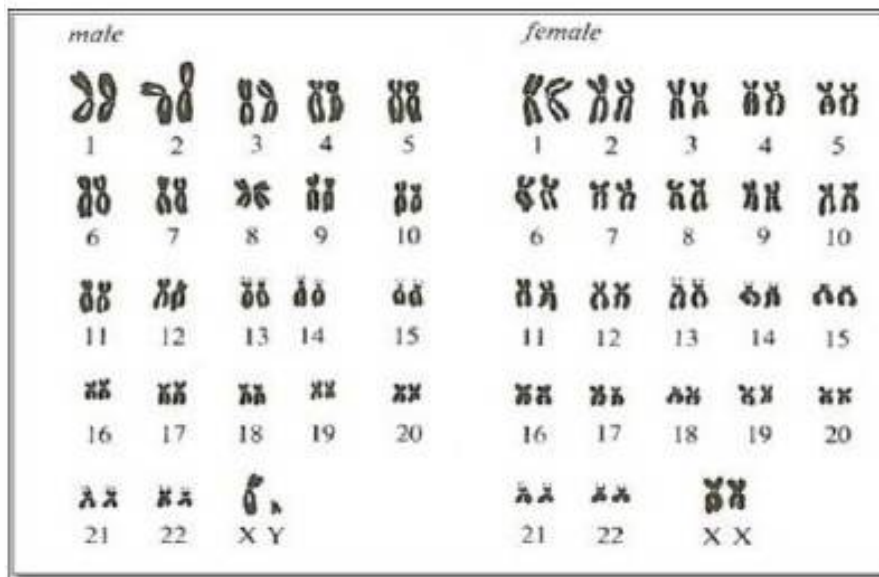
Occasionally, chromosomal material is lost or rearranged during the formation of gametes or during cell division of the early embryo. Such changes, primarily the result of nondisjunction or translocation, are so severe that the pregnancy ends in miscarriage – meaning loss of an embryo or fetus before the 20th week of pregnancy or fertilization does not occur at all. It is estimated that one in 156 live births has some kind of chromosomal abnormality.

Some of the abnormalities associated with chromosome structure and number can be detected by a test called a karyotype. A karyotype is an image of the full set of chromosomes of an individual that displays the normal number, size, and shape. Karyotypes may reveal the gender of a fetus or test for certain defects through examination of cells from uterine fluid – a procedure called amniocentesis – or through sampling of placental membranes as shown in Figure 15.



**Figure 15.** Amniocentesis

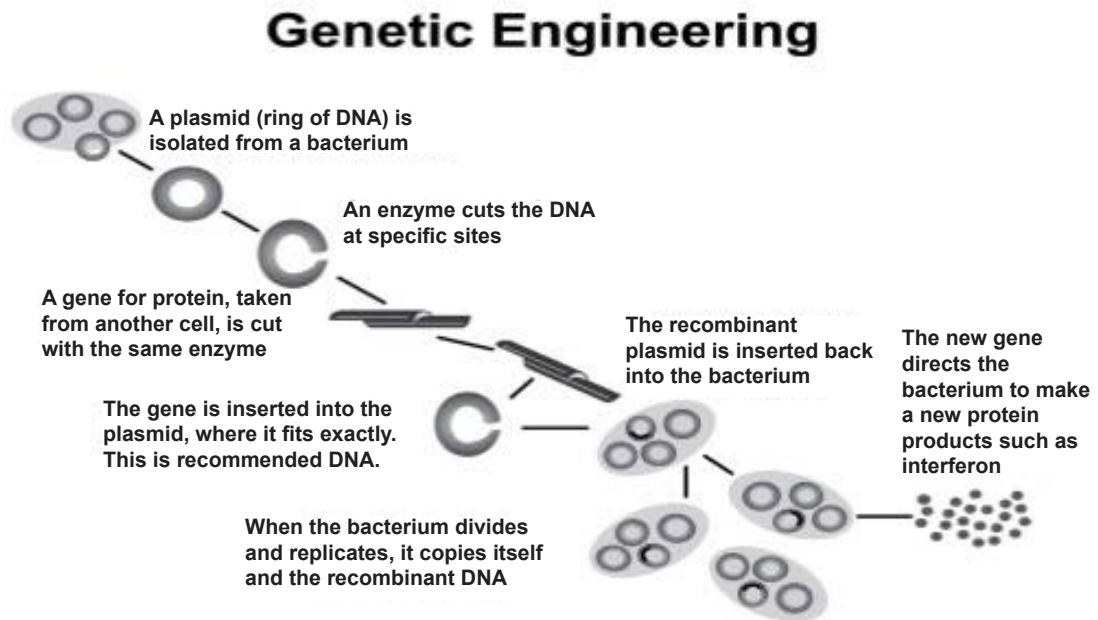
To produce a karyotype, chromosomes commonly derived from actively dividing white blood cells are stained and photographed. The homologous pairs of chromosomes are identified and arranged in order by size, with the exception of the sex chromosomes; these appear last as shown in Figure 16. These tests are typically done on a blood sample, although any body cell could be used. The cell must be undergoing mitosis – preferably in metaphase – so that the chromosomes are replicated, condensed, and visible under a microscope.



Source: [www.austincc.edu](http://www.austincc.edu)  
**Figure 16.** Karyotype of Human Male and Female

## Genetic Engineering

Understanding the gene has led to the remarkable development of methods for changing a cell's DNA. A modern biotechnology called genetic engineering produces transgenic or GM crops of organisms. Scientists have developed methods to move genes from one species into another. When DNA from two different species are joined together, it is called **recombinant DNA**. This process uses restriction enzymes to cleave one organism's DNA into fragments and other enzymes to splice the DNA fragment into a plasmid or viral DNA. Transgenic organisms are able to manufacture genetic products foreign to them using recombinant DNA. Genetic engineering has already been applied to bacteria, plants, and animals. These organisms are engineered to be of use to humans. Figure 17 shows the method for producing recombinant DNA.



**Figure 17.** Diagrammatic Illustration of the Steps in Genetic Engineering

Today, molecular biologists are finding applications for recombinant DNA technology: from medical applications, including gene therapy and vaccines; DNA fingerprinting used to identify persons responsible for crimes and provide evidence for identity of dead persons; to the creation of genetically modified crops that are resistant to pesticides, or that make extra vitamins and minerals; to bacteria that can clean oil spills. While the applications of recombinant DNA technology are numerous, its limitations are its potential effects on our ecosystem.

**KEY CONCEPTS:**

- • A mutation is a change in the base sequence of DNA. Mutations may affect only one gene, or they may affect whole chromosomes.
- Mutations in eggs or sperm affect future generations by transmitting these changes to their offsprings.
- Mutations in body cells affect only the individual and are not passed on to the offspring.
- When DNA from two different species are joined together, it is called recombinant DNA. This process uses restriction enzymes to cleave one organism's DNA into fragments and other enzymes to splice the DNA fragment into a plasmid or viral DNA.

Now that you have learned that protein is made using the information from DNA and how mutations may cause changes in the structure and function of a protein, it would be worth finding out how a deeper understanding of molecular genetics may affect your life. What do you think are the significant contributions of this knowledge to human society? You may share your thoughts and ideas with your classmates.

## V. Summary/Synthesis/Feedback

- Deoxyribonucleic Acid (DNA) is the genetic material of organisms. A DNA is a double helix molecule composed of two complementary strands of deoxyribonucleotides units. The complementary base pairs of the DNA are held by hydrogen bonds.
- The central dogma of the transfer of genetic information states that the sequence involved in the expression of hereditary characteristics is from DNA to RNA to proteins.
- Genes are segments of DNA that may code for RNA or proteins.
- Most sequences of three bases in the DNA of a gene code for a single amino acid in a protein.
- Transcription is the process by which the information in a strand of DNA is copied into a new molecule of messenger RNA (mRNA).
- There are three major types of RNA in the cell and their functions:
  - 1) The mRNA carries the information from DNA to the ribosomes.
  - 2) The tRNA translates the genetic message carried by the mRNA through protein synthesis.
  - 3) The rRNA forms the structural component of the ribosome.
- Ribosomal RNA serves as the site for attachment of mRNA and tRNA and for protein synthesis
- Translation is a process which determines the order of bases in mRNA of amino acids into a protein. It occurs in a ribosome in the cytoplasm.
- A mutation is a change in the base sequence of DNA. Mutations may affect only one gene, or they may affect whole chromosomes.
- Mutations in eggs or sperm may affect future generations by transmitting these changes in the offsprings. Mutations in non-sex (somatic) cells only are not hereditary.
- When DNA from two different species are joined together, it is called **recombinant DNA**. This process uses restriction enzymes to cleave one organism's DNA into fragments and other enzymes to splice the DNA fragment into a plasmid or viral DNA.

## VI. Summative Assessment

A. Choose the letter of the correct answer:

The following is the base sequence on one strand of a DNA molecule:

**A A T G C C A G T G G T**

- If this strand is replicated, which of the following is the complementary strand that is produced?
    - TCGTCCGTCTAG
    - AGCAGGCAGGGT
    - TTACGGTCACCA
    - UCGUCCUCUAGA
  - If transcribed into an mRNA, what would be the resulting strand?
    - UUACGGUCACCA
    - AGCAGGAGATC
    - AGCAGGCAGAUC
    - TCGTCCGTCTAG
  - During translation, the tRNA sequence of nucleotides arranged linearly is \_\_\_\_\_.
    - TCGTCCGTCTAG
    - AAUGCCAGUGGU
    - AGCAGGCAGAUC
    - UCGUCCGUCUAG
- B. Each combinations of nitrogen bases on the mRNA molecule is a codon, which is a three letter code for a specific amino acid. The table shows the mRNA codon for each amino acid. Use the Genetic Code Table to answer the questions.
- The codon for tryptophan is \_\_\_\_\_.
  - For leucine, there are \_\_\_\_\_ different codons.
  - The codon GAU is for \_\_\_\_\_.
  - In a stop codon, if the second base is G, the first and third bases are \_\_\_\_ and \_\_\_\_.
- C. Sequence the following steps in protein synthesis from first to last (1-6).
- Transcription
  - tRNA – amino acid units link to mRNA
  - Amino acid separate from tRNA
  - Polypeptide chain assembled
  - mRNA links to ribosome
  - Stop codon encountered in mRNA
- D. Given the list of amino acids, determine the sequence of bases in the codon of the mRNA that codes for these amino acids. Use the table for the Genetic Code.

