PEAC
PRIVATE EDUCATION ASSISTANCE COMMITTEE
Trustee of the Fund for Assistance to Private Education

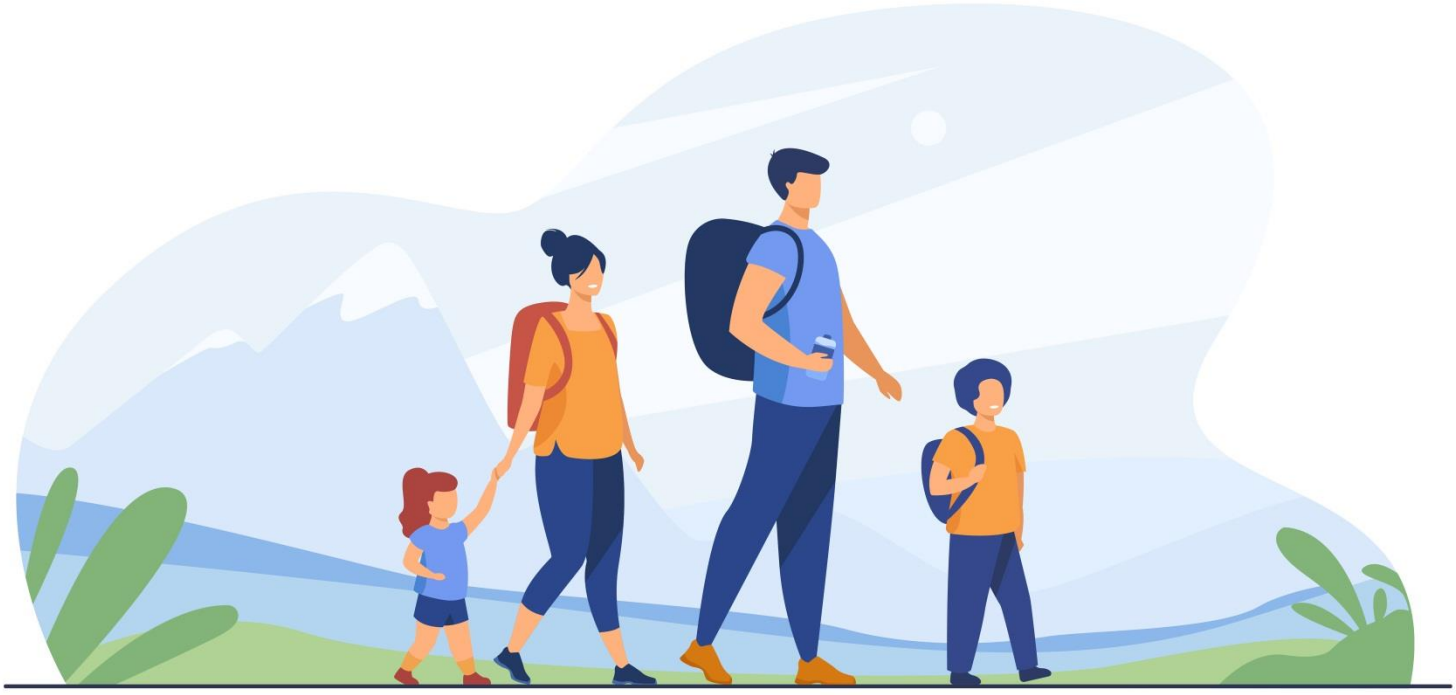
DepED
DEPARTMENT OF EDUCATION

2018

LEARNING MODULE

Science G10| Q3

Living Things and Their Environment



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NOTICE TO THE SCHOOLS

This learning module (LM) was developed by the Private Education Assistance Committee under the GASTPE Program of the Department of Education. The learning modules were written by the PEAC Junior High School (JHS) Trainers and were used as exemplars either as a sample for presentation or for workshop purposes in the JHS In-Service Training (INSET) program for teachers in private schools.

The LM is designed for online learning and can also be used for blended learning and remote learning modalities. The year indicated on the cover of this LM refers to the year when the LM was used as an exemplar in the JHS INSET and the year it was written or revised. For instance, 2017 means the LM was written in SY 2016-2017 and was used in the 2017 Summer JHS INSET. The quarter indicated on the cover refers to the quarter of the current curriculum guide at the time the LM was written. The most recently revised LMs were in 2018 and 2019.

The LM is also designed such that it encourages independent and self-regulated learning among the students and develops their 21st century skills. It is written in such a way that the teacher is communicating directly to the learner. Participants in the JHS INSET are trained how to unpack the standards and competencies from the K-12 curriculum guides to identify desired results and design standards-based assessment and instruction. Hence, the teachers are trained how to write their own standards-based learning plan.

The parts or stages of this LM include Explore, Firm Up, Deepen and Transfer. It is possible that some links or online resources in some parts of this LM may no longer be available, thus, teachers are urged to provide alternative learning resources or reading materials they deem fit for their students which are aligned with the standards and competencies. Teachers are encouraged to write their own standards-based learning plan or learning module with respect to attainment of their school's vision and mission.

The learning modules developed by PEAC are aligned with the K to 12 Basic Education Curriculum of the Department of Education. Public school teachers may also download and use the learning modules.

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SCIENCE 10

Module 1: Living Things And Their Environment

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

INTRODUCTION AND FOCUS QUESTION(S):

http://www.medicalmalpracticeinquirer.com/assets_c/2011/01/iStock_000004641088Large-thumb-300x200-6230.jpg

Do you think it is possible to live a normal life if your endocrine and nervous systems are not able to stabilize conditions inside your body? What kind of life would this be?

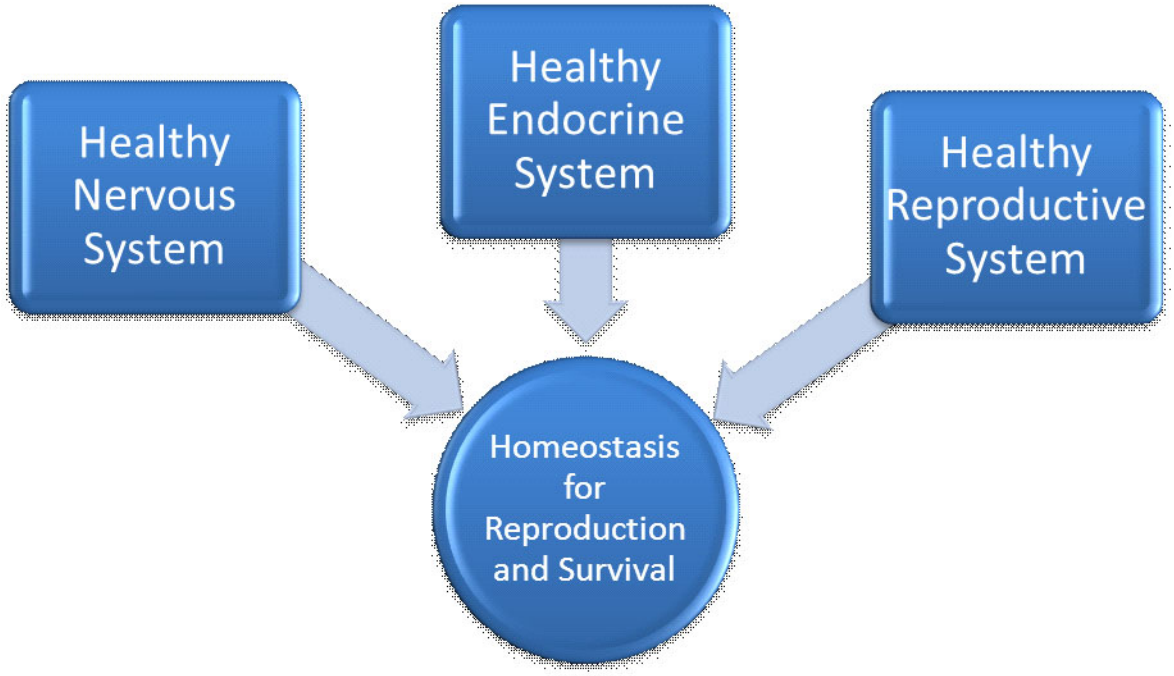
In this module, you will find out how the nervous, endocrine, and reproductive systems work together to maintain homeostasis, the body's internal balance. Remember to search for the answer to the following question: Why should the body's internal balance be maintained? How can this balance be achieved?

LESSON COVERAGE:

In this lesson, you will learn the following:

- Identify feedback mechanisms in organisms which are coordinated by the nervous and endocrine systems.
- Describe how these feedback mechanisms help the organism maintain homeostasis to reproduce and survive.
- Practice healthful habits to maintain proper functioning of the organs of the reproductive system.

LESSON MAP:
Here is a simple map of the lesson you will cover:



EXPECTED SKILLS:
To do well in this lesson, you need to remember and do the following:

a) *Identify and remember the key terms in each lesson. Take note of the examples given.*
b) *Read and study carefully the resources and online links.*
c) *Answer all questions and exercises as best as you can.*
d) *Take down notes as you go along.*

PRE-ASSESSMENT:

Let's find out how much you already know about this module. Click on the letter that you think best answers the question. Please answer all items. After taking this short test, you will see your score. Take note of the items that you were not able to correctly answer and look for the right answer as you go through this module.

(A) 1. An egg cell is released by a sexually-mature female every month and leaves the ovary via the _____.

a. cervix
b. fallopian tube
c. uterus
d. vagina

(A) 2. The _____ is a part of the brain that works in close coordination with the endocrine system.

a. brainstem
b. cerebellum
c. cerebrum
d. pituitary gland

(A) 3. When we get stressed, or when we are faced with something very exciting, we would usually feel a "rush." This happens when the _____ gland sitting on top of each of our kidneys release epinephrine.

a. adrenal
b. pancreatic
c. pineal
d. salivary

(A) 4. FSH (follicle-stimulating hormone) is responsible for stimulating the ovaries to _____ estrogen. When _____ levels of estrogen are present, FSH production will be inhibited (stopped).

a. release; low
b. stop production of; high
c. stop production of; low
d. release; high

(A) 5. The hypothalamus contains thermoreceptors; these are nerve endings that are sensitive to the temperature of the body's blood. If we become too hot, the hypothalamus will send signals

a. to make blood vessels get wider for blood to lose heat.*
b. to make blood vessels get narrower for blood to retain cold.
c. to activate sweat glands that increase our temperature.
d. to deactivate sweat glands that lower our temperature.

(A) 6. LH (luteinising hormone) is released from the pituitary gland after it is stimulated by estrogen. This controls the production of progesterone. Therefore, _____ levels of progesterone inhibit further release of LH.

a. equal
b. fluctuating
c. high
d. low

(A) 7. You stay in a cold office, yet you strictly follow drinking 8 glasses of water everyday. You noticed that the entire day, you kept on going to the washroom to urinate. Your urine looked just like water with no color at all! The reason for this is that

a. your hypothalamus detected that the color of your urine has been dark yellow which is unhealthy.
b. your hypothalamus detected too much water in the blood, and can therefore release more of it in urine.
c. your hypothalamus released anti-diuretic hormones continuously.
d. your hypothalamus released anti-diuretic hormones at the end of the day.

(A) 8. The pituitary gland produces TSH (thyroid stimulating hormone) so that the thyroid gland will release thyroxine, the hormone that leads to oxygen consumption needed in tissue and cellular metabolism. The pituitary gland can be expected to discontinue TSH release when

a. there is a lot of food that needs to be digested and metabolized for heat production.
b. there is lack of food as an adaptation to starvation, as it slows nutrient use for generating heat.*
c. there is food present whether in abundance or when it is scarce.
d. there is need to increase one's temperature.

(M) 9. A famous race car driver got into an accident which affected his brain. According to doctors, his hypothalamus was seriously affected by the trauma. As he jumped off his car to celebrate a victory, his foot got entangled with the seatbelt which caused him to hit his head on the ground. He already took off his helmet by then. Since the accident happened, his family noticed how much he seemed to have lost his appetite. What might be the most likely reason behind this condition that he is suffering from?

a. His weight gain after the accident triggered his taste and smell receptors to reject food which led him losing his appetite.
b. The protein leptin is proportionate to body fat. Leptin release is inhibited with continuous weight loss of a person. It is likely that the disorder in the hypothalamus released more leptin in the blood.
c. All patients who suffer from traumatic brain injuries lose their appetite since the nerve used by taste receptors are sure to get affected.

d. Continuous weight loss from hospitalization promotes release of hormones from the hypothalamus that lead to loss of appetite.

(M) 10. Breast Cancer Awareness month is observed every month of October. Estrogen is the hormone known to function for growth and development of breasts and organs vital for childbearing. However, high lifetime exposure to estrogen has been linked to increased risk of breast cancer. Instances when this could happen include being overweight, having a high intake of animal-based foods, and xenoestrogens (*synthetic chemicals that mimic human estrogen*). What is the best advice that you could give to your female relatives in order to lessen their risk of getting breast cancer?

a. Eat vegetables that are rich in phytoestrogens (*they have the same, yet weaker effects as human estrogen*).
b. Continue having a high meat intake but lose weight.
c. Do a 3-minute strenuous exercise every week.
d. Minimize exposure to environmental estrogens by staying indoors.

(M) 11. *Osteoporosis*, or the weakening of bones due to bone loss, may be may be caused by low levels of estrogen (in women) and testosterone (in men). The release of Follicle-stimulating hormone (FSH), together with Luteinizing hormone (LH), increases testosterone levels. FSH and LH are dependent on Gonadotropin-releasing hormone (GnRH) that is produced by the hypothalamus. Once GnRH is released, it also cascades to the release of FSH and LH, which in turn, release testosterone. Which among the following might worsen an early onset osteoporosis in a 50-year old male?

a. jogging regularly for at least an hour
b. head injury affecting the hypothalamus
c. increased absorption of vitamin D in the digestive tract
d. getting involved in testosterone replacement therapy

(M) 12. Diabetes is a condition wherein elevated levels of glucose are present in the blood. This is due to the lack of insulin, a pancreatic hormone, the action of which is to increase absorption of glucose from the blood to be stored in the liver. Diabetes can lead to a variety of medical complications; to identify a few, it may affect the eyes, nerves (referred to as a *neuropathy*), as well as blood pressure (elevation). Why is it that doctors would say that even ectomorphs (small-built bodies) should watch their diet?

a. Their risk for hypertension (high blood pressure) is 2x higher than those who may be overweight.
b. They can also have pancreas that are not properly synthesizing insulin.
c. Insulin is produced less in ectomorphs since they have smaller pancreas.
d. Elevated glucose levels are seen more in ectomorphs compared to those who are obese.

(M) 13. Testosterone replacement therapy is prescribed to those who have symptoms of low testosterone levels. A major concern with this treatment is that patients are more predisposed to heart attacks and other heart-related conditions. It is normal for men to experience decreased blood testosterone levels as they age. Because of this drop in hormone level, one may develop infertility because of the possibility of low sperm count. Aside from this, decreased muscle mass and low bone density can also be expected. The following would not be advisable for middle-aged men except

a. join triathlon races while undergoing testosterone therapy.
b. get testosterone therapy even without symptoms of low testosterone levels.
c. request to possibly have testosterone replacement therapy for cancer patients undergoing testosterone-decreasing chemotherapy.
d. undergo testosterone replacement therapy for lost muscle mass due to a sports injury.

(M) 14. Recently, we have seen tight-fitting jeans in young adult males as one of the latest trends. Why should it not be surprising if ever those who followed this fashion trend would have low sperm count in their future medical tests?

a. Blood from the arms cannot reach the testes and promote sperm production.
b. Jeans that are tight would increase temperature in the region of the scrotum and cause low sperm production.*
c. Walking, which promotes sperm production, is limited by tight-fitting pants.
d. It is a mistake to form a correlation between tight pants and sperm production.

(T) 15. November has been declared as National Reading month. In cooperation with your school library, you wanted to grab the opportunity to raise awareness on the importance of maintaining internal balance through healthy nervous and endocrine systems. You will be handing flyers to high school students as they visit the different booths of the publishing companies that put up exhibits in your school. To be effective, your flyer should

a. compare and contrast the nervous and endocrine systems.
b. indicate how hormone imbalance can worsen if the nervous and endocrine systems are malfunctioning.
c. colorful to attract attention and encourage reading.
d. use high resolution photos of the different nervous an endocrine organs.

(T) 16. Diego learned that glucose regulation in the blood is the main function of the pancreas as it releases insulin. If he is writing the script for a skit that will be performed in class and a classmate would play the role of an insulin molecule, in which scene would that classmate be rarely seen?

a. insulin production in the pancreas

b. after a person eats pizza and pasta
c. late morning when one did not take breakfast
d. an hour after eating a chocolate bar

(T) 17. Cholo is almost finished preparing his presentation for his biology class. He was tasked to report in class the importance of homeostasis and the role that the nervous and endocrine systems perform in maintaining this internal balance. What will you advise him as he puts the finishing touches in his infographic?

a. Eskimos have evolved and no longer have sweat glands because of the extreme cold in their habitat.
b. Indicate that the release of all hormones follow a positive feedback mechanism.
c. Emphasize that sweat glands should always be enabled to release sweat to avoid overheating.
d. Emphasize that both systems are greatly dependent on blood to transport hormones to the target organs.

(T) 18. Ziggy's cousin Levi witnessed on the news a lady lift their grand piano on her shoulder as a fire quickly spread in their neighborhood. "*It's the effect of adrenaline,*" Ziggy told Levi about this feat which seemed to involve some super powers which lasted for a few seconds. Levi then blurted, "*I'd want that adrenaline effect too! But I want it to last longer, like several hours!*" If you were Ziggy, you would respond by saying that

a. "*It's a bad idea; you're going to run out of adrenaline in your adrenal glands and not be able to replace it.*"
b. "*It's not possible; you're still too young to produce adrenaline that would last for several hours.*"
c. "*It's not possible; at your age, only one adrenal gland is active while the other one gets activated only by age 20.*"
d. " *It's a bad idea since adrenaline also makes your respiratory rate and blood pressure high."*

(T) 19. You received a call from the school where you applied for a teaching position. The topic you chose was the nervous system and its role in maintaining homeostasis. You wanted your demo class to be engaging and opted not to do a lecture. Which among the following would you choose?

a. Show a short video of the topic then let students sing your original composition on the topic to the tune of a popular song.
b. Do a cooperative learning activity having a maximum of only 3 students per group.
c. Use a professionally-made animation that demonstrates how a nerve impulse is conducted along a nerve.
d. PowerPoint presentation clearly showing the location of the pituitary gland in relation to the rest of the brain.

(T) 20. Being the sports editor of your school paper, you got the rare chance to interview Brandon Vera, the popular Filipino-American mixed martial artist who competes in the sport professionally. As you played back the audio recording of your interview with him, he mentioned that mixed martial arts is a *testosterone-charged* sport. How would you expound on this in your feature article? You will probably say

a. It's a sport joined only by men since women do not have testosterone.
b. It's a sport requiring more muscle mass and high bone density, the traits promoted by high testosterone levels.
c. It's a sport where many athletes have been found taking testosterone supplements to improve their decision-making capabilities.
d. It's a contact sport participated in by both men and women where participants are given testosterone shots as a safety precaution.

EXPLORE

At your age, you probably have friends or classmates who are so engrossed about going to the gym to make their muscles bigger or probably to lose weight; there are those as well who regularly join mini-marathons like the 3K, 5K, or 10K while keeping in mind a healthier heart. But how come you are not likely to hear teenagers doing activities that would benefit their endocrine, nervous, or reproductive systems? These three systems need to have very close coordination to keep our internal conditions stable. How can such stability inside our bodies be achieved? **Why should the body's internal balance be maintained? How can this balance be achieved?**

http://www.clearcomplexionb5.com/wp-content/uploads/2013/10/guy-running-gym.jpg

ACTIVITY NO. 1: Webpage Reading

http://banglabox.com/wp-content/uploads/healthy-skin.jpg

Follow this link: http://www.organicauthority.com/health/top-ten-healthy-foods-for-women.html in order to have a better idea of what foods should be considered for women's health.

PROCESS QUESTIONS:

1. What ideas on food and reproductive health did you learn after reading this article?
2. **Why should the body's internal balance be maintained?**

ACTIVITY NO. 2: Video Viewing

Click on this link: www.youtube.com/watch?v=RcBgo8IDiUU to have an idea as to what hypothyroidism is. (*watch only up to the 2:52 mark*)

http://i.ytimg.com/vi/RcBgo8IDiUU/maxresdefault.jpg

PROCESS QUESTIONS:

1. What ideas on hypothyroidism did you learn after viewing the video?
2. **Why should the body's internal balance be maintained?**

ACTIVITY NO. 3: ELICITING PRIOR KNOWLEDGE THROUGH I-R-F CHART

What were your initial answers to the questions posed in the previous activity, **why should the body's internal balance be maintained?**

Summarize your answers to the question, and your thoughts and ideas in the first column of the IRF Chart.

WHY SHOULD THE BODY'S INTERNAL BALANCE BE MAINTAINED?		
Initial	**R**evised	**F**inal

End of EXPLORE:

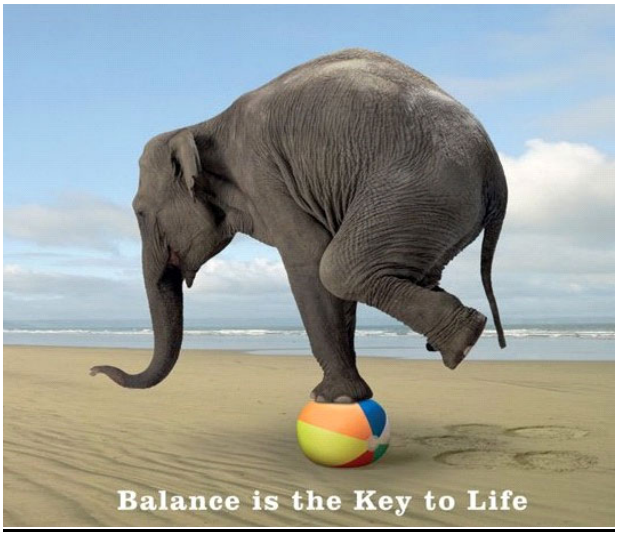
You just tried finding out how the nervous, endocrine, and reproductive systems work together.

Let's find out how your other classmates answered the first column of the IRF chart. You can make use of the *Discussion Forum* to communicate with your classmates. Compare their ideas with your own.

What you learn in the next sections will also enable you to do the final project which involves presenting healthful habits that promote proper functioning of the organs of the reproductive system.

Let's start gathering information by proceeding to the next part.

FIRM-UP



http://www.livelifeactive.com/wp-content/uploads/2014/03/Balance-is-the-key-to-life1.jpg

Let's continue this module by gathering your thoughts about the processes involved in the nervous, endocrine, and reproductive systems. Your goal in this section is to learn and understand the coordination among these three systems in ensuring that a balance is always maintained inside the body. You will determine and relate the different factors that are at work as these systems constantly exert effort in order to achieve homeostasis.

I. Reproductive System

ACTIVITY NO. 4a: WEBPAGE READING

Read the webpages below by following the links provided. These articles present, in a student-friendly way, how the reproductive system performs its role in males and females.

a. http://kidshealth.org/teen/your_body/body_basics/male_repro.html - Male Reproductive System
b. http://kidshealth.org/teen/sexual_health/girls/female_repro.html - Female Reproductive System

PROCESS QUESTIONS:
1. What are the *three main functions* of the male reproductive system? Describe how the different organs of the system enable it to perform those functions.

2. What are the *three main functions* of the female reproductive system? Describe how the different organs of the system enable it to perform those functions.

3. What are the problems affecting the male reproductive system? The female reproductive system?

4. How will an organ malfunction (*e.g.from ovaries, testes, etc.*) influence the entire organism?

5. **How can internal balance be maintained in the reproductive system?**

II. Endocrine and Nervous System

ACTIVITY NO. 4b: VIDEO VIEWING

Watch the videos below by following the links provided. These videos present in a student-friendly way how the nervous and endocrine systems must coordinate to efficiently perform their roles.

a. https://www.youtube.com/watch?v=f_Z1zsR9lFM – Intro to the Endocrine System
b. https://www.youtube.com/watch?v=QsftxduyET8 – Nervous System Remix (Ice Ice Baby)

PROCESS QUESTIONS:

1. What are the main functions of the endocrine system? Describe how the major endocrine organs perform these functions.
2. What are hormones? How are they involved in the endocrine system?
3. What are the main functions of the nervous system? Describe how the major endocrine organs perform these functions.
4. Why is it important that the nervous, endocrine, and reproductive organs are kept healthy? Consider how this can be evident in a member of a dance group or a bodybuilder by giving specific situations.
5. **Why should the body's internal balance be maintained? How can it be achieved?**

Be sure to take note of the important terms that you will encounter.
What are the terms that you gathered? Do the terms sound familiar? What can help you more easily remember these terms? Look back at your notes and try to cluster related concepts.

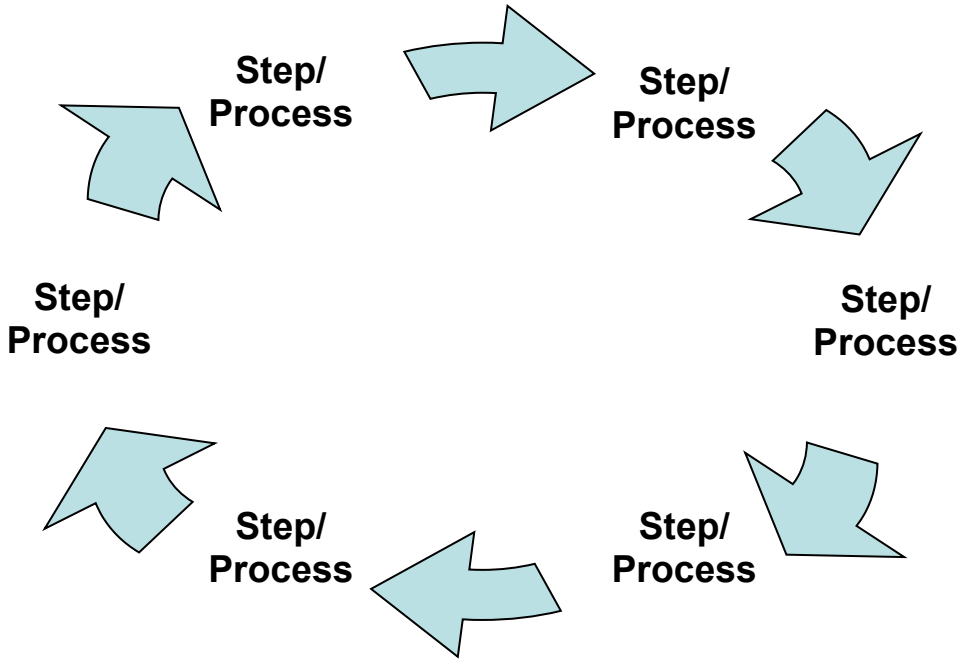
ACTIVITY NO. 5a: WEBPAGE READING

To gather idea on how blood glucose levels are regulated, click on the link below: http://www.abpischools.org.uk/page/modules/diabetes/diabetes4.cfm?coSiteNavigation_allTopic=1 – Controlling blood glucose levels

ACTIVITY NO. 5b: VIDEO VIEWING

Watch this video to further understand how blood glucose is kept within normal limits; click on the link: https://www.youtube.com/watch?v=vO-aMVzpgE8&index=12&list=PLXwnjgs_UWpIyKAZ9yaEUbv8Sz1AMve45 – Glucose regulation in the body

PROCESS QUESTIONS:
1. How is blood glucose regulated? Illustrate through a cyclic map.



2. What might be the likely consequences if it were not regulated in an elderly person?

3. Explain how a malfunctioning pancreas causes diabetes.

4. **Why should the body's internal balance (*including blood glucose levels*) be maintained?**

Go over the excerpt below on an article on diabetes that was lifted from a World Health Organization website:
(http://www.who.int/mediacentre/factsheets/fs312/en/)

Diabetes is a chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces. Insulin is a hormone that regulates blood sugar. Hyperglycaemia, or raised blood sugar, is a common effect of uncontrolled diabetes and over time leads to serious damage to many of the body's systems, especially the nerves and blood vessels.
347 million people worldwide have diabetes. In 2012 diabetes was the direct cause of 1.5 million deaths. More than 80% of diabetes deaths occur in low- and middle-income countries.

Type 1 diabetes
Type 1 diabetes (previously known as insulin-dependent, juvenile or childhood-onset) is characterized by deficient insulin production and requires daily administration of insulin. The cause of type 1 diabetes is not known and it is not preventable with current knowledge.
Symptoms include excessive excretion of urine (polyuria), thirst (polydipsia), constant hunger, weight loss, vision changes and fatigue. These symptoms may occur suddenly.

Type 2 diabetes
Type 2 diabetes (formerly called non-insulin-dependent or adult-onset) results from the body's ineffective use of insulin. Type 2 diabetes comprises 90% of people with diabetes around the world (5), and is largely the result of excess body weight and physical inactivity.
Symptoms may be similar to those of Type 1 diabetes, but are often less marked. As a result, the disease may be diagnosed several years after onset, once complications have already arisen.
Until recently, this type of diabetes was seen only in adults but it is now also occurring in children.

What are the main differences between the 2 types of diabetes?
Will a teenager with a regular diet of junk food and soft drinks develop diabetes? Explain your answer.

Invite online classmates to compare answers and exchange ideas by chatting in the *Discussion Forum*.

From the webpages that you have read and the videos that you have watched, keep in mind the mechanisms that our bodies follow in order to maintain blood glucose levels through the coordination of the different body systems. By doing the activity below, you could learn how body temperature is kept constant whether in a cold or warm environment.

ACTIVITY NO. 6: IMAGE INTERPRETATION

Study the image below to learn about homeostasis and temperature control.
http://physiology-11.wikispaces.com/file/view/homeostasis.gif/197284866/559x393/homeostasis.gif - Homeostasis and temperature control

PROCESS QUESTIONS:
1. How is temperature regulated?
2. Why is it important for temperature - as part of internal balance - to be kept constant? Consider Eskimos or desert-dwelling tribes as you answer this question.

Choose between Eskimos and desert-dwellers, and then write a persuasive letter as to why it might be easier for their bodies to live in the Philippines and not where they are currently living. Don't fail to mention how the different systems coordinate in maintaining constant temperature. E-mail your letter to your teacher for comments.

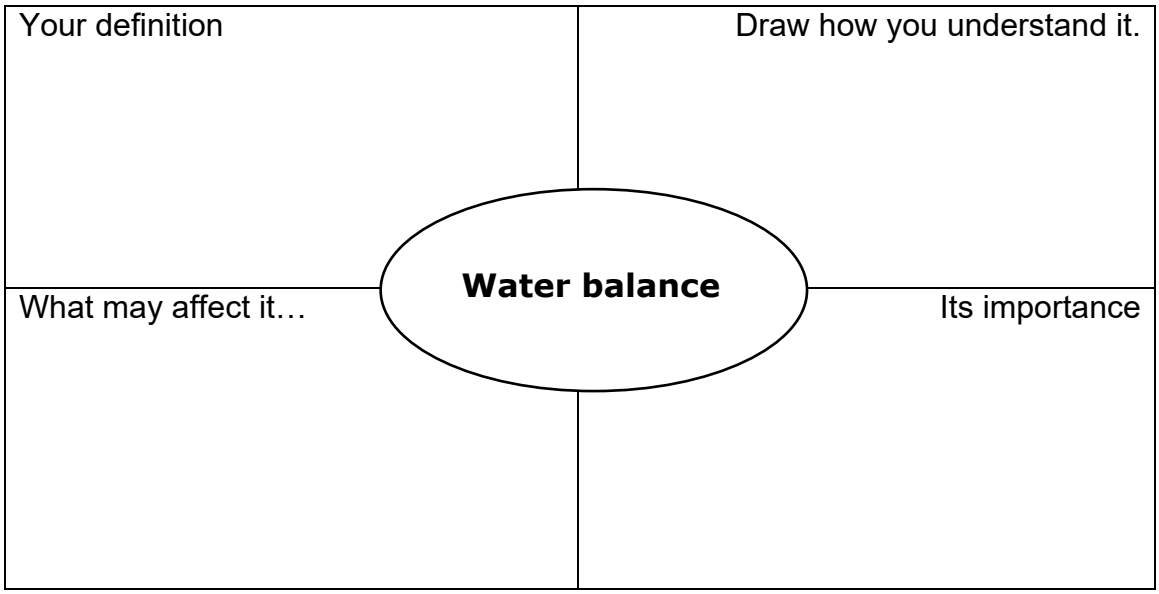
Now that you have learned how your body keeps a constant temperature, find out another internal condition that is closely related to temperature: *hydration*, or maintaining normal water levels in the body. Do the next activity and learn how our bodies keep us hydrated.