1. Methionine
2. Leucine
3. Arginine
4. Threonine
5. Lysine
6. Asparagine
7. Valine
8. Glycine
9. Aspartic acid
10. Glutamic acid

		Second letter					
		U	C	A	G		
First letter	U	UUU UUC	UCU UCC UCA UCG	UAU UAC	UGU UGC	U	
		UUA UUG		UAA UAG		UGA UGG	C
				Stop codon Stop codon		Stop codon Tryptophan	A
	C	CUU CUC CUA CUG	CCU CCC CCA CCG	CAU CAC	CGU CGC CGA CGG	U	
		CAA CAG		Arginine		C	
		Glutamine		A			
A	AUU AUC AUA	ACU ACC ACA ACG	AAU AAC	AGU AGC	U		
			AAA AAG		Arginine	C	
	AUG		Lysine		AGA AGG	A	
G	GUU GUC GUA GUG	GCU GCC GCA GCG	GAU GAC	GGU GGC GGA GGG	U		
			GAA GAG		Glycine	C	
			Aspartic acid Glutamic acid		A		

E. Write the sequence of bases in the mRNA molecule from which the protein molecule in letter D was identified.

## Glossary of Terms

<b>Amino acid</b>	the building blocks of a protein molecule
<b>Anticodon</b>	the complement of the mRNA; triplet code in the tRNA
<b>Chromosomal mutations</b>	changes in the chromosomes where parts of the chromosomes are broken and lost during mitosis.
<b>Codon</b>	each set of three nitrogenous bases in mRNA representing an amino acid or a start/stop signal
<b>DNA replication</b>	process in which the DNA is copied
<b>Genetic code</b>	set of rules that specify the codons in DNA or RNA that corresponds to the amino acids in proteins

<b>mRNA</b>	messenger RNA; brings information from the DNA in the nucleus to the cytoplasm
<b>Mutation</b>	any change in the DNA sequence.
<b>Nitrogenous base</b>	is a carbon ring structure that contains one or more atoms of nitrogen. In DNA, there are four possible nitrogen bases: adenine(A), thymine(T), cytosine(C) and guanine(G)
<b>Recombinant DNA</b>	a form of DNA produced by combining genetic material from two or more different sources by means of genetic engineering.
<b>rRNA</b>	ribosomal RNA; hold tightly to the mRNA and use its information to assemble amino acids
<b>Transcription</b>	process of copying DNA sequence into RNA.
<b>Translation</b>	process of converting information in mRNA into a sequence of amino acids in a protein.
<b>tRNA</b>	transfer RNA; a type of RNA that attach the correct amino acid to the protein chain that is being synthesized in the ribosome.



## References and Links

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### Electronic Sources:

[www.chemguide.co.uk/organic\\_props/amino\\_acids/dna1.html/](http://www.chemguide.co.uk/organic_props/amino_acids/dna1.html/)

[www.accessexcellence.org](http://www.accessexcellence.org)

[www.elmhurst.edu](http://www.elmhurst.edu)

[ghr.nlm.nih.gov/handbook/mutations and disorders/gene mutation](http://ghr.nlm.nih.gov/handbook/mutations_and_disorders/gene_mutation)

[ww.nature.com/scitable/topicpage/Genetic-Mutation - 1127](http://ww.nature.com/scitable/topicpage/Genetic-Mutation-1127)

[www.buzzle.com/articles/hybrid-fruits-and-vegetables.html](http://www.buzzle.com/articles/hybrid-fruits-and-vegetables.html)

[internalcampaignschools.org](http://internalcampaignschools.org)

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[education-portal.com](http://education-portal.com)

[playermashpedia.com](http://playermashpedia.com)

[www.healthtap.com](http://www.healthtap.com)

[healthtap.com](http://healthtap.com)

<http://chengmoh.blogspot.com/2012/08/genetic-diseases.html>

[www.austincc.edu](http://www.austincc.edu)

### DepEd Materials

APEX Biology Unit 6 Anatomy of Genes Lessons 1-5 Heredity and Genetics  
BEAM Learning Guide, Nov.2008, Genetic Book of Life pp. 28-34

EASE Biology Lesson 3 The DNA Material pp. 20 -24

**Unit 3  
MODULE**

**3**

**BIODIVERSITY AND  
EVOLUTION**

**Suggested Time Allotment: 8 hrs.**

**I. Introduction**

Do you know why dinosaurs no longer exist today? Why some animals before are very different from the animals we have now? From Grade 7 to Grade 9 you have learned that organisms are grouped into Kingdom, Phylum, Class, Order, Family, Genus, and Species. You also learned that organisms possess unique characteristics. Some organisms may look the same but have distinct differences from each other, others may not be related to one another but they have similar functional features and characteristics. You may also wonder why some animals that are present before are no longer existing today. Such extinction of organisms were caused by various environmental factors and human activities.

This module will give you an idea that maintaining individual differences and variety of characteristics are important to ensure the survival of species.

This module will also discuss the different sources of possible evidence for evolution such as fossil records, and developmental and molecular biology which gave way to the different concepts about the origin of life. It will also provide a variety of activities to help you understand the processes and mechanism of evolution.

Through this module, it is hoped that you will be encouraged to further take care of and protect our environment (e.g. natural resources), to ensure the survival of species and conservation of our biodiversity.

**II. Learning Competencies/Objectives**

At the end of this module you are expected to:

1. Understand how evolution is being studied from the fossil record and molecular data.
2. Give the importance of understanding the origin of life.
3. Explain why reproduction, variation, and adaptation are necessary for the survival of species.
4. Discuss how natural selection promotes expression and propagation of traits and species that adapt with the changing environment.

### Key questions for this module:

1. Why are evidences important in the study of origin of life?
2. Explain how reproduction, variation, and adaptation are necessary for survival of species.
3. How can Natural Selection contribute to biodiversity or extinction?

### III. Pre- Assessment

#### I. Multiple Choice. Choose the best answer.

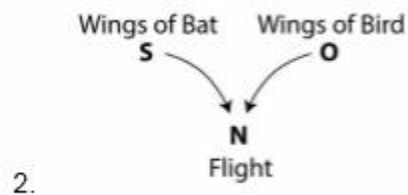
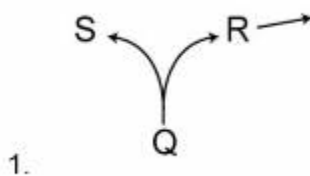
1. Where can most of the fossils be found?
  - a. Sedimentary rock
  - b. Granite rock
  - c. Lava flows
  - d. Black soil
2. Which of the following statements DOES NOT describe evolution?
  - a. Evolution is continuous.
  - b. Evolution refers to change.
  - c. The world is stable and unchanging.
  - d. If there is mutation, there is evolution.
3. Which pairs of animals show a correct example of homologous structures?
  - a. Wings of butterfly and bat.
  - b. Flipper of whale and forelimb of cat.
  - c. Fingers of human and arm of starfish
  - d. Tongue of frog and proboscis of mosquito.
4. In what Era can the oldest fossils be found?
  - a. Cenozoic
  - b. Mesozoic
  - c. Paleozoic
  - d. Pre-Cambrian

5. Which of the following statements best explains the Theory of Natural Selection?
  - a. Organs that are not used may disappear while organs that are constantly used may develop.
  - b. In nature, the organisms with desirable characteristics may survive while those with weaker traits may not.
  - c. Organisms develop desirable structures to survive in a given environment.
  - d. Acquired characteristics of parents can be passed on to offsprings.
  
6. Which is a more definite characteristics to show relatedness of two organisms?
  - a. Similarity in development
  - b. Similarity in courting behavior
  - c. Similarity in structure
  - d. Similarity in genomic DNA
  
7. Which of the following statement explains Lamarck's Theory of Use and Disuse?
  - a. Body structures develop because they are used extensively
  - b. Body structures develop because they are not in use
  - c. Body structures develop because of competition
  - d. Body structures develop because of mutation
  
8. Which of the following statements **does not** show the process of adaptation?
  - a. Dying out of dinosaurs during Cretaceous period.
  - b. Certain group of birds eating different kinds of food.
  - c. The finches in Galapagos with different beaks.
  - d. A child learning to walk on his own.
  
9. Why do organisms with close biochemical similarities show stronger evolutionary relationships?
  - a. They have varied and different ancestry.
  - b. They have similar patterns during their early stages of development.
  - c. They have a common ancestor and have the same kind of proteins.
  - d. They possess same vestigial structure that made their evolutionary relationship closer.

10. Which of the following statements supports the idea that extinction is necessary?
- To give way for other organisms to develop
  - To let other organisms evolve and progress
  - To know who is the fittest
  - All of the above

- II. Draw the appropriate graphical representation of the following situations.
- Equal population of black peppered moths and white peppered moths inhabit a particular area in the city. After a while, modernization and industrialization came. Because of pollution, white peppered moths did not survive while the dark peppered moths enjoy the smog.
  - A variety of species of deer lives in a certain part of the forest. But after sometime a new organism was introduced to the wild; the fast deer increased in number, while the slow ones became extinct.

- III. Pattern of Evolution. Tell whether the diagrams illustrate convergent evolution or divergent evolution.



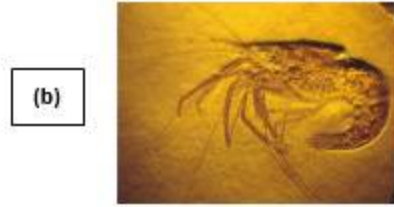
#### IV. Reading Resources and Instructional Activities

### SOURCES OF EVIDENCE FOR EVOLUTION

Organisms inhabiting the earth have changed overtime, their structures, traits, and abilities allowed them to adapt and survive in their environment. Data from the fossil records, anatomy and morphology, embryonic development and biochemistry could be analyzed to demonstrate if evolution of life on earth has taken place.

#### Evidence from Fossil Records

Have you ever seen fossils of any organism? Fossils are examples of evidences that paleontologists use in studying evolution. They are traces of organisms that lived in the past and were preserved by natural process or catastrophic events. They can be remains of organisms which include bones, shells, teeth and also feces embedded in rocks, peat, resin, and ice. Paleontologist is a person who studies fossils.



Sources: (a) [www.albertawow.com](http://www.albertawow.com) (b) [www.earthhistory.uk](http://www.earthhistory.uk)

Most fossils were commonly found in sedimentary rocks. They were from the hard parts of the organism like woody stem, bones, or teeth.

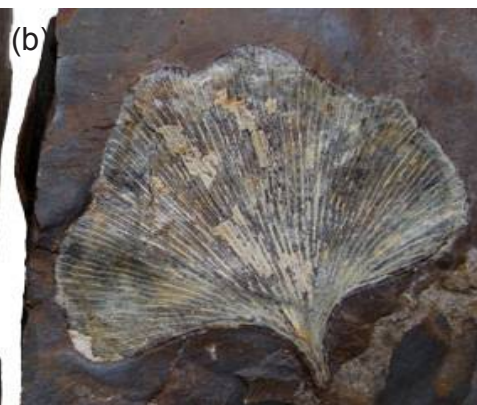


Compression

Impression

Source: The Virtual Petrified Wood Museum

Another type of fossil is an imprint or impression. Imprints are shallow external molds left by animal or plant tissues with little or no organic materials present. Compression is the other side with more organic material.