ACTIVITY NO. 7: WEBPAGE READING

Learn how the body works so that dehydration and thirst can be avoided; follow the link: http://www.abpischools.org.uk/page/modules/homeostasis_kidneys/kidneys6.cfm?coSiteNavigation_allTopic=1 – ADH and control of the water balance

PROCESS QUESTIONS:
1. How does our body prevent dehydration?
2. Why should constant water levels be maintained in the body?

Complete the Frayer model below to put together the different ideas from the article that you have just read. Compare your output with online classmates by sharing a picture of your Frayer model.



By now you have probably realized the importance of keeping yourself hydrated especially since you are living in a tropical country. In the next activity, learn about pea-sized glands in the neck that perform an equally-important job: the parathyroid glands.

ACTIVITY NO. 8: VIDEO VIEWING

Here's another example as to how the parathyroid gland (an endocrine gland) regulates the release of its hormones around the body; visit the link to learn more about this: https://www.youtube.com/watch?v=ejwQf4fm9QM&index=10&list=PLXwnjgs_UWpIyKAZ9yaEUbv8Sz1AMve45 – Parathyroid hormone animation.

PROCESS QUESTIONS:

1. What would likely result from malfunctioning parathyroid glands in a patient who just had a neck surgery? Explain.
2. Formulate a hypothesis to explain what may happen to the body when blood calcium level is high. What is your basis for the hypothesis?
3. **Why should the body's internal balance be maintained?**

The next two activities fully explain how the different internal conditions are maintained despite changing external and internal environments through *positive and negative feedback mechanisms*.

ACTIVITY NO. 9a: VIDEO VIEWING

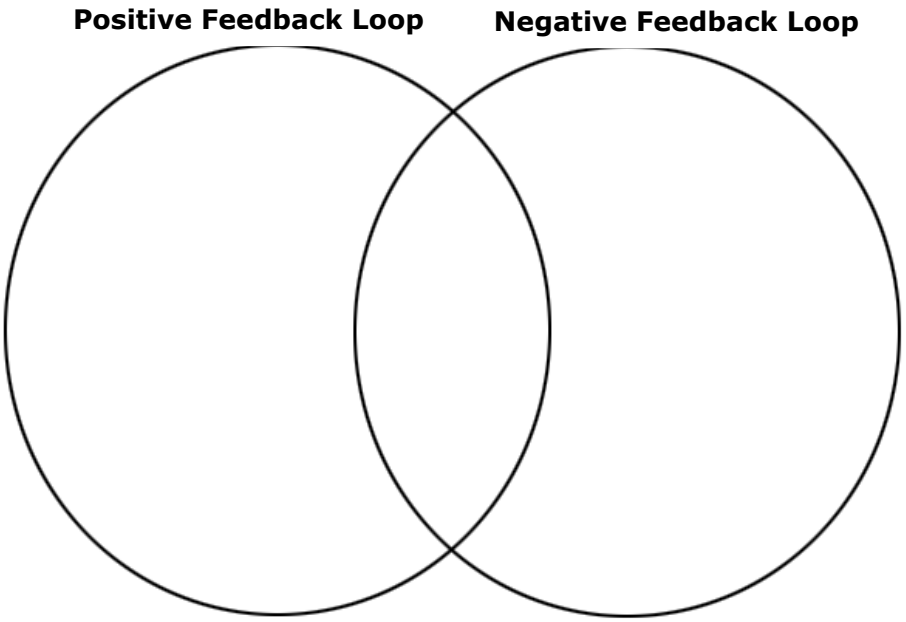
View this podcast: https://www.youtube.com/watch?v=CLv3SkF_Eag – *Positive and negative feedback loops* to understand the principle behind maintaining homeostasis.

ACTIVITY NO. 9b: VIDEO VIEWING

Watch this video to further understand the so-called feedback mechanisms at work inside our bodies, a complex series of processes that maintain internal conditions stable. Click on the link: https://www.youtube.com/watch?v=7WlbbYnkVf4&list=PLXwnjgs_UWpIyKAZ9yaEUbv8Sz1AMve45&index=1 – Positive and negative feedback in the body

PROCESS QUESTIONS:

1. What are the similarities and differences between positive and negative feedback loops? Complete the Venn diagram below to show these, then share and compare with online classmates.



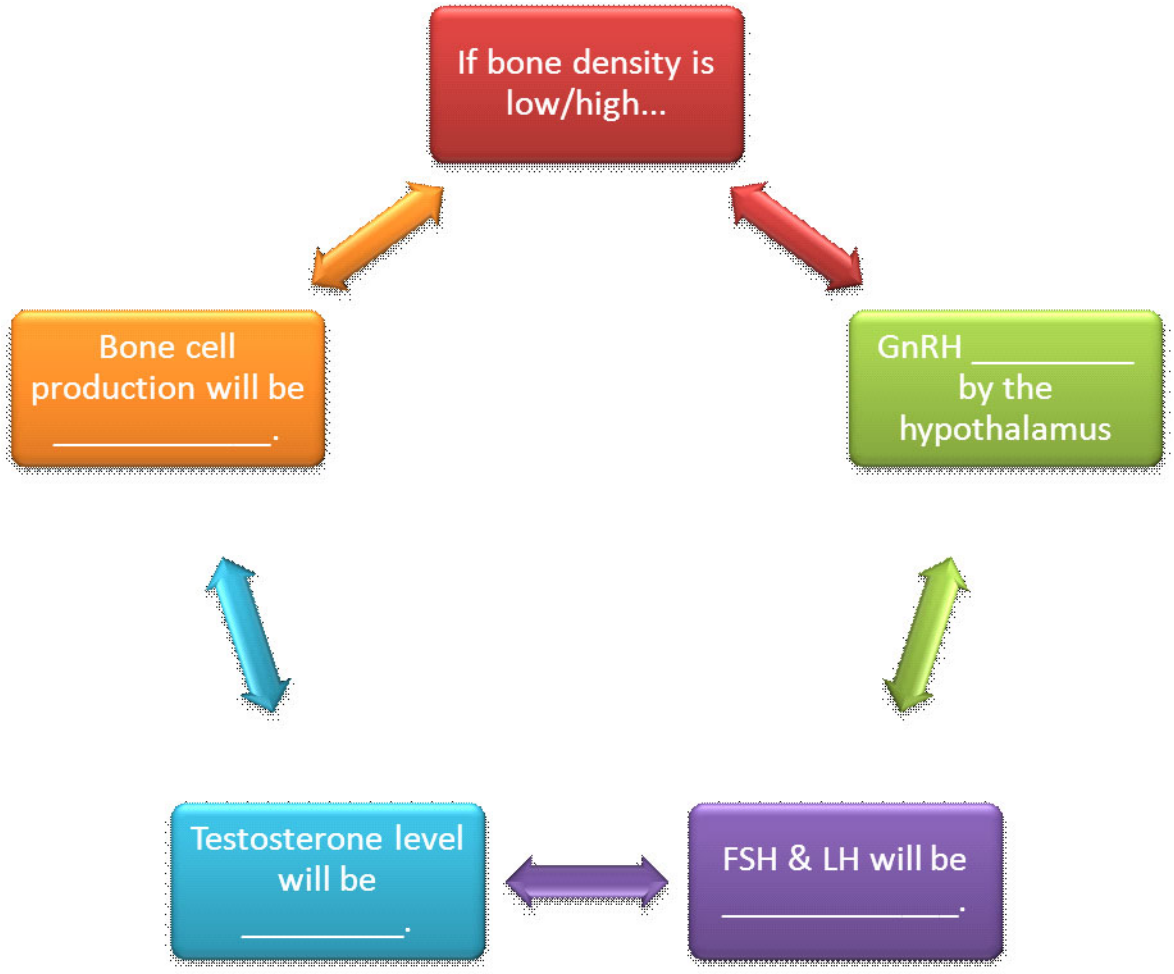
2. Would a *feedback loop* mechanism be a better alternative than a cause and effect mechanism? Why? Justify your answer by citing an example.

3. **Why are these mechanisms important in maintaining internal balance?**

Consider the process questions above as you complete a *Main Idea – Detail Notes* graphic organizer. Using this tool, you will determine the important concepts from the videos that you have viewed as well as the pertinent details that support these concepts.

Main Idea	Detail notes

Use a cyclic graphic organizer to show the actions and relationships among glands and hormones of the nervous and reproductive systems.



Submit both graphic organizers (*Main Idea – Detail Notes & Cyclic organizer*) to your teacher through email.

Read the given situation below then answer the questions that follow.

When she was 54, Prof. Christine Bennett of the University of Notre Dame Australia was diagnosed with low bone density. Both her mother and younger sister already had low bone density and she had taken steroid medication related to asthma in the past. It was also discovered that her vitamin D levels were low which has resulted to a need to take vitamin D supplements, increase calcium into her diet and do specific exercises for her bones.

After almost a year, she had a fall and fractured her wrist. The hospital took excellent care of the fracture but she was keen to check if her bone density was part of the cause (in addition to falling). She asked for her bone health to be investigated and was sent for another bone density test. She was surprised to discover she had osteoporosis – her bones had deteriorated around 7% in almost a year. The good news was that her vitamin D levels were back to normal because of the supplements. Her doctor discussed treatment options with her since she was approaching menopause. Her decision was to try Hormone Replacement Therapy (HRT) for several years, with a plan to proceed to another osteoporosis medication in the future. It's been 2 years since commencing treatment and she has had no other fractures.

Explain how Prof. Bennett's internal condition may look like prior to treatment. How about after receiving treatment? Use 2 separate cyclic graphic organizers to justify your answers.

ACTIVITY NO. 10: INTERACTIVES

Try the interactive link below to simulate how internal conditions in the body are kept constant through the coordination of the different systems in the body.
http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/homeo/homeosts.shtml - Homeostasis activity

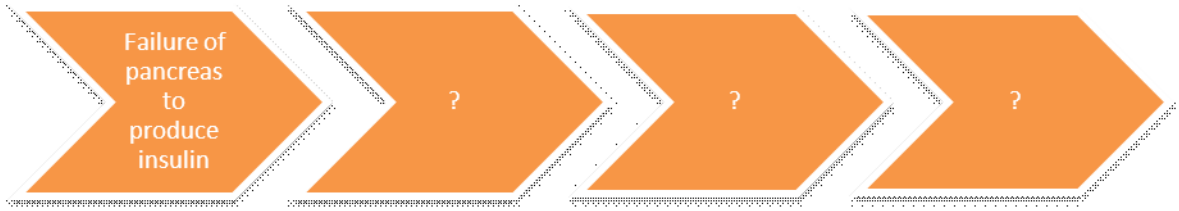
PROCESS QUESTIONS:
1. What kind of mechanisms did you encounter? Cite an example.
2. Discuss the regulatory mechanisms involved in maintaining balance of our body's:
   a. Water content
   b. Ion content
   c. Temperature
   d. Blood glucose concentration

	If above normal levels, the body will…	If below normal levels, the body will…
Water content		
Ion content		
Temperature		
Blood glucose		

3. Which among these would you say would have the most immediate and serious consequences once an imbalance is not corrected? Justify your answer by referring to the table above.

4. **Why should the body's internal balance be maintained?**

Complete the *flow diagram* below as you consider blood glucose levels in the body. How would your graphic organizer look like if one's pancreas fails to synthesize insulin? E-mail your completed flow diagram to your teacher.



ACTIVITY NO. 11: Revising Prior Knowledge through I-R-F Chart
Go back to the question: **Why should the body's internal balance be maintained?**

Write your revised answers to this question in the R column of the IRF chart.

WHY SHOULD THE BODY'S INTERNAL BALANCE BE MAINTAINED?		
Initial	**Revised**	**F**inal

After being introduced to the different organs and systems involved in maintaining internal balance, show evidence of your understanding by making a concept map of the following terms:

pituitary gland	negative feedback loop	water content	ovaries
homeostasis	testes	hormone	temperature
blood glucose	endocrine system	hypothalamus	positive feedback loop

You could use www.spicynodes.org or similar websites in making your concept map. Share with online classmates and your teacher once you are done.

End of FIRM UP:

In this section, the discussion was about the processes involved as the nervous, endocrine, and reproductive systems coordinated their functions in order to maintain internal balance or homeostasis.

Go back to the previous section and compare your initial ideas with the discussion. How much of your initial ideas are found in the discussion? Which ideas are different and need revision?

Now that you know the important ideas about this topic, let's go deeper by moving on to the next section.

DEEPEN

Our bodies perform a tough internal balancing act on a daily basis. Interestingly, this happens 24/7, with no breaks, and without our voluntary control.

This makes it an even tougher act to sustain as the balance involves coordination within the nervous, endocrine, and reproductive systems. Even with just one of these systems failing, the consequences could seriously affect our health; these consequences could range from acne, infertility, and even up to cancer.

Do you know someone who might have this imbalance as well as some of its health consequences? Do you know how this balance can be disrupted? What changes in your lifestyle can you do to ensure that this internal balance is maintained at all times?

Your goal in this section is to take a closer look at some aspects of the topic. Determine how hormonal imbalances occur, how these lead to some medical concerns, and how these could be managed.

Go deeper into the topic as you read the article below on how the environment can affect reproductive health.

ACTIVITY NO. 12: WEBPAGE READING

Learn how substances in the environment may affect the reproductive health; follow the link: https://www.guttmacher.org/pubs/journals/2908297.html - Environmental Effects on Reproductive Health: The Endocrine Disruption Hypothesis

Summarize what you have read by answering the table below; let the process questions be your guide as you accomplish the table. Look for specific instances where hormonal imbalance can possibly happen and cause some health concerns. Once done, take a screenshot of your work then e-mail it to your teacher.

Environmental Effects on Reproductive Health: The Endocrine Disruption Hypothesis: *A Summary*		
Here's What (*Describe one very important concept that you learned from what you read.*)	**So What** (*How can you use this concept so you will know that you understand it?*)	**Now What** (*How can you use this concept in life?*)

PROCESS QUESTIONS:

1. What are endocrine disrupters? Cite a specific example in the article that explains how a substance can be considered an endocrine disrupter.

2. Based on the article, **why do you think is there a need to maintain the body's homeostasis?**

Fill out the Think Pad below by initially accomplishing the “Connections To Life” box; write how the article might apply to a real life situation.

WORDS	PICTURE
CONNECTIONS TO LIFE	SYMBOLS

Now that you have read how the environment can possibly affect reproductive health through the involvement of the endocrine system, find out how closely coordinated the endocrine system has to be with the nervous and reproductive systems to play their crucial roles in our bodies by reading the next article.

ACTIVITY NO. 13: WEBPAGE READING

Learn how the endocrine system performs crucial bodily functions as it works closely with the nervous and reproductive systems by following the link: http://wps.aw.com/bc_marieb_hap_9_oa/218/55881/14305789.cw/index.html - Closer Connections: The Endocrine System and Interrelationships with the Nervous and Reproductive Systems

Make a summary of the webpage that you have read by completing a *Sum It Up* sheet found in the link: http://www.readingquest.org. List the main idea words on the *Sum It Up* sheet; put one word in each blank. Write a summary of the article using as many of the main idea words as possible. Imagine you have only $2.00 and that each word you use is worth ten cents. *You’ll “sum it up” in 20 words!* The process questions provided below can keep you on track as to what you need to focus on in the article.

PROCESS QUESTIONS:

1. With regards to our development, what crucial roles should the endocrine system perform? Cite a specific example from the article.
2. **Why should the body’s internal balance be maintained?**

Continue with the Think Pad by accomplishing the “Words” box; write one or two sentences to describe the function of the ***endocrine system***.

WORDS	PICTURE
CONNECTIONS TO LIFE	SYMBOLS

The previous article has made you realize the crucial roles performed together by the endocrine, reproductive, and nervous systems. The succeeding video will be an opportunity to learn precautionary measures that can be taken in relation to common household products and how they can adversely affect our endocrine system.

ACTIVITY NO. 14: VIDEO VIEWING

Watch this video to understand how common household products that we use poison the body. Click on the link: https://www.youtube.com/watch?v=Dcdj7bh_dXk - Must See – Common Household Goods That Poison Your Body

After watching the video, make a concept map by visiting the website www.spicynodes.org. Share and compare your outputs with your classmates by posting the link in the *Discussion Forum*. Submit the same to your teacher for evaluation.

PROCESS QUESTIONS:

1. Which among the common household products that you have will you stop using? Why?
2. **Why is it detrimental or harmful if the body’s internal balance is not maintained?**

Do the third installment of the Think Pad by accomplishing the “Picture” box; draw a picture showing the effects of certain chemicals to our body based on the video that you have just watched.

WORDS	PICTURE
CONNECTIONS TO LIFE	SYMBOLS

Did you just check the products you have in your shelves? Watch the next video and learn more about other reproductive and endocrine conditions that can be caused by something almost every household might be using: *plastics.*

ACTIVITY NO. 15: VIDEO VIEWING

Watch this video to understand how the use of plastics is linked to breast cancer formation. Click on the link: https://www.youtube.com/watch?v=jUSsbFN70KA - Plastics: Breast Cancer & Estrogen

Answer the process questions below by using an avatar from www.voki.com or any similar website. You could share this to your teacher by sharing your Voki account.

PROCESS QUESTIONS:

1. Will you advise the continued use of plastic products? Cite a portion of the video that would support your answer.
2. **Why should estrogen levels be maintained in both men and women?**

Finish the Think Pad by accomplishing the “Symbols” box; draw a graphic organizer that would summarize the action between chemicals and the reproductive and endocrine systems.

WORDS	PICTURE
CONNECTIONS TO LIFE	SYMBOLS

ACTIVITY NO. 16: ***Checks and Balances***

In the preceding activities of the *Deepen* section, we looked at different texts and videos about hormonal imbalances, their possible causes and their serious effects on our health. Let’s put together in the table below our answers to the essential question that we asked for each text or video.

	TEXT #1	TEXT #2	VIDEO #1	VIDEO #2
ESSENTIAL QUESTION: Why should the body’s internal balance be maintained? How can this internal balance be achieved?	*Environmental Effects on Reproductive Health: The Endocrine Disruption Hypothesis* How does the text answer the EQ? Place your answer here.	*Closer Connections: The Endocrine System and Interrelationships with the Nervous and Reproductive Systems* How does the text answer the EQ? Place your answer here.	*Must See – Common Household Goods That Poison Your Body* How does the video answer the EQ? Place your answer here.	*Plastics: Breast Cancer & Estrogen* How does the video answer the EQ? Place your answer here.

PROCESS QUESTIONS:
1. Compare the answers to the EQ and find what is common among them.
2. After finding the similarities, what may be different from the answers? Determine what influenced these variations. This is the controlling Big Idea.
3. Since there are different ways in which internal balance is maintained, how will you be able to know which mechanism to use? Complete the statement below. Then justify your answer by indicating in the space below for supporting reasons and examples.

Complete the following:

The body's internal balance must be maintained…

Or

The body's internal balance is achieved…

Supporting reasons and examples:

Share and compare answers with classmates online; have your teacher evaluate your work. Do these in the *Discussion Forum*.

Now that you have tried answering the essential questions based on the different articles and videos presented, do a little "investigation" by reading the article below.

ACTIVITY NO. 17: WEBPAGE READING
Show evidence of what you have understood so far by investigating the case provided, click on the link below:
http://pituitary.asn.au/Portals/0/Pdfs/patient_stories/Prolactinoma%20-%20Amanda%20F.pdf – Prolactinoma – My Journey – Amanda

PROCESS QUESTIONS:
1. What is prolactinoma? What is its cause?
2. How can this condition affect homeostasis? Cite specific examples in the article to support your answer.

How much have you understood after doing this section? Complete the table below so you could evaluate how far you've come since starting this lesson. Put a check mark (√) on the column that describes your level of understanding of the topic.

	GREEN (On my own, I can make others understand the topic.)	**YELLOW** (I understand most of the topic, but there are still some that need clarification)	**RED** (I will need help from my teacher or classmates to understand the lesson.)
1. I understand that organisms have feedback mechanisms which are coordinated by the nervous and endocrine systems.			
2. I understand that these feedback mechanisms help the organism maintain homeostasis to reproduce and survive.			
3. I can describe the feedback mechanisms involved in regulating processes in the female reproductive system.			
4. I can describe how the nervous system coordinates and regulates these feedback mechanisms to maintain homeostasis.			
5. I can explain the role of hormones involved in the female and male reproductive systems			
6. I can prove that organisms have feedback mechanisms which are coordinated by the nervous and endocrine systems			
7. I can predict the feedback mechanisms that help an organism maintain homeostasis for reproduction and survival.			

End of DEEPEN:

In this section, the discussion was about environmental and lifestyle factors that may disrupt homeostasis that lead to serious medical problems. What new realizations do you have about the topic? What new connections have you made for yourself? Now that you have a deeper understanding of the topic, you are ready to do the tasks in the next section.

TRANSFER

Your goal in this section is apply your learning to real life situations. You will be given a practical task which will demonstrate your understanding.

<u>ACTIVITY NO. 18:</u> Strengthening New Knowledge through I-R-F Chart
Go back to the question: **Why should the body's internal balance be maintained?**

Write your final answers to this question in the F column of the IRF chart.

WHY SHOULD THE BODY'S INTERNAL BALANCE BE MAINTAINED?		
Initial	**R**evised	**F**inal

ACTIVITY NO. 19: TRANSFER TASK: Be rePRO-active! Get a Healthy rePROductive System!

You have been commissioned by a popular drugstore chain to prepare for them an information dissemination tool as they visit different barangays with their mobile clinic. Part of the medical mission that they are offering is to educate people about the importance of homeostasis in the body. The output that you are expected to accomplish must emphasize the roles played by various body systems in relation to a person's overall health and survival. Consider how your output will be if you have been commissioned as a: computer animator, science writer, or science artist. Your product will be evaluated based on content, organization, and impact.

POSSIBLE TRANSFER TASK PRODUCTS		
As a *computer animator**, emphasize the role played by a healthy reproductive system in relation to a person's overall health and survival through the - use of an animation - use of an online comic - use of an infographic - use of a PowerPoint presentation **Choose one of the possible options indicated above.*	As a *science writer**, emphasize the role played by a healthy reproductive system in relation to a person's overall health and survival by - writing a blog for the municipal website - writing an article for the village paper - writing the script for the infomercial **Choose one of the possible options indicated above.*	As a *science artist**, emphasize the role played by a healthy reproductive system in relation to a person's overall health and survival by - making a poster - making a pamphlet for distribution during the medical mission - making an instructional video where you will do role-playing **Choose one of the possible options indicated above.*

RUBRIC FOR TRANSFER TASK

STANDARDS SCALE → ↓	Content	Organization	Impact
Outstanding 4	Provides exhaustive and reliable background information about the topic; Provides information that is detailed and relevant to the objective of the presentation	Places details of the presentation in a logical and interesting order and it effectively sustains the interest of the audience.	The product provides rich and stimulating information (*through text or visuals*) that enable audiences to take the appropriate action. For PowerPoint presentations: Follows the direction of using only a maximum of 15 slides; slides are visually stimulating (*maximum of 8 lines per slide*).
STANDARDS SCALE → ↓	**Content**	**Organization**	**Impact**
Satisfactory 3	Provides accurate background information; Provides information that is related to the objective of the presentation	Places details in a logical order thereby helping the audience understand the presentation without difficulty.	The product has sufficient information (*texts or visuals*) to keep audiences' attention. For PowerPoint presentations: Follows the direction of using only a maximum of 15 slides; slides have sufficient text (*maximum of 8 lines per slide*).
Developing 2	Provides unrelated background information; Some information are not relevant to the objective of the presentation	Some details are not in a logical or expected order and have the potential to confuse the audience.	Amount of information (*through text or visuals*) given is rather overwhelming in certain parts. For PowerPoint presentations: Some slides are text-heavy (*10 lines or more*), number of slides used exceeds the maximum limit.

Beginning **1**	No background information	Many details are not in a logical or expected order. There is little sense that the presentation is organized.	The amount and level of information (*texts or visuals are not age-appropriate*) presented leads audience ignoring the presentation. For PowerPoint presentations: Slides are text-heavy (or the product had information overload) which leads to audience losing interest in the presentation.

End of TRANSFER:

In this section, your task was to inform as many people as you could by making them aware of the importance of maintaining a healthy reproductive system in preventing possible hormonal imbalances.

At this point that you have finished working on the performance task, it is best to reflect on your learning experiences for this topic by answering the following questions below. These reflections can help you by using the information for future tasks or assignments.

1. How did you react to new ideas of the assignment? How did you handle these?
2. Was there a need for others to help you? Did you ask for it? Give examples.
3. Did you have a feeling of accomplishment after finishing the task? Give specific examples to support your answer.

Share these reflections with your teacher; you may also form small groups with your online classmates and share each other's reflections through the *Discussion forum*.

How did you find the performance task? How did the task help you see the real world use of the topic?
You have completed this lesson. Before you go to the next lesson, you have to answer the following post-assessment.

POST-ASSESSMENT:

It's now time to evaluate your learning. Click on the letter of the answer that you think best answers the question. Your score will only appear after you answer all items. If you do well, you may move on to the next module. If your score is not at the expected level, you have to go back and take the module again.

(A) 1. The _____ is the sac that ensures optimum temperature for the sperm cells.
   a. penis
   b. scrotum
   c. seminiferous tubules
   d. vas deferens

(A) 2. The _____ is the part of the brain that works in close coordination with the pituitary gland in terms of hormone production and release.
   a. brainstem
   b. cerebellum
   c. cerebrum
   d. hypothalamus

(A) 3. When we consume a lot of sugary food, the _____ automatically releases insulin so that excess sugar in the blood will be taken up by cells and normal blood sugar levels are maintained.
   a. adrenal glands
   b. pancreas
   c. pineal gland
   d. thyroid gland

(A) 4. One can expect that with high levels of estrogen, there will be a/an
   a. decrease in the release of GnRH.
   b. decrease in the release of LH.
   c. increase in the release of PTH
   d. increase in the release of thyroxine.

(A) 5. The hypothalamus contains thermoreceptors; these are nerve endings that are sensitive to the temperature of the body's blood. If we become too cold, the hypothalamus will send signals
   a. to make blood vessels get wider for blood to lose cold.
   b. to make blood vessels get narrower for blood to retain heat.
   c. to activate sweat glands that increase our temperature.
   d. to deactivate sweat glands and lower our temperature.

(A) 6. Known as the *love hormone*, oxytocin is responsible in stimulating contractions of the uterus. Which among the choices is correct in relation to oxytocin action?
   a. It is released more after parturition (the birth process).
   b. It follows a positive feedback mechanism, thus, less can be expected once it has been released.
   c. Elevated amounts can be expected during labor.
   d. Release of the hormone should be expected at the second semester of pregnancy.

(A) 7. *Thyrotoxicosis* is a condition that results from abnormally high levels of thyroxine. Its symptoms include intolerance to heat, increased bowel movement, and rapid or irregular heartbeat among others. The production of the hormone thyroxine is influenced by a multi-stage process involving the release of thyrotropin-releasing hormone (TRH) as well as thyroid-stimulating hormone (TSH). TRH is secreted by the hypothalamus; this action leads to the release of TSH, which in turn, releases thyroxine. Which among the following would be a correct statement?
   a. Thyroxine can be released in the absence of TRH.
   b. TSH levels influence thyroxine release using a negative feedback mechanism; low TSH means low thyroxine release.
   c. Low TRH levels stimulate TSH release.
   d. High TRH levels inhibit TSH release.

(A) 8. Aside from promoting lactation, prolactin has been found to perform around three hundred other functions which include immune system regulation and metabolism. Prolactin has a negative feedback relationship with dopamine, a chemical released by the hypothalamus. The following statements are true except
   a. During and after pregnancy, prolactin levels are likely to be elevated.
   b. Since they follow a negative feedback system, an increase in dopamine increases prolactin levels as well.
   c. Medications that decrease the effects of dopamine increase prolactin levels in the blood.
   d. Mothers who do not produce milk after birth may have prolactin deficiency.

(M) 9. Cushing syndrome is a medical condition characterized by progressive obesity and skin problems that range from acne to slow-healing cuts. It is caused by excessive production of the hormone cortisol due to increased production of adrenocorticotropic hormone (ACTH) which promotes its release. Cortisol is produced by different glands including the pituitary. If you learned that you have high levels of cortisol,

a. you would request for an increase in the dosage of your corticosteroid medication for asthma.
b. you might consider a check-up with a neurologist (*doctor who specializes with the nervous system*).
c. you would continue taking the prescribed medications for rheumatoid arthritis without your doctor's advice.
d. you would exercise more than your usual regimen to improve endurance to discontinue use of asthma medications (*corticosteroids*).

(M) 10. *"Basti, you're so fond of chocolates. If you don't stop it you're going to get diabetes!"* This is what Basti's mom would usually tell him. If you were Basti,
a. you would tell your mom that diabetes is caused by the pancreas which is not functioning properly.
b. you would continue with your love for chocolates since you drink lots of water anyway.
c. you would tell your mom that the sugars are quickly absorbed by the small intestine, therefore you can't develop diabetes.
d. you would tell your mom that diabetes is only for girls since she has it and your dad doesn't have it.

(M) 11. Graves' disease is primarily caused by a compromised immune system. As one of its consequences, the body abnormally releases an antibody that mimics the pituitary hormone. This results to an overproduction of thyroid hormones. What advise will you give to someone who is starting to have signs and symptoms of Graves' disease?
a. Consult a neurologist to have his pituitary gland treated.
b. Consult an immunologist (*doctors specializing with the immune system function*) to confirm if he has goiter (*swelling of the thyroid gland*).
c. Consult an endocrinologist (*doctor who specializes with the endocrine system function*).
d. Consult an immunologist first to confirm if the immune system is functioning properly before meeting with an endocrinologist.

(M) 12. Turner syndrome is a condition that is found only in girls; its prevalent feature would be a single X chromosome or missing parts of an X chromosome. Because of this, Tuner syndrome prevents the ovaries to develop. Which among the statements is most suitable to Turner syndrome?
a. Changes in puberty can be checked by age 7, the age of reason.
b. Elevated estrogen levels are normal for patients with this condition.
c. Karyotyping is not the procedure of choice in making the final diagnosis.

d. Individuals with this condition cannot be expected to get pregnant under natural circumstances.

(M) 13. Polycystic ovary syndrome (PCOS) is a condition in girls that involve their reproductive system. In particular, the ovaries would form cysts (*fluid-filled sacs*) instead of mature egg cells. Experts suggest that there is a direct relationship between insulin release and male hormones (*which females also have*). This health scenario includes a wide array of conditions ranging from acne, heart disease, to cancer. In relation to PCOS, which among the following statements would be correct?
   a. Individuals with this condition are prone to growing male reproductive organs.
   b. Women with PCOS cannot be expected to have regular, monthly menstruation.
   c. An irregular menstruation can be confirmed as early as 5 years old to provide the right medications.
   d. The sooner a neurologist is consulted, the better to confirm the diagnosis for PCOS.

(M) 14. Aside from its primary role in the promotion of skin pigmentation, melanocyte-stimulating hormone (MSH) also influences one's appetite. It has been noted that low levels of MSH released by the pituitary gland, hypothalamus, and skin cells result to high food intake, which in turn, leads to obesity. Which would be a correct statement from the choices below?
   a. Since MSH promotes melanin production, its levels can be greatly influenced by the amount of exposure to the sun.
   b. Consistent high food intake lowers the amount of MSH that will be released by the body.
   c. It is an abnormal reaction for those who stay under the sun for prolonged periods of time to have high levels of MSH.
   d. Without skin pigmentation, it would be easier to avoid skin cancer that is caused by UV rays from the sun.

(T) 15. During class discussions, Zachary shared that both his parents have diabetes. Should he be worried that he might have it? Which among the choices below would you not tell Zachary if you were his teacher?
   a. "*By now, you should have been brought to an endocrinologist by your parents.*"
   b. "*Diabetes is a recessive genetic disorder; you should not worry about getting it.*"
   c. "*Even though you're still young, you should be watching your diet, not too much sweet or carbohydrates.*"
   d. "*Have you noticed if your wounds take longer than usual to heal?*"

(T) 16. You are the scriptwriter for the health segment of a morning show on television. For the following day's episode, you have been asked to team up with the program's computer animator to prepare a short animation on homeostasis. What will you likely tell your animator to include?
   a. Use an avatar to define what a hormone is.
   b. Show the latest dance that the undersecretary of health has thought of with regards to polycystic ovary syndrome.
   c. Present a graph indicating the percentage of Filipinos affected by diabetes for the last ten years.
   d. Make sure that coordination among the nervous, endocrine, and reproductive systems are shown in the computer animation and that it will be understood by lay people.

(T) 17. As a health worker, one of Miguel's responsibilities is to transcribe the medical records of the patients in their barangay. One of the records caught his attention as it indicated a hormonal imbalance that led to the patient's stunted growth, something that is uncommon in your barangay. What entry in the medical chart should you not expect to see?
   a. Patient showed elevated levels of human growth hormone.
   b. Patient advised to see an endocrinologist.
   c. Patient advised to consult a neurologist.
   d. Patient's x-ray showed poor growth in the bones of the legs and arms.

(T) 18. You are working for a pharmaceutical company and you have been tasked to come up with a draft for an insert that will be placed inside the box of your products for treating thyroid conditions. The following can be included in your insert except
   a. parathyroid hormone (PTH) is released by the thyroid gland in large amounts during stressful siuations.
   b. the thyroid gland is swollen in patients with goiter.
   c. thyrotoxicosis leads to irregular heartbeat.
   d. thyroxine is released by the thyroid gland upon the action of TSH.

(T) 19. During a visit by the municipal health officer in your school, he noticed that many of the grade one students seem overweight. His suspicion was further strengthened when he saw during lunch that many were eating a lot of pasta, rice, and sweets. He challenged you, as the chairman of the student council, to raise awareness on how excessive sugars in the diet can contribute to gaining weight. What might be your likely choice?
   a. Show a medical animation which includes insulin production in the pancreas.
   b. Show how food is absorbed in the small intestine using a concept map.

c. Visit classes and involve students in a role-play activity emphasizing how sugars can lead to gaining weight.
d. Visit classes and give a lecture on homeostasis.

(T) 20. After passing the medical board examination, you opted to work as a doctor to the barrios. You have been assigned to a far-flung community in the Cordillera region where there is no cellphone signal as well as electricity. You decided to write to a former professor in order to make sure that your diagnosis on a male patient is correct. In your letter, you mentioned that the 30-year old patient presented with undeveloped testicles, no history of facial hair, and little to no increase in muscle mass. What hormonal deficiency is the likely reply of the professor?
a. These are signs and symptoms of testosterone deficiency; testosterone replacement therapy could be beneficial.
b. These are classic signs and symptoms of estrogen deficiency; the patient can be given estrogen pills.
c. With the signs and symptoms presented, it is likely that the patient has ovarian cancer.
d. Prostate cancer can be suspected from the seemingly low levels of estrogen.

GLOSSARY OF TERMS USED IN THIS LESSON:

adrenaline – the hormone released during stressful situations, involved in the *fight or flight* syndrome

adrenal glands – a pair of glands found on top of each kidney, responsible for releasing the hormone *adrenaline*

estrogen – primary female hormone, responsible for female characteristics, present in both males and females

hormone – substance released by glands that effect change in a target organ

hypothalamus – part of the brain that regulates body temperature, appetite, thirst, and water balance

negative feedback loop – a process in which a change from the normal range of function elicits a response that opposes or resists change

ovary – pair of organs forming part of the female reproductive system, releases an egg cell every month and produces female hormones including *estrogen* and *progesterone*

oxytocin – a hormone that promotes uterine contractions as well as lactation; synthesized in the hypothalamus

parathyroid – endocrine glands embedded on the thyroid gland, influences bone development

PTH (*parathyroid hormone*) – substance produced by the parathyroid gland that increases blood calcium levels by stimulating bones to release calcium

pituitary – endocrine gland located at the base of the brain; also known as the "master gland" because it regulates many body functions

positive feedback loop – a process in which a change from the normal range of function elicits a response that amplifies or enhances that change

prolactin – hormone known to have many functions, mainly responsible for *letting milk down*, or lactation

thyroxine – thyroid hormone that increases the metabolic rate of cells

testosterone – the hormone responsible for primary male characteristics**,** present in both males and females

testes – male reproductive organs where the hormone testosterone is synthesized

TRH (*thyrotropin-releasing hormone*) – hormone produced in the hypothalamus which stimulates release of thyroid-stimulating hormone (TSH)

TSH (*thyroid-stimulating hormone*) – hormone secreted by the anterior portion of the pituitary gland; controls the release of thyroid hormone and is necessary for growth and function of the thyroid gland

REFERENCES AND WEBSITE LINKS USED IN THIS LESSON:

http://www.medicalmalpracticeinquirer.com/assets_c/2011/01/iStock_000004641088Large-thumb-300x200-6230.jpg - Photo of a diabetic patient

http://www.clearcomplexionb5.com/wp-content/uploads/2013/10/guy-running-gym.jpg - Running man

http://banglabox.com/wp-content/uploads/healthy-skin.jpg - Woman and fruits

http://www.organicauthority.com/health/top-ten-healthy-foods-for-women.html - Healthy food for women

www.youtube.com/watch?v=RcBgo8IDiUU – Hypothyroidism
http://i.ytimg.com/vi/RcBgo8IDiUU/maxresdefault.jpg - Hypothyroidism video

http://www.livelifeactive.com/wp-content/uploads/2014/03/Balance-is-the-key-to-life1.jpg - Balance is the key to life photo

http://kidshealth.org/teen/your_body/body_basics/male_repro.html - Male Reproductive System

http://kidshealth.org/teen/sexual_health/girls/female_repro.html - Female Reproductive System

https://www.youtube.com/watch?v=f_Z1zsR9IFM – Intro to the Endocrine System

https://www.youtube.com/watch?v=QsftxduyET8 – Nervous System Remix (Ice Ice Baby)

http://www.abpischools.org.uk/page/modules/diabetes/diabetes4.cfm?coSiteNavigation_allTopic=1 – Controlling blood glucose levels

http://languagemagazine.com/internetedition/images/figure_4_soto.jpg - Frayer model

https://www.youtube.com/watch?v=vO-aMVzpgE8&index=12&list=PLXwnjgs_UWpIyKAZ9yaEUbv8Sz1AMve45 – Glucose regulation in the body

http://www.who.int/mediacentre/factsheets/fs312/en/ - Diabetes factsheet

http://physiology-11.wikispaces.com/file/view/homeostasis.gif/197284866/559x393/homeostasis.gif - Homeostasis and temperature control
http://www.abpischools.org.uk/page/modules/homeostasis_kidneys/kidneys6.cfm?coSiteNavigation_allTopic=1 – ADH and control of the water balance

https://www.youtube.com/watch?v=ejwQf4fm9QM&index=10&list=PLXwnjgs_UWpIyKAZ9yaEUbv8Sz1AMve45 – Parathyroid hormone animation

https://www.youtube.com/watch?v=CLv3SkF_Eag – *Positive and negative feedback loops* to understand the principle behind maintaining homeostasis

https://www.youtube.com/watch?v=7WlbbYnkVf4&list=PLXwnjgs_UWpIyKAZ9yaEUbv8Sz1AMve45&index=1 – Positive and negative feedback in the body

http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/homeo/homeosts.shtml - Homeostasis activity

https://www.guttmacher.org/pubs/journals/2908297.html - Environmental Effects on Reproductive Health: The Endocrine Disruption Hypothesis

http://wps.aw.com/bc_marieb_hap_9_oa/218/55881/14305789.cw/index.html - Closer Connections: The Endocrine System and Interrelationships with the Nervous and Reproductive Systems

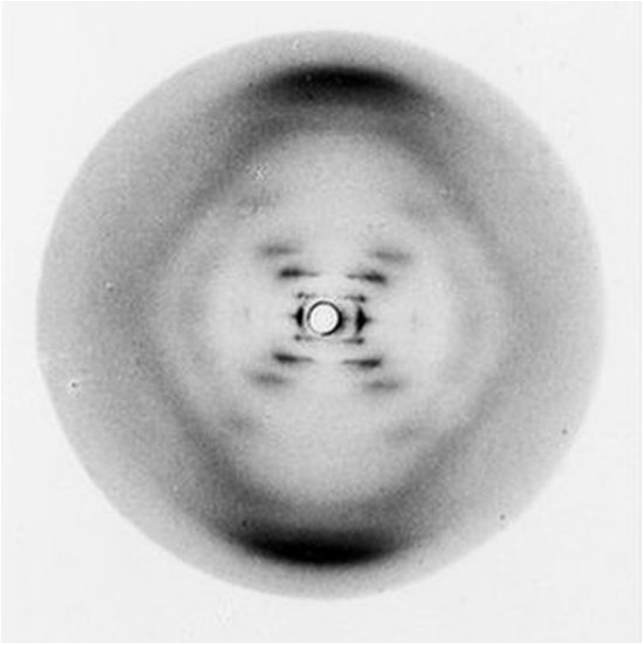
https://www.youtube.com/watch?v=Dcdj7bh_dXk - Must See – Common Household Goods That Poison Your Body

https://www.youtube.com/watch?v=jUSsbFN70KA - Plastics: Breast Cancer & Estrogen

http://pituitary.asn.au/Portals/0/Pdfs/patient_stories/Prolactinoma%20-%20Amanda%20F.pdf – Prolactinoma – My Journey - Amanda

Lesson 2: HEREDITY: Inheritance and Variation: *The Molecular Basis of Inheritance and Variation*

INTRODUCTION AND FOCUS QUESTION(S):



http://www.bbc.com/news/health-18041884

Nicknamed *Photo 51*, the image above is the first X-ray diffraction image of the **DNA**, deoxyribonucleic acid, which is dubbed as the ***molecule of life***. The discovery of the DNA structure is one of the most celebrated discoveries of the 20th century, and this photo which provided key information to that discovery has at least a claim to be the "most important image ever taken."

In the previous modules, you have explored the concept of inheritance at the cellular and subcellular level. It is now time for you to look at heredity at the *molecular* level, right where it all starts. Among the molecules you will encounter are DNA and proteins.

What is DNA, and why is it so important to heredity? Why are proteins associated with DNA and traits? How are these proteins synthesized in the cell? How do these molecules contribute to genetic variation? These are the questions you will find answers to as you go through this module.

LESSON COVERAGE:
In this lesson, you will examine those questions when you take the following topics:

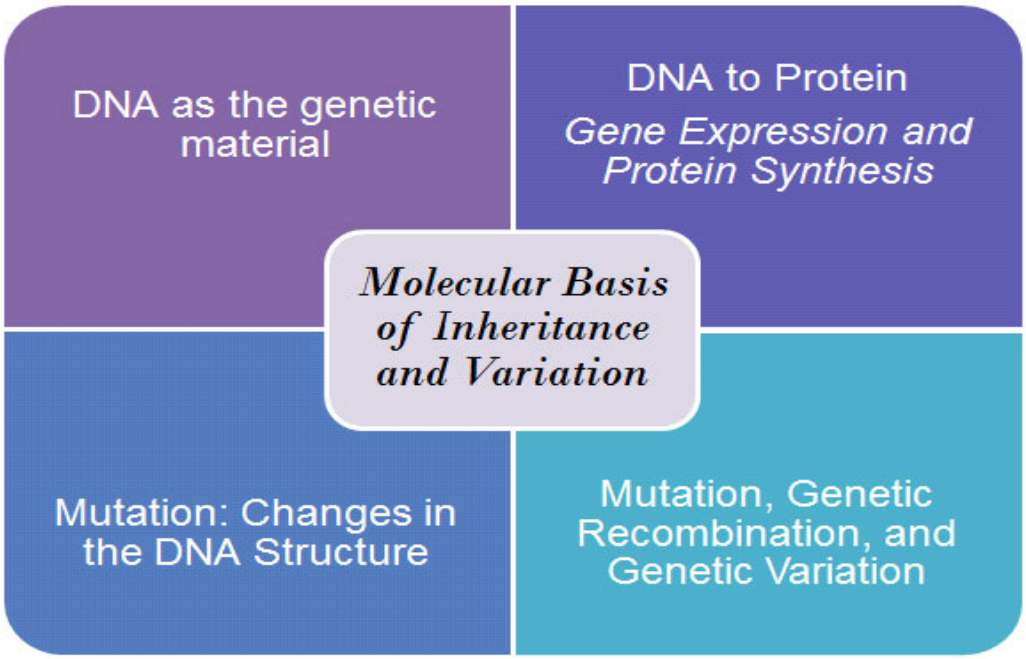
Lesson 2.1 – Gene Expression and Protein Synthesis
Lesson 2.2 – Mutation

Lesson 2.3 – Molecular Basis of Genetic Variation

In this lesson, you will learn the following:

Lesson 2.1	• Explain how protein is made using information from DNA.
Lesson 2.2	• Explain how mutations may cause changes in the structure and function of a protein. • Discuss how mutations can be heritable.
Lesson 2.3	• Explain in different ways how genetic variation is achieved at the molecular level and discuss its implications to biodiversity and the species' adaptability and survivability.

LESSON MAP:
Here is a simple map of the above topics you will cover:



EXPECTED SKILLS:
To do well in this lesson, you need to remember and do the following:

1. Read the instructions carefully before starting anything.
2. Complete **all** the activities and worksheets. Follow instructions on how to submit them.
3. Look up the meaning of words that you do not know.
4. You will frequently come across process questions as you go through different lessons. Keep a notebook (or use the Notepad) where you can write

(and revise) your answers to these questions. Use also the notebook to jot down short notes, draw diagrams, and summarize what you have just read.
5. For worksheets and reports that need to be submitted, use the provided checklist and rubric to evaluate your work before submission.
6. Allow time for relaxation and recreation when you are mentally tired. Make a time table to schedule your study and recreation.

PRE-ASSESSMENT:

Let's find out how much you already know about this module. Click on the letter that you think best answers the question. Please answer all items. After taking this short test, you will see your score. Take note of the items that you were not able to correctly answer and look for the right answer as you go through this module.

(A) 1. During cell division, each new daughter cell must have the same copy of genetic information found in the DNA. Which of the following refers to the process of copying a DNA molecule?
   A. Replication
   B. Transcription
   C. Translation
   D. Reverse Transcription

(A) 2. In order to produce a protein, segments of the DNA called *genes* must be expressed. During ***transcription*****,** specific segments of the DNA are copied in order to produce what molecule?
   A. Amino acid
   B. cDNA
   C. Polypeptide
   D. RNA

(A) 3. Which of the following events happen during ***translation***?
   A. DNA nucleotide sequences are changed into amino acid sequence.
   B. RNA gets translated into DNA.
   C. Sequence of codons in the mRNA directs the sequence of amino acids.
   D. The amino acid sequence forms into a protein and denatures.

(A) 4. If a mutation has occurred in a gene coding for a specific protein, which of the following is **not** likely to occur?
   A. Protein will not be formed.
   B. Protein will be formed but in lower amounts.
   C. Protein will have an additional function.
   D. Protein will not have any amino acid.

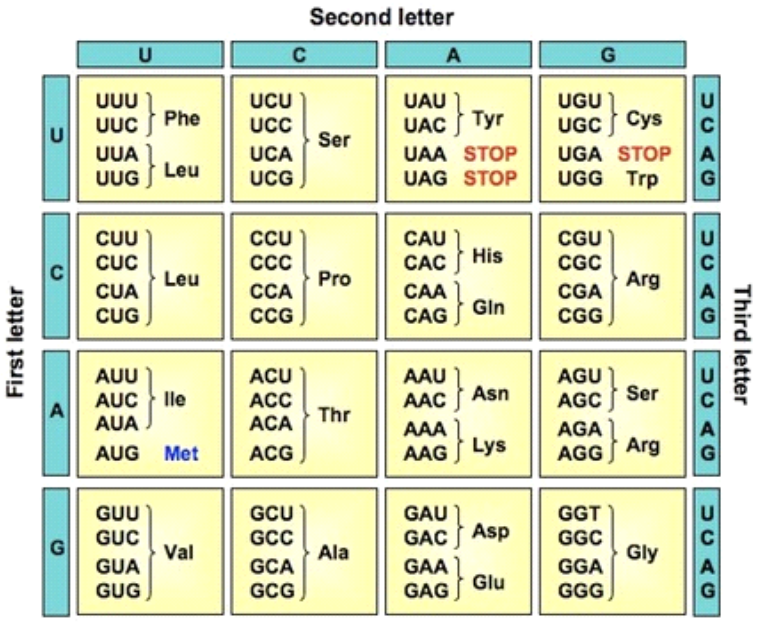
(A) 5. Consider this DNA sequence: AGT CGA. If a substitution happens in the fourth base such that the new sequence copied during replication is AGT AGA, what kind of mutation has occurred?
   A. Chromosomal aberration
   B. Frameshift mutation
   C. Point mutation
   D. Polyploidy

(A) 6. A mutation always causes a mutant phenotype. What can be said of this statement?
   A. True, mutations are errors in DNA replication and will definitely affect protein production.
   B. True, a change in the DNA structure causes a change in both the genotype and phenotype.
   C. False, some changes in the DNA do not alter the amino acid sequence.
   D. False, mutations are not always harmful, and may sometimes lead to better phenotypes.

(A) 7. Down syndrome is a chromosomal condition that is associated with intellectual disability, a characteristic facial appearance, and weak muscle tone (hypotonia) in infancy. Below is a diagram of the set of chromosomes found in each cell of an individual with Down syndrome:

Based on the diagram, what type of genetic change causes Down syndrome?
   A. Base substitution
   B. Inversion
   C. Monosomy
   D. Trisomy

(A) 8. Refer to the given genetic code chart to predict the type of mutation and the protein produced if the mRNA codon **GAG** is changed to **GAA**.



A. Missense mutation. Protein is non-functional.
B. Neutral mutation. Protein may still be functional.
C. Nonsense mutation. Protein synthesis stops.
D. Silent mutation. Protein produced is the same.

(M) 9. Why is the DNA considered as the cell's ***genetic material?***

I. The DNA is variable *between* species and able to store information that causes species to vary from one another.
II. The DNA is able to undergo rare changes, called mutations, that provide genetic variability for evolution.
III. The DNA is constant *within* a species and able to be replicated with high fidelity during cell division.
IV. The DNA is a macromolecule, found inside the cell, which contains sugar, nitrogen, and phosphate groups.

A. I only
B. I and II
C. I, II, and III
D. I, II, III, and IV

(M) 10. A 38-year old male appears slightly overweight for his 6-foot, pear-shaped stature. He has narrow shoulders, enlarged breasts, and barely any facial hair. Recently, he got to see a documentary on genetic conditions; interestingly, one of them seemed to describe his physical features. He also learned that the Y-chromosome is responsible for male traits, while the X-chromosome holds genes for female traits. He started to get concerned and thought of seeing an expert to determine if he has the said condition. The condition that he suspects that he might

have is Klinefelter's syndrome; it is a genetic condition in males that is characterized by having female characteristics. What might be found in his karyotype?

A. 3 chromosomes in chromosome 21
B. XXY in chromosome 23*
C. only the X chromosome in chromosome 23
D. only the Y chromosome in chromosome 21

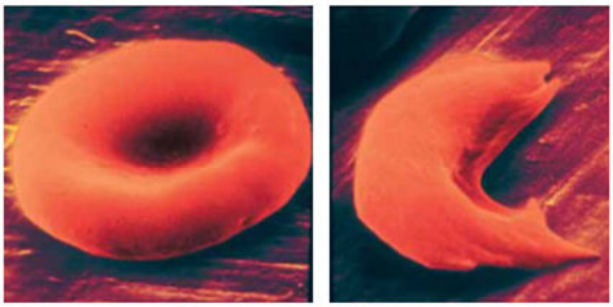
(M) 11. Refer to the following early genetic experiments:

- Yanofsky showed that the order of observed mutations in the *E. coli* tryptophan synthetase gene was the same as the corresponding amino acid changes in the protein.
- Crick and Brenner demonstrated, from a large series of double mutants of the bacteriophage T4, that the genetic code is read in a sequential manner starting from a fixed point in the gene, the code was most likely a triplet and that all 64 possible combinations of the 4 nucleotides code for amino acids, i.e. the code is degenerate since there are only 20 amino acids.

What can be concluded from these experiments?

A. A change in the amino acid sequence will cause a change in the protein product.
B. Any change in the DNA structure is considered as mutation.
C. Information stored in the DNA is used in the synthesis of protein.
D. There are many possible combinations of the four nucleotides that make up the DNA.

(M) 12. Below is a diagram comparing a normal red blood cell from a sickled red blood cell. The latter is found in individuals suffering from sickle-cell anemia.



Normal phenotype Sickle-cell phenotype

Investigation of hemoglobin in the red blood cells of persons with sickle cell disease showed its structural difference with hemoglobin in normal individuals. In one location, normal hemoglobin contains the negatively-charged amino acid glutamate, and in sickle cell hemoglobin, the glutamate is replaced by the nonpolar amino acid valine.

What is the most likely explanation for this structural difference?

A. During replication, a single base change in the DNA occurred that led to the synthesis of a faulty protein.*
B. During transcription, a copying error occurred in the mRNA transcript which led to the production of a defective protein.
C. During translation, an incorrect amino acid becomes attached to the tRNA molecule thereby causing a change in the protein structure.
D. During protein folding, a lack of enzyme causes incorrect folding and modification of the protein structure.

(M) 13. Which of the following situations illustrate a mutation that may be passed on by the parent to its offspring?

A. A man with normal chromosomes had a hip X-ray without a protective shield. A year later, his wife gives birth to a child with a chromosomal aberration.*
B. An embryo missing one copy of chromosome 3 is miscarried very early in pregnancy.
C. Exposure to excessive UV radiation causes changes in the DNA of a skin cell, leading to basal cell carcinoma (skin cancer).
D. In a very early human embryo, a mistake in mitosis causes loss of a chromosome in one daughter cell. The resulting child is a fertile male.

(M) 14. In 1996, Susan Rosenberg, then a young professor at the University of Alberta, undertook a risky and laborious experiment. Her team painstakingly screened hundreds of thousands of bacterial colonies grown under different conditions. Rosenberg's findings suggested that bacteria were capable of increasing their mutation rates, which might in turn produce strains capable of surviving new conditions. This raised questions from the scientific community because it **disagrees** with which long accepted idea in Biology?

A. Adaptive mutation occurs when microorganisms are able to choose which genes to mutate.
B. Mutations are much less random and more purposeful.
C. Mutations occur randomly, creating a mixture of harmful, harmless or beneficial outcomes, which in turn fueled the process of natural selection.
D. Organisms can in some cases control how they mutate, enabling them to more rapidly evolve to adapt to new environments.

(T) 15. If all members of a species have the same set of genes, how can there be genetic variation?
Who among the following gave a correct explanation?

A. Francis pointed out that while there may be similar set of genes for all members of a species, each of these genes give rise to different phenotypes.
B. Frederick explained that even though there are similar types of genes for species, each gene comes in different forms called alleles.
C. James clarified that members of the same species have the same set of genes, but being exposed to different environment cause them to have varied genotypes.
D. Rosalind discussed that the same set of genes found among members of the same species undergo different genetic processing..

(T) 16. Gene duplication is defined as any duplication of a region of DNA that contains a gene.
You are one of the biologists who believe in the *gene-duplication hypothesis of evolution.* If you are asked to explain how gene duplication can contribute to evolution, which of the following statements will you most likely use?
A. Mutation can cause the duplication of a gene that allows one copy of the gene to mutate and evolve to perform a new function.
B. Mutation can cause the duplication of a gene that doubles the amount and functionality of the trait-causing protein.
C. Mutation can cause the duplication of a gene that may lead to the production of a disease-causing protein.
D. Mutation can cause the duplication of the whole genome that give rise to entirely new species.

(T) 17. One of your projects in the *Institute of Molecular Biology and Biotechnology* is the creation and distribution of online educational materials for use by high school students. If you want to explain how genetic variation is achieved at the molecular level, which of the following will you use?
A. Brochure
B. Interactive animation
C. Journal Article
D. Lecture

(T) 18. Cuticular proteins are crucial components of the insect cuticle. Qiao et al (2014) studied a deletion mutation in a gene coding for a cuticular protein in silkworm, BmorCPR2. The dysfunctional protein lost chitin-binding ability, leading to reduced chitin content in larval cuticle and limitation of cuticle extension. These variations in silkworm caused by mutation may lead to:
A. better adaptability of the mutant silkworm.
B. increased reproductive capacity of the mutant silkworm.

C. lower mortality rate of the mutant silkworm.
D. serious defects in larval adaptability of the mutant silkworm.

(T) 19. Male house finches (*Carpodus mexicanus*) vary in the amount of red pigmentation in their head and throat feathers. Colors range from pale yellow to bright red. The colors come from carotenoid pigments that are obtained from the birds' diet, because no vertebrates are known to synthesize carotenoid pigments. Thus, it can be said that the brighter red the male's feathers are, the more successful he has been at acquiring the red carotenoid pigment by his food-gathering efforts.

During breeding season, female house finches prefer to mate with males with the brightest red feathers. Which of the following is the **most** favorable condition for male house finches to attract female mate?

A. Alleles that promote more efficient food-gathering skills of males should increase over the course of generations.
B. Alleles that promote more effective deposition of carotenoid pigments in the feathers of males should increase over the course of generations.
C. Both A and B
D. Neither A nor B

(T) 20. Swine may be infected by a bird flu virus or a human flu virus, or both viruses in an individual pig at the same time. When both viruses are present in an individual, it is possible for genes from bird flu virus and human flu virus to be combined, thereby producing a genetically distinctive virus, which can then cause widespread disease.

Given this situation, who among the following might be making an inaccurate conclusion/decision?

A. An infectious disease specialist warned that the occurrence may lead to an outbreak or epidemic because a new strain of virus exists.
B. A molecular biologist confirmed that during such occurrence, viruses undergo genetic mutation, combination, and reassortment of the genetic material.
C. A population geneticist made a remark that this occurrence enhances the genetic variability of the human species.
D. A team of health workers reviews the epidemiological situation regularly and recommends new vaccine strains whenever necessary.

EXPLORE

Variation, in biology, refers to any difference between cells, individual organisms, or groups of organism. Variation may be shown in physical appearance, metabolism, fertility, mode of reproduction, behavior, learning and mental ability, and other obvious or measurable characters.

Molecules, in chemistry, are groups of atoms bonded together representing the smallest fundamental unit of a chemical compound that can take part in a chemical reaction.

What role could the tiny molecules possibly play in variation? Your goal in this section is to start exploring this relationship.

Let's begin by examining a case of variation in humans.

ACTIVITY NO. 1: CASE ANALYSIS – Human Skin Color Variation

Read the given case carefully:

Modern Human Diversity - Skin Color
http://humanorigins.si.edu/evidence/genetics/skin-color/modern-human-diversity-skin-color

Why do people from different parts of the world have different colored skin? Why do people from the tropics generally have darker skin color than those who live in colder climates? Variations in human skin color are adaptive traits that correlate closely with geography and the sun's ultraviolet (UV) radiation.

As early humans moved into hot, open environments in search of food and water, one big challenge was keeping cool. The adaptation that was favored involved an increase in the number of sweat glands on the skin while at the same time reducing the amount of body hair. With less hair, perspiration could evaporate more easily and cool the body more efficiently. But this less-hairy skin was a problem because it was exposed to a very strong sun, especially in lands near the equator. Since strong sun exposure damages the body, the solution was to evolve skin that was permanently dark so as to protect against the sun's more damaging rays.

Melanin, the skin's brown pigment, is a natural sunscreen that protects tropical peoples from the many harmful effects of ultraviolet (UV) rays. UV rays can, for example, strip away folic acid, a nutrient essential to the development of healthy fetuses. Yet when a certain amount of UV rays penetrates the skin, it helps the human body use vitamin D to absorb the calcium necessary for strong bones. This delicate balancing act explains why the peoples that migrated to colder geographic zones with less sunlight developed lighter skin color. As people moved to areas farther from the equator with lower UV levels, natural

selection favored lighter skin which allowed UV rays to penetrate and produce essential vitamin D. The darker skin of peoples who lived closer to the equator was important in preventing folate deficiency.

There is also a third factor which affects skin color: coastal peoples who eat diets rich in seafood enjoy this alternate source of vitamin D. That means that some Arctic peoples, such as native peoples of Alaska and Canada, can afford to remain dark-skinned even in low UV areas. In the summer they get high levels of UV rays reflected from the surface of snow and ice, and their dark skin protects them from this reflected light.

Process Questions:
1. Describe how skin color differs for the human species.
2. Why do our skin colors vary? Enumerate some of the factors mentioned in the text.
3. ***How do you think does variation arise in human skin color?*** Write your **hypothesis** and explain briefly why you came up with such hypothesis.

This is only the first step in your exploration of *human skin color variation and the factors affecting it*. You will go back to this case in the succeeding sections of this module.

ACTIVITY NO. 2: Eliciting Prior Knowledge through K-W-L Chart

In the previous activity, you examined the factors that affect skin color. Environment plays a big role in the evolution of skin color in humans. A natural substance, called melanin, gives our skin its color. It also gives color to our hair and the iris of our eyes.

The traits or characteristics that organisms inherit and possess are provided by **substances** found in their bodies. Usually, these trait-giving substances are in the form of proteins.

Recall what you know about proteins and other biological macromolecules. ***How are these proteins synthesized in the cell?*** Could the differences in the proteins affect the way organisms grow and develop? To what extent do proteins influence variety among species? ***How exactly does variation arise?***

Write what you **know** about these questions in the **K** column of the K-W-L chart. Then, write what you **want to know** about the topic in the **W** column. Leave the third column blank.

K-W-L Chart		
How are proteins synthesized in the cell? *How does genetic variation arise?*		
WHAT I **K**NOW	WHAT I **W**ANT TO KNOW	WHAT I **L**EARNED

Each organism has a set of unique and different traits. Learn in this module how this variation in traits is achieved. Learn further how this variation of traits affects an organism's adaptability and survivability. **Your task at the end of this unit will have you explain in the molecular level how traits develop and how traits vary from generation to generation.**

End of EXPLORE:

You looked at variation, which is a *broad* concept in biology. You looked at molecules, substances, and proteins which are *small* entities that play important roles in organisms.

The contrast of "big" and "small" may have overwhelmed you. But you need not worry. This module will take you to a guided, step-by-step journey through the *tiny* molecules and their *huge* impact to variation of species and populations.

Let's start to find answers by doing the next activity.

FIRM-UP

Let's start small. In this section, you will be introduced to the "tiny" molecules found inside the cell that are the bases of inheritance. You will learn about the structure of these molecules and the processes they undergo. You will also learn what kind of action these processes do to our traits.

Do **self-monitoring** of your progress in the different topics through the checklist below. The topics that will be covered in this section are indicated in the checklist.

Topics	*Is the topic clear to you?*		
	YES	*A LITTLE*	*NOT YET*
DNA is the genetic material.			
DNA makes copies of itself through Replication.			
Information from the DNA is copied to RNA through Transcription.			
Information from DNA (and RNA) is 'translated' to protein.			

ACTIVITY NO. 3: Uncovering Mendel's "hereditary factors"
(*DNA is the genetic material.)*

Gregor Mendel explained in the year 1865 that traits are passed from the parent to the offspring through "hereditary factors."

In the early 20th century, scientists established that Mendel's "hereditary factors" are called **genes**. The **gene** is the unit of inheritance and different forms of the same gene are called **alleles**.

But the individual genes make up a bigger whole. Humans, for instance, have about 30,000 genes. All these genes are found in a very long genetic material, the **DNA** or deoxyribonucleic acid.