Compression

Impression

Source: The Virtual Petrified Wood Museum

## **Determining the age of fossils**

Do you know how a paleontologist usually determines the age of a fossil? Paleontologists make initial estimates of the age through the position in the sedimentary rocks. Fossils found in the bottom layer are much older than those found in upper layer of rocks.

The following activities will teach us how to determine the age of fossils.

### **Activity 1A**

#### **Where Do I Belong?**

##### **Objective:**





Draw and place the fossil of organisms in its proper Era and Period.

##### **Material:**

pen and paper

##### **Directions:**

Try to place or draw the fossils of the following organisms in the Era and period where they belong.

<p>Trilobite</p> 	<p>An invertebrate, it lived in a shallow marine environment during Ordovician and Silurian periods.</p>	<p><b>Era</b></p>	<p><b>Period</b></p>	<p><b>Organism</b></p>
<p>Crinoid Stem</p> 	<p>Crinoids look like plants but are actually animals related to our modern day starfish. They belong to Phylum Echinodermata and lived during the Triassic Period.</p>	Cenozoic	Recent	
			Quaternary	
<p>Dinosaur bone</p> 	<p>Dinosaurs or giant reptiles ruled the earth during the Jurassic Period under Mesozoic Era.</p>		Tertiary	
		Mesozoic	Cretaceous	
			Jurassic	Dinosaurs
			Triassic	Crinoids
<p>Vascular Plant</p> 	<p>This fossilized leaf is once part of an early vascular plant during the Carboniferous Period.</p>	Paleozoic	Permian	
			Carboniferous	Vascular Plants
			Devonian	
			Silurian	Trilobites
			Ordovician	Trilobites
	Cambrian			

Source: Images of trilobite and crinoid stem taken from The Virtual Petrified Wood Museum

- Q1. Analyze the table above. Which is assumed to be the oldest organism? Why do you think so? What is the probable age of the fossil?
- Q2. In what era can you possibly find the most recent fossil? Why do you say so?
- Q3. Do you think there are organisms that lived during the Cambrian Period? Explain your answer.
- Q4. When do you think did the present day humans first appeared on earth?
- Q5. Describe how organisms are arranged in the table.



Relative dating is a method used to determine the age of the rocks by comparing them with the rocks in the other layer. The younger sedimentary rock layer is assumed to be found on top and the older rock is found at the bottom layer. Fossils found at the bottom layer are assumed to be older than those on the upper layer.

The fossils of invertebrates found at the bottom part of the rock layer suggest that invertebrates are probably one of the first and oldest organisms that lived on earth.

Another method is through the use of radioactive isotopes such as carbon-14. Radiometric dating is a method used to determine the age of rocks using the decay of radioactive isotopes present in rocks.

All organisms have decaying carbon-14 in it. Plants and animals that are still alive constantly replace the supply of carbon in their body and the amount of carbon -14 in their body stays the same. When an organism dies, carbon-14 starts to decay.

Carbon dating is used to tell the age of organic materials. Art collectors use carbon dating to determine if a piece of art work is genuine or not. Do you want to know how to determine the age of a fossil? Try this activity.

## **Activity 1B**

### **What's My Age?**

#### **Objective:**

Determine the age of fossil.

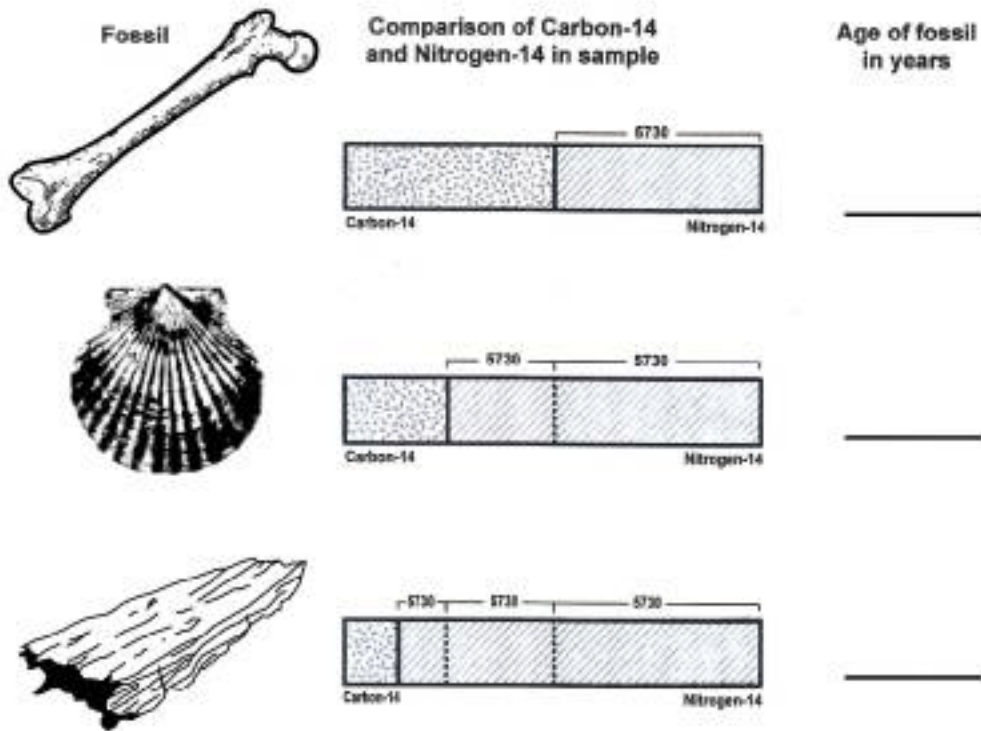
#### **Materials:**

- Paper
- pen

#### **Directions:**

Use the information below to answer the age of the fossils.

**One way scientists determine the age of fossils is by checking the amount of radioactive carbon-14 in the fossil. Carbon-14 breaks down or decays to form nitrogen-14; the rate of this decay is constant e.g. half of the remaining Carbon-14 breaks down every 5730 years. Use this information and compute the age of the fossils on the next page.**



Source: Payawal P. (1993)

Q6. What is the oldest fossil?

Q7. Why is it important to know the age of the fossil?

Out of the examination of layers of rocks and dating fossils, scientists were able to develop the Geologic Time Scale. The Geologic Time Scale shows the major events in the Earth's history. It also shows the appearance of various kinds of organisms in a particular period of time on earth.

# GEOLOGIC TIME SCALE

Time Units		Began (millions of years ago)	Life Milestones
Cenozoic Era	Recent	0-0.01	
	Pliocene epoch	1.8	
	Pleistocene epoch	12	
	Miocene epoch	25	
	Oligocene epoch	34	
	Eocene epoch	66	
	Paleocene epoch	65	
Mesozoic Era	Cretaceous Period	135	
	Jurassic Period	190	
	Triassic Period	235	
Paleozoic Era	Permian Period	280	
	Carboniferous Period	370-350	
	Devonian Period	400	
	Silurian Period	440	
	Ordovician Period	500	
	Cambrian Period	570-530	
Precambrian Era	Late Proterozoic Period		
	Early Proterozoic Period	3,400	
		3,100-3,500	
		4,000	

Source: Biology- Science and Technology II Textbook, 1990.

Era is the largest division of Geologic Time Scale, namely Precambrian, Paleozoic, Mesozoic, and Cenozoic. Each Era is further divided into Period.

Looking at the Geologic Time Scale, can you determine how old is the Earth? Do you have any idea why particular organisms exist in every period or era?

## Hint of Evolution from Comparative Anatomy

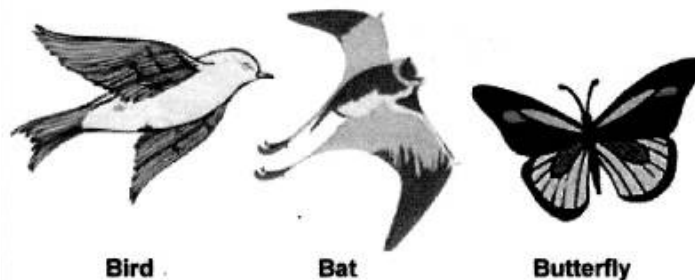
Another hint of evolutionary concept is from the comparative anatomy. Structures from different species which have similar internal framework, position, and embryonic development are considered to be homologous.

Homologous structures may perform different functions in the species living in the different environment, or it may have the same origin but different functions.



Here are some example of homologous structures: forelimbs of dog, bird, lizard, and whale, which are structurally the same, but functionally different.

Structures of unrelated species may evolve to look alike, because the structure is adapted to similar function. These are called analogous structures. Analogous structures have similar functions but different origin.



Examples are wings of birds, bats, and insects that have the same function but different in origin.

Q8. Can you give some examples of analogous structures? What are those?

## Activity 2

### AHA! Analogous! Homologous!




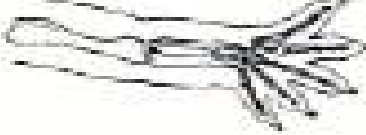




#### Objectives:

- Distinguish homologous structure from analogous structure.
- Explain the relevance of comparative anatomy as an evidence of evolution.

#### Materials:

- paper
- pen

**Directions:** Write in the space provided **H** if the structures below are homologous and **A** if they are analogous.

Structure		Classification
 Human arm	 Whale flipper	
 Human arm	 Alligator forelimb	
 Bat wing	 Butterfly wing	
 Bird wing	 Butterfly wing	

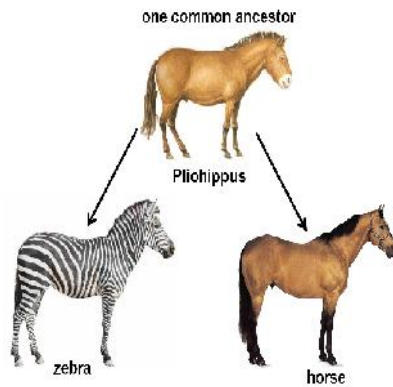
Activity from Payawal P. (1993)

Q9. Can you say that human, whale and bat might belong to a common ancestral group? Explain why.

Q10. Give other examples of homologous structures.

Front limbs of man, cat, horse, bat, whales, and other mammals are made up of same kinds of bones, they just vary only in size and function differently.

Divergent evolution

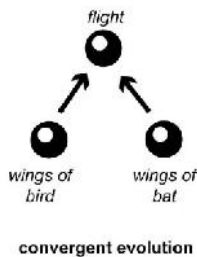


Source: pixgood.com  
(Pliohippus), pixshark.com  
(horse), background-kid.com  
(zebra)

The presence of homologous structures is a strong indicator that the organisms evolved from common ancestors. This type of evolution is called divergent evolution.