Interactive A: DNA Structure

Click on the links below to learn what the DNA is.

http://www.pbs.org/wgbh/nova/genome/dna_flash.html - Journey into DNA

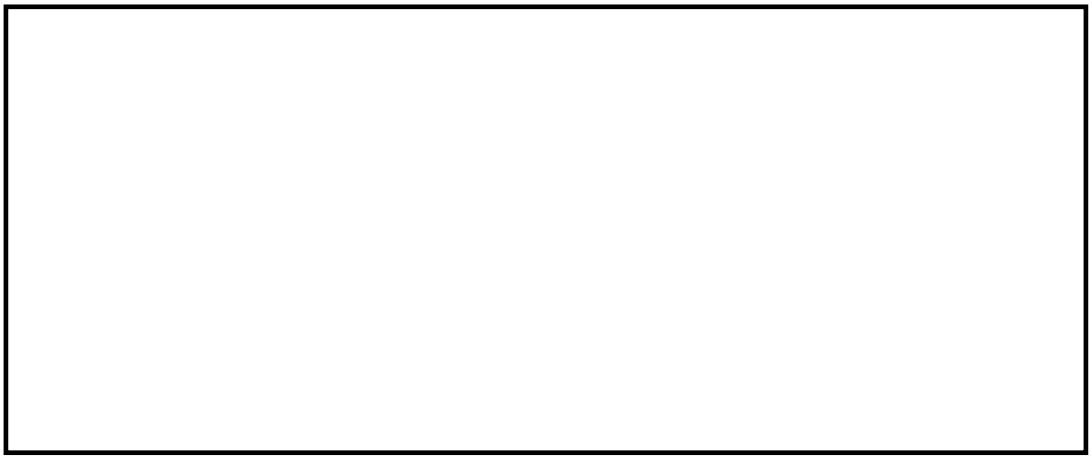
http://learn.genetics.utah.edu/content/molecules/dna/ - What is DNA?

http://www.nature.com/scitable/topicpage/dna-is-a-structure-that-encodes-biological-6493050 - DNA is a structure that encodes biological information

http://www.johnkyrk.com/DNAanatomy.html - DNA Anatomy

Process Questions:

1. Instructions providing all of the information needed for an organism to grow and live are found in the DNA. What do these instructions ***look*** like? Answer this question by drawing the detailed structure of DNA in the box provided below:



2. How can the DNA molecule hold information? Answer this question by *labelling* the parts of the DNA structure that enables it to encode a detailed set of plan for the cells of our body.
3. Why is the DNA considered as the genetic material?

Interactive B: Discovery of the DNA

Click on the link below to go to an interactive timeline about discoveries related to the DNA.

http://www.learner.org/interactives/dna/history.html - How DNA was discovered

Take note of the important conclusions made by each of the scientists/ group of scientists who studied DNA. Use the table below to summarize all information:

Scientists	**Experiment** *(**Remember!** Summarize. Do not "copy and paste." Include only the most important ideas. Put together the main ideas in meaningful sentences.)*	**Conclusion** *(**Remember!** Summarize. Do not "copy and paste." Include only the most important ideas. Put together the main ideas in meaningful sentences.)*

Process Questions:
1. What are the important conclusions that led the scientists to decide that the DNA is the *substance/molecule of inheritance?* Explain.
2. What parts of the DNA structure enables it to perform its function as the *genetic material*?

Before you end this activity, complete the exercise found in the link below:

http://learn.genetics.utah.edu/content/molecules/builddna/ - Build a DNA molecule

http://www.nobelprize.org/educational/medicine/dna_double_helix/dnahelix.html - DNA, the Double Helix

Process Questions:
1. What are the components of the DNA molecule?
2. How are these components arranged in order to build a DNA molecule?
3. How is DNA related to proteins? ***How are proteins synthesized in the cell?***

ACTIVITY NO. 4: "Be a Careful Reader"
(*DNA makes copies of itself through Replication.)*

In the previous activity, you studied the DNA molecule. You have already understood its double-helical structure. You have also seen how its structure relates to its function as genetic material. Learn more about how "structure fits function" for DNA as you study another crucial process that our genetic material undergoes – its own **replication**.

Below are several learning materials on DNA replication:
http://science.howstuffworks.com/life/cellular-microscopic/dna3.htm - How DNA works

https://www.youtube.com/watch?v=27TxKoFU2Nw – DNA replication process

http://www.johnkyrk.com/DNAreplication.html - DNA makes DNA

In this module, you will come across a lot of reading materials, some of which may be too long and complicated. For you to better understand the content of the given materials, always follow these four strategies: (taken from www.interventioncentral.org)

1. **Prediction.** Before you begin to read, look at the main title, scan the material to read the major headings, and look at the illustrations. Based on these clues, try to **predict** what the material is about. Write your prediction in the space provided.
2. **List Main Ideas.** Stop after each paragraph or major section of the learning material. Construct one or two complete sentences that sum up only the most important idea(s) that appear in the section. Good summary sentences include key concepts or events but leave out less important details. Write these summary (main idea) sentences down and continue reading.
3. **Question Generation.** Look at the ideas that you have summarized as you work through the learning material. For each main idea listed, write down at least one question that the main idea will answer.
4. **Clarifying.** Sometimes in your reading you will run into words, phrases, or whole sentences that really don't make sense. Here are some ways that you can clarify the meaning of your reading before moving on:
   - If you come across a word whose meaning you do not know, read the sentences before and after it to see if they give you clues. If the word is still unclear, look it up in a dictionary.
   - Reread the phrase or sentence carefully and try to understand it. If it contains words such as "them", "it" or "they", be sure that you know what nouns to which these words refer.

Ready to summarize information about DNA replication? Complete the given worksheet:

DNA Replication			
Predicting	Listing Main Ideas	Questioning	Clarifying
I think that the learning materials will talk about/show…	*The most important ideas are…*	*For each main idea, these are the questions that might be asked…*	*These are terms /concepts/ ideas that are not yet clear to me…*
Summarizing: *Here's a summary of what I learned about DNA Replication:*			

Process Questions:
1. Why does the DNA molecule need to make identical copies of itself?
2. Why does DNA replication need to be error-free? Why does the DNA need to be a "careful reader?"
3. What is the importance of DNA replication to DNA's function of storing genetic information?

Quick Review:
Click on the letter that corresponds to the best answer:
1. During DNA replication, the parental strand is GAATCT. What will be the complementary DNA strand?
    A. GAATCT
    B. CTTAGA
    C. TCTAAG
2. After replication, two identical daughter molecules are produced. Each daughter molecule contains one old strand of DNA. This is because DNA replication
    A. conservative.
    B. continuous.
    C. semiconservative.

For nos. 3-5, choose from the following enzymes used in replication.
    A. DNA helicase
    B. DNA ligase
    C. DNA polymerase
3. Unwinds and unzips DNA
4. Adds new complementary DNA nucleotides to the daughter strand
5. Seals breaks in the DNA backbone

ACTIVITY NO. 5: "Pass the Message"
(*Information from the DNA is copied to RNA through Transcription.)*

You've seen from the previous activities how DNA is a very important molecule. So important that every cell in an organism's body has to have the same DNA; and that if ever a cell is to divide itself, it has to first make sure it has identical copies of its DNA. It is important, during replication, to preserve and pass on the **same** information found in the DNA.

The DNA is found inside the nucleus; the molecule **does not** go out of there. However, the instructions contained in the DNA go beyond the nucleus to reach other parts of the cell. How is that made possible by the cell? To answer that question, you have to get to know another molecule: **RNA or ribonucleic acid**.

Interactive A: *What is RNA?*

Click on the links below to learn what the RNA is.

http://learn.genetics.utah.edu/content/molecules/rnamolecule/ - RNA, the Versatile Molecule

http://www.rnasociety.org/about/what-is-rna/ - What is RNA?

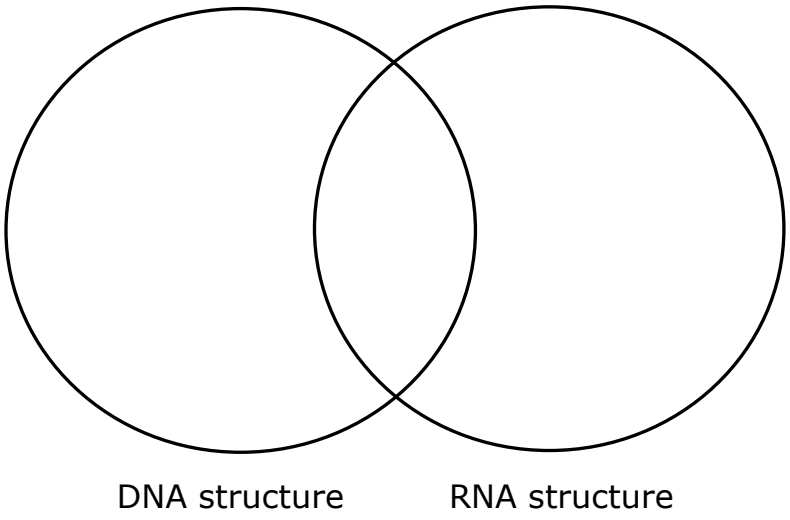
http://www.pbs.org/wgbh/nova/labs/video_popup/4/25/ - RNA VirtuaLab (video intro)

https://www.youtube.com/watch?v=0Elo-zX1k8M – Why RNA is just as cool as DNA

Process Questions:

1. What important role does RNA play in the expression of information found in the DNA?

2. Compare and contrast the *structure* of DNA and RNA through a Venn diagram.



Interactive B: Transcription

How do genes (which are found in the DNA) give rise to actual traits or characteristics? If I got that part of my mother's DNA that tell me I should also have a curly hair, how come I actually get a curly hair? How do our cells accomplish that **gene expression**?

You have now come to the first step in gene expression which is **transcription**. The RNA molecule takes part in this process.

Click on the links below to learn about transcription:

http://www.dnalc.org/resources/3d/12-transcription-basic.html - Transcription

https://www.youtube.com/watch?v=AGzsgTMgSog – video of transcription

http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/transcription.swf - transcription animation

Process questions:
1. What is transcription?
2. What molecule is produced after transcription? Why does it need to be produced?
3. What does transcription have to do with **protein synthesis**?

   Read the following study about "junk" DNA, found in the given link. This will help you discover important facts and events about transcription.

   http://healthland.time.com/2012/09/06/junk-dna-not-so-useless-after-all/ - Junk DNA – Not So Useless After All

4. What is "junk" DNA?
5. Do you think these portions of the DNA get ***transcribed***? Why or why not?
6. According to studies, why are junk DNA "not so useless after all?"
7. How does "junk" DNA assist the process of transcription?
8. What can you conclude about the process of gene expression in living things?

Quick Review:
Click on the letter that corresponds to the best answer:
1. If the sequence of bases in DNA is GACT, then the sequence of bases in RNA is:
   A. GACT
   B. GACU
   C. CTGA
   D. CUGA

2. The process of transcription produces
    A. cDNA
    B. mRNA
    C. protein
3. Which of the following is **not true** about transcription?
    A. In making RNA, uracil, instead of thymine, pairs with adenine.
    B. RNA is made from a DNA template.
    C. RNA is produced in the cytoplasm of eukaryotic cells.
    D. The enzyme RNA polymerase synthesizes RNA.

ACTIVITY NO. 6: "In English, Please"
(Information from DNA (and RNA) is 'translated' to protein.)

The first step in gene expression was covered in the previous activity. "Instructions" from the DNA is transcribed to RNA. RNA is an intermediate product that serves as a messenger from the nucleus, where the DNA is, to the ribosomes where proteins will be synthesized. Once the information from the DNA has been *transcribed* and the messenger RNA (mRNA) produced, the mRNA goes out of the nucleus to bring the information to the ribosomes.

Proteins are important molecules in our cells. They come in the form of enzymes, some hormones, and structural proteins that together dictate what our **traits** will be.

Learn more about proteins and their importance through this animation:
http://learn.genetics.utah.edu/content/molecules/proteins/ - What is a Protein?

Proteins are said to be the building blocks of our body. They constitute about 80% of the dry weight of muscle, 70% of the dry weight of skin and 90% of the dry weight of blood. Proteins make up your hair, skin, eyes, muscle, and organs. ***Collagen****, for instance, is the protein found in our bones, tendons, and ligaments, while* ***keratin*** *is the protein of nails, hair, and feathers.*
Proteins are also responsible for almost all biochemical processes that keep you alive.

Click on this link to learn more:
http://healthyeating.sfgate.com/6-primary-functions-proteins-5372.html - 6 Primary Functions of Proteins

To produce proteins, information from the DNA (brought by the mRNA) is used. However, DNA and RNA are both made up of nucleotides, while proteins are made up of amino acids. They don't "speak" the same "language." Hence, another process must happen for genes to be expressed into protein. This process is referred to as **translation.**

Before you go through the process of translation, discover first how the cell "reads" genes. Read the following excerpt:

How do cells read genes?
http://learn.genetics.utah.edu/content/molecules/dnacodes/

Like words in a sentence, the DNA sequence of a gene determines the amino acid sequence for the protein it encodes. In the protein-coding region of a gene, the DNA sequence is interpreted in groups of three nucleotide bases, called codons. Each codon specifies a single amino acid in a protein.

We can think about the protein-coding sequence of a gene as a sentence made up entirely of 3-letter words. In the sequence, each 3-letter word is a codon, specifying a single amino acid in a protein. Have a look at this sentence:

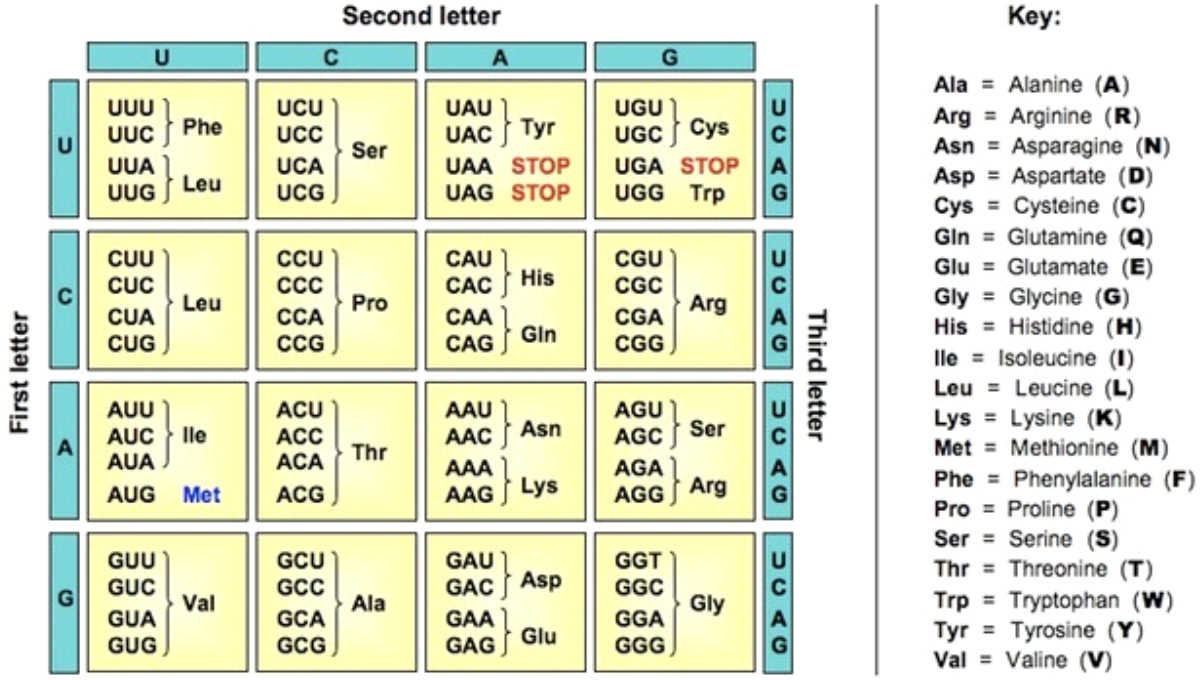
Thesunwashotbuttheoldmandidnotgethishat.

If you were to split this sentence into individual 3-letter words, you would probably read it like this:

The sun was hot but the old man did not get his hat.

This sentence represents a gene. Each letter corresponds to a nucleotide base, and each word represents a codon.

To know what amino acid is coded by a given codon, a genetic code chart is used:



Notice that the genetic code is **degenerate,** this means more than one codon codes for the same amino acid. The genetic code is **unambiguous,** each triplet code has only one meaning. Notice also that the code has start and stop signals.

Click on the links below to learn about the process of translation:

http://www.nobelprize.org/educational/medicine/dna/b/translation/translation.html - Translation

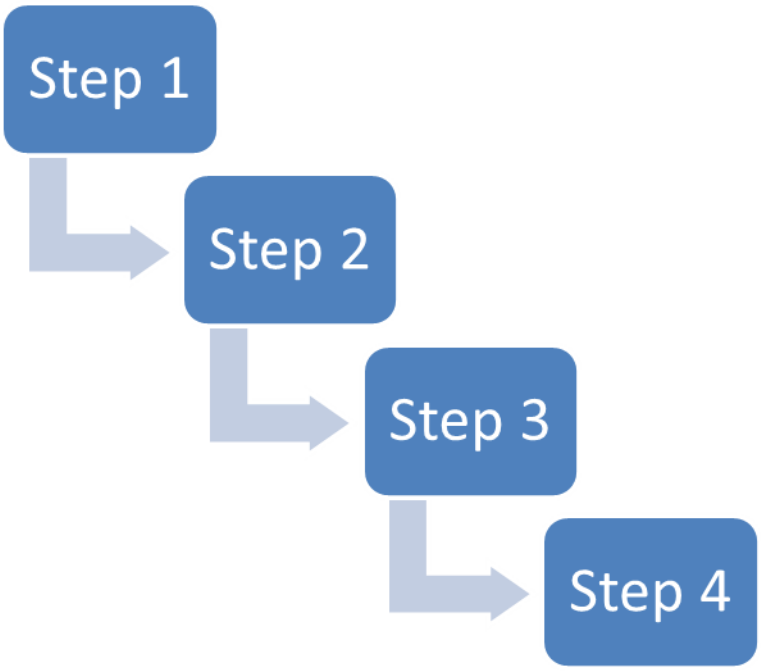
https://www.youtube.com/watch?v=h5mJbP23Buo – Protein Synthesis and the Lean, Mean Ribosome Machines

http://highered.mheducation.com/olcweb/cgi/pluginpop.cgi?it=swf::535::535::/sites/dl/free/0072437316/120077/micro06.swf::Protein+Synthesis – Protein Synthesis

http://learn.genetics.utah.edu/content/molecules/transcribe/ - Transcribe and Translate a Gene

Process Questions:

1. What information is “translated” in the process of protein synthesis?
2. How does the cell pick up this information? Discuss all the molecules involved and the action of these molecules.
3. **How are proteins synthesized in the cell?** Answer this question through a graphic organizer:



4. Do all cells of the body produce the same protein? Do all genes get expressed at the same time? Explain.
5. What would happen if a change/irregularity happens in any of the steps? How will this change affect the protein?

Quick review:
Determine the amino acid coded by the following mRNA codons:

1. CUU
2. ACA
3. GAC
4. UUU

Determine the amino acid sequence that can be produced from this **DNA** strand:
T A C T G T C A G G A A A A A T C T A T T

ACTIVITY NO. 7: CASE ANALYSIS – Human Skin Color Variation

Recall the first activity you did in this module. It was an analysis of the case of skin color variation in humans. Retrieve the text as well as your initial analysis to the case.

Now that you have learned a great deal about DNA and protein synthesis, we can already discuss the case in more detail. Answer the following questions after reviewing the text *Modern Human Diversity – Skin Color.*

1. What are the **three** factors that affect skin color in humans? Write each factor in the columns of the given table:

Factor 1: _____	Factor 2: _____	Factor 3: _____

2. How does each of these factors determine whether people will develop lighter or darker skin color?

   To answer this, go back to the text and *summarize* the main points for each factor. *List* the most important *ideas* and write a summary using as many of the main idea words as possible. Your list and summary should appear in the appropriate columns of the table:

Factor 1: _____	Factor 2: _____	Factor 3: _____

3. What substance, which was mentioned in the text, gives color to our skin?

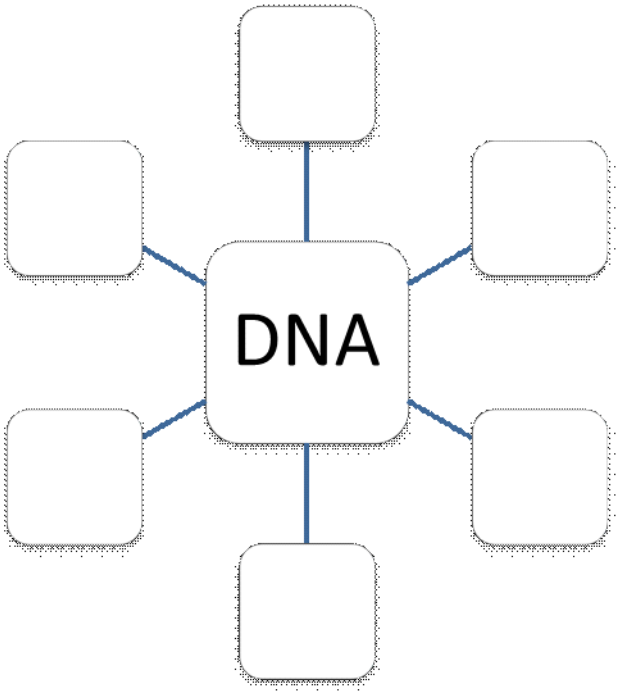
   How do you think does this substance give color to our skin? Why does it give a lighter color to one, and a darker color to another? Make a detailed guess and **illustrate** that in the box provided below:

EXPLAINING HUMAN SKIN COLOR VARIATION
(CONCRETE)

At present, the genetics of skin color is still largely unclear, even for the biologists and experts. In the succeeding section, however, we will still look at some studies that attempt to know and target the *actual* genes that control human skin color and how it varies for peoples of different races.

It doesn't yet fully answer our query about skin color variation. But, studying those will deepen your understanding of the molecular basis of inheritance and genetic variation.

Before ending this section, review and look back at how DNA has come to be called the substance of inheritance, our genetic material. Show, through a cluster map, the many substances and processes that rely on the DNA. Use http://www.spicynodes.org/ to construct your map.



End of FIRM UP:

In this section, the discussion was about the DNA and how information from the DNA is used to synthesize proteins.

How did you do?

Skills	*Self-Assessment*		
	YES	*A LITTLE*	*NOT YET*
I can infer, based on its structure, that the DNA is the genetic material.			
I can explain how DNA makes copies of itself through Replication.			
I can differentiate DNA and RNA structure, as well as their corresponding functions.			
I can describe how information from the DNA is copied to RNA through Transcription.			

I can interpret nucleotide codes and their corresponding amino acids using the genetic code and following the steps in the process of Translation.			

Go back to the previous section and compare your initial ideas with the discussion. How much of your initial ideas are found in the discussion? Which ideas are different and need revision?
Now that you know the important ideas about this topic, let's go deeper by moving on to the next section.

DEEPEN

In the previous section, you learned about the flow of genetic information from the DNA to the RNA to proteins. That is the **central dogma of molecular biology.**

Your goal in this section is to take a closer look at these processes by studying actual proteins and their synthesis. You will also learn about the consequences (or benefits) if an error or change occurred in the processing of DNA. Learn how such changes may have implications to an organism's adaptation and survival.

ACTIVITY NO. 8: "Transcribe and Translate"
(*Changes in the DNA may affect protein production.*)

Have you ever experienced sending a wrong message to somebody? Or you delivered a message and it was misinterpreted by someone? On some occasions, this may bring negative consequences. But there could also be some instances when it could actually lead to something positive and good. Or, it may not have any effect at all.

The process of replication is not entirely error-free. Changes may happen to the DNA sequence. Such change is called **mutation**.

What happens if there is a mutation in the DNA sequence? Click on the link below to do an activity about mutation. In this virtual lab, you will complete mRNA and protein sequences based on the given information. Compare the original and mutated sequences to see the impact of the mutation.

http://www.mhhe.com/biosci/genbio/virtual_labs/BL_26/BL_26.html - Virtual Lab: DNA and Genes

Process Questions:
1. Describe the differences between the original and mutated sequences.
2. How many amino acids were changed or affected?
3. What do you think will be the impact of this mutation? Why?
4. Does changing the sequence of nucleotides always result in a different amino acid sequence? Explain.

Learn more about mutation by exploring the learning materials found in the following links:

http://biology.about.com/od/basicgenetics/ss/gene-mutation.htm - Gene mutation

http://www.uvm.edu/~cgep/Education/Mutations.html - Mutations

http://learn.genetics.utah.edu/content/variation/mutation/ - What is Mutation?

In order for you to get the most out of the materials provided, you will be introduced to another writing strategy.

Just as the cell transcribes and translates information from the DNA, you will also try to "transcribe" and "translate" the information given about mutation using the **POW+TREE Strategy**.

<table>
<tr><td colspan="2">Pick an idea or opinion.</td></tr>
<tr><td rowspan="4">Organize and generate notes and ideas for each part of the TREE:</td><td>Topic Sentence</td></tr>
<tr><td>Reason</td></tr>
<tr><td>Explanation</td></tr>
<tr><td>Ending</td></tr>
</table>

Write and say more.

Process Questions:
1. What are the causes of mutation? Explain each.
2. Differentiate the types of mutation.
3. ***How can mutation affect protein synthesis in the cell?*** Discuss thoroughly.

Many known diseases are caused by mutation. Click on the link below to learn about some common genetic disorders:

http://www.steadyhealth.com/articles/The_16_Most_Common_Genetic_Diseases_a1547.html - The 16 Most Common Genetic Diseases

http://www.cdc.gov/ncbddd/birthdefects/DownSyndrome.html - Facts about Down Syndrome

4. As you have read, these diseases are usually resulting from lack of a necessary protein or presence of wrong or malfunctioning proteins. ***How does mutation contribute to the production of faulty proteins?***

Quick Review:
Review the animation and answer the questions that follow to test your understanding.

http://highered.mheducation.com/sites/0072552980/student_view0/chapter9/animation_quiz_5.html - Addition and Deletion Mutations

ACTIVITY NO. 9: SITUATION ANALYSIS

You have looked at mutation and the effects it may have in protein synthesis. You have also explored *real* situations related to the said topic.

This next activity will have you examine more real-life situations that illustrate protein synthesis.

PROBLEM 1

What makes a firefly glow?

http://learn.genetics.utah.edu/content/molecules/firefly/

Process Questions:
1. Why is it possible for a firefly to produce its own light?
2. ***How is the protein (luciferase) synthesized in the cell?*** What results from this?
3. If the synthesis is altered, what is the possible outcome?

PROBLEM 2

Viruses have no cells. How come they can "*live*?"

Tinkering with translation: protein synthesis in virus-infected cells
Walsh, Matthews, and Mohr, January 2013
http://www.ncbi.nlm.nih.gov/pubmed/23209131

Viruses are obligate intracellular parasites, and their replication requires host cell functions. Although the size, composition, complexity, and functions encoded by their genomes are remarkably diverse, all viruses rely absolutely on the protein synthesis machinery of their host cells. Lacking their own translational apparatus, they must recruit cellular ribosomes in order to translate viral mRNAs and produce the protein products required for their replication. In addition, there are other constraints on viral protein production. Crucially, host innate defenses and stress responses capable of inactivating the translation machinery must be effectively neutralized. Furthermore, the limited coding capacity of the viral genome needs to be used optimally. These demands have resulted in complex interactions between virus and host that exploit ostensibly virus-specific mechanisms and, at the same time, illuminate the functioning of the cellular protein synthesis apparatus.

Process Questions:
1. What determines the size, composition, complexity, and functions of a virus?
2. ***How are viral proteins synthesized if viruses don't have cells?***
3. What may happen if the viral protein synthesis is altered? Why do many scientists find ways to alter this process in viruses?

PROBLEM 3

Why are some people born with a disease?

http://www.dnalc.org/resources/3d/17-sickle-cell.html - Disease and Mutation: Sickle Cell

Process Questions:
1. What happens to the red blood cells of individuals with sickle cell anemia? Explain why this happens.
2. Why do cells produce abnormal or faulty proteins?
3. ***How are these proteins synthesized in the cell?***
4. Can the production of these proteins be prevented? If yes, how? If no, why not?

You have looked at different situations related to protein synthesis. Put together in the table below your answers to the essential question that was asked for each problem.

	PROBLEM 1	PROBLEM 2	PROBLEM 3
ESSENTIAL QUESTION: ***How are proteins synthesized in the cell?*** ***What happens if the process is altered?***	What makes a firefly glow? *Cells in the firefly's tail produce…*	Viruses have no cells. How come they can "***live***?" *Tinkering with translation: protein synthesis in virus-infected cells* *Protein synthesis in viruses…*	Why are some people born with a disease? *Disease and Mutation: Sickle Cell* *Sickle-cell anemia is a disease that results due to alteration in the synthesis of…*

Process Questions:

1. Look at your answers to the essential question in the above table. What do all the answers have in common?
2. Are all the factors the same? How do the answers differ? What are the different factors that affect protein synthesis in cells?
3. Complete the following statement and support your answer with examples from the above situations.

The synthesis of proteins…

Supporting reasons and examples:

Be sure that everything is clear to you before you move on to the next activity. Use the following self-monitoring guide:

Skills	RED I still need more activities to understand all the concepts.	YELLOW More than 50% of the concepts I fully understand.	GREEN I understand all and will be able to apply.
I can describe the relationship between DNA, RNA, and proteins.			
I can prove, *by discussing the processes and showing examples*, that the DNA holds the genetic information that are expressed as traits.			
I can investigate the effects of mutation on protein synthesis, and the consequent effects to the organism.			

ACTIVITY NO. 10: CASE ANALYSIS – Human Skin Color Variation

It is now time for you to go back to the case you have been investigating in the previous sections.

Read the following additional information:

Rees in 2003 made a study entitled Genetics of Hair and Skin Color. According to the study, "differences in skin and hair color are principally genetically determined and are due to variation in the ***amount, type, and packaging of melanin polymers*** *produced by melanocytes secreted into keratinocytes."*

Let us get to know **melanin** in more detail then.

Melanin is the substance that gives skin, hair, and eyes their color. Melanin is also found in the light-sensitive tissue at the back of the eye (the retina), where it plays a role in normal vision. Melanin is produced in specialized cells called melanocytes.

Tyrosinase *is an enzyme located in melanocytes. This enzyme is responsible for the first step in melanin production. It converts a protein building block (amino acid) called tyrosine to another compound called dopaquinone. A series of additional chemical reactions convert dopaquinone to melanin in the skin, hair follicles, the colored part of the eye (the iris), and the retina.*

The ***TYR gene*** *provides instructions for making the enzyme tyrosinase.*

(Taken from: http://ghr.nlm.nih.gov/gene/TYR)

Process Questions:

1. ***How is tyrosinase (a protein) synthesized in the cell?*** Based on what you know about gene expression and protein synthesis, make a **simple model** of the synthesis of tyrosinase from the TYR gene.

EXPLAINING HUMAN SKIN COLOR VARIATION
SYNTHESIS OF TYROSINASE
A Model
(REPRESENTATIONAL)

2. Do you think melanin and tyrosinase could play a role in human skin color variation? How may they contribute to variation? Explain.

The next activity will help you analyze this case more deeply. The focus is on **genetic variation**.

ACTIVITY NO. 11: VIDEO ANALYSIS

Biodiversity, the variety of life on earth, is crucial to both the abiotic and biotic components of the ecosystem. One level of biodiversity is **genetic diversity.** It refers to the total number of genetic characteristics in species.

Genetic diversity allows populations to adapt to changing environments. With more variation, there is higher chance that some individuals will possess variations of genes and alleles that are more suited for the environment. Those individuals have higher chance of survival and will produce more offspring bearing that allele. The population will continue to survive through generations because of the success of these individuals.

How does genetic variation arise?

To help you understand how genetic variation occurs at the molecular level, watch carefully the following videos and answer the questions that follow:

VIDEO 1

https://www.youtube.com/watch?v=z9HIYjRRaDE – Where do Genes come from?

Process Questions:

1. According to the video, what makes it possible for **new** genes to enter a population?
2. ***How does genetic variation arise?***

VIDEO 2

https://www.youtube.com/watch?v=xkVv52EyKzc – Are Mutations Heritable?

Process Questions:

1. What are heritable mutations?
2. How can mutations in genes be passed from the parent to offspring?
3. What is/are the possible contribution/s of heritable mutations to genetic variation?

4. How does genetic variation arise?

Before you leave this topic on heritable mutations, spend some time thinking about this additional question: ***Does mutation happen randomly or does it happen as a response to the environment?*** Gather pertinent resources and discuss this controversial issue with your classmates through an online discussion forum.

VIDEO 3

https://www.youtube.com/watch?v=11iYk0Yrx3g - Genetic Variation, Gene Flow, and New Species

Process Questions:
1. In terms of genetic variation, why is sexual reproduction more advantageous than asexual reproduction?
2. ***How does genetic variation arise from sexual reproduction?***

You have looked at three different videos related to genetic variation. Put together in the table below your answers to the essential question that was asked for each problem.