Divergent evolution is the splitting of an ancestral population into two or more sub-populations that are geographically isolated from one another.

Convergent evolution



Convergence is an increase in similarities among species derived from different ancestors as a result of similar adaptation to similar environment.

In convergent evolution, analogous structures of unrelated organisms from different ancestors develop similar function such as butterfly wings and bird wings.

Is it true that humans are related to other organisms? If yes, then who's your relative?

### Activity 3

#### So, Who is My Relative?

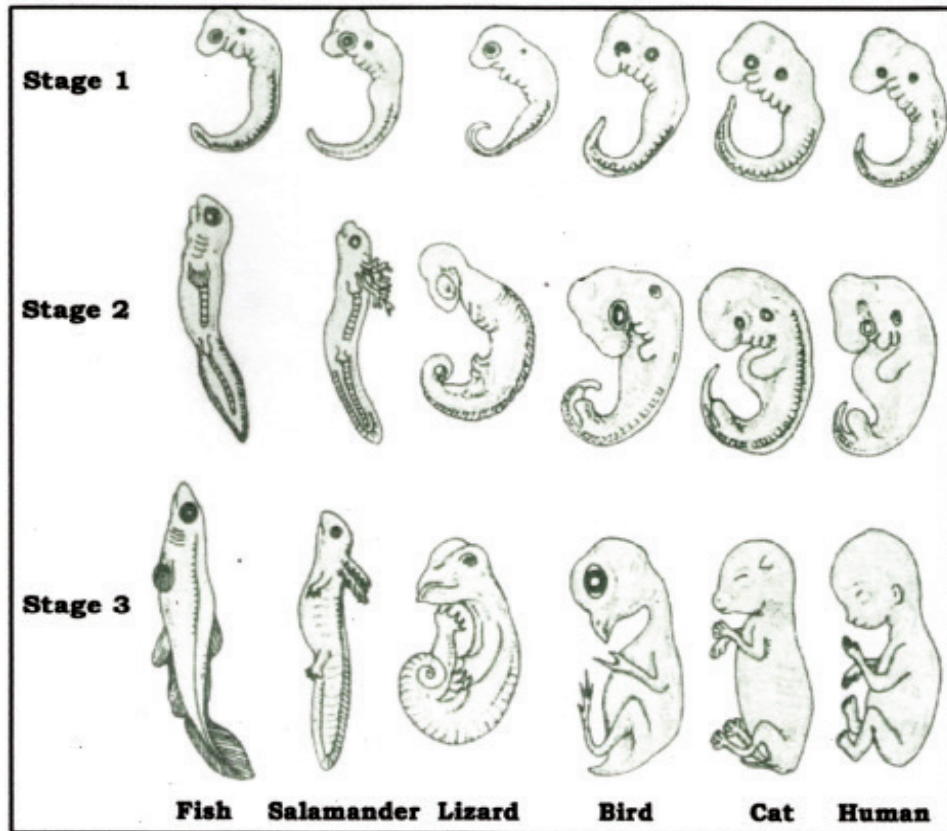
##### Objectives:

- Compare the stages embryonic development of different organisms.
- Explain how embryonic development provides clues for evolution.

##### Materials:

- paper
- pen

**Directions:** Study and compare the stages of embryonic development of the different vertebrates.



Source: Carale (1989)

- Q11. In what stages of development of the organisms above show similarities?
- Q12. Identify the structure, how and where are they similar?
- Q13. In stage 3, identify the structures that made the organisms different from each other?
- Q14. Can embryonic development be an evidence that evolution took place? Explain.

## Evidence from Embryonic Development

An embryo is an early stage of development in organisms. Embryonic development include stages such as blastula, gastrula, and organogenesis. The embryo of fishes, salamanders, lizards, birds, cats, and humans are similar during the first stage of their embryonic development; and have several homologous structures that are not present when the organisms are adults

Studies show that species that are closely related exhibit similar embryonic development. Even when in the adult stage, the organisms are quite different.

After the three activities, you've learned that fossil records, anatomical structures and embryonic development can be used to study the relationship of organisms. Another evidence of evolution is provided by the biochemical analysis and amino acid sequence of the organisms' DNA. The next activity will further help you understand more the relationship of organisms based on their amino acid sequences.

### Activity 4

#### Let's Compare

##### Objectives:

- Compare the sequence of amino acids in the cytochrome C of the different vertebrates.
- Infer about the evolutionary relationship of the organisms from the differences in amino acid sequence.

##### Materials:

- Pen
- paper
- graphing paper
- coloring materials.

##### Procedures:

1. Given are the sequences of amino acids in the cytochrome C of the human, chimpanzee, gorilla, Rhesus monkey, horse, and kangaroo. Cytochrome C is a respiratory enzyme located inside the mitochondria.
2. Study carefully the sequence of the amino acid.



- Supply the missing amino acid sequence of chimpanzee, gorilla, Rhesus monkey, horse, and kangaroo to complete Tables 2, 3 and 4. Refer to table 1 for your answer.
- Identify the differences using the amino acid sequence of human as reference.
- Complete Table 5 to show the number of amino acid differences and the position which they vary.

**Table 1**

	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101
Human	THR	LEU	SER	GLU	LEU	HIS	CYS	ASP	LYS	LEU	HIS	VAL	ASP	PRO	GLU
Chimpanzee	THR	LEU	SER	GLU	LEU	HIS	CYS	ASP	LYS	LEU	HIS	VAL	ASP	PRO	GLU
Gorilla	THR	LEU	SER	GLU	LEU	HIS	CYS	ASP	LYS	LEU	HIS	VAL	ASP	PRO	GLU
Rhesus monkey	GLN	LEU	SER	GLU	LEU	HIS	CYS	ASP	LYS	LEU	HIS	VAL	ASP	PRO	GLU
Horse	ALA	LEU	SER	GLU	LEU	HIS	CYS	ASP	LYS	LEU	HIS	VAL	ASP	PRO	GLU
Kangaroo	LYS	LEU	SER	GLU	LEU	HIS	CYS	ASP	LYS	LEU	HIS	VAL	ASP	PRO	GLU
	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
Human	ASN	PHE	ARG	LEU	LEU	GLY	ASN	VAL	LEU	VAL	CYS	VAL	LEU	ALA	HIS
Chimpanzee	ASN	PHE	ARG	LEU	LEU	GLY	ASN	VAL	LEU	VAL	CYS	VAL	LEU	ALA	HIS
Gorilla	ASN	PHE	LYS	LEU	LEU	GLY	ASN	VAL	LEU	VAL	CYS	VAL	LEU	ALA	HIS
Rhesus monkey	ASN	PHE	LYS	LEU	LEU	GLY	ASN	VAL	LEU	VAL	CYS	VAL	LEU	ALA	HIS
Horse	ASN	PHE	ARG	LEU	LEU	GLY	ASN	VAL	LEU	ALA	LEU	VAL	VAL	ALA	ARG
Kangaroo	ASN	PHE	LYS	LEU	LEU	GLY	ASN	ILE	ILE	VAL	ILE	CYS	LEU	ALA	GLU

Activity taken from Brittain T. (Biology the Living World) Lab Manual, 1989

**Table 2**

	87	88	89	90	91	92	93	94	95	96
<b>Human</b>	THR	LEU	SER	GLU	LEU	HIS	CYS	ASP	LYS	LEU
<b>Chimpanzee</b>	---	---	---	---	---	---	---	---	---	---
<b>Gorilla</b>	---	---	---	---	---	---	---	---	---	---
<b>Rhesus monkey</b>	---	---	---	---	---	---	---	---	---	---
<b>Horse</b>	---	---	---	---	---	---	---	---	---	---
<b>Kangaroo</b>	---	---	---	---	---	---	---	---	---	---

**Table 3**

	91	98	99	100	101	102	103	104	105	106
<b>Human</b>	HIS	VAL	ASP	PRO	GLU	ASN	PHE	ARG	LEU	LEU
<b>Chimpanzee</b>	---	---	---	---	---	---	---	---	---	---
<b>Gorilla</b>	---	---	---	---	---	---	---	---	---	---
<b>Rhesus monkey</b>	---	---	---	---	---	---	---	---	---	---
<b>Horse</b>	---	---	---	---	---	---	---	---	---	---
<b>Kangaroo</b>	---	---	---	---	---	---	---	---	---	---

**Table 4**

107	108	109	110	111	112	113	114	115	116
<b>Human</b>									
GLY	ASN	VAL	LEU	VAL	CYS	VAL	LEU	ALA	HIS
<b>Chimpanzee</b>									
---	---	---	---	---	---	---	---	---	---
<b>Gorilla</b>									
---	---	---	---	---	---	---	---	---	---
<b>Rhesus-monkey</b>									
---	---	---	---	---	---	---	---	---	---
<b>Horse</b>									
---	---	---	---	---	---	---	---	---	---
<b>Kangaroo</b>									
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**Table 5**

Organism	Number of amino acid differences
Human and chimpanzee	
Human and gorilla	
Human and Rhesus monkey	
Human and horse	
Human and kangaroo	

Activity taken from Brittain T. (Biology the Living World) Lab Manual, 1989

Q15. Based on the activity, which organism is closely related to humans?

Q16. Which organism is least related to humans?

1. Study tables 6 and 7 below.

**Table 6**

Species Pairings	Number of Differences in Amino Acid
Human - chimpanzee	0
Human - fruit fry	29
Human - horse	12
Human - pigeon	12
Human - rattlesnake	14
Human - red bread mold	48
Human - rhesus monkey	1
Human - screwworm fly	27
Human - snapping turtle	15
Human - tuna fish	21
Human - wheat	43

**Table 7**

Species Pairings	Number of Differences in Amino Acid
Fruit fly - dogfish shark	26
Fruit fly - pigeon	25
Fruit fly - screwworm	2
Fruit fly - silkworm moth	15
Fruit fly - tobacco hornworm moth	14
Fruit fly - wheat	47

2. In a graphing paper, plot the information on Table 6 and Table 7 in a bar graph, and use different colors to represent each pairing of species.

Q17. What organism appears to be least related to humans?

Q18. In Tables 6 and 7, which pair of organisms appears to be more related to each other? Which pair of organisms is the least related to each other? Why did you say so?

Q19. If the amino acid sequence of the two organisms are similar, would their DNA be also similar? Why?

Q20. Do you think the chimpanzee, gorilla, and humans have a common ancestry? Explain your answer.

The greater the similarity in amino acid sequence, the closer the relationship of the organisms. The organisms which are similar in structure and also possess similarity at the biochemical level could probably have a common ancestor.

## Theories of Evolution



Jean Baptiste de Lamarck was the first evolutionist to believe that organisms change over time. Using fossil records as a guide, Lamarck was able to develop three theories; one is The Theory of Need which states that organisms change in response to their environment. Their ability to survive helped them develop characteristics necessary for them to adapt in a given environment.

Next is The Theory of Use and Disuse; which according to Lamarck, organs not in use will disappear while organs in use will develop. Lamarck believed that giraffes before have short necks, but because of the need to survive and in order to reach tall trees for food, they kept stretching their necks until these became longer and able to reach taller trees. These acquired characteristics were believed to be inherited by their offsprings and propagated by the next generation of giraffes. Lamarck called it as The Theory of Acquired Characteristics.

If you change the color of your hair from black to blond, do you think your child can inherit the blond color of your hair? A young lady keeps on using whitening soap and becomes fair? Can her child inherit her acquired fairness?

Many scientists rejected the theories of Lamarck. They understood that if there were changes in cell or body structure, there could be changes in the genetic information of the species.

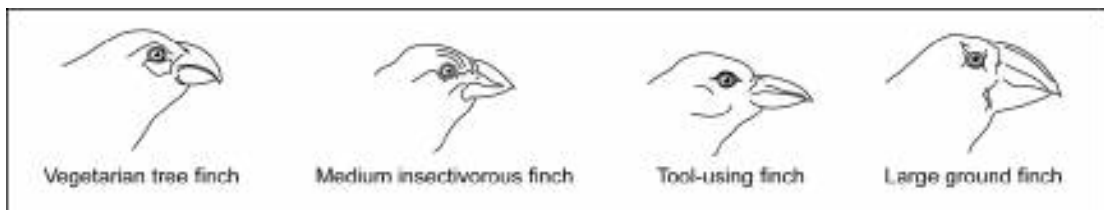
## Darwinian Theory



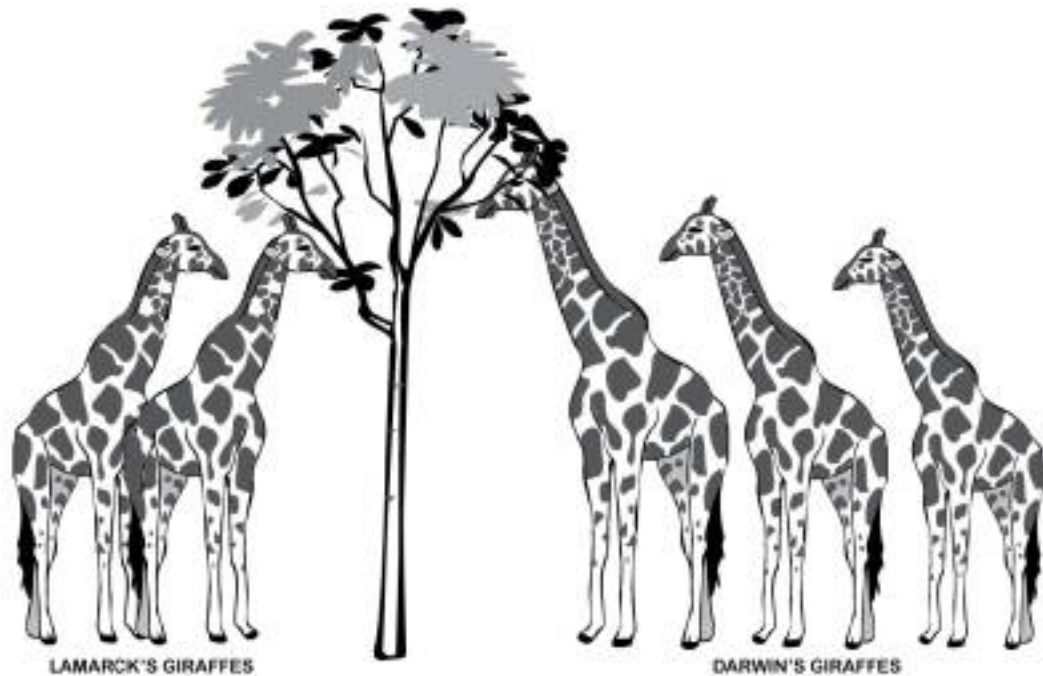
The more popular Theory of Evolution proposed by Charles Darwin based on natural selection is different from the theories of Lamarck. According to Darwin, giraffe species originally had varying neck lengths but natural selection favored the survival of giraffes with longer necks that could feed on taller trees that were available. Giraffes with short neck were eliminated due to lack of accessible food supply.

Fifty years after Lamarck's Theory of Use and Disuse, Charles Darwin suggested the Theory of Natural Selection, after his voyage to the Galapagos Island in HMS Beagle. He was fascinated by the diversity of organisms he found along the journey.

In Galapagos Island, he observed that finch species have different beak structures for different food types. The abundance of certain finch species in an island was somehow related to the type of available food for these birds.



Darwin suggested that selection also takes place in nature. In selective breeding, farmer identifies and selects the best and desirable trait to propagate. In natural selection, environmental factors promote the survival of the fittest and eliminates the less fit.



## Activity 5

### Follow the Track

#### Objective:

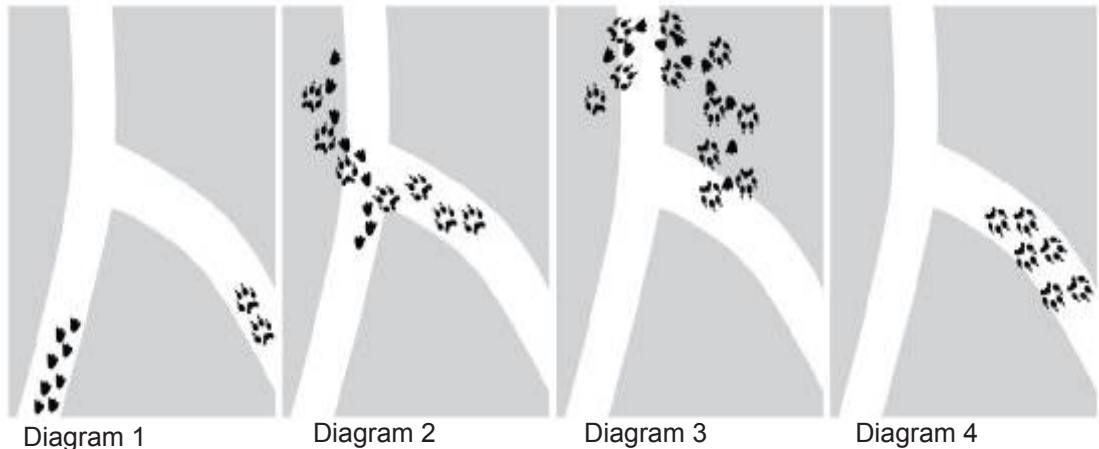
- Explain the Theory of Natural Selection.

#### Materials:

- pen
- paper

#### Procedure:

1. Observe the set of footprints in the diagram.
2. Try to tell a story about the different events.
3. Predict what can probably happen at the end of the diagram.



Q21. In Diagram 1, how many sets of footprints are there? Based on the size of footprints, describe the organisms.

Q22. In what directions are the footprints going?

Q23. Describe or predict what is happening in Diagram 3. In Diagram 4.

Create your own story using the four diagrams and share it to the class.

Organisms struggle for existence in order to survive; they compete for food and space. Organisms with favorable and advantageous characteristics survive and reproduce. Fitness refers to the ability of an organism to survive and produce offsprings. Different individuals in a population possess different characteristics and abilities. This is called variation.

Variation among individuals in the population would likely bring greater chance of survival. An organism that is adapted and has structures fitted to survive in a given environment would likely produce offsprings.

## Activity 6

### Survivor

#### Objective:

Determine the effect of environmental changes on adaptation and survival of a species.

#### Materials:

Tray (made up of chicken wire, 30 cm x 25 cm long and 4 cm thick), surgical mask, alcohol lamp, magnet, rags or mittens, glass of tap water, 25 pieces of marbles, paper clips, paper square (1.5 cm x 1.5 cm), candles, (1.5 cm x 1.5 cm), plastic cellophane (1.5 cm x 1.5 cm)

**Procedure:**

1. Place inside the tray, 6 pieces each of marbles, paper clips, square paper, plastic cellophane, and candles. Spread them thoroughly on the tray.
2. Hold the tray with a mitten and run it over an alcohol lamp for one minute. **Be careful while working with an alcohol lamp.**
3. Remove the burnt materials and record the “survivors” or those that did not get burned.
4. For every one survivor, add two offsprings. (Ex. for one marble, add two more marbles.)
5. Run along the magnet on the tray.
6. Count the number of survivors. Repeat procedure 4.
7. Using a glass of water, sprinkle water inside the tray.
8. Remove the wet and destroyed organisms on the tray.
9. Count and record the number of survivors and repeat procedure 4.

Disturbances				
Materials/ Organisms	Fire (alcohol lamp)	Earthquake (magnet)	Flood/ typhoon (water)	Total number of survivors
Marbles				
Paper				
Candles				
Plastics				
Paper Clips				

- Q24. Which of the organisms has the most number of survivors?
- Q25. Are there organisms that decrease in number or did not survive the three environmental disturbances?
- Q26. Compare and contrast the characteristics of organisms that survive and did not survive the three environmental disturbances.

Q27. How can changes and disturbances in the environment affect the survival of the species?

Your lesson in Grades 8 and 9 will affirm that genes can be transferred from parents to offspring. You also learned that the combined genes of parents will bring about variation of traits.

Variation increases the chance of survival of living things. Organisms with the best and desirable traits would likely adapt to environmental changes and may gradually become better suited to survive in a given environment.

Organisms which are best adapted to the environment will continue to reproduce and perpetuate their own kind. Mating between surviving populations of the same species may shift the abundance of a new breed of organism because of mutation, gene combination, and natural selection. This then leads to speciation and may subsequently increase biodiversity.

Q28. Can destruction of our natural resources affect the survival of species? How?

Q29. In what way can you help to protect our natural resources and save our biodiversity?

Do you want to survive in any given environment or situation? Better equip yourself with things and skills you need in order to survive.



## Performance Task

After learning about variation and adaptation you will now create a multimedia presentation about the things an individual must do in order to adapt and survive in environmental changes and challenges.

You can express your thoughts and ideas from the point of view of an environmentalist, a climate change advocate, a mayor or governor of a particular town or a barangay official. Your presentation should cater to the common citizens to encourage them to be aware of environmental changes that can occur, to prepare them for things they need to do, and to help them adapt and survive in these environmental changes. You can interview people from Department of Environmental and Natural Resources (DENR), Climate Change Commission, National Disaster Risk Reduction and Management Council (NDRRMC), and other government agencies and Non-Government Organization (NGO's) where you can gather information that will help you with your presentation.

Your multimedia presentation will be graded accordingly using a rubric. It will be assessed based on purpose, content, understanding of the concepts, additional information, and creativity.