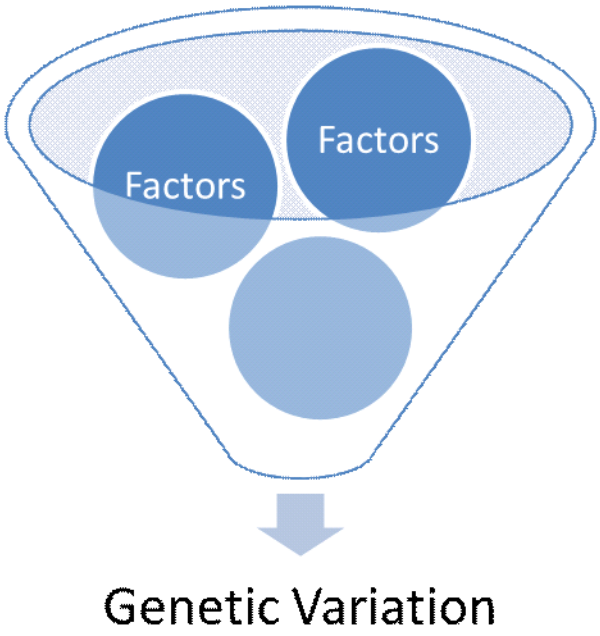
	VIDEO 1	VIDEO 2	VIDEO 3
ESSENTIAL QUESTION: ***How does genetic variation arise?***	Where do Genes come from? *Genetic variation may arise from…*	Are Mutations Heritable? *Genetic variation may arise from…*	Genetic Variation, Gene Flow, and New Species *Genetic variation may arise from…*

Process Questions:

1. Look at your answers to the essential question in the above table. What do all the answers have in common?
2. Are all the factors the same? How do the answers differ? What are the different ways by which genetic variation can be attained?
3. Complete the following statement:

Genetic variation arises as a result of …

Present your supporting reasons and examples through a funnel graphic organizer. Modify as you see fit:



Read the article found in the given link:
http://evolution.berkeley.edu/evolibrary/news/120301_chipmunks - Climate change causes loss of genetic diversity

Process questions:
1. Describe the situation of alpine chipmunks (*Tamias alpinus)* in the Yosemite National Park. Why is it now difficult for park visitors to encounter the chipmunks?
2. Discuss all the factors that led to the supposed loss of genetic variation in alpine chipmunks.
3. Based on the analysis you've done, suggest measures that may be taken in order to improve genetic variation in alpine chipmunks.

ACTIVITY NO. 12: Summarizing New Knowledge through K-W-L Chart

Recall the two focus questions that you dealt with in the different activities:

- ***How are proteins synthesized in the cell?***
- ***How does genetic variation arise?***

Write your final answers to these questions in the **L** column of the K-W-L chart. Compare your new answers with your answers in the previous columns.

K-W-L Chart		
How are proteins synthesized in the cell? *How does genetic variation arise?*		
WHAT I **K**NOW	WHAT I **W**ANT TO KNOW	WHAT I **L**EARNED

End of DEEPEN:

In this section, the discussion was about mutation and genetic variation.

What new realizations do you have about the topic? What new connections have you made for yourself? What helped you make these connections?

Now that you have a deeper understanding of the topic, you are ready to do the tasks in the next section.

TRANSFER

Your goal in this section is apply your learning to real life situations. You will be given a practical task which will demonstrate your understanding.

ACTIVITY NO.13: CASE ANALYSIS – Human Skin Color Variation

You now reached the concluding part of this case analysis of human skin color variation. This time, you will **write** your own analysis of the case based on the topics you learned about *gene expression, mutation, and genetic variation.*

Use as references the related activities you accomplished in the previous sections. Below are additional references as well:

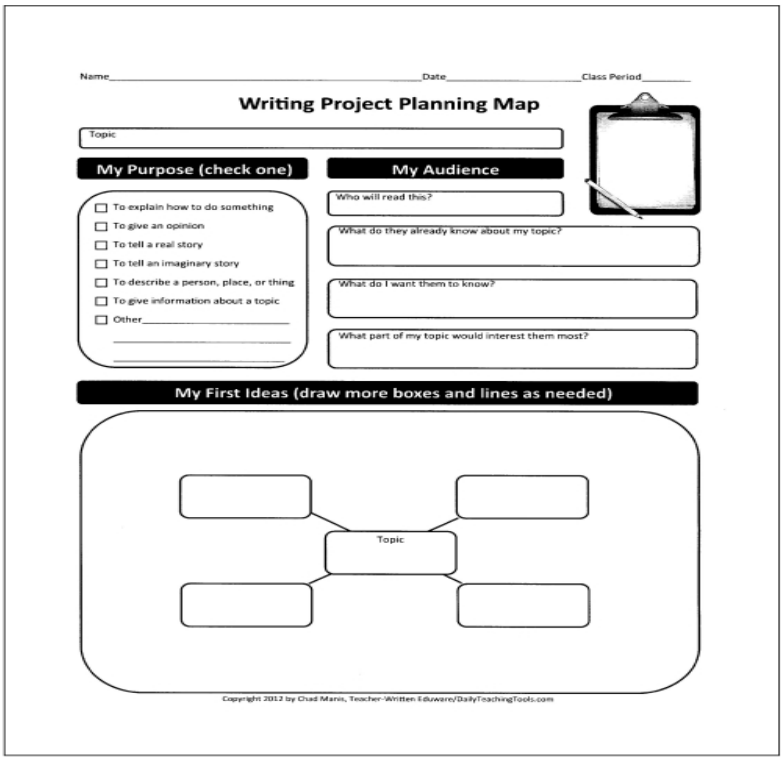
http://www.scientificamerican.com/article/researchers-identify-huma/ - Researchers Identify Human Skin Color Gene

http://medicalxpress.com/news/2014-01-skin-gene-global-populations-reveal.html - Studies of a skin color gene across global populations reveal shared origins

http://humanorigins.si.edu/evidence/genetics/skin-color/modern-human-diversity-genetics - Modern Human Diversity – Genetics

Process Questions:
1. Why is there variation in human skin color?
2. Why is this variation important?

You will communicate the information you gathered and your analysis to your classmates. Choose the mode which you think will best communicate your thoughts. Use a **project planning map** to guide you through this task. See sample map below.



Name_____Date_____Class Period_____

Writing Project Planning Map

Topic

My Purpose (check one)

- ☐ To explain how to do something
- ☐ To give an opinion
- ☐ To tell a real story
- ☐ To tell an imaginary story
- ☐ To describe a person, place, or thing
- ☐ To give information about a topic
- ☐ Other_____

My Audience

Who will read this?

What do they already know about my topic?

What do I want them to know?

What part of my topic would interest them most?

My First Ideas (draw more boxes and lines as needed)

Topic

EXPLAINING HUMAN SKIN COLOR VARIATION

My Own Analysis

(ABSTRACT)

Before submitting your work, do a self-assessment through this checkbric:

CRITERIA	YES	NO
I have a clear idea of what the case is about. I asked questions and defined problems / variables.		
I planned the project and carried out some investigations.		
I gathered enough data and information, and evaluated them so as to include only those that are accurate and relevant to the purpose of the task.		
I organized my ideas in a manner that is easy to follow and suited to my purpose.		
I cited all references and sources of information.		
I communicated my ideas in a manner that is appropriate to the purpose and audience.		
My work is objective and evidence-based, but is creative and engaging.		

ACTIVITY NO.14: TRANSFER TASK

Read carefully your final task for this module:

Environmental change is now occurring on a global scale due to human activities and many species will have to adapt to this change or experience an ever increasing chance of extinction.

One of your projects in the Institute of Molecular Biology and Biotechnology is the creation and distribution of online educational materials (videos, video podcasts, interactive simulations, etc.) that explain the molecular basis of genetic variation and species adaptability.

The responsibility of producing the materials is left to the media team composed of a researcher, a scriptwriter, and an animator.

Materials are intended for students and are therefore expected to be informative, engaging, and creative.

Rubric:

CRITERIA	Exemplary 4	Proficient 3	Developing 2	Beginning 1
CONTENT ***What is the evidence that the student can obtain and evaluate useful information?***	Content is insightful and highly relevant to the objectives of the project, and wisely chosen to address the needs of the audience. Advanced level of scientific understanding is apparent in the information presented. Thorough research was done and all sources of information are clearly identified and credited using citations.	Content is relevant to the objectives of the project. All information presented is correct, accurate, and useful. All sources of information are clearly identified and credited using citations.	Some parts are distracting or unnecessary and some information is inaccurate, unclear, and rambling. Some sources of information are not cited.	Content is irrelevant to the objectives; information presented is very shallow, many are false and confusing. No citations were made.

COMMUNICATION ***What is the evidence that the student can communicate the information in an organized and effective manner?***	Information is communicated using sophisticated and varied language that is suited to the purpose, audience, and task. Organization is appropriate to the purpose and audience and supports with great detail the line of reasoning; effectively hooks and sustains audience engagement.	Information is communicated using appropriate language and style that is suited to the purpose, audience, and task. Organization is appropriate to the purpose and audience and establishes the line of reasoning; transitions guide audience understanding.	Information is communicated using language and style that is at times inappropriate to the purpose, audience, and task. Inconsistencies in organization and limited use of transitions sometimes confuse the audience.	Information is communicated using language and style that is totally different from the purpose, audience, and task. A lack of organization makes it difficult to follow the ideas and line of reasoning.
CREATIVITY ***What is the evidence that the student can put together resources and information in a creative way?***	The work is put together by the student in a novel and resourceful way. The work has insightful and striking ideas. Some experimentation is done which gives the work a unique and personal style.	The work is put together by the student in a resourceful way. The work has new ideas.	The work is put together by the student following another model or work. The work has borrowed ideas from another source.	The work is entirely copied and shows no effort at all to reflect one's own ideas. The work does not acknowledge the original source that it copied.

End of TRANSFER:

In this section, your task was to explain in different ways how genetic variation is achieved at the molecular level and discuss its implications to biodiversity and the species' adaptability and survivability. How did you find the performance task? How did the task help you see the real world use of the topic? You have completed this lesson. Before you go to the next lesson, you have to answer the following post-assessment.

POST-ASSESSMENT:

It's now time to evaluate your learning. Click on the letter of the answer that you think best answers the question. Your score will only appear after you answer all items. If you do well, you may move on to the next module. If your score is not at the expected level, you have to go back and take the module again.

(A) 1. During transcription, information from specific genes is transferred to the intermediate molecule, RNA. After DNA has been transcribed into RNA,
   A. mRNA will then leave the nucleus.
   B. mRNA will attach to the DNA template.
   C. rRNA will begin to make new DNA strands.
   D. rRNA will supply the required amino acid from the split DNA.

(A) 2. The sequence found in the mRNA molecule determines the following except:
   A. the protein that will be synthesized.
   B. the amino acids to be brought by mRNA.
   C. the complementary DNA sequence.
   D. the amino acids that will form a protein.

(A) 3. A gene is expressed when its product, a protein, is produced and is functioning in a cell. What is the scientific term for making a protein according to the instructions found in the DNA?
   A. Replication
   B. Transcription
   C. Translation
   D. Reverse Transcription

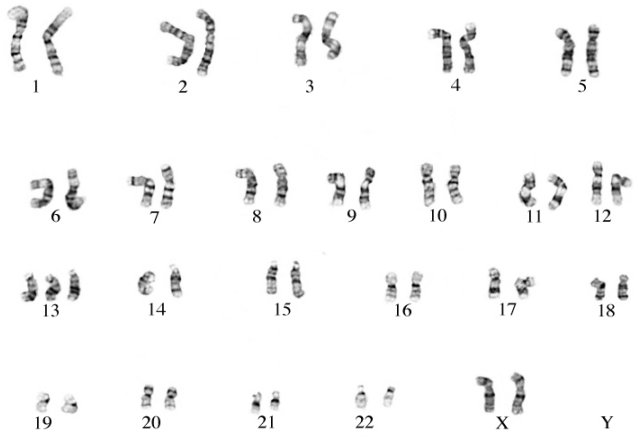
(A) 4. A mutation in a DNA segment can possibly lead to the following except
   A. change in amino acid sequence.
   B. synthesis of a different protein.
   C. no change in the protein that will be formed.

D. retention of the original position of the bases in the gene.

(A) 5. Consider this DNA sequence: AGT CGA GGC. If an adenine base (A) is added to the sequence such that the new sequence copied during replication is AGT **A**CG AGG C, what kind of mutation has occurred?
   A. Chromosomal aberration
   B. Frameshift mutation
   C. Point mutation
   D. Polyploidy

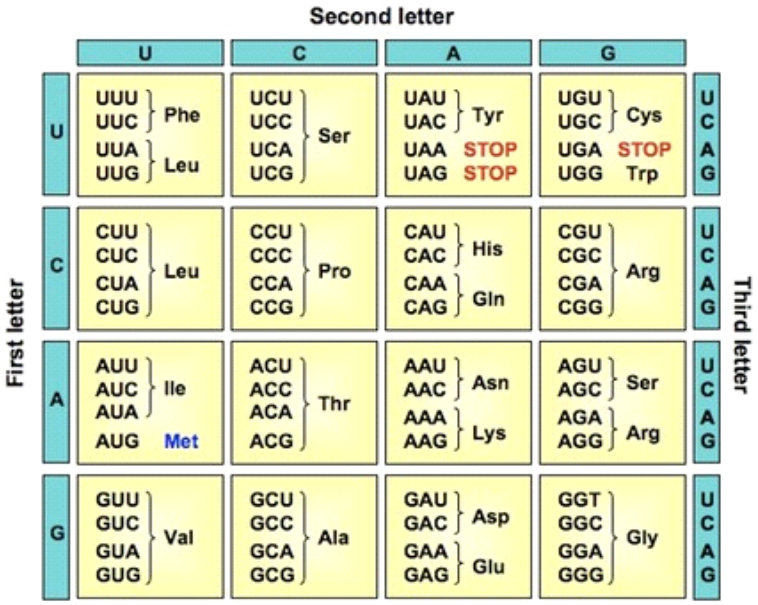
(A) 6. Does a mutation always give rise to a mutant phenotype?
   A. No, because some mutations are harmful, but some are beneficial.
   B. No, some changes in the DNA do not alter the amino acid sequence.
   C. Yes, a change in the DNA structure causes a change in both the genotype and phenotype.
   D. Yes, mutations are errors in DNA replication and will definitely affect protein synthesis.

(A) 7. Patau syndrome is a genetic disorder associated with severe intellectual disability and physical abnormalities in many parts of the body. Due to the presence of several life-threatening medical problems, many infants with this condition die within their first days or weeks of life. Below is a karyotype of a female with Patau syndrome:



Based on the diagram, what type of genetic change causes Patau syndrome?
   A. Base substitution
   B. Inversion
   C. Trisomy
   D. Triploidy

(A) 8. Refer to the given genetic code chart to predict which mutation that changed the mRNA codon would be most likely to affect protein function.



A. AUU to ACU
B. CAC to CAG
C. GUU to GUC
D. UCC to UCG

(M) 9. In 1952, Hershey and Chase conducted a study to determine which component, DNA or protein, was responsible for the ability of a bacteriophage (a virus that infects bacteria) to take over and control the metabolic activity of the bacteria in order to produce new phages. Phages have a very simple structure – they are composed of a strand of DNA surrounded by a protein coat.

In their experiment, they used two radioactive markers to label the proteins and the DNA of the phages. To the proteins, they used a radioactive sulfur and to the DNA, radioactive phosphorus.

They allowed the phages to infect the bacteria for a short time. Then, the bacterial cells were pelleted in a centrifuge. They found that the radioactive DNA was always found with the bacterial cells while the radioactive protein was always in the supernatant (outside of the bacterial cells).

During a phage infection, it was determined that some part of the phage was injected into the bacterium and it was this injected material that

conveyed the **genetic material** necessary to produce new phages. Having said this, which of the following is the conclusion made by Hershey and Chase about the genetic material of bacteriophages?

A. DNA is the genetic material.
B. Protein is the genetic material.
C. DNA and protein together serve as the genetic material.
D. Bacteriophages do not have a genetic material.

(M) 10. Linda Hunt is an American actress known as one of the lead characters in the TV series NCIS. She has taken a variety of roles both on TV and in the movies in her more than 3 decades as an actress. Her efforts have not gone unnoticed as she has received recognition from numerous award-giving bodies. Linda has Turner syndrome, a condition wherein a female would have a single X chromosome instead of the usual pair. What could be a possible consequence of having just a single X chromosome?

A. taller than usual because of genes that promote bone development
B. there could be missing genes that lead to undeveloped reproductive organs
C. inhibited breast development because of inactivated genes in the Y chromosome
D. increased muscle mass from genes found in the Y chromosome

(M) 11. George W. Beadle and Edward L. Tatum, in 1941, conducted an experiment using *Neurospora crassa*, a bread mold. First, they irradiated (exposed to radiation) a large number of *Neurospora*, and thereby produced some organisms with mutant genes. They then crossed these potential mutants with non-irradiated *Neurospora*. Normal products of this sexual recombination could multiply in a simple growth medium. However, Beadle and Tatum showed that some of the mutant spores would not replicate without addition of a specific amino acid—arginine. They developed four strains of arginine-dependent *Neurospora*—each of which, they showed, had lost use of a specific gene that ordinarily facilitates one particular enzyme necessary to the production of arginine.
What can be concluded from the experiment?

A. A change in the amino acid sequence will cause a change in the protein product.
B. A gene specifies the production of an enzyme.
C. Any change in the DNA structure is considered as mutation.
D. Radiation causes mutations in genes.

(M) 12. Amyotrophic lateral sclerosis (ALS), often referred to as “Lou Gehrig’s Disease,” is a progressive neurodegenerative disease that affects nerve cells in the brain and the spinal cord. Early symptoms of ALS often

include increasing muscle weakness, especially involving the arms and legs, speech, swallowing or breathing. When muscles no longer receive the messages from the motor neurons that they require to function, the muscles begin to “atrophy” or become smaller.

Stephen Hawking, an English physicist, cosmologist, and author, suffers from ALS.

Most cases of ALS are sporadic, however some are genetic and are attributed to a faulty gene. For instance, mutation in superoxide dismutase 1 (SOD1) gene which affects the SOD1 protein is associated with ALS symptoms.

What is the most likely explanation for this genetic cause of ALS?

A. During replication, a change in the SOD1 gene occurred that led to the synthesis of SOD1 protein with a new and toxic function.
B. During transcription, a copying error occurred in the mRNA transcript of SOD1 gene which led to the production of a defective SOD1 protein.
C. During translation, an incorrect amino acid becomes attached to the tRNA molecule thereby causing a change in the SOD1 protein structure.
D. During protein folding, a lack of enzyme causes incorrect folding and modification of the SOD1 protein structure.

(M) 13. Which of the following mutations is heritable?

A. A cell in the uterine wall of a human female undergoes a chromosomal alteration.
B. A primary sex cell in human forms a gamete that contains 24 chromosomes.
C. The DNA of a human lung cell undergoes random breakage.
D. Ultraviolet radiation causes skin cells to undergo uncontrolled mitotic divisions.

(M) 14. A paper entitled "To Mutate or Not to Mutate" was posted in the Institute of Science in Society website. A quote from the paper goes:

*Contrary to views widely held not so long ago, genes **do not** as a rule mutate at random, and cells **may choose** what, or at least, when to mutate.*

Which of the following is a valid **question** to the above declaration?

A. Are all organisms capable of mutation?
B. Are mutations harmful or beneficial?
C. Does the cells' environment play a role in mutation?
D. How can we prevent mutation from happening?

(T) 15. You are one of the invited guests in the annual biologists' forum. This year's topic is "mutation-driven evolution." You've made a number of studies about the said topic and you've decided that your talk will focus on which of the following?

A. Causes and mechanisms of mutation
B. Darwin's theory of natural selection
C. Effects of mutation on population
D. Evidences of species' evolution by mutation

(T) 16. You are a writer for the journal *Trends in Evolution*. If you are currently writing an article entitled "Evolution by Gene Duplication," which of the following will you **not** include in your article?

A. In all three domains of life – bacteria, archaebacteria, and eukaryotes – large proportions of genes were generated by gene duplication.
B. Many genome sequences are determined and analyzed that demonstrated the prevalence and importance of gene duplication.
C. Many studies concluded that the origin of a new function appears to be a very rare fate for a gene that has been duplicated.
D. The doubling of a chromosomal band in a mutant of the fruit fly *Drosophila melanogaster* exhibited extreme reduction in eye size.

(T) 17. Without genetic variation, some of the basic mechanisms of evolutionary change cannot operate. Genetic variation allows new traits to enter the population. Several students investigated the different sources of variation and following are their conclusions. Who among them has an **inaccurate** conclusion?

A. Al concluded that genetic variation may arise from random changes that occur in DNA of sex cells.
B. Barbara concluded that genetic variation may arise from genetic recombination which occurs during meiosis.
C. Martha concluded that genetic variation may arise from errors in DNA replication that cause a change in the DNA sequence.

D. Oswald concluded that genetic variation may arise from cloning a gene, a portion of the DNA sequence.

(T) 18. Cystic fibrosis is an autosomal recessive disorder that causes thick, sticky mucus to build up in the lungs, digestive tract, and other areas of the body. It is one of the most common chronic lung diseases in children and young adults.
Mutations in the CFTR gene cause cystic fibrosis. The CFTR gene encodes an ion transporter protein normally expressed in the respiratory and digestive tracts. Individuals homozygous for mutated CFTR gene died at very early ages then due to lack of advanced medical intervention. Despite this, the mutation persists at relatively high frequency in populations of European descent. A possible explanation is that heterozygotes for such mutations are said to gain immunity to the lethal effects of diseases such as typhoid fever. Which of the statements below is most accurate?
A. The cystic fibrosis mutation is a beneficial mutation.
B. The cystic fibrosis mutation is a conditional mutation.
C. The cystic fibrosis mutation is a lethal mutation.
D. The cystic fibrosis mutation is a neutral mutation.

(T) 19. Bacteria use restriction enzymes to protect themselves against successful attack by bacteriophages (viruses that infect bacteria) because these enzymes can degrade the genome of the phages. The bacterial genomes are **not** vulnerable to these restriction enzymes because some bacterial DNA is *methylated*.

However there are also some bacteriophages whose genomes are methylated, and some bacteria whose DNA is non-methylated.

Over the course of time, what should occur in order to maintain **genetic variation**?
A. Methylated DNA should become fixed in the genes of all bacterial species.
B. Non-methylated DNA should become fixed in the genome of all bacteriophages.
C. Gene for DNA methylation should be eliminated in the populations over time.
D. Methylated and non-methylated strains should be maintained among both bacteria and bacteriophages.*

(T) 20. Human Immunodeficiency Virus (HIV), the virus that causes Acquired Immune Deficiency Syndrome (AIDS) reproduces much more rapidly than most other viruses. It can produce billions of copies of itself each day. As it makes rapid-fire copies of itself, it commonly makes errors, which translate into mutations in its genetic code. If the mutations turn

out to be beneficial to the virus's survival, it is likely that the mutated virus will reproduce itself more.

Another cause of the variability in HIV is the virus's ability to recombine and form new variants within an individual. This happens when a host cell is infected with two different variations of HIV. Elements of the two viruses may combine to result in a new virus that is a unique combination of the two parents.

Which of the following is an important implication of the high variability in HIV?

A. Anti-HIV drugs can easily target the viruses.
B. Development of a vaccine against HIV is difficult.
C. Humans can quickly develop resistance to HIV.
D. There is a slow rate of HIV evolution.

GLOSSARY OF TERMS USED IN THIS LESSON:

allele Alternative form of a gene

amino acid Organic molecule having an amino group and an acid group, which covalently bonds to produce peptide molecules.

anticodon Three-base sequence in a transfer RNA that pairs with a complementary codon in mRNA

bacteriophage Virus that infects bacteria

chromosome Chromatin condensed into a compact structure

DNA (deoxyribonucleic acid) Nucleic acid polymer produced from covalent bonding of nucleotide monomers that contain the sugar deoxyribose; the genetic material of nearly all organisms.

DNA replication Synthesis of a new double helix prior to mitosis and meiosis in eukaryotic cells and during prokaryotic fission in prokaryotic cells

enzyme Organic catalyst, usually a protein, that speeds a reaction in cells due to its particular shape.

gene Unit of heredity existing as alleles on the chromosomes

genetic code Universal code that specifies protein synthesis in the cells of all living things. Each codon consists of three letters standing for the DNA nucleotides that make up one of the 20 amino acids found in proteins.

genetic diversity Variety among members of a population

messenger RNA (mRNA) Type of RNA formed from a DNA template that bears coded information for the amino acid sequence of a polypeptide.

mutation Alteration in chromosome structure or number and also an alteration in a gene due to a change in DNA composition.

peptide Two or more amino acids joined together by covalent bonding

protein Molecule consisting of one or more polypeptides

ribosome RNA and protein in two subunits; site of protein synthesis in the cytoplasm.

RNA (ribonucleic acid) Nucleic acid produced from covalent bonding of nucleotide monomers that contain the sugar ribose; occurs in three forms: messenger RNA, ribosomal RNA, and transfer RNA.

transcription Process whereby a DNA strand serves as a template for the formation of mRNA.

transfer RNA Type of RNA that transfers a particular amino acid to a ribosome during protein synthesis.

translation Process whereby ribosomes use the sequence of codons in mRNA to produce a polypeptide with a particular sequence of amino acids.

REFERENCES AND WEBSITE LINKS USED IN THIS LESSON:

Mader, Sylvia S. *Concepts of Biology*. New York: The McGraw-Hill Companies, Inc., 2009.

http://humanorigins.si.edu/evidence/genetics/skin-color/modern-human-diversity-skin-color - Modern Human Diversity – Skin Color

http://www.pbs.org/wgbh/nova/genome/dna_flash.html - Journey into DNA

http://learn.genetics.utah.edu/content/molecules/dna/ - What is DNA?

http://www.nature.com/scitable/topicpage/dna-is-a-structure-that-encodes-biological-6493050 - DNA is a structure that encodes biological information

http://www.johnkyrk.com/DNAanatomy.html - DNA Anatomy

http://www.learner.org/interactives/dna/history.html - How DNA was discovered

http://learn.genetics.utah.edu/content/molecules/builddna/ - Build a DNA molecule

http://www.nobelprize.org/educational/medicine/dna_double_helix/dnahelix.html - DNA, the Double Helix

http://science.howstuffworks.com/life/cellular-microscopic/dna3.htm - How DNA works

https://www.youtube.com/watch?v=27TxKoFU2Nw – DNA replication process

http://www.johnkyrk.com/DNAreplication.html - DNA makes DNA

http://learn.genetics.utah.edu/content/molecules/rnamolecule/ - RNA, the Versatile Molecule

http://www.rnasociety.org/about/what-is-rna/ - What is RNA?

http://www.pbs.org/wgbh/nova/labs/video_popup/4/25/ - RNA VirtuaLab (video intro)

https://www.youtube.com/watch?v=0Elo-zX1k8M – Why RNA is just as cool as DNA

http://www.dnalc.org/resources/3d/12-transcription-basic.html - Transcription

https://www.youtube.com/watch?v=AGzsgTMgSog – video of transcription

http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/transcription.swf - transcription animation

http://healthland.time.com/2012/09/06/junk-dna-not-so-useless-after-all/ - Junk DNA – Not So Useless After All

http://learn.genetics.utah.edu/content/molecules/proteins/ - What is a Protein?

http://healthyeating.sfgate.com/6-primary-functions-proteins-5372.html - 6 Primary Functions of Proteins

http://learn.genetics.utah.edu/content/molecules/dnacodes/ - How do Cells Read Genes?

http://www.nobelprize.org/educational/medicine/dna/b/translation/translation.html - Translation

https://www.youtube.com/watch?v=h5mJbP23Buo – Protein Synthesis and the Lean, Mean Ribosome Machines

http://highered.mheducation.com/olcweb/cgi/pluginpop.cgi?it=swf::535::535::/sites/dl/free/0072437316/120077/micro06.swf::Protein+Synthesis – Protein Synthesis

http://learn.genetics.utah.edu/content/molecules/transcribe/ - Transcribe and Translate a Gene

http://ghr.nlm.nih.gov/gene/TYR - TYR gene

http://www.mhhe.com/biosci/genbio/virtual_labs/BL_26/BL_26.html - Virtual Lab: DNA and Genes

http://biology.about.com/od/basicgenetics/ss/gene-mutation.htm - Gene mutation

http://www.uvm.edu/~cgep/Education/Mutations.html - Mutations

http://learn.genetics.utah.edu/content/variation/mutation/ - What is Mutation?

http://www.cdc.gov/ncbddd/birthdefects/DownSyndrome.html - Facts about Down Syndrome

http://www.steadyhealth.com/articles/The_16_Most_Common_Genetic_Diseases_a1547.html - The 16 Most Common Genetic Diseases

http://highered.mheducation.com/sites/0072552980/student_view0/chapter9/animation_quiz_5.html - Addition and Deletion Mutations

http://learn.genetics.utah.edu/content/molecules/firefly/ - What makes a firefly glow?

http://www.ncbi.nlm.nih.gov/pubmed/23209131 - Tinkering with translation: protein synthesis in virus-infected cells

http://www.dnalc.org/resources/3d/17-sickle-cell.html - Disease and Mutation: Sickle Cell

https://www.youtube.com/watch?v=z9HIYjRRaDE – Where do Genes come from?

https://www.youtube.com/watch?v=xkVv52EyKzc – Are Mutations Heritable?

https://www.youtube.com/watch?v=11iYk0Yrx3g - Genetic Variation, Gene Flow, and New Species

http://evolution.berkeley.edu/evolibrary/news/120301_chipmunks - Climate change causes loss of genetic diversity

http://www.scientificamerican.com/article/researchers-identify-huma/ - Researchers Identify Human Skin Color Gene

http://medicalxpress.com/news/2014-01-skin-gene-global-populations-reveal.html - Studies of a skin color gene across global populations reveal shared origins

http://humanorigins.si.edu/evidence/genetics/skin-color/modern-human-diversity-genetics - Modern Human Diversity – Genetics

Image Credits:
http://www.bbc.com/news/health-18041884 - X-ray diffraction image of the DNA

http://labtestsonline.org/assets/images/article_images/KARO+21.jpg – Down syndrome karyotype

http://www.vce.bioninja.com.au/_Media/genetic_code_med.jpeg - Genetic code chart

http://www.nature.com/scitable/content/sickle-shaped-and-normal-red-blood-cells-21172 - Normal and sickle-shaped red blood cells

http://worms.zoology.wisc.edu/zooweb/Phelps/ZWK99034k.jpeg - Patau syndrome karyotype

http://healertoday.com/wp-content/uploads/2013/08/ALS-Stephen-Hawking.jpg - Stephen Hawking

Lesson 3: Biodiversity and Evolution

INTRODUCTION AND FOCUS QUESTION(S):
A mutualistic relationship occurs when two organisms of different species "work together," each benefiting from the relationship. This interaction helps both organisms to survive. The honeybees, for example, get pollen from the flower; the flower, in turn, gets its pollen spread to other areas. Another example is between ants and the acacia tree. The tree provides food for the ants, as well as shelter. In return, the ants defend the tree from other herbivores, and remove other plants from the vicinity so that the tree can grow better.

How did these organisms develop characteristics that allow them to participate in such beneficial interactions? How did they evolve to become "suited for each other?" and for their environment? Why do organisms change, or adapt, or evolve?