## V. Summary/Synthesis/Feedback

- Species may change over time. Fossil records, Developmental and Molecular Biology and Genetics may provide possible evidence for evolution.
- Patterns in animal development suggest that some organisms may have one common ancestor.
- Evidence in structure and molecular studies suggests that organisms are related with one another.
- Jean Baptiste de Lamarck proposed The Theory of Need, The Theory of Use and Disuse and The Theory of Acquired Characteristics.
- Charles Darwin presented the Theory of Evolution based on natural selection.
- Speciation or formation of a new species may occur through mutation, gene combination, and natural selection.
- Speciation increases biodiversity.

## VI. Summative Assessment

Multiple Choice: Directions: Choose the correct answer.

1. Where can most of the fossils be found?
  - a. Sedimentary rock
  - b. Granite rock
  - c. Lava flows
  - d. Black soil
2. Which of the following statements DOES NOT describe evolution?
  - a. Evolution is continuous.
  - b. Evolution refers to change.
  - c. The world is stable and unchanging.
  - d. If there is mutation, there is evolution.
3. Which pairs of animals shows a correct example of homologous structures?
  - a. Wings of butterfly and wings of bat.
  - b. Flipper of whale and forelimb of cat.
  - c. Fingers of human and arm of starfish
  - d. Tongue of frog and proboscis of mosquito.
4. In what era can the oldest fossils be found?
  - a. Cenozoic
  - b. Mesozoic
  - c. Paleozoic
  - d. Pre Cambrian
5. Which of the following statements best explains the Theory of Natural Selection?
  - a. Organs that are not used may disappear, while organs that are constantly used may develop.
  - b. In nature, the organism with desirable characteristics may survive, while those with weaker traits may not.
  - c. Organisms develop desirable structures to survive in a given environment.
  - d. Acquired characteristics of parents can be passed on to offsprings.
6. According to evolutionists, which is the best test to show the relatedness of two organisms?
  - a. Similarity in development
  - b. Similarity in courting behavior
  - c. Similarity in structure
  - d. Similarity in genomic DNA

7. Which of the following statements explains Lamarck's Theory of Use and Disuse?
  - a. Body structures develop because they are used extensively
  - b. Body structures develop because they are not in use
  - c. Body structures develop because of competition
  - d. Body structures develop because of mutation
  
8. Based on the number of differences in amino acid sequence, which pair of organisms is least related to each other?
  - a. Fruit fly-wheat
  - b. Human-horse
  - c. Fruit fly- pigeon
  - d. Human - wheat
  
9. Why do organisms with close biochemical similarities show stronger evolutionary relationships?
  - a. They have varied and different ancestry.
  - b. They have similar pattern during their early stage of development.
  - c. They have a common ancestor and have the same kind of proteins.
  - d. They possess same vestigial structure that made their evolutionary relationship closer.
  
10. Which of the following statements supports the idea that extinction is necessary?
  - a. To give way for other organisms to develop
  - b. To let other organisms evolve and progress
  - c. To know who is the fittest
  - d. All of the above

Test II. Identify whether the following statements describe convergent or divergent evolution.

1. Two organisms which live in a certain area developed the same characteristics after a while.
  
2. A population of certain organisms went separate ways and developed different structures.

For numbers 3 and 4, draw the appropriate graphical representations of the following situations.

3. Three species of lizards inhabit a particular area in a forest; the heavily pigmented lizard, medium pigmented, and lightly pigmented lizard. After the introduction of new species of birds, only the heavily pigmented lizard increased in number; the medium and light pigmented lizard disappeared in the forest.

4. According to Charles Darwin, the necks of giraffes vary in length: the long neck, medium neck, and short neck. Shortage of food and competition made the short and medium neck giraffes disappear, while the giraffes with long necks survived.

## Glossary of Terms

<b>Adaptation</b>	ability of an organism to adjust and thrive in a given environment.
<b>Analogous structures</b>	structures in different organisms that are similar in function but different in origin
<b>Convergent evolution</b>	an increase in similarities among species derived from different ancestors as a result of similar adaptation to similar environment
<b>Divergent evolution</b>	an increase in the difference among descendants of a single ancestral species as time passes
<b>Evolution</b>	species change over time
<b>Fitness</b>	ability to survive and produce offsprings
<b>Fossils</b>	remains of once living things, fossil remains include bones, shells, teeth and also feces
<b>Gene</b>	a segment of DNA or RNA that codes for protein or RNA, a molecular unit of hereditary trait

<b>Homologous structures</b>	parts of different organisms that are similar in structure but serve different functions
<b>Reproduction</b>	the process by which an organism produces offspring and thus perpetuate the species
<b>Variation</b>	differences in traits of organisms in a population

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Unit 3  
MODULE

4

**ECOSYSTEM:  
BIODIVERSITY**

**Suggested Time Allotment: 10-11 hrs.**

## **I. Introduction**

In Module 3, you have learned how evolution through natural selection can result in biodiversity.

In this module, you will learn how biodiversity can influence the stability of an ecosystem, the relationship between population growth and carrying capacity of a specific environment. You will become aware of the different human activities that have a negative impact on the environment and propose projects (e.g., Clean and Green Project, Sagip Ilog, War on Waste, Urban Gardening, Adopt a River, etc.) that will help protect and conserve the biodiversity you have in your community.

Biodiversity describes how varied are life forms in different ecosystems. The Philippines is known for its very rich biodiversity. According to an article published in the Department of Environment and Natural Resources (DENR) 2014 website, “The country has more than 52,177 described species of which more than half is found nowhere else in the world.” On a per unit area basis, the Philippines probably harbors more diversity of life than any other country on the planet. But our country is also considered as a biodiversity hotspot. This is because our country is continuously experiencing an alarming rate of environmental destruction like damage of coral reefs, forests and other similar important resources. Do you know how important biodiversity is? You will find out as you go through this module.

## **II. Learning Competencies/Objectives**

### **What are expected for you to learn?**

1. How diversity of species increases the probability of adaptation and survival of organisms in a changing environment.
2. The relationship between population growth and carrying capacity.
3. The limiting factors that affect population growth.
4. Ways to minimize human impact on the environment.

### Key questions for this module:

How does biodiversity affect the stability of an ecosystem?  
What are the limiting factors that affect population growth?  
How does population growth affect the carrying capacity of an ecosystem?  
How do human activities affect the environment?  
What can you do to protect and conserve biodiversity in your community?

### III. Pre-Assessment

**Directions:** Fill in the table below to assess your prior knowledge about biodiversity and stability, and identify the skills needed in accomplishing the learning tasks in this module.

K	W	H	L
What do I know?	What do I want to find out?	How can I find out what I want to learn?	What did I learn?
Skills I expect to use:			

### IV. Reading Resources and Instructional Activities

#### Biodiversity and Stability

Biodiversity is a term that describes how varied living things are in a specific area. How many kinds of living things can be found in your community? Think about a place in your community; try to identify organisms that can be found in your locality and are valuable to your life. Why do you consider those organisms important to you?

Organisms are part of biodiversity and may be economically and ecologically valuable. Their products are source of food, medicine, clothing, shelter, and energy. These organisms are also important in maintaining balance in the ecosystem as they performing their specific roles. Some species maintain the quality of natural bodies of water; some prevent soil erosion and floods, cycle minerals in the soil and absorb pollutants. Others feed on insects and pests which control the population of organisms in a certain environment, thus making the ecosystem balance and stable.



The value of species can be divided into various categories:

1. **Direct economic value**

The species is considered to have direct economic value if their products are sources of food, medicine, clothing, shelter, and energy. For example, some medicines being used nowadays have formulations extracted from plants or animals. Vinblastine and vincristine are two chemicals that have been extracted from rosy periwinkle (tsitsirika in Tagalog) and are used in chemotherapy for Hodgkin's disease and some form of cancer, including lymphocytic leukemia. Another common plant, Vitex negundo (lagundi) is extracted for cough syrup production.

2. **Indirect economic value**

A species has an **indirect** economic value if there are benefits produced by the organism without using them. For example, certain species maintain the chemical quality of natural bodies of water, prevent soil erosion and floods, cycle materials in the soil, and absorb pollutants.

3. **Aesthetic value**

A lot of species provides visual or artistic enjoyment, like a forested landscape and the calming beauty of a natural park; or they may be used for spiritual meditation like the Prayer Mountains.

Now it's your turn to classify the value of biodiversity in an ecosystem. This will let you appreciate more the importance of the living things found in your community. Then try to think about how you can help conserve them.

## Activity 1

### Classifying the Value of Biodiversity\*

As a group, you are going to visit a specific area or ecosystem designated by your teacher. You will list down the organisms found in that area and describe the value of the organism. Then you will classify the value by putting a happy face (☺) on the space under the correct column.

**Table 1. Organisms and their value**

Organism	Value	Direct economic value	Indirect economic value	Aesthetic value
Example: Trees	• Freshen the air		☺	
	• Provide shade		☺	
	• Source of lumber	☺		

\*(Adapted from DepEd Science and Technology Biology textbook, pages 326-327)

Biodiversity is very important because it sustains through flow of energy the food web on earth and contributes to environmental stability. **Stability** of an ecosystem can be described as the resilience to withstand changes that may occur in the environment. There are many changes that occur in the environment which may be a result of natural or human activities. These changes may severely reduce biodiversity and result to the instability of the ecosystem.

Now that you appreciated the importance of biodiversity, try to examine how the population of organisms in an ecosystem affects biodiversity.

## The Ups and Downs of Population Growth

A population is a group of organisms of the same species that live in a certain area. Ecologists regularly monitor the number of organisms in many populations, but why do they do this? Why should we care if the number of organisms in an area is increasing or decreasing? Well, populations that are growing or diminishing can be indicators of potential problems in the organisms' environment, and such conditions alarm the ecologists if something is going wrong. But it is not enough to simply know if the number of organisms in an area is increasing or decreasing; ecologists need to know why the number of organisms is decreasing. So, one of the main questions ecologists ask themselves is this: Why is a population's size increasing or decreasing?

There are many factors that can cause a population's size to change. But first, you must understand the basic reasons behind why a population increases or decreases. Any population, whether it be that of humans, animals, the mold growing on bread, or the bacteria living in your intestines, will grow if more organisms are being developed (Genetically modified organisms), or born, than are dying. The number of births in a population is called the **birth rate** (natality). The number of organisms that are dying in a population is called

the death rate (mortality). Thus, if the birth rate is greater than the death rate, a population will grow. If the death rate is greater than the birth rate, then the population will decrease.

(Adapted from the activity on ecosystem created by Terie Engelbrecht)  
Source: [http://www.crazyteacherlady.com/uploads/5/1/4/8/5148626/objective\\_2\\_activities\\_pop\\_growth.pdf](http://www.crazyteacherlady.com/uploads/5/1/4/8/5148626/objective_2_activities_pop_growth.pdf)

### Think about this!

1. The human population is currently growing at an exponential rate. How can this be explained in terms of birth and death rates?
2. The monkey-eating eagle (*Pithecophaga jefferyi*) is considered an endangered species. What does this mean in terms of the birth and the death rate of monkey-eating eagles?