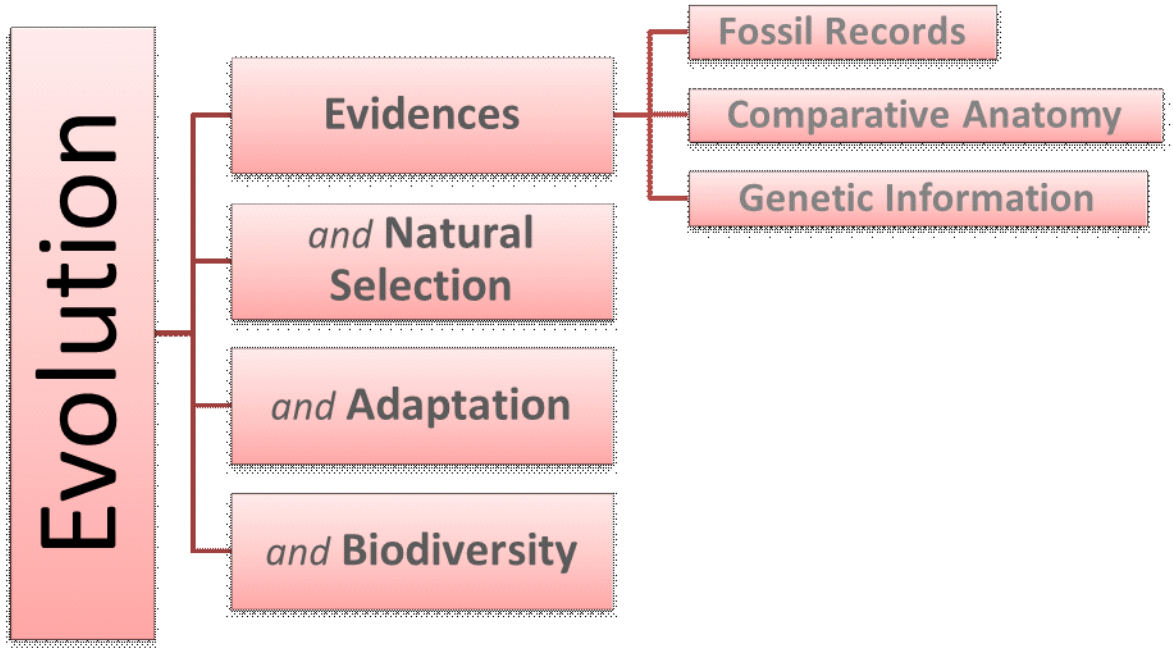
These are questions that you will answer as you go through this module.

LESSON COVERAGE:
In this lesson, you will examine this question when you take the following topics:
Lesson 3.1 – ***Evolution – Evidences and Mechanism***
Lesson 3.2 – ***Adaptation, Evolution, and Biodiversity***

In these topics, you will learn the following:

Lesson 3.1	• Explain how fossil records, comparative anatomy, and genetic information provide evidence for evolution. • Explain the occurrence of evolution.
Lesson 3.2	• Discuss how evolution through natural selection can result in biodiversity. • Explain the importance of adaptation as a mechanism for the survival of species.

LESSON MAP:
Here is a simple map of the above topics you will cover:



EXPECTED SKILLS:
To do well in this module, you need to remember and do the following:

1. Read the instructions carefully before starting anything.
7. Complete **all** the activities and worksheets. Follow instructions on how to submit them.
8. Look up the meaning of words that you do not know.
9. You will frequently come across process questions as you go through different lessons. Keep a notebook (or use the Notepad) where you can write (and revise) your answers to these questions. Use also the notebook to jot down short notes, draw diagrams, and summarize what you have just read.
10. For worksheets and reports that need to be submitted, use the provided checklist and rubric to evaluate your work before submission.
11. Allow time for relaxation and recreation when you are mentally tired. Make a time table to schedule your study and recreation.

PRE-ASSESSMENT:

Let's find out how much you already know about this module. Click on the letter that you think best answers the question. Please answer all items. After taking this short test, you will see your score. Take note of the items that you were not able to correctly answer and look for the right answer as you go through this module.

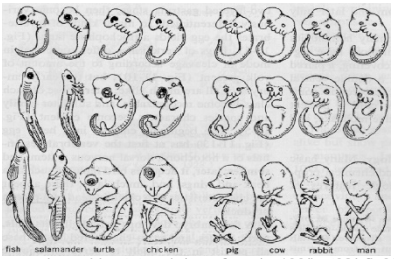
(A) 1. Only a small fraction of our DNA is different from those of gorillas, and an even greater similarity is found in chimpanzees. Just like us, they are organisms that are social in nature, intelligent, and are capable of manifesting problem-solving abilities. This _____ is one of the significant reasons that experts consider as evidence for evolution.

a. ability to walk in a bipedal manner (*on 2 feet*)
b. closeness in genetic makeup
c. characteristic of forward-looking eyes
d. ability to have a leader in a group

(A) 2. _____ provide data that could prove how organisms that we see today evolved from organisms that may have gone extinct long ago.

a. Doctors
b. History books
c. Account by experts
d. Fossil records

(A)



http://www.geology.ohio-state.edu/~vonfrese/gs100/lect32/xfig32_04.jpg

3. Taking the above picture into consideration, we may conclude that different organisms might have:

a. evolved from a common ancestor.
b. similar sizes during the embryonic stage.
c. lived underwater into adulthood because of gills.
d. tails that were used for locomotion.

(A) 4. Wooly mammoths that appeared during the Ice Age and the appearance of present-day elephants can be a good example of:

a. climate change that led to extinction of mammoths.
b. species replacement due to rising sea levels.
c. temperature fluctuation that brought forth present-day elephants.

d. the evolutionary process that has been influenced by changes in the environment.

(A)

http://fany.savina.net/wp-content/uploads/2010/06/HumpbackWhaleSkeleton.jpg

5. According to experts, whales share a common ancestor with dolphins and hippopotamus. Look at the image above of a whale's skeleton. What is the likely reason why whales have thigh bones?

a. It's possible that the shared ancestor was a terrestrial or land-based animal.*
b. It might be an adaptation to grow legs when it begins to live on land.
c. It is an isolated case and therefore seen only in that particular whale.
d. It could be a result of mutation that affected the skeletal system.

(A) 6. Which of the following best describes evolution?

a. an intentional physical change of a species depending on what the environment "requires"
b. an intentional behavioral change of a species depending on what the environment "requires"
c. depends on random mutations that may lead to increased survivability of a species
d. depends on expected mutations that may lead to increased survivability of a species

(A) 7. The following statements on mutation are correct **except**

a. They can increase a species' survivability.
b. They cause no changes to the genetic make-up of organisms.
c. They can decrease a species' survivability.
d. They may randomly take place or may be influenced by certain substances in the environment.

(A) 8. It is believed that dolphins, hippopotamuses, and whales share a common terrestrial (land-based) ancestor. From being terrestrial to aquatic, the likely reason for this evolutionary change would be all of the following **except**

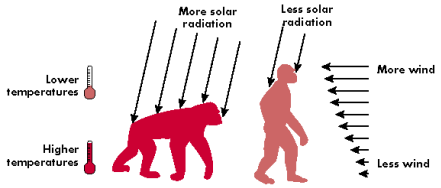
a. The ability to live in an aquatic environment allowed the species to have more food source with less competition.
b. A hippopotamus – *with its 4 legs* - can actually move faster through water than on land since it becomes "weightless" when in such an environment.

c. The development of flippers or fluke effectively allows whales and dolphins to propel in water to catch prey and evade predators.
d. There was probably an increase in aquatic environments thousands of years ago that became advantageous to organisms that can survive in such habitats.

(M) 9. For organisms living in the African savannah or grasslands, the ability to stand and walk on hind legs include the following adaptations **except for**

a. improved ability to see predator or prey.
b. ability to run faster.
c. lesser body surface area exposed to the sun.
d. frees the hands for other necessary functions.

(M)

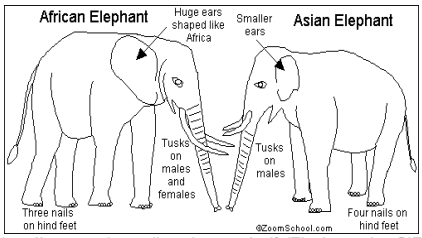


http://www.wwnorton.com/college/anthro/bioanth/ch11/thermoregulation.gif

10. From a gait that was quadrupedal (*walking on all fours*) to one that is bipedal (*walking upright on two feet*), certain species can be considered to have acquired such an adaptation in order to

a. conserve energy.
b. run faster.
c. lose the tail for lack of use.
d. ease the mating process.

(M)

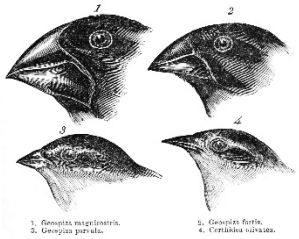


http://www.enchantedlearning.com/egifs/Elephants_bw.GIF

11. African elephants are easily distinguishable from other elephant species because of their enormous ears that appear like oversized fans. The high temperature in the region resulted to the African elephant to

a. evolve into smaller species.
b. quickly lose body heat from their huge ears that contain many blood vessels.
c. store more water in their proboscis (*trunk*)
d. stop melanin production and become albinos.

(M)



http://upload.wikimedia.org/wikipedia/commons/a/ae/Darwin's_finches_by_Gould.jpg

12. The illustrations above show Darwin's finches. As a tribute to Charles Darwin, these birds have been collectively named after the father of evolutionary theory. In his observations, Darwin noted that these birds share the same ancestor even though there is glaring evidence that the size and shape of their beaks vary. What was the likely basis for this?

a. change in beak structure from small to large indicates increased brain size and intelligence
b. change in beak structure allowed finches to thrive in their respective environments
c. change in beak structure would have a corresponding change in height of the organism
d. change in beak structure indicates the evolutionary rate of an organism

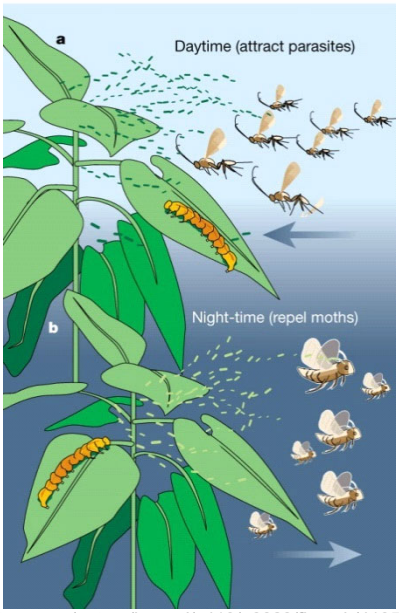
(M)

http://qph.is.quoracdn.net/main-qimg-5439de3d588aa85a6b7bc40ebc6a6b49?convert_to_webp=true

13. The above photograph shows 2 tapirs, one is an adult female while the smaller one is still a calf. Depending on the species, tapirs weigh from 100-300 kilograms. Despite their size, they can easily maneuver rainforests because of their tapered body. An elongated snout allows them to grab hold of vegetation similar to elephants. Based on the physical characteristics of this organism, one can safely assume that the following statements are correct **except for**

a. Tapirs are not easily brought down by predatory cats because of their size.
b. The color of tapirs is well-suited for movement along the forest floor of rainforests.
c. A snowy habitat during winter can easily increase their chances of survival.
d. Their elongated snout can be used like a snorkel when moving through water.

(M)

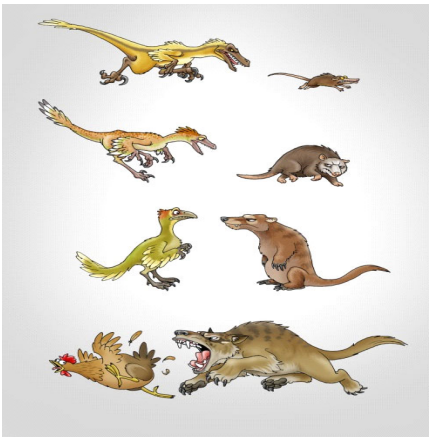


http://www.nature.com/nature/journal/v410/n6828/fig_tab/410530a0_F1.html

14. Tobacco plants interact with many organisms; these include those that feed on its leaves or those that use it as a nest to lay eggs in. The following traits allow tobacco plants to survive these "attacks" that take place both day and night **except for**

a. chemical compounds that influence the behavior of certain insects.
b. chemical compounds that attract herbivorous insects.
c. chemicals released to attract insects that prey on herbivores.
d. chemicals released that repel moths that lay eggs on the leaves.

(T)



http://files.broadsheet.ie/wp-content/uploads/2012/04/8666.jpg

15. If your school is holding an exhibit on evolution, why can't the above image be a good representation of this complex process in nature?

a. It is impossible for mice to grow as large as wolves.
b. Mutations that will decrease a species' survivability are not passed on into the next generations.
c. This representation cannot happen since there is no link between dinosaurs and birds.
d. Large species cannot evolve into smaller ones since being small cannot increase survivability.

(T) 16. An interschool song composition contest was launched in your town. Since this was an initiative by music teachers in coordination with the science teachers, it was agreed that the original compositions will focus on the concept of *evolution* to give the contest an opportunity for science to integrate with another subject. As one of the judges in the contest, you expect the scoring to look for the descriptors below **except for**

a. amount of time taken for an evolutionary change to develop.
b. environmental conditions that was addressed by a physical adaptation.
c. number of organisms that underwent increase in size.

d. species with increased survivability because of mutations that affected it.

(T) 17. If you are living in the NCR (National Capital Region), there is a very high likelihood that you no longer see – *or have not seen* – fireflies. Just like frogs, fireflies can be a good indicator of a location's condition in terms of the level of pollution. This is the reason why some people would say that the NCR is so polluted that organisms like frogs and fireflies can no longer thrive in this part of the country. Let's say that this statement is true, which among the following statements related to evolution can support it?

a. Frogs and fireflies adapted by migrating to nearby cities that are also highly-urbanized like the NCR.
b. Frogs and fireflies have adapted by simply hibernating, therefore these species are not seen from December to February.
c. Frogs and fireflies evolved by blending into the surroundings, therefore they can no longer be observed.
d. Frogs and fireflies have not had random mutations that allowed them to survive high levels of pollution.

(T) 18. *"Evolution is the Solution to Surviving Pollution,"* is the theme that your school wanted you to keep in mind before you start to work on your short videos for the science film festival. In your storyline, you were intent in making sure that your chosen species will gradually show physical changes from how it was hundreds of years ago. Aside from this, what other important concept should you include in your video?

a. It would make the video more scientifically accurate if a timeline of Charles Darwin's discoveries will be shown.
b. The experts who will be invited in the film festival will expect behavioral changes in organisms living inside a person's body.
c. In videos on evolution, predator-prey coevolution is always included to show corresponding adaptations from each species involved.
d. It is also important to show how the environment might have changed which made certain mutations beneficial to some species.

(T) 19. *"Why isn't the crocodile included in the featured species of your infographic?"* Being one of the judges for the best evolution infographic, this was the question that you were asked by the curator of the museum of natural history after he viewed your work. Which statement below would best answer the curator's question?

a. The crocodile was not included since it is known that since the time of the dinosaurs, it is a species that did not need to evolve in order to survive.
b. Evolutionary changes in crocodiles and other reptiles are difficult to record since these species pose danger to herpetologists.

c. Reptiles do not evolve; therefore, they should not be included in the infographic.
d. Crocodiles are the only reptiles that do not undergo mutations; therefore, they cannot be considered in becoming part of the infographic.

(T) 20. "*You're just somebody that I used to know.*" This was what *Corey the Crocodile* blurted as he was thinking out loud while he dreamt as he bumped into a familiar face near the shore of a river. *Corey the Crocodile* is the main character in the evolution cartoon that you were making for grade 4 students. In relation to evolution, to which organism would Corey have said the line above?
a. Billy the Bullfrog
b. Dylan the Dodo bird
c. Henry the Hippopotamus
d. Zoe the Zebra

EXPLORE

Evolution is said to be the "unifying force in modern biology," but it remains to be a source of misunderstandings and controversy. How about you, what is your own point of view about evolution?

Let's begin this module by gathering your thoughts.

ACTIVITY NO. 1: VIDEO VIEWING

Evolution is said to be the core theme of biology, accounting for the unity and diversity in living things.
What are your ideas about evolution?

Click on the link below to watch a short cartoon video about evolution.
https://www.youtube.com/watch?v=faRIFsYmkeY – The Simpsons – Homer Evolution

Process Questions:
1. Based from the video, what changes happened to the organisms involved?
2. Why do you think they had to change? What part of the video supports your answer?
3. Which of your ideas about evolution are shown in the video?
4. Which of your ideas about evolution are **not** shown in the video?

ACTIVITY NO. 2: ELICITING PRIOR KNOWLEDGE THROUGH I-R-F CHART

In the previous activity, you were asked why organisms have to undergo change. What were your initial answers to this question?

Why do species evolve?

Summarize these ideas and write them in the first column, Initial or I column, of the IRF Chart.

Why do species evolve?		
Initial *What are your initial answers to the essential question?*	**Revised** *What are your revised answers to the essential question?*	**Final** *What are your final answers to the essential question?*

End of EXPLORE:

You gave your initial ideas on evolution by answering the I-R-F chart.
Let's find out how others would answer the above and compare their ideas to our own. As you compare, you will find out if your ideas are in line with the standard. You will also learn other concepts which will help you complete a required project found at the end. You are to submit an article about adaptation and evolution.

We will start by doing the next activity.

FIRM-UP

Your goal in this section is to learn and understand key concepts about evolution. At the end of this section, you should be able to:

- explain the occurrence of evolution; and
- explain how fossil records, comparative anatomy, and genetic information provide evidence for evolution.

ACTIVITY NO. 3: VIRTUAL FIELD TRIP

You will begin your study of evolution by examining the work of Charles Darwin who offered a mechanism for evolution.

Take a virtual trip to where Darwin gained many evidences to support evolution, the Galapagos Island.

Click on this link:
http://www.pbs.org/wgbh/nova/evolution/explore-galapagos.html - Explore Galapagos

Guide to exploration:
When you get to the link, you'll see two main tabs: "*Explore the Islands"* and *"What Darwin Saw."* Click on *"Explore the Islands"* first and complete your own exploration. Write a detailed account of your own journey in the first column of the given chart:

Galapagos Exploration	
What I Saw	

Then, click on *"What Darwin Saw."* Read Darwin's account and hear commentary from biologists Sean Carroll and Cliff Tabin. Write a summary of the account in the second column of the chart:

Galapagos Exploration	
What I Saw	***What Darwin Saw***

Process Questions:
1. Compare your account with that of Darwin.
2. What did Darwin see in Galapagos that supported his ideas about the "origin of species?"
3. Describe Darwin's theory of natural selection.

Write a summary of Darwin's mechanism of evolution by natural selection using the POW+TREE Strategy.

Strategy		Activity
Pick an idea or opinion.		Formulate an opinion and state that opinion clearly.
Organize and generate notes and ideas for each part of the TREE.		Organize notes by completing a graphic organizer:
	**T**opic Sentence	Formulate a topic sentence expressing an opinion.
	Reason	Give at least three reasons to support the topic sentence.
	Explanation	Explain your reasons.
	Ending	Formulate a statement to summarize the topic sentence.
Write and say more.		Write a complete paragraph. Follow the plan developed using the TREE strategy.

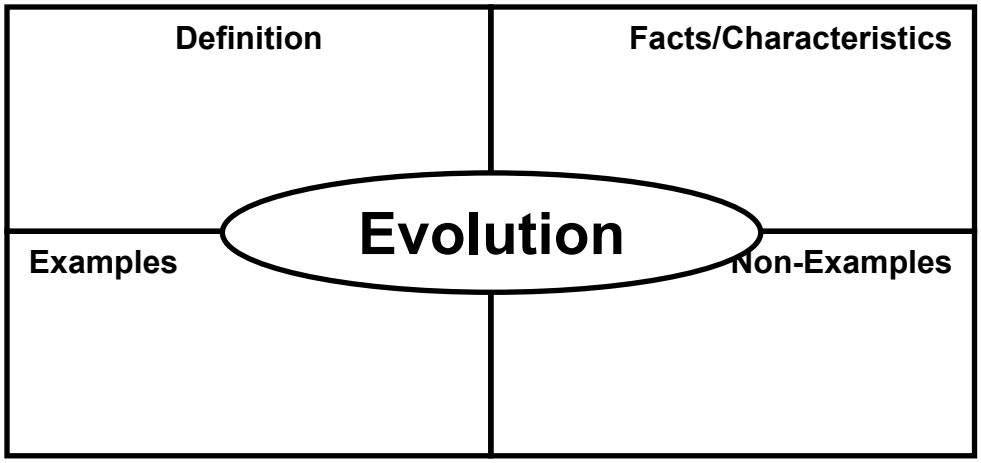
ACTIVITY NO. 4: FRAYER MODEL

You have just learned about Darwin's theory of natural selection. Why did Darwin consider natural selection as the driving force of evolution? Make that connection clearer by looking closely at the important aspects about evolution.

A. Read the article found in this link:

http://www.newscientist.com/article/dn9952-faq-evolution.html?full=true#.VQ041SyzmWw – 5 Frequently Asked Questions about Evolution

Make a list of the important words, terms, or ideas that you got from the article. From the list, come up with phrases or statements which you think define or describe EVOLUTION. Complete the "Definition" box of the given Frayer model:



B. Learn more facts about evolution and discover its many facets by watching the videos found in the following links.

https://www.youtube.com/watch?v=cC8k2Sb1oQ8 - evidence of evolution (bozeman science)

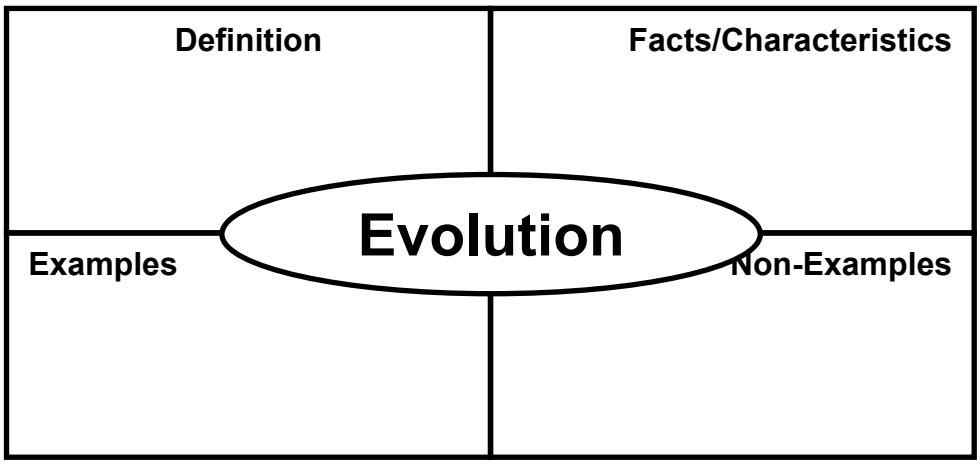
https://www.youtube.com/watch?v=0SCjhI86grU - what is natural selection?

https://www.youtube.com/watch?v=GcjgWov7mTM - introduction to evolution & natural selection (khan academy)

4. https://www.youtube.com/watch?v=aTftyFboC_M - natural selection (crash course biology)

Process Questions:

1. What are the facts and characteristics of evolution that you gathered from the videos you watched? Write them in the “Facts/Characteristics” box of the Frayer model.
2. What are situations that show evolution? What are situations that do not exemplify the process? Write them in the “Examples” and “Non-examples” boxes of the Frayer model.



SUBMIT

3. How does evolution occur by natural selection?
4. **Why do species evolve?**

ACTIVITY NO. 5: MISSION: ADAPTATION

In the previous activities, you studied natural selection and evolution. Recall: what does it take for an organism to be "selected," and eventually survive?

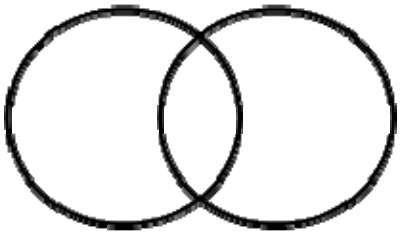
Explore this issue in more detail by looking at another concept, adaptation.

Learn about adaptation by exploring the interactivity found in the link below, *Mission Adaptation.* Travel different environments, take pictures of different organisms, and decide how it has adapted to its environment.

http://www.planet-science.com/categories/under-11s/games/2010/09/mission-adaptation.aspx - "Mission Adaptation"

Process questions:

1. Based on the examples you encountered, how will you define adaptation?
2. How do species adapt to their environment?
3. Why do they need to adapt?
4. Why is adaptation important to evolution?
5. Compare and contrast adaptation and evolution through a Venn diagram. *How are the two concepts similar? How are they different?*

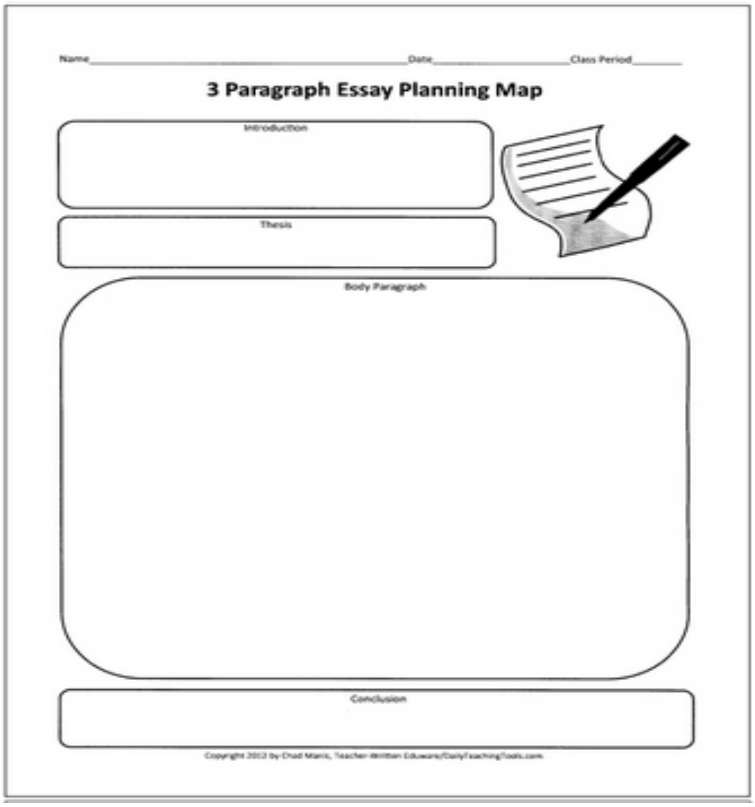


Read more articles about adaptation and evolution found in the following links:
http://www.thescientist.com/?articles.view/articleNo/41088/title/Cave-dwelling-Fish-Fail-to-Keep-Time/ - Cave-dwelling Fish Fail to Keep Time

http://www.the-scientist.com/?articles.view/articleNo/34797/title/-White-Blooded--Icefish--1927/ - "White-Blooded" Icefish, 1927

http://www.thescientist.com/?articles.view/articleNo/31581/title/How-to-Survive-Freezing-Waters/ - How to Survive Freezing Waters

Explain why and how species adapt through a three-paragraph essay.
But first, complete a 3-paragraph essay planning map. See sample map below.



Type your final essay in the space provided, then click “Submit.”

ACTIVITY NO. 6: "*GRAB THAT TRAIT!*"

You have just finished explaining why and how species adapt using the *Essay Planning Map*. The succeeding activity gives you an opportunity to visualize the same thing that you just worked on in your essay. Click on the given link below to proceed to try out the interactive.

http://www.biologyinmotion.com/evol/index.html - this activity makes use of fictitious population of 20 blue organisms that satisfy their hunger by capturing prey through their "grabbers" and examine how natural selection works to bring about evolution of adaptations

Process Questions:

1. In the simulation, what should the blue organisms do in order to survive?
2. What adaptation(s) should the blue organisms develop in order to survive?
3. What process(es) will make them acquire these adaptations?

Consider a similar scenario, this time involving a population of finches, mice, or butterflies, by clicking on the link below:
http://www2.edc.org/weblabs/NaturalSelection/Main.html - the activity examines how population changes over time and how the environment affects these changes

Guide to the activity:

1. Select a population of finches, mice or butterflies. Explore and continue to step 2.
2. Once you have your population, record the important information about the animals in that population and the environment in which they live. *Your objective is to see what happens to the population when changes occur in the environment*.
3. Run the simulation and record ALL the data. Answer all the questions that are in the text portion of the simulation. ALL OF THEM. You **MUST WRITE** out the questions and answers.
4. If you change any of the settings such as beak size, color of mouse, etc., then you must record what you changed and what the results were.
5. **Record at least two graphs** that appear for your results. This needs to be accurate and you need to explain what the graph means. Make sure your labels are correct etc.
6. Go back and repeat steps 1-5 for one of the other populations of organisms. Repeat steps 1-5 for the new population.

Process Questions:
For the population of finches:

1. What is the relationship between precipitation, beak size, and population size of finches?
2. What enabled a particular population of finch to survive better than the other?

For the population of butterflies:
3. What did the results tell you about what color of butterflies the predators eat?
4. Who survives better – the brightly-colored butterflies or the well-camouflaged butterflies? Explain.

For the population of mice:
5. What color of mice increased in population after certain period of time with corresponding interventions in the granary?
6. In the simulation, can you say that human behavior and intervention affect changes in traits of certain organisms? Explain.

7. Why do some species survive better than other species?
8. **Why do species evolve?**

ACTIVITY NO. 7: THINKPAD (*EVIDENCES OF EVOLUTION*)
Now that you have learned about natural selection and adaptation as mechanisms for evolution to occur, it is now time for you to discover how scientists knew that evolution occurs by studying the different evidences.

What are the evidences that prove evolution has occurred or is occurring? Find out in this activity.

http://www.talkorigins.org/faqs/comdesc/ - 29+ Evidences for Macroevolution - The Scientific Case for Common Descent
http://www.fromquarkstoquasars.com/three-main-pieces-of-evidence-supporting-evolution/ - Three Main Pieces of Evidence Supporting Evolution
http://evolution.berkeley.edu/evolibrary/article/lines_01 - Lines of Evidence – The Science of Evolution

Process Questions:
1. What evidences do scientists use to study evolution? Enumerate the evidences that you have read from the articles.
2. How are these evidences useful? How are they used to explain the occurrence of evolution?
3. **Why do species evolve? What do evidences tell?**

Complete this ThinkPad to summarize your answers to the process questions.

WORDS *What are the evidences of evolution based on the articles?*	**PICTURE** *Draw a picture showing concepts based on the given article.*

CONNECTIONS TO LIFE *How are these evidences useful?*	**PRINCIPLES** *Why do species evolve?*

End of FIRM UP:

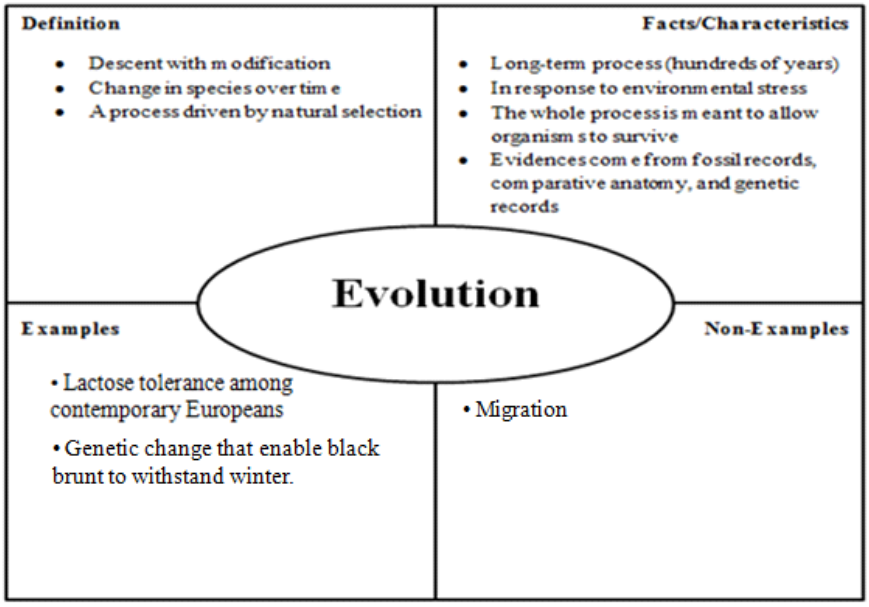
In this section, the discussion was about how evolution occurs Go back to the previous section and compare your initial ideas with the discussion. How much of your initial ideas are found in the discussion? Which ideas are different and need revision? What new learning goal should you now try to achieve? Now that you know the important ideas about this topic, let's go deeper by moving on to the next section.

DEEPEN

Your goal in this section is to take a closer look at some aspects of the topic. You will have an opportunity to correct some misconceptions about evolution and you will also explore situations where evolution is at work.

ACTIVITY NO. 8: MYTHS AND MISCONCEPTIONS ABOUT EVOLUTION

In the previous section, you have completed a Frayer model about Evolution. Click here to retrieve your submitted model:



In this activity, we will set the record straight on the *finer* points of evolution by looking at the myths and misconceptions about it. Go through your entries to the Frayer model and compare with the new ideas you will learn about evolution.

Click on the link below to watch a video entitled *Myths and Misconceptions about Evolution.*
http://ed.ted.com/lessons/myths-and-misconceptions-about-evolution-alex-gendler#watch

Let us test how much you have remembered about the video by answering the questions found in this interactive link:
http://ed.ted.com/lessons/myths-and-misconceptions-about-evolution-alex-gendler#review

Process questions:
1. Evolution involves the “survival of the fittest.” By “fittest,” do we mean the biggest, strongest, and fastest? Why or why not?
2. What makes an organism evolutionarily “useful?”
3. Is there an outside force or mechanism that controls evolution or does it happen randomly? Justify.
4. **Why do species evolve? Discuss how evolution can result in biodiversity.**

The additional resources found in this link will dispel some more myths and clarify confusion/misconceptions about evolution:
http://ed.ted.com/lessons/myths-and-misconceptions-about-evolution-alex-gendler#digdeeper

It's now time for you to share your insights or pose questions about evolution to your classmates and teacher.

Start a ***guided discussion*** with your teacher by opening a conversation with him/her in the OHSP system.
AND/OR
Engage in an ***open discussion*** with your classmates by posting in the discussion board.

ACTIVITY NO. 9: REVISING PRIOR KNOWLEDGE THROUGH I-R-F CHART
Let us go back to the question you tried to answer in the previous activities: **Why do species evolve?**

What are now your revised answers to this question? Summarize these ideas and write them in the second column, Revised or R column, of the IRF Chart. Compare your revised answers with your initial answers.

Why do species evolve?		
Initial *What are your initial answers to the essential question?*	**Revised** *What are your revised answers to the essential question?*	**Final** *What are your final answers to the essential question?*

ACTIVITY NO. 10: "*THE ONLY THING THAT'S CONSTANT…*"
People say that the only thing that is constant is change. This saying is true even among the different species around us. Get to know interesting species that have embraced change by reading the following articles.

Part A. "*Wa*SPIDER"

Extend your understanding of evolution as a process that species go through in order to be fit in its changing environment. Please read the article below.

(An excerpt from)**Nature CAN cope with climate change: Unusual behavior of plants and animals suggests we've underestimated their ability to adapt, claim studies.**

http://www.dailymail.co.uk/sciencetech/article-2622454/Nature-CAN-cope-climate-change-Unusual-behaviour-plants-animals-suggests-weve-underestimated-ability-adapt-claim-studies.html

DNA evidence also suggests the European wasp spider is evolving and have colonised new areas as they seek cooler climates.
The spiders primarily lived in Mediterranean regions until the 1930s but have gradually crept northwards to colonise Scandinavia, Poland and the Baltic region.
Interestingly while scientists thought they were trying to find new places to live that were the same temperature as the Mediterranean before temperatures have risen, the spiders have actually moved into regions that are cooler than their original homes.
The reason for their behaviour is they have been mating with spiders that like the cold, to create an invading species that can survive freezing temperatures that would kill its Mediterranean relatives, researchers from Germany's Max Plank Institute told Dr White.
A 2011 review of data on hundreds of moving species found a average shift to higher altitudes of 36 feet (11 metres) per decade and a average shift to higher latitudes of about 10.5 miles (17 km) per decade.
'I think we should feel impressed by the impact that we have, that we can change the course of evolution around us by the way we change the environment,' Menno Schilthuizen, from Naturalis Biodiversity Center in Leiden, Netherlands told National Geographic.
'Our impact is much further and deeper than we tend to think.'

Process Questions:

1. Go back to the article and focus on the highlighted part of the text. What caused the wasp spider's evolution?
2. Is your answer in no. 1 found among your initial thoughts about evolution? If not, you may add your answer to the spider map.

3. Why does this species of spider evolve?

Part B. "Change or Die"

The whole idea of natural selection rests on the gradual adaptation of organisms to their environment. If the environment changes, some individuals will have characteristics that make them better able to cope than others, and these individuals will be more likely to pass on their genes to future generations.

The environment is changing. Climate change is now a widely accepted global environmental concern that will have impacts on how species will adapt. Is it possible for some species to evolve as a response to climate change or are they simply waiting in line to die?

Find out more about this by first watching the video entitled “Ocean Acidification – What does it mean for Shellfish?”. Click the URL link https://www.youtube.com/watch?v=DtENyHKZPIU. The video is 5.49 minutes long.

Next, read the article “Can Evolution Beat Climate Change?” found in this link, http://www.scientificamerican.com/article/sea-urchin-evolution-to-cope-with-climate-change-ocean-acidification/. Then answer the questions that follow.

Process Questions:

1. Why is ocean acidification a threat to the purple sea urchins? How will this affect the structure and function of the said species?
2. What evidence suggests that purple sea urchins have the capability to combat this threat?
3. **Why do species evolve?**

Now, it is time for you to organize your answers to the process questions by making a short slideshow presentation using www.emaze.com. Emaze allows you to create incredible presentations in minutes using their ready-made templates and slides. Just create a free account and you’re good to go. Should you need assistance, there are quick tutorials available within the website itself that will help you get started. Then, submit your work to the teacher. There is a share button in the emaze website that will allow you to send a link of your presentation to your teacher’s email.

PART C. *TIT FOR TAT*

It’s a virtual rubber match as organisms – *both predator and prey* – outdo each other in their quest for survival, unintentionally.

Click on the link below for an interactive that would give you an idea of how predators and preys undergo the process of co-evolution as they race to outlast each other in their natural habitats.

http://www.pbs.org/wgbh/evolution/survival/coral/index.html - Evolution: Survival: Coral Reef Connections

After visiting this interactive website, try to provide answers to the process questions below:

1. What caused the reef organisms to evolve?

2. Was there a single factor that led these organisms to evolve? Were there similarities or differences in terms of the said factors? Support your answer by citing examples from the interactive.
3. **Why do species evolve?**

Part D. Evolution of Antibiotic Resistance in Bacteria

Antibiotic resistance is a form of drug resistance where some species or subpopulations of microorganisms, like bacteria, are able to survive after exposure to one or more antibiotics.

Watch a video about antibiotic resistance:
https://www.youtube.com/watch?v=znnp-lvj2ek

Learn through this article how and why the bacterium *Staphylococcus aureus* evolve antibiotic resistance:

http://evolution.berkeley.edu/evolibrary/news/080401_mrsa - Superbug, Super-fast Evolution

Process Questions:
1. Why is MRSA (methicillin-resistant *Staphylococcus aureus*) said to be more threatening than HIV?
2. How did it evolve antibiotic resistance?
3. **What does this event/situation tell you about why species evolve?**

PART E. SYNTHESIS
In the previous section, we looked at different articles about evolution. Let's put together in the table below our answers to the essential question that we asked for each article.

	ARTICLE 1	ARTICLE 2	ARTICLE 3	ARTICLE 4
ESSENTIAL QUESTION: Why do species evolve?	**Nature CAN cope with climate change: Unusual behavior of plants and animals suggests we've underestimated their ability to adapt, claim studies** Species evolve because…	**Can Evolution Beat Climate Change?** Species evolve because…	**Predator-Prey Relationship** Species evolve because…	**Methicillin-Resistant *Staphylococcus aureus*: An Evolutionary, Epidemiologic, and Therapeutic Odyssey** Stan Deresinski Species evolve because…

PROCESS QUESTIONS:

4. Look at your answers to the essential question in the above table. What do all the answers have in common?
5. Are all the factors the same? How do the answers differ? What are the different causes that led these species to evolve?
6. How can evolution result in biodiversity?
7. Complete the following statement and support your answer with examples from the above articles.

The evolution of varied characteristics in species depends on…

_____
_____

Supporting reasons and examples:

_____
_____
_____

End of DEEPEN:

In this section, the discussion was about why and how species evolve. What new realizations do you have about the topic? What new connections have you made for yourself? What helped you make these connections? Now that you have a deeper understanding of the topic, you are ready to do the tasks in the next section.

TRANSFER

Your goal in this section is apply your learning to real life situations. You will be given a practical task which will demonstrate your understanding.

ACTIVITY NO. 11: ARTICULATING NEW KNOWLEDGE THROUGH I-R-F CHART

Let us go back to the question you tried to answer in the previous activities: **Why do species evolve?**

What are now your final answers to this question? Summarize these ideas and write them in the third column, Final or F column, of the IRF Chart. Compare your answers with your previous answers.

Why do species evolve?		
Initial *What are your initial answers to the essential question?*	**Revised** *What are your revised answers to the essential question?*	**Final** *What are your final answers to the essential question?*

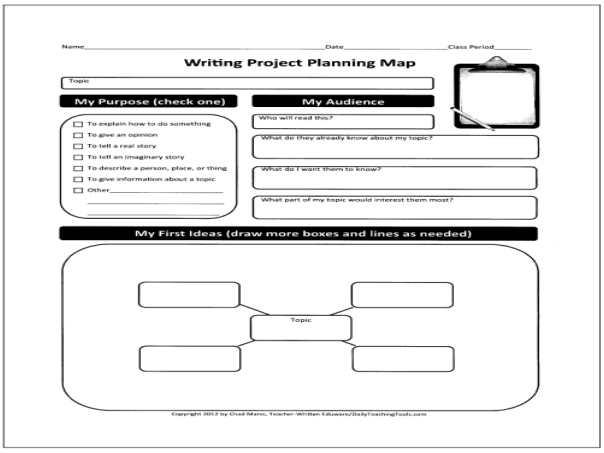
ACTIVITY NO. 12: PLANNING AN UNPLANNED CHANGE

You will be assigned one species whose evolutionary history has been well-studied.

Research how the species evolved, why it had evolved, and the factors and mechanisms involved.

Submit an abstract to report and present your findings. The abstract should have a purpose statement, discussion, analysis, and conclusion.

Use a project planning map to guide you through this task. See sample map below.



Do self-assessment of your work before submission. Use this chec-bric:

CRITERIA	YES	NO
I have a clear idea of what the case is about. I asked questions and defined problems / variables.		
I planned the project and carried out some investigations.		
I gathered enough data and information, and evaluated them so as to include only those that are accurate and relevant to the purpose of the task.		
I organized my ideas in a manner that is easy to follow and suited to my purpose.		
I cited all references and sources of information.		
I communicated my ideas in a manner that is appropriate to the purpose and audience.		
My work is objective and evidence-based, but is creative and engaging.		

ACTIVITY NO. 13: TRANSFER TASK

Evolution journal is a peer-reviewed online open-access journal. It publishes essays and articles that utilize concepts of evolutionary biology to address issues relevant to health, environment, biodiversity, and economy. Papers published should be accessible to a diverse audience within the industry, government, and

health care, in terms of the types of questions asked and investigated, and the interpretation and discussion of findings.

The editorial board is accepting articles from contributors working in the following fields: medicine, agriculture, conservation biology, environmental sciences (including climate change), and microbiology.

The theme for the upcoming issue is “Adapt or Die.” Submissions are now being accepted. All contributors are required to submit an article or essay that explores important questions related to the theme and discusses how the results and findings are broadly applicable to certain fields.

For your paper to be published, it must be scientifically sound, sufficiently integrate applied or practical aspects of the chosen topic, and engaging.
Rubric:

CRITERIA	Outstanding 4	Satisfactory 3	Developing 2	Beginning 1
Content	Advanced level of scientific understanding is apparent in the information presented. Information is useful to the objectives of the paper. Thorough research was done and all sources of information are clearly identified and credited using citations.	Information presented is correct, accurate, and useful. Data presented are sufficient. Findings and recommendations are based on valid evidences. All sources of information are clearly identified and credited using citations.	Some information is inaccurate, unclear, and rambling. Some parts are distracting and unnecessary. Some sources of information are not cited.	Information presented is very shallow, many are false and confusing. Content is irrelevant to the objectives of the paper. No citations were made.
Relevance	Chosen topic or issue is highly relevant and will greatly contribute to one’s field. Questions	Chosen topic or issue is relevant to one’s field. Practical aspects and applications are	Paper focused more on stating information or facts, few real or practical questions are raised.	Topic or issue is clearly irrelevant to given field. Applied or practical

	raised are timely and important. Applied or practical aspects of the topic are integrated in a unique way throughout the paper.	sufficiently integrated in the paper.	Applied or practical aspects of the topic are incorrectly integrated in the paper.	aspects of the topic are not integrated in the paper.
Organization	Information is communicated using sophisticated and varied language that is suited to the purpose, audience, and task. Organization is appropriate to the purpose and audience and supports with great detail the line of reasoning; effectively hooks and sustains audience engagement.	Information is communicated using appropriate language and style that is suited to the purpose, audience, and task. Organization is appropriate to the purpose and audience and reveals the line of reasoning; transitions guide audience understanding.	Information is communicated using language and style that is at times inappropriate to the purpose, audience, and task. Inconsistencies in organization and limited use of transitions sometimes confuse the audience.	Information is communicated using language and style that is totally different from the purpose, audience, and task. A lack of organization makes it difficult to follow the ideas and line of reasoning.

End of TRANSFER:

In this section, your task was to write an article that explains why species must adapt.

How did you find the performance task? How did the task help you see the real world use of the topic?

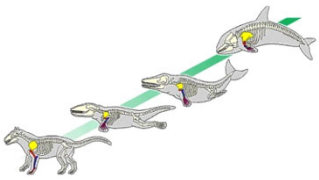
You have completed this lesson. Before you go to the next lesson, you have to answer the following post-assessment.

POST-ASSESSMENT:

It's now time to evaluate your learning. Click on the letter of the answer that you think best answers the question. Your score will only appear after you answer all items. If you do well, you may move on to the next module. If your score is not at the expected level, you have to go back and take the module again.

(A) 1. The following can provide evidence for evolution **except**
   a. comparative anatomy.
   b. word-of-mouth history.
   c. fossil records.
   d. genetic information.

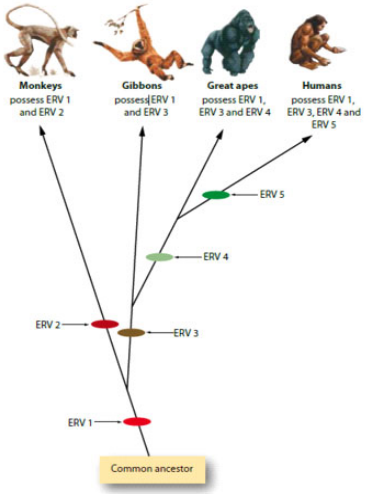
(A)



http://biologos.org/uploads/static-content/whale-evolution-570.jpg

2. Above, the fossils from extinct organisms when compared to the skeleton of present-day organisms show homologous structures. These are body parts that different organisms share, like shoulder bones, leg, toes, or finger bones. These could be
   a. evidences of complexity.
   b. evidences of growth.
   c. evidences of dominance.
   d. evidences of evolution.

(A)

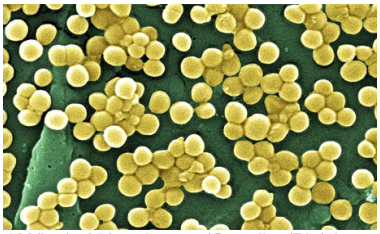


http://hbstudy.wikispaces.com/Evidence+for+Evolution

3. Look at the data found below for each organism. These are gene sequences that are found in each one of them. What could be evidence of evolution?

a. Certain sequences are shared even though they are different species.
b. More sequences appear as the organism evolves to become more complex.
c. The exact same sequences are shared by the tree-dwelling species.
d. Larger organisms have less in common with the rest of the species.

(A)



http://i.guim.co.uk/static/w-460/h--/q-95/sys-images/Guardian/Pix/pictures/2008/05/18/mrsa460.jpg

4. Meet methicillin-resistant *Staphylococcus aureus*, better known as MRSA. It is a bacterium that has been making the rounds because of its "stubbornness" and ability to cause some serious health damage to humans. In the 1940s, this organism was unheard of. In the succeeding decade, a strain was discovered that was resistant to penicillin. Come 1961, methicillin was introduced. It took only one year when MRSA was discovered. Since then, strains of this bacterium have been found to

resist a wide array of antibiotics. What makes this microbe some sort of a "rockstar" among microbiologists?

a. It is one of the oldest unicellular organisms that exists up to this day.
b. It is capable of multiplying in large numbers in a short time.
c. It causes skin infections like pimples or boils to those who are unhygienic.
d. It changes "quickly," therefore, capable of developing resistance to antibiotics.

(A) 5. Scientists at the International Rice Research Institute (IRRI) in U.P. Los Banos have successfully developed flood-resistant as well as salt-resistant rice variants. Such traits allowed rice farmers to grow rice in areas that are perennially suffering from heavy rains and floods or those living in coastal towns. These species may not be considered to have undergone evolution as the changes in the genes involved human intervention, but the principle is quite similar. Plants have water as one of its basic needs, yet hundreds of species have been identified in desert biomes. Why is this so?

a. Desert species evolved traits allowing them to lose little water and gain whatever water resource is available
b. Minimal competition is present among plant species found in the desert.
c. There are no herbivores or species that use plants for shelter.
d. There is an abundance of water underground though they may not be seen on the surface.

(A) 6. It is believed that terrestrial (land-based) species came from aquatic ancestors. The following traits allowed them to survive life on land **except**

a. developed ability to move on land.
b. defense mechanism to terrestrial predators.
c. gills that function in both fresh and saltwater.
d. reproductive process that is not water-dependent.

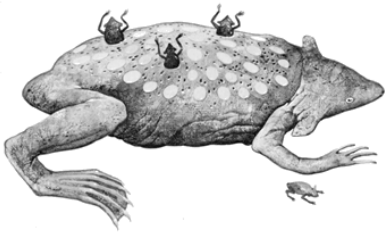
(A)

http://voices.nationalgeographic.com/files/2014/09/archerfish-projectile-water-01.jpg

7. We are familiar with aquarium fish being fed by the owner, or fish that swim after their prey while in the water. But a fish that shoots down its non-aquatic prey? Yes, this might sound and look new to you. The archerfish is a rather unique species of fish as it forces a stream of water from its mouth to make its prey fall into the water and be swallowed. What is the likely reason for this interesting way that archerfish hunt their prey?

a. The pressurized water from the archerfish's mouth immediately kills the prey.
b. There might be less competition if their prey is non-aquatic.
c. Just like some dolphins and whales, archerfish also "play" with their food before eating it.
d. They are not good swimmers to enable them to hunt in the water.

(A)



http://maxcdn.fooyoh.com/files/attach/images/591/727/583/004/byl_surinamtoadsm.jpg

8. Sometimes, parents would say that their children are starting to *get under their skin*. This is an expression used by parents when they begin to encounter some difficulty with misbehaving children. Female Surinam toads literally have their offspring under their skin as seen in the illustration above. Compared to the usual *egg-tadpole-frog/toad* metamorphic pattern in water, young Surinam toads "erupt" from the back of their mother. The following benefits are due to this special trait of Surinam toads **except for**

a. Laying of eggs will not be a problem even with very low water levels in their habitat.
b. The young toads on the back are equally exposed to predators as the mother.
c. The female no longer has to watch over her eggs to keep them safe from predators.
d. Hunting for prey can still be done even with the eggs on the back of the female.

(M)

https://us.vwr.com/stibo/low_res/std.lang.all/06/43/10150643.jpg

9. The above photo shows the skeleton of a gibbon, a 3-foot primate that thrives in tropical rainforests. Even in this upright position, one can easily notice the gibbon's unusually long arms. How can this physical trait be advantageous to gibbons?

a. Long arms will allow them to wrap around trees easily.
b. Elongated arms allow them to effectively swing from branch to branch.
c. The long arms provide greater reproductive advantage.
d. Walking on two legs, they walk faster as their arms get dragged on the ground.

(M)

http://blogs.biomedcentral.com/bugbitten/wp-content/uploads/sites/11/2014/11/cordyceps1.jpg

10. This photograph features the Zombie-ant fungus (*Ophiocordyceps unilateralis*) sprouting from the head of the ant *Camponotus castaneus* in a rainforest in Brazil. 2-3 weeks after its spore enters the ant, the fungus takes over the ant's brain. Unwillingly, the ant goes up an elevated stem and bites into a leaf one last time until it dies. How can this ability of the fungus help it survive its environment?

a. This elevated position allows the fungus' spores to spread to a wider area.

b. The fungus can survive dry areas because of its ability to control ants.
c. The elevated position can provide more sunlight to the growth of new fungal spores.
d. The fungus can be predicted to adapt by producing less spores in the future.

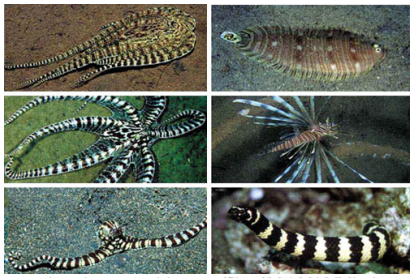
(M)

https://writingcitiesdotcom.files.wordpress.com/2015/02/h1dkeub.jpg

11. Weighing in at around 20 pounds, the *Rafflesia arnoldii* is the world's largest flower. Aside from its huge size, and spotted appearance, it also has an odor which can be mistaken for a rotting cadaver. What could decrease the *Rafflesia's* survivability if its habitat remains stable?

a. a sweet fragrance
b. a significantly smaller size
c. a heavier weight
d. a brighter shade of red

(M)



http://phenomena.nationalgeographic.com/files/2012/12/Mimicoctopus-guises.jpg

12. The photos on the left are just some of the forms that a mimic octopus (*Thaumoctopus mimicus*) can do. On the other hand, those on the right are the organisms that it mimics/copies in terms of appearance as well as behavior. The mimic octopus is a small organism, its head roughly the size of a fist. This ability to mimic other species

a. can increase its survival by getting the prey of the organisms that it mimics.

b. can increase its survival by confusing the mimic octopus' would-be predators.
c. increases competition within the species it mimics.
d. increases competition for territory in the ocean floor.

(M)

http://www.stuartxchange.com/Makahiya.jpg

13. *Mimosa pudica* (*better known as the "makahiya" plant in the Philippines*) closes its leaves when touched, or when the plant is shaken. Why should its leaves close when touched? The following are likely adaptations for survival **except**:

a. It may look wilted and unappealing to herbivores.
b. Its thorns will be exposed and deter herbivores.
c. When leaves are together, it increases surface area to receive sunlight.
d. Closed leaves stop photosynthesis and prevent water loss.

(M)

http://qph.is.quoracdn.net/main-qimg-a8faffab14c5b435c281fbaef47c98de?convert_to_webp=true

14. The illustration above shows an adult hoatzin (*Opisthocomus hoazin*) with its young. This bird from South America is also called "stinkbird" because of its reputation of smelling like cow manure. Aside from its cow-like digestive system that makes it smell like cow manure, what makes this species really special is the presence of "wingclaws" during the first 60-70 days of its life when it is still incapable of flight. These

wingclaws will be lost as the organism grows into its adult form. How can these wingclaws increase this species' ability to survive?

a. The presence of claws can develop its ability to fly by creating the *lift* that is needed for flight.
b. The wingclaws can be used for grabbing onto branches to evade ground-dwelling predators.
c. Since they do not have teeth, the wingclaws may be used for tearing leaves which happen to be its staple food.
d. The adult male hoatzin uses its wingclaws to hold its partner during reproduction.

(T) 15. You are part of the second generation of researchers in a 100-year study of species X's evolutionary course. Species X is a desert-dwelling reptile that has consistently manifested physical and behavioral changes. To give an update on the study, you have been tasked to write a journal article on this long-term study on species X. Which from the following statements is least expected to be included in the article that you will submit?

a. The rapid population growth of the members of species X showed high numbers of random mutations.
b. The habitat of species X has remained relatively stable in the past fifty years.
c. The effects of climate change are very pronounced in the known habitats of species X.
d. An influx of species X's potential prey have been recorded in the past thirty years.

(T) 16. As a climatologist working in the mountain provinces of the Philippines, you have been invited to speak in an international convention on evolution. What would likely be included in your talk?

a. information on predicted average increase in sea levels and water surface temperatures for the next decades
b. migration of Russian bird species to Philippine mountain ranges where increases in temperature will be expected
c. information on predicted temperature and rainfall for the next decades that may affect mountain species
d. predicted daily temperature fluctuations in the plains of Central Luzon for the next 10 months

(T) 17. For your school's Science Week, an exhibit on evolution will be the grandest part of the activity. Together with the exhibit, you suggested that flyers be given to the exhibit-goers so that they could have something to read even when they are no longer in the exhibit. Your grade 10 batch has been assigned to prepare flyers that contain an infographic on how certain species evolved into what they are now. It is important that the following are in your infographic **except for**

a. available prey if the chosen species is predatory
b. climatic events recorded for several decades
c. observed mutations within the species
d. species' annual death rate from poaching

(T) 18. You are one of the experts who have been invited to form the panel of judges in a nationally-televised game show. In the tie-breaking question on evolution, you declared the winning team because they said that
a. adaptation is not part of the evolutionary process.
b. evolution cannot be observed in a lifetime.
c. organisms evolve the traits that they need.
d. only through mutations will evolution be possible.

(T) 19. As a world-renowned biologist, you have been invited to give a talk to high school students to make the topic of evolution more easily understood and to correct common misconceptions that students may have about it. During the open forum, one student asked what "survival of the fittest" really means as it is something that is commonly mentioned when evolution is being talked about. How will you answer?
a. It refers to organisms with mutations that allow survival in a changing environment.
b. In primates, it refers to the strongest members of a species.
c. In birds, it refers to members of a species with the most attractive feather colors.
d. It refers to organisms that can compete successfully only against members of its species.

(T) 20. A certain municipality in Pampanga is known for their exotic frog dishes. Restaurant owners are getting concerned since they have been experiencing droughts these past years. Frogs are known to breed in watery environments; therefore, it is possible that the frog population will suffer from the drought. You have been commissioned to study the situation and prepare a report to the municipal office concerned. Your report can include the following **except**
a. frog consumption should be regulated to arrest population decline.
b. frogs should be moved to a dry, elevated habitat.
c. mutations should enable eggs to be laid on dry ground.
d. female frogs should be returned when caught.

GLOSSARY OF TERMS USED IN THIS LESSON:

adaptation – a feature that is common in a population because it provides some improved function; organism's modification in structure, function, or behavior suitable to the environment

biodiversity – variety of species

evolution – descent of organisms from common ancestors with the development of genetic and phenotypic changes over time that make them more suited to the environment

fossil record – history of life recorded from remains from the past

mutation – alteration in chromosome structure or number and also an alteration in a gene due to a change in DNA composition

natural selection – mechanism resulting in adaptation to the environment

species – group of similarly constructed organisms capable of interbreeding and producing fertile offspring

REFERENCES AND WEBSITE LINKS USED IN THIS LESSON:

https://www.youtube.com/watch?v=faRIFsYmkeY – The Simpsons – Homer Evolution

http://www.pbs.org/wgbh/nova/evolution/explore-galapagos.html - Explore Galapagos

http://www.newscientist.com/article/dn9952-faq-evolution.html?full=true#.VQ041SyzmWw – 5 Frequently Asked Questions about Evolution

https://www.youtube.com/watch?v=cC8k2Sb1oQ8 - evidence of evolution (bozeman science)

https://www.youtube.com/watch?v=0SCjhI86grU - what is natural selection?

https://www.youtube.com/watch?v=GcjgWov7mTM - introduction to evolution & natural selection (khan academy)

https://www.youtube.com/watch?v=aTftyFboC_M - Natural selection (crash course biology)

http://www.planet-science.com/categories/under-11s/games/2010/09/mission-adaptation.aspx - "Mission Adaptation"

http://www.the-scientist.com/?articles.view/articleNo/41088/title/Cave-dwelling-Fish-Fail-to-Keep-Time/ - Cave-dwelling Fish Fail to Keep Time

http://www.the-scientist.com/?articles.view/articleNo/34797/title/-White-Blooded--Icefish--1927/ - “White-Blooded” Icefish, 1927

http://www.the-scientist.com/?articles.view/articleNo/31581/title/How-to-Survive-Freezing-Waters/ - How to Survive Freezing Waters

http://www.biologyinmotion.com/evol/index.html - Adaptation interactive

http://www2.edc.org/weblabs/NaturalSelection/Main.html - Natural selection interactive

http://www.talkorigins.org/faqs/comdesc/ - 29+ Evidences for Macroevolution - The Scientific Case for Common Descent

http://www.fromquarkstoquasars.com/three-main-pieces-of-evidence-supporting-evolution/ - Three Main Pieces of Evidence Supporting Evolution

http://evolution.berkeley.edu/evolibrary/article/lines_01 - Lines of Evidence – The Science of Evolution

http://ed.ted.com/lessons/myths-and-misconceptions-about-evolution-alex-gendler#watch – Myths and Misconceptions About Evolution

http://ed.ted.com/lessons/myths-and-misconceptions-about-evolution-alex-gendler#review - Myths and Misconceptions About Evolution Interactive

http://ed.ted.com/lessons/myths-and-misconceptions-about-evolution-alex-gendler#digdeeper – Dispelling More Myths and Misconceptions About Evolution

http://www.dailymail.co.uk/sciencetech/article-2622454/Nature-CAN-cope-climate-change-Unusual-behaviour-plants-animals-suggests-weve-underestimated-ability-adapt-claim-studies.html - Nature can cope with climate change

https://www.youtube.com/watch?v=DtENyHKZPIU – Ocean Acidification – What Does It Mean for Shellfish?

http://www.scientificamerican.com/article/sea-urchin-evolution-to-cope-with-climate-change-ocean-acidification/ - Can Evolution Beat Climate Change?

http://www.pbs.org/wgbh/evolution/survival/coral/index.html - Evolution: Survival: Coral Reef Connections

https://www.youtube.com/watch?v=znnp-lvj2ek – Antibiotic Resistance

http://evolution.berkeley.edu/evolibrary/news/080401_mrsa - Superbug, Super-fast Evolution

Lesson 4: Ecosystem

Introduction and Focus Question

It is a cool morning and you walk along a white sandbar on an island. You thought that you are alone, but from the corner of your eyes you can see tiny creatures moving about on the sand unmindful of your presence. You start to focus on them, and several more types came to your view.

Have you wondered how each and every creature contributes to the stability of the ecosystem? In this module, you will find out about ecosystem. Remember to search for the answer to the following question: How is a stable ecosystem attained?

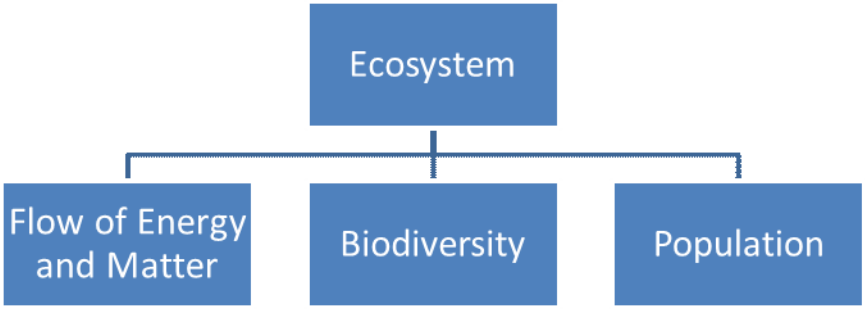
LESSON COVERAGE

This lesson has the following topics:

Lesson No.	Estimated Time	Title	You'll learn to…
Lesson 1.1	**1 week**	Ecosystems: Flow of Energy and Matter in	• Describe the flow of energy and matter in ecosystems.
Lesson 1.2	**1 week**	Biodiversity and Stability	• Explain how species diversity increases the probability of adaptation.
Lesson 1.3	**1 week**	Population Growth and Carrying capacity	• Explain the relationship between population growth and carrying capacity;
Lesson 1.4	**1 week**	Human Impact in the Ecosystem	• Suggest ways to minimize human impact on the environment.