**Figure 1.** Sample Population Density of people in a certain community

While populations would probably to continue to grow in size, a population of organisms cannot grow forever—its growth will be limited, or stopped, at some point, and the death rate will be greater than the birth rate. A population's growth is limited by two general factors: density-independent factors and density-dependent factors.

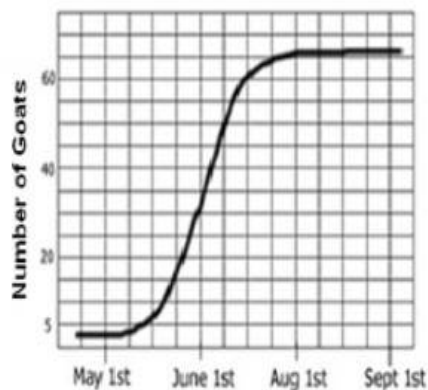
To understand why scientists named these factors in the way they did, you must first understand the concept of population density. Population density refers to the number of organisms per unit area. If a population's density is very high, that means there are a lot of organisms crowded into a certain area. If a population's density is low, that means there are very few organisms in an area.

A factor that regulates a population's growth and is influenced by population density, is called density-dependent limiting factor. If the population's density does not directly influence changes in population's growth, then it is called a density-independent limiting factor.

Density-independent limiting factors that can stop a population from growing can be such things as natural disasters, temperature, sunlight, and the activities of humans in the environment. Natural disasters such as tropical cyclones, floods, earthquakes and fires will stop a population from growing no matter how many organisms are living in a certain area. The same goes for the temperature of an area and the amount of sunlight it receives. If the temperature increases due to global warming, this will cause a decrease in a population's numbers, no matter how large or small the population was to begin with. Human activities that alter the environment will also decrease the number of organisms in a population, regardless of the size of a population.

Density-dependent limiting factors come into play when a population reaches a certain number of organisms. For example, when a population reaches a certain size, there won't be enough resources (food, shelter, water) for all of the organisms. This could cause the population to stop growing when it reaches the maximum number of organisms that can be supported, or "carried," by the environment. This number is known as the population's carrying capacity in a particular environment. Each population of organisms has a different carrying capacity, depending on the amount of resources available in the area in which it lives.

Below is a graph of a habitat where a goat population has reached its carrying capacity:

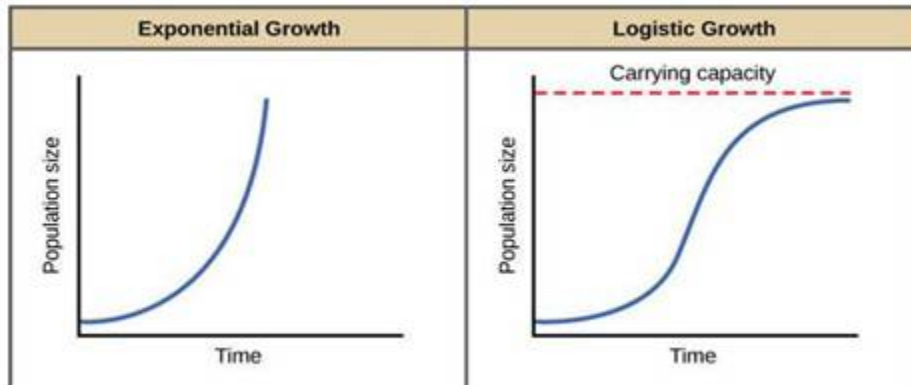


Q1. What is the carrying capacity?

Why? \_\_\_\_\_  
\_\_\_\_\_

Q2. What have you noticed with the population of goat between mid-May and mid-June? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Before a population reaches its carrying capacity, it experiences a period of rapid growth. This period of growth is called exponential population growth. During this period, there are plenty of resources available for all organisms, so more births are recorded than deaths in organisms.



When resources are unlimited, populations exhibit exponential growth, resulting in a J-shaped curve. When resources are limited, populations exhibit logistic growth. In logistic growth, population expansion decreases as resources become scarce, and it levels off when the carrying capacity of the environment is reached, resulting in a S-shaped curve.

Source: <http://cnx.org/content/m47780/1.1/>

**Think about this!**

3. Fill in the differences of the terms in the chart below:

Density-dependent limiting factor	Density-independent limiting factor
Logistic population growth	Exponential population growth

4. The human population is growing at an exponential rate. Since you have learned that population cannot grow infinitely, what do you think will happen if the human population reaches its carrying capacity? \_\_\_\_\_

## Limiting Factors that depend on population density

1. Diseases and parasites – Infectious diseases and parasites spread faster in densely populated areas.

2. Competition for resources - Organism with better adaptations to obtain (food) resources will be able to reproduce more often, and its population will grow. The organisms that have limited abilities to compete for the resources will not reproduce as often, may not be fit enough to live long, and can cause their population to decrease.

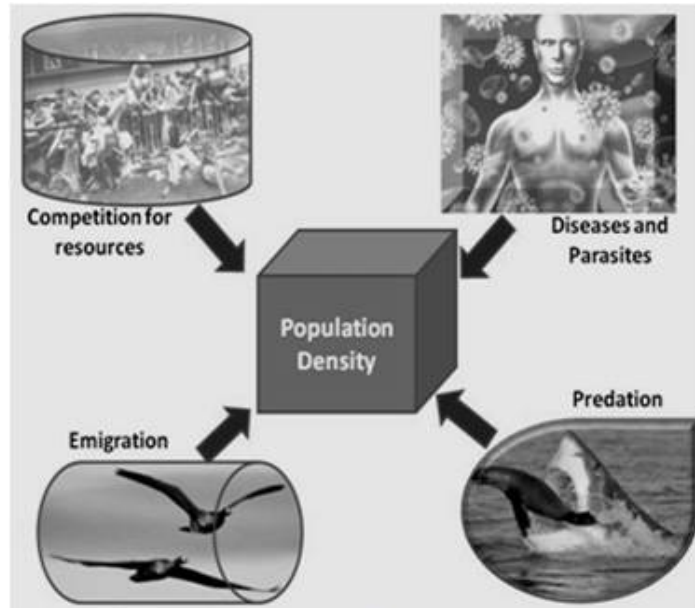


Figure 2. Diagram of Limiting Factors

3. Predation - plenty of prey are available, predators will be able to eat sufficiently, thus have energy to reproduce much, and increase their numbers. The population of their prey will begin to decrease as more and more of them are eaten. However, the predator population will eventually reach carrying capacity—there will not be enough prey for all of the predators in the population, since the predators themselves compete for their “prey” resource. As the number of prey decreases, so will the number of predators, because there is not enough food to sustain them.
4. Emigration - Emigration occurs when, as a population approaches its carrying capacity, and individual organisms leave and go to a new area where they can find enough resources for survival and reproduction. This will obviously cause a decrease in the amount of organisms in a population.

## Activity 2

### Dependent or independent?

1. Read each situation in the table below, then state if it is a density-independent limiting factor or a density-dependent limiting factor. Indicate the specific limiting factor that is occurring.

Situation	Density-independent or density-dependent?	Limiting factor
Mrs. Rosales has 55 students in her biology class, but she has room for 50. Because the room was crowded, the 5 students were asked to go to the curriculum chairperson to change their schedule.		
Dinoflagellates in Laguna de Bay increase in population due to increase in organic substance in the body of water brought by water pollution.		
The oil spill in Cavite area harmed many aquatic organisms in the vicinity.		
A new strain of Dengue virus breaks out in the country.		
Super typhoon Yolanda caused many residents to leave Leyte.		
Population of wild boar decreases because of deforestation.		
An increase in population of house lizard in Barangay Himpot causes a decrease in population of mosquito.		

2. Cause and Effect

Read the causes on the left side of the chart then predict and write the effect on the right side of the table.

Cause	Effect
Statistics show that the number of babies born per day doubles the number of death per day.	
Palawangovernmentcreatesmoreimprovised breeding areas for the endangered marine turtle and coral reef fishes in their area.	
Sharks are hunted and killed for their fins.	

You have learned how a certain activity or phenomena affects the environment; now, try to think of possible solutions to some of the pressing environmental concerns in our country.

## **Environmental Problems and Issues**

The Philippines is considered as one of the biologically richest country in the world because of its high biodiversity at various levels. Our country has both aquatic and terrestrial ecosystems, and also a high degree of endemism, meaning high numbers of native species of flora and fauna are found only in tropical communities.

We have all these rich natural biological resources but we have not truly protected them. We are losing this global heritage due to habitat destruction, overuse and pollution. As our forests are destroyed at a fast rate, the natural habitats which are dwelling places of plant and animal species are also lost. Our coral reefs, where the fishes lay eggs, are badly damaged by destructive fishing methods such as muro-ami, dynamite and fine nets in fishing. In addition, people hunt animals, collect plants, and sell corals and exotic animals for livelihood, and other activities that cause the population of these organisms to decrease at a faster rate. Hence, in view of these harmful human activities, our country is also noted in the world as a hot spot for conservation and protection of species.

The rate of development in some parts of the country is extraordinary. The natural landscape has been changed by tall buildings, establishments, housing projects, expressways, railway systems and overpasses. Other reclaimed areas have been converted into industrial structures and techno parks.



**Figure 3.** Forested area converted into housing



You may observe similar changes taking place in your community. How do these changes in the community might affect biodiversity in your locality?

For you to provide a good solution you need to analyze these problems. To do that you have to perform the following activities.