Concept Map of the Lesson

Here is a simple map of the above topics you will cover:



Expected Skills

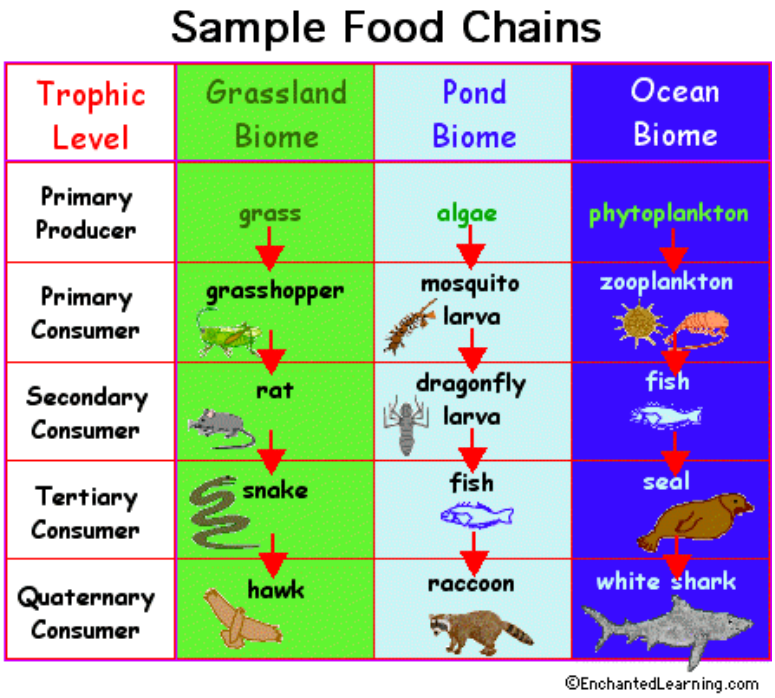
1. To do well in this lesson, you need to remember and do the following: Follow directions always.
2. Complete all the activities and worksheets.
3. Consult the glossary for difficult words.
4. Keep a notebook handy to scribble notes or use a notepad. Use it also to write answers to the questions that you will encounter.
5. Use the checklist and rubric provided to evaluate your work before submitting them.
6. Make a time table to schedule your study and recreation. Discipline is very important.

PRE-ASSESSMENT

Let's find out how much you already know about ecosystems. Answer the exercise below.

Click on the letter that you think best answers the question. Please answer all items. After taking this short test, click on "Submit" to see your score. Take note of the items that you were not able to answer correctly and look for the right answer as you go through this module.

For item number 1 refer to the diagram below.



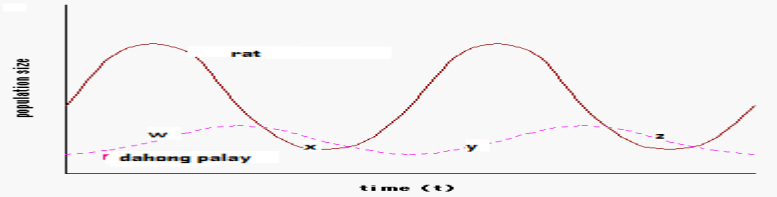
A 1. What happens to the amount of energy as it moves from the primary producer to the quarternary consumer?

A. The energy decreases because it flows to the environment.
B. The energy decreases because the consumer uses it in its metabolism.
C. The energy increases as it is accumulated in the body.
D. There is an increase because the consumers increase in size.

A 2. Which of the following statements is true?

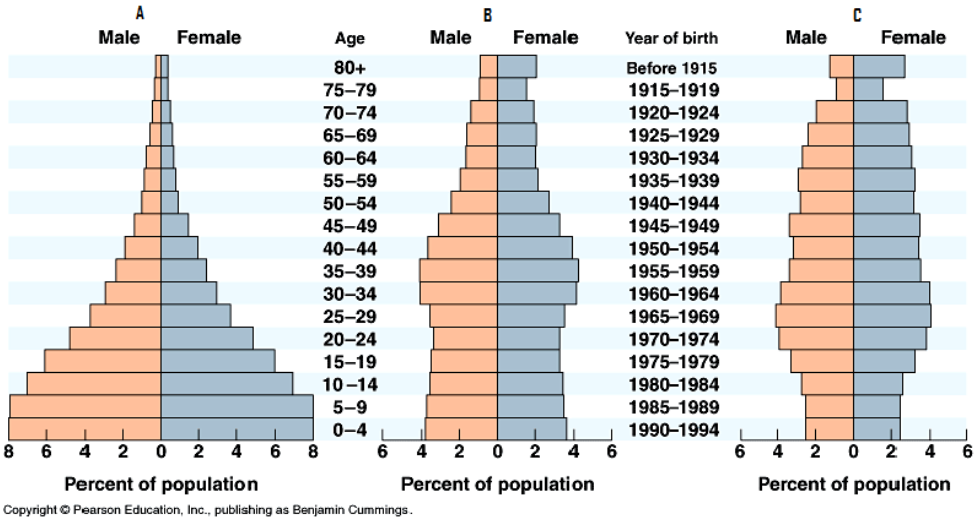
A. In terms of elements or nutrient, the Earth is an open system.
B. The Earth is a closed system for both energy and nutrient.
C. The Earth is an open system with regards to the flow of energy.
D. The Earth is both an open and close system in terms of energy.

A 3. Consider the graph below. At what point in the graph is the population of rat critical to the survival of the snake (dahong palay) population?



A. w
B. x
C. y
D. z

4. Study the graphs below, which country will exceed its carrying capacity after ten years?



http://www.studyblue.com/notes/note/n/ehs-3060-study-guide-2012-13-zimeri/deck/9725320

A. A
B. B
C. C
D. A and B

A 5. Which of the following statements is true?

x

y

http://www.esa.org/esa/wp-content/uploads/2013/03/issue4.pdf

A. Both X and Y are stable.
B. Both X and Y are unstable.
C. Ecosystem X is more stable that Ecosystem Y.
D. Ecosystem Y is more stable than ecosystem X.

A 6. A keystone species is a species that plays a critical role in maintaining the structure of an ecological community and whose impact on the community is greater than would be expected based on its relative abundance or total biomass. Which of the following is a keystone species?

A. A group of microorganisms that decomposes any dead organism.
B. A species of mammals whose biological function is to prey on other mammals.
C. A starfish which is observed to control the two species of mussels. When the starfish is removed, the two mussels' population grow unchecked.
D. The producers in an ecosystem.

A 7. Which of the following is a lasting effort to protect biodiversity?

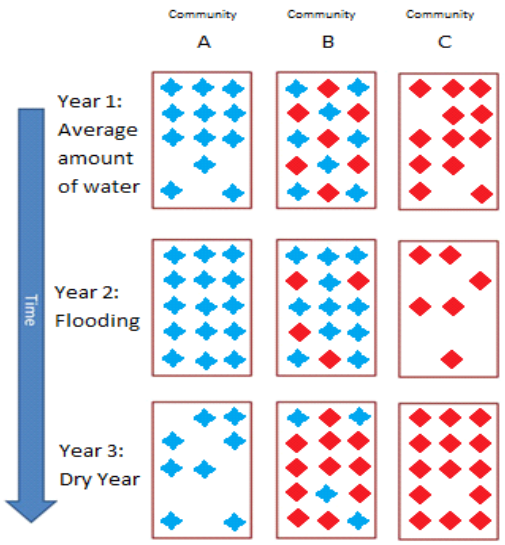
A. A forest is declared a protected area.
B. A theatre group presented a play on environmental degradation.
C. A group of teachers joined a nationwide coastal clean-up.
D. School children planted 1000 propagules last July.

8. Recently, news on the rise of contagious diseases graced headlines of newspapers. Which of the following is the ecological reason for the spread of these diseases?
   A. economic cost of biodiversity.
   B. habitat fragmentation
   C. loss of livelihood
   D. reduced food security

M 9. Read the following paragraph, then answer the following question:
A general principle of caring for the forest is that high biodiversity provides stability and resiliency to it, especially with regard to pests. A diversity of tree species provides some assurance that pest outbreaks will not kill all of the trees, largely because most native pests have some degree of host specificity. Diverse forests also will contain habitats and conditions suitable for the many natural factors that help keep pest populations and levels of damage within acceptable levels.

Which of the following is true ?
   A. A natural forest is more vulnerable to pests than a mahogany forest.
   B. Forests are stable ecosystems.
   C. Monoculture such as plantations would have the least pests because man can control them through pesticides.
   D. Pests cannot damage the entire forest if the tree species in it are varied because pests are host- specific.

M 10. Below is a diagram of hypothetical communities and their response to the changes in the environment.



What does this tell about diversity and stability of an ecosystem?

A. Red and blue species tolerate each other's presence in the ecosystem.
B. The blue population fluctuates in the three years.
C. The more blue species there is, the greater the stability of an ecosystem.
D. The more diverse an ecosystem, the greater is the chance of survival of the population.

M 11. What do these diagrams say?

Diagram 1

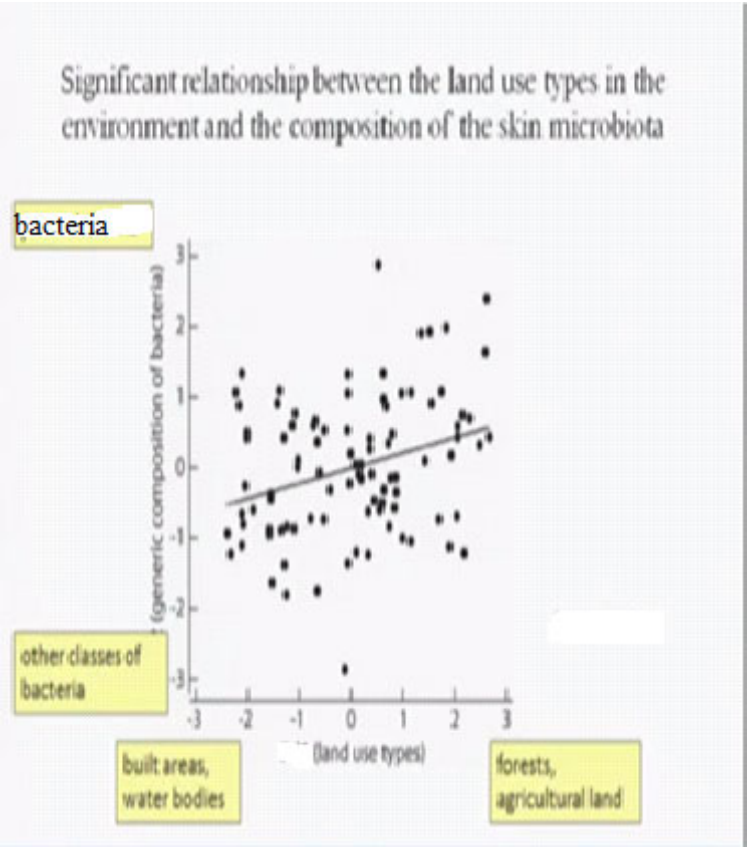


Diagram 2

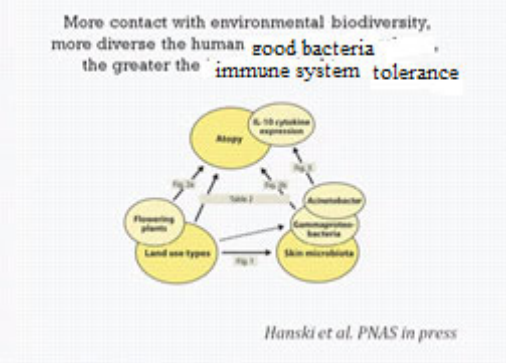
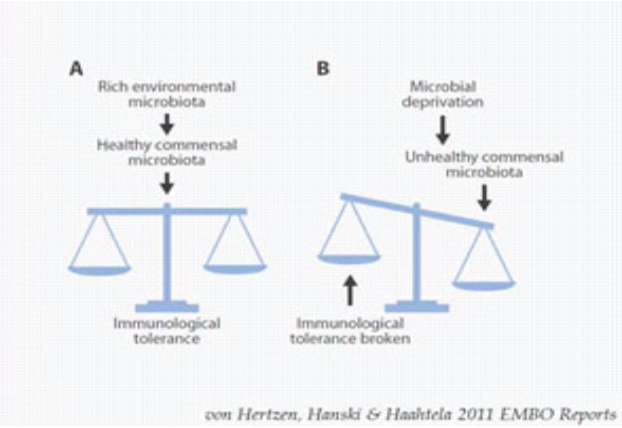
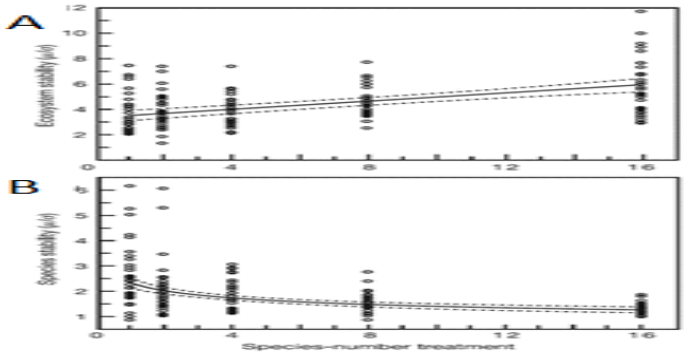


Diagram 3



A. Bacteria thrive abundantly in different ecosystems.
B. Diverse ecosystem results to a healthier organism.
C. Land use is important for the survival of the bacteria.
D. More bacteria are found in the skin than in any other parts of the body.

M 12. What does these graphs imply?



A. Diverse ecosystem influences stability more than species diversity.
B. Diversity should be studied in big areas over long periods of time.
C. Diversity, whether in an ecosystem or species level results to stable ecosystem.
D. The greater the area, the more stable it is.

M 13. Here is a conservation account made by a conservationist group:

Community leaders and key informants were gathered in three communities in Mount Kitanglad Range Natural Park to develop a conservation plan to sustain the conservation of their forest. These communities live close to two eagle nesting sites within the protected area. Based on the extent of forest left within the protected area, we estimate that there are two more eagle territories that could be found. Results of conservation planning revealed that the community preferred community-based ecotourism projects such as bird-watching and nature-trekking. Community reforestation was also prioritized. Focus groups identified poverty and the rapid increase of population as the ultimate drivers of forest degradation. However, they stressed that the issue can be mitigated by implementing alternative rural livelihood projects, including assistance with sustainable farming technologies and non-timber forest product (NTFP)-based enterprises such as handicraft-making and marketing (http://www.peregrinefund.org/projects/philippine-eagle).

What is the most basic principle why the Philippine eagle has to be conserved?

A. It is the pride of the Filipinos being a well-known species.
B. It plays a very important role in maintaining balance in the forest ecosystem.
C. Its conservation will provide livelihood for the community.
D. There are four nesting sites found in the community.

M 14. Two students were arguing in the canteen. The first student said that any species can become extinct without disturbing the ecosystem. The second argued that when a species dominates an ecosystem, it is important. Who among the two is more ecologically informed?
A. The first student- One species is negligible in number compared to the thousands already discovered.
B. The second- The number of species determines the importance of a species.
C. Both are correct for they have a very good understanding of how an ecosystem works.
D. Both are wrong. Each species is important for the stability of an ecosystem.

T 15. You are an editor of a local newspaper. To promote more readership of your family-owned paper, you are sponsoring a writing contest on the contribution of the indigenous people to biodiversity. Who among the contributors below will have a greater chance to win the contest?
A. Bryan elaborated on the passion of the Lumads to own the land that they are tilling.
B. Eloisa wrote on the success story of a Mangyan who finished college through a scholarship grant.
C. Neil expressed great satisfaction that the indigenous people in the locality received their landownership certificates.
D. Xenia wrote on the use of herbal medicines of the indigenous people.

T 16. Read the following paragraphs then answer the question:

Species abundance and ecosystem functioning

Many species are being reduced in abundance or driven to local extinction by human activities. Although changing biodiversity clearly has consequences of the functioning of ecosystems, the relative importance of different kinds of changes is not clear.

MarBEF scientists working on the BIOFUSE project used an experimental system of intertidal communities of algae and invertebrates to assess the effects of changes in key species on the functioning of the selected ecosystem. The results showed that changes in the abundance of certain species were more important than changes in the variety of species. The key result was that, although the effects of changes in diversity vary according to the habitat and location, the effects of changes in species abundance are much more consistent. Therefore alteration of key species abundances affects ecosystem functioning more

than changes in species diversity. This outcome emphasizes the importance of preserving not only particular species but also the relative abundances with which species populate our marine coastal environments.[1]
http://www.marbef.org/wiki/Disturbances,_biodiversity_changes_and_ecosystem_stability

Based on the above report, marine biologist would be working more towards

A. Increasing the number of tourists in an island
B. Maintaining the abundance of key species.
C. Maintaining the number of a species of algae in a coastal ecosystem
D. Preservation of species diversity.

T 17. A youth organization in a rural area is into replanting of mangroves in the seashore. To enlist more youth to the project, the organization sponsors a basketball tournament. For a team to be able to participate in the said tournament, the members have to plant mangroves and their registration will be offset by the organization. Which would be the most sustainable answer to this question: Do you agree with the strategy of the organization and why?

A. No, the youth should not be forced to work.
B. No. The strategy is against the rights of a child.
C. Yes, the youth should work in order to enjoy an activity.
D. Yes. The environment is cared for and the youth are able to join the tournament.

T 18. An ecologist read the following article from a business magazine:
Modern society's focus on market-delivered components of well-being, and our almost total dependence on market prices to indicate value, means that we generally do not measure or manage economic values exchanged other than through markets. This is especially true of the public goods and services that comprise a large part of the benefits that nature provides humanity.
Society generally ignores third-party effects of private exchanges (so-called 'externalities') unless they are actually declared illegal. This in turn leads to serious human and economic costs which are being felt now, have been felt for much of that last half-century, and will be felt at an accelerating pace if we continue 'business as usual'.

Which of the following should the ecologist suggest:
A. Businessmen should have tree planting program for their employees.
B. Every commodity sold in the market should be given an environmental cost so that businesses would see the value of each organism where the product came.
C. Society stops using products from nature to prevent further degradation of the environment.
D. Use of synthetic commodities should be increased to lower the use of natural products.

T 19. A forest manager ensures that the forest has different levels of tree growth and enough sunlight penetrates the understory. He also ensures that wildlife have enough old growth trees as habitat. Even the river flowing along the forest, he makes sure to have debris of litters and woods. Infer the primary reason for these.
A. Illegal loggers find it difficult to enter a forest with uneven height of trees.
B. The forest becomes a challenging place for tourist to visit.
C. The forest could easily be inspected.
D. Variety of habitat condition favors variety of wildlife.

T 20. A forester was tasked to report on the contribution of indigenous people to the stability of the forest ecosystem in a forum. What would be the best way to present his report to these people?
A. A brochure explaining how the forest is slowly degraded.
B. A multimedia showing a summary of the research finding translated to the native tongue of the audience.
C. A poster presentation focusing on the achievements of the indigenous peoples partners in development.
D. A PowerPoint presentation showing the creativity of the indigenous people.

EXPLORE

Let's begin by reading an article on the emergency landing done by an airplane in the Hudson River. What could have caused this emergency landing? Let us find out!

ACTIVITY NO. 1: NEW GUYS IN THE BLOCK

Read the two articles on the invasion of new species in an ecosystem. The first article is on the emergency landing of an airplane in the Hudson River and the second one is on the Apple snail invasion in the Philippines. Find out how these two articles are similar.

THE HONKING EMERGENCY LANDING

Read this article on the Hudson River emergency landing of a plane. What did the authorities discover?

The Honking Mess

http://books.google.com.ph/books?id=edTsIG--n5QC&pg=PA413&lpg=PA413&dq=honking+mess&source=bl&ots=hkbY6I7Dwh&sig=emov7aM0gLY5nsRUD17nMiBNeh&hl=en&output=html_text

PROCESS QUESTIONS:

1. What did the investigators find out about the cause of the emergency landing?
2. What caused the engine failure?
3. How could the population of these geese be controlled?
4. Is this a disruption in the ecosystem? Explain.
5. How is a stable ecosystem attained?
6. Will the legalization of hunting be a solution to the problem? Justify your answer.

Let us then take a look at a local situation. Read the article on http://applesnail.net/. This article expounds on the invasion of apple snails in Philippine ecosystem. Are the implications to the environment mentioned in the two articles similar?

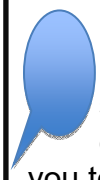
ACTIVITY NO. 2: WHAT DO I KNOW?

Consider this question again: How is a stable ecosystem attained?
To record your ideas and thoughts about this question, answer the What I know and What I want to know columns of the table below.

What I know	*What I want to know*	*What I have learned?*

The What I learned column will be answered at the Deepen Section of this module.

END OF EXPLORE



You have just tried finding out something about a stable ecosystem. You gave your initial ideas on what makes a stable ecosystem. Let's now find out what the answer is by doing the next part. What you learn in the next sections will also enable you to do the final project which involves writing a report or a feature article or a blog on indigenous knowledge that promotes biodiversity and a stable ecosystem.
The article or blog or feature article should be based on a research or interview of indigenous people in your locality.

FIRM-UP

Your goal in this section is to learn and understand key concepts on ecosystem, biodiversity, and carrying capacity.
Reflect on the following question:

- **How is a stable ecosystem attained?**

ACTIVITY NO. 3: THROWBACK: WHAT IS AN ECOSYSTEM?

DESCRIPTION: This activity will guide you to understand or recall the concepts of ecosystem. Let us start by clicking on the video Intro to Ecosystem and the article on the stability of ecosystems . Use your notebook or notepad to record your answer to the process questions that follow.

Intro to Ecosystem
http://www.youtube.com/watch?v=1CPlo9Ra2W0

The stability of ecosystems

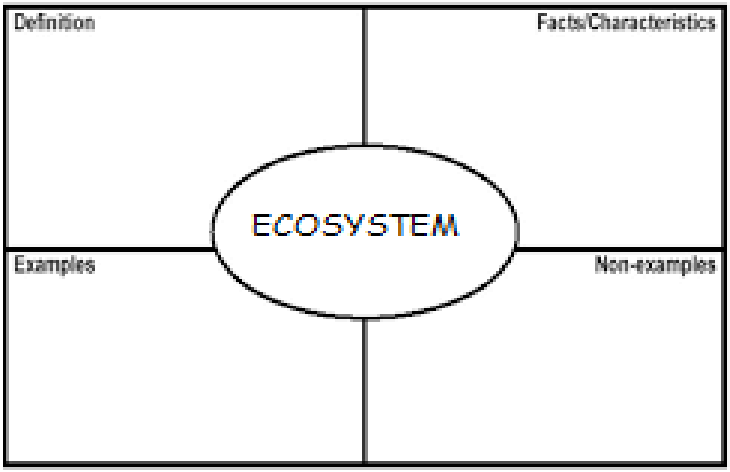
http://www.glyndwr.ac.uk/bartlett/ecology/stability.htm

PROCESS QUESTIONS:

1. What is an ecosystem?
2. What are the components of an ecosystem?
3. What makes an ecosystem stable?

Using a Frayer model, summarize your understanding of what an ecosystem is. Write the following on the appropriate box:

a. on the definition box the meaning of ecosystem;
b. on the fact/characteristic box the description and characteristics of an ecosystem;
c. on the example box samples of ecosystems, and
d. on the non-example box the non-samples of ecosystems.



Now that you are already familiar or have recalled what an ecosystem is, proceed to the indicated activity below.

ACTIVITY NO. 4: FLOW OF ENERGY IN THE ECOSYSTEM

DESCRIPTION: Each meal an organism takes contains energy in the form of carbohydrates, fats and protein. The organism uses this for movement, growth and other activities. Some are used to keep its body at its normal temperature. The body is very inefficient in converting food into useful energy. Some materials will not be used and will be excreted as waste.

In this activity, you will study several pyramids and how energy is transferred from one trophic level to the next. Click on the sites below.

a. Ecological pyramids
   http://www.youtube.com/watch?v=NJplkrliUEg
   https://www.youtube.com/watch?v=CReZd9OHEfs

b. The transfer of energy- the 10% rule
   http://www.youtube.com/watch?v=ScizkxMlEOM
c. Food Chains, Trophic Levels and Ecological Pyramids
   https://www.youtube.com/watch?v=wD3OlaTf7Ig
d. Energy and Food Chains in Ecosystems
   https://www.youtube.com/watch?v=LBagx9Qhdx

PROCESS QUESTIONS

1. What are the different ecological pyramids?
2. How does one differ from the other?
3. What information can be gleaned from these pyramids?
4. What pyramid will you use to show the amount of energy in each trophic level? Explain.
5. Why is energy reduced by 90% as it moves from one trophic level to another?
6. Given that a producer has 9000 kcal, predict the amount of energy available to the last consumer in a three level pyramid.
7. What important lesson did you learn from this activity?

We already have studied the flow of energy in the ecosystem. In the next activity, find out how matter flows in the ecosystem.

ACTIVITY NO. 5: FLOW OF MATTER IN THE ECOSYSTEM

DESCRIPTION: In this activity, you will watch a video on the flow of matter and energy in an ecosystem. Find out what happens to matter in the ecosystem.

Flow of Matter and Energy

https://www.youtube.com/watch?v=8qMgdEBNBOE

PROCESS QUESTIONS:

1. Describe how matter flows in an ecosystem.
2. What model will you use to represent the number of organisms in a ricefield?
3. How would you draw the pyramid of number of a tree and maya birds?

Now that you have understood the concept of a stable ecosystem we will now proceed to study how biodiversity affects an ecosystem.

ACTIVITY NO. 6: BIODIVERSITY: RECIPROCAL READING

To be sure that you fully understand the content follow the directions:

a. Before reading, write a prediction of what the article is all about by looking at the main title, scanning the pages to read the major headings, and looking at any illustrations .

Here is the article link: http://www.nature.com/scitable/knowledge/library/biodiversity-and-ecosystem-stability-17059965

Prediction:_____

b. After writing your prediction, read the article, stop at after each paragraph or major section of the passage. Write one or two sentences that sum up most of the important ideas that appear in the section. Include key concepts or events but leave out less important details. Write these summary or main idea sentences in your notepad or notebook.
Main ideas:
1._____
2. _____
3. _____

c. Go over your main ideas again. For each main idea, write a question that the main idea will answer. Start you question with the Wh (who, what, where, when).
Questions:
Wh_____
Wh_____
Wh_____

d. You sometimes encounter words or phrases or whole sentences that really are difficult to understand. List these as unknown words and unclear phrases. Use the dictionary and read the sentences before and after the phrase. If still you cannot understand, ask help from the teacher during face to face meeting or call a friend.

e. Complete the template below, after you have done the above steps.

_____ I think I know _____ _____ _____	
Predict I think we will learn…	Question: I wonder…
Clarify	Summarize

What will happen if an organism became extinct? We might be thinking that a certain species of organism is not important. For instance, is a snake species dispensable because it harms people? Let us examine the importance of a certain species and the effect of its loss to the ecosystem.

ACTIVITY NO. 7: ABSENCE OF ONE, LOSS FOR ALL

DESCRIPTION: Read the articles provided.

Absence of wolves causes imbalance in US ecosystem, say scientists
http://www.theguardian.com/environment/2009/jan/29/endangered-habitats-washington-state

PROCESS QUESTIONS:

1. What caused the absence of wolves in the Olympic National Park?
2. What is the result of the loss of wolves to the park?
3. Is there a strong basis for the hypothesis of Beschta that the loss of wolves would mean disaster to the other organisms in the park? Justify your answer.
4. What are keystone species?
5. Why are keystone species important?
6. Could the wolves in the park be considered keystone species? Support your answer.

Now, read the articles on the Filipino conservationist wins prize for 'rebranding' world's rarest crocodile and the importance of the Philippine crocodile. Infer why a Filipina uses every means to protect the Philippine crocodile.

Filipino conservationist wins prize for 'rebranding' world's rarest crocodile
http://www.theguardian.com/environment/2014/may/08/world-rarest-crocodile-philippine-marites-gatan-balbas

Philippine crocodile 080
http://ecop.pbworks.com/w/page/18520760/Philippine%20crocodile%200809

What is the ecological importance of the Philippine crocodile?

Write your answer through Evernote (https://evernote.com/) and send it to your teacher.

Having established the importance of organisms in the ecosystem, let us now proceed to one component of an ecosystem, population. What is population and what determines population size? To find out, proceed to the next activity!

ACTIVITY NO. 8: POPULATION CHANGES

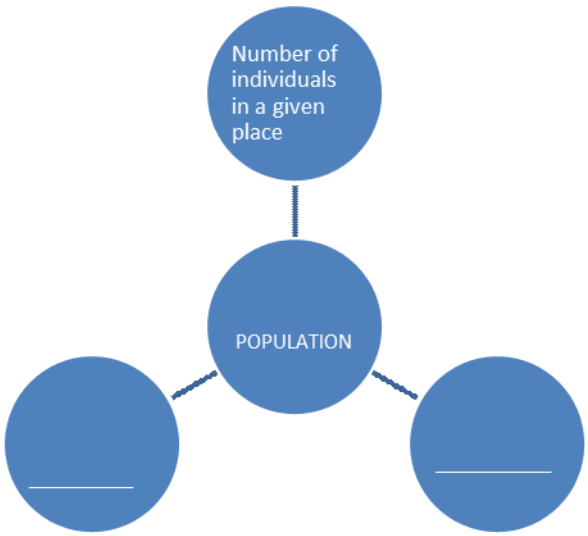
DESCRIPTION: This is an activity on population. Find out how population affects the ecosystem. Complete the organizer below to summarize salient points on population.

a. Population
http://www.neok12.com/video/Ecosystems/zX797e605c645d5f006f7d45.htm
http://www.physicalgeography.net/fundamentals/9d.html

http://studyjams.scholastic.com/studyjams/jams/science/ecosystems/population-growth.htm

b. Population size and density

http://education-portal.com/academy/lesson/what-is-population-density-definition-lesson-quiz.html#lesson



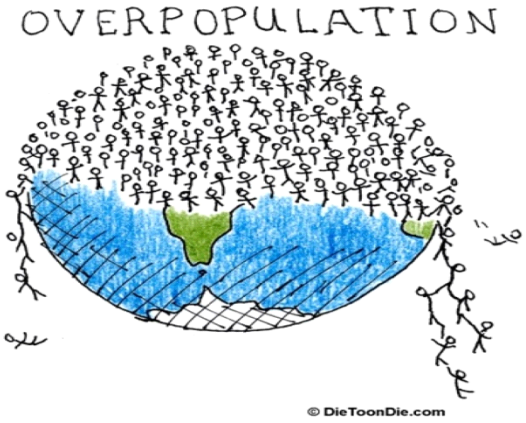
c. Simulation on population growth: Foxes and Rabbits
http://www.abpischools.org.uk/activescience/module3/group3.html
In this simulation, how is the rabbit population affected by the number of foxes present in the ecosystem? Why is the number of foxes able to control the population of rabbits? What happens when the foxes are eliminated from the ecosystem? What conditions contribute to the stability of the rabbits' population?

PROCESS QUESTIONS:

1. What is population?
2. How does a population affect the ecosystem?
3. How does a change in population size of one population, affect another population?
4. Why is this dynamics in population changes important?
5. Why do you think the human population continues to grow?

Having studied the concept of population, proceed to the activity below.

What does this picture tell you?

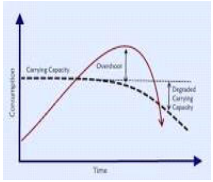


https://www.thinglink.com/scene/499621227044798464

The illustration shows an extreme case of congestion and huge population density. Could human beings survive this scenario? Suppose your friends will take a boat ride from the port of Balingoan going to Camiguin island. The boat's capacity is only 50 persons but 85 insist on riding it. What will happen to the boat?

Let's take a look at the next activity.

ACTIVITY NO. 9: CARRYING CAPACITY



DESCRIPTION: Imagine a small aquarium with a capacity of 20 fishes. In it are one male and one female guppies. Over time these two cute little fishes reproduced and produced 25 offspring. How would you describe this little community in terms of the space and food available for each individual organism?

The carrying capacity is the maximum number of each species that the ecosystem can support. The carrying capacity of the aquarium depends on the space and food available for each fish. The following are articles on carrying capacity. Click on the following links then answer the following questions.

a. Carrying capacity Activity

http://www.gov.mb.ca/conservation/sustain/carcap.pdf

b. What Factors Affect the Carrying Capacity of an Environment?

http://education.seattlepi.com/factors-affect-carrying-capacity-environment-6190.html

PROCESS QUESTIONS:

1. What is carrying capacity?
2. When does a population exceed its carrying capacity?
3. What can be done to limit population growth?
4. When is an ecosystem considered stable?

Sometimes the ecosystem changes dramatically brought about by natural or man-made causes. In the next activities you will study how the ecosystem recovers from such changes.

ACTIVITY NO. 10: ECOLOGICAL SUCCESSION

DESCRIPTION: We may ask what will happen to an area after a forest fire has damaged it? Or what will happen to an area after volcanic eruption? Study the articles below and find how ecosystems adapt to changes in the environment and attain