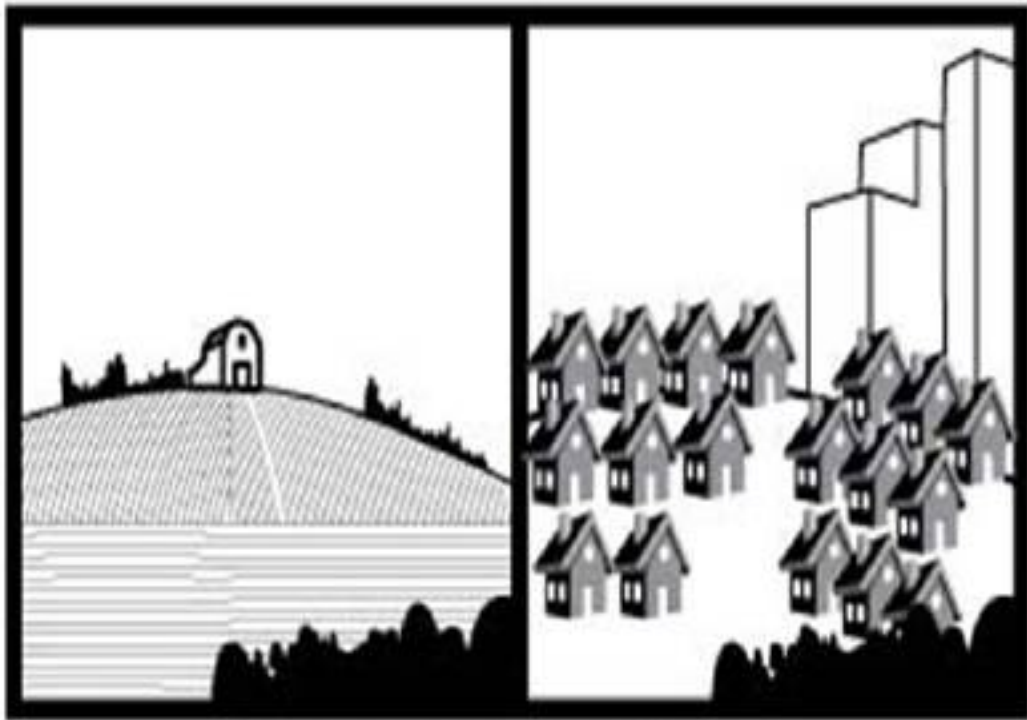
### Activity 3

#### Analyzing Environmental Issues

(Adapted from DepEd Science and Technology Biology Textbook page 345)

Directions: Analyze the problems depicted in the pictures that follow. What effects do these problems create on the ecosystem? What causes these problems?

#### Problem 1. Farmlands are converted into housing projects



**Farmland to Housing Project**

**Problem 2. River ecosystem dumped with garbage from illegal settlers and toxic wastes from industries.**



**River to Wasteland**

**Problem 3. Forested area is converted into technopark.**



**Forest to Techno Park**

You have learned in the previous activity that human activities have impacts on the environment that may have negative or positive result to economic and social attributes of the community.

The next activity will guide you in determining the status of biodiversity in your area and identifying its effect on the economy, environment and social aspects in the locality. Try to think of a possible project proposal that will help conserve or improve this status and lessen the negative impact on the society.

## Activity 4

### Biodiversity Status in the Community

You need to gather data about the status of biodiversity, population density, and carrying capacity of your locality to determine the effects of these concerns on the economic, environment and social aspects of your community.

A. Use the guide questions below to plan out how you will accomplish this task.

Guide Questions:

1. What will be the task of each member of your group? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
2. What are the possible questions that you will ask in your survey/interview? \_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
3. Who are your target respondents for your survey/interview? \_\_\_\_\_  
\_\_\_\_\_
4. How will you organize the data that you gathered? \_\_\_\_\_  
\_\_\_\_\_
5. What are the possible ways that your group can do beyond class hours to complete your learning tasks? \_\_\_\_\_  
\_\_\_\_\_

Take home task: Conduct a survey or interview at the local Department of Environment and Natural Resources Office (DENR).

## B. Analyzing local biodiversity status

Complete the table below based on the data gathered from the survey or interview.

Status of Local Biodiversity	Threats Faced by Local Biodiversity	Local Conservation Efforts	Gaps	Proposed Possible Strategies

### Activity 5

#### Product Creation

Now that you are done with the analysis and plan on how to conserve and protect your local biodiversity, you will produce materials that support the strategies and programs in its conservation and protection. During the creation of your product, you will undergo the cycles of creations: planning, doing reviewing and sharing to ensure quality in your output.

#### Planning

After learning about the project or ideas, you will be asked to select one project to work on with a group of three to five students. Before beginning with your project, you must first write a project plan and get it approved by your teacher.

#### Questions to consider:

1. How has your community changed since the time you have lived there?
2. What important issue is your community facing with regards to conservation and protection of local biodiversity? Why is the issue considered a problem or challenge in conserving the local biodiversity?

3. What other information will you need to find out about this issue? Where will you find this information?
4. How is your community likely to change in the next few years?
5. What can people do in the community do to help protect and conserve the local biodiversity?
6. How can you encourage them to participate in this project?
7. What materials do you need for this project?

### **Planning for your presentation**

Work with your group to plan for your presentation. Discuss your answers to the following guide questions. Write your ideas on a sheet of paper.

1. Review the description of the project you will be working on and rewrite the challenges in your own words. Discuss the questions you need to consider.
2. What are the big ideas that you will address in your presentation? Which ones will you need to research and explore further?
3. How will you begin your presentation? What information do you think should your presentation contain? How do you want your presentation to end?
4. What smaller activities might you include as part of your presentation?
5. How will you entertain your audience? Will you have printed materials for them? Will some of your members act, sing, or dance?
6. Who among your group members will work on specific tasks?
7. How long would it take for each member to complete his/her assigned task? Which task/part should be completed first? Which should come last?

Review your presentation plan. Use a rubric as guide and present it to your teacher.

## **Doing**

Now that your group has put together the plan that has been approved by your teacher, you can now start working on your presentation. Remember that you only have few class sessions to complete your work, so it is important that you use your time wisely.

Before you begin your work, meet as a group and review the steps below.

1. Read and check your approved plan. Be sure that everyone knows what task to accomplish.
2. Complete the required research. Use available resources including the data gathered from the survey or interview.
3. Check on your progress using the progress checklist provided by your teacher.

## **Reviewing**

Towards the end of the class session, you should review the work you have completed and consider the following questions:

1. From the information that you gathered, which do you think is not necessary? What other information do you need?
2. How does each completed task help make your big ideas clear?
3. What could be done to make the different parts look like they belong in the same presentation?
4. Make any desired changes. Remember to acknowledge or appreciate the task done by each member of the group.
5. Practice your presentation.
6. As you practice, make sure you take note of all the possible questions that your audience may ask you. Come up with the possible answers in advance.

## Activity 6

### Showcasing of Products

Your group will give a final presentation to an audience including invited members of the community, parents, teachers and classmates.

In addition, you will watch and listen to other groups' presentation.

A. Review the steps below:

1. When it is your turn to share, remember to speak slowly and clearly so people can understand what you are saying. When you are finished, allow members of the audience to ask questions.
2. As other groups give their presentations, watch and listen quietly, pay attention to the information they are sharing. Think about the things you like about the presentation, as well as any questions you may wish to ask later.

## V. Summary/Synthesis/Feedback

- Biodiversity benefits people in many ways. It can be of economic, ecological or aesthetic value.
- Greater biodiversity promotes a more stable ecosystem.
- The more recent loss of biodiversity has been attributed primarily to human activities such as overfishing, overhunting, and loss of habitat.
- Population growth gives us an idea on how fast a population changes over time.
- Population growth can be affected by density-dependent or density-independent limiting factors.
- Changes in the habitat may cause an increase or decrease in biodiversity.
- Humans are obliged to take responsibility in maintaining a clean and healthy state of the ecosystem.

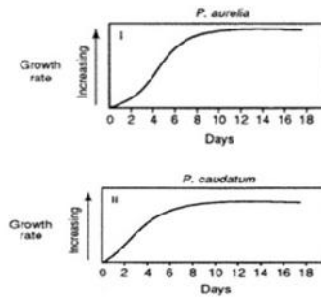
## VI. Summative Assessment

Directions: Answer the following questions.

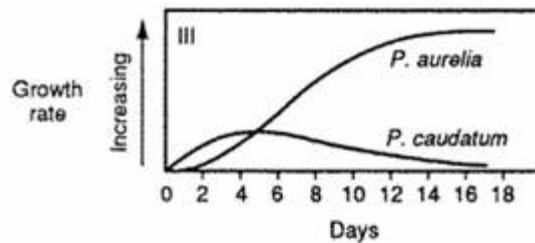
- A. How should each of the ecosystems below be used to conserve its resources? Explain your choice.
1. Coral reef
    - a. Promote it as an ecotourism destination
    - b. Collect coral fishes and sell them to pet shops.
    - c. Collect corals as souvenir items for tourists.
  
  2. Hilly land
    - a. Convert it into an industrial area
    - b. Build a community where houses are built among the trees.
    - c. Turn it into a jogging area
  
  3. Rainforest
    - a. Cut the trees into logs and make timber.
    - b. Get only minor forest products.
    - c. Advertise it as a camping site.
  
  4. Cocolisap infestation outbreak has been declared in some parts of the Philippines. The cocolisap feeds on the sap of the coconut tree and injects toxic enzymes, resulting in discolored leaves and deformed plant tissues that retard its growth of coconut tree. This, results in a decrease of the survival rate of coconut trees. Which of the following factors limit the population of coconut trees?
    - a. diseases and parasites
    - b. emigration
    - c. predation
    - d. competition for resources
  
  5. Davao is known for its wide variety of fruits and other plant species that makes it more attractive to tourists. Which of the following classification of value of biodiversity is described?
    - a. Direct economic value
    - b. Indirect economic value
    - c. Ethical/cultural
    - d. both a and c



6. What type of population growth is shown in the graph:
- normal growth
  - exponential growth
  - logistic growth
  - none of the above



For question no. 7-8 study the graph below.



7. What can you infer about the graph?
- The graph shows that an increase in population of the protist *P. aurelia* causes a decrease in the population of *P. caudatum* when they are grown together.
  - The graph is an example of a density-dependent limiting factor.
  - The graph is an example of a density-independent limiting factor.
  - The population of *P. caudatum* decreases while the population of *P. aurelia* increases when they are grown together.
8. Which of the two protists is better adapted to competition?
- P. aurelia*
  - Both of them
  - P. caudatum*
  - None of them
9. Which of the following causes a decreasing wildlife population in most of the places in our country?
- loss of limiting factor
  - loss of natural disturbances
  - loss of habitat
  - loss of carrying capacity
10. A person breeds guinea pigs in a cage. After a few generation, the breeder observes that the guinea pigs are more aggressive towards each other, the young are less healthy and more young guinea pigs die. What do you think will happen to the population of the guinea pigs?
- The population will remain the same.
  - The population will increase.
  - The population will decrease.
  - The population is not affected.

## Glossary of Terms

<b>Biodiversity</b>	the variety of life forms in a particular ecosystem
<b>Carrying capacity</b>	the maximum number of organisms that an environment can support
<b>Ecosystem</b>	a community of organisms that live, feed and interact with the environment
<b>Exponential growth</b>	a constant increase in the number of population
<b>Limiting factors</b>	factors that control the growth of a population
<b>Logistic growth</b>	a population growth in which the growth rate decreases with increasing number of organisms, until it becomes zero when the population reaches its carrying capacity
<b>Population</b>	the total number of organisms belonging to the same species in a particular environment
<b>Population density</b>	the measurement of population per unit area
<b>Stability</b>	the ability of an ecosystem to be self-regulating, and again become steady after a disturbance

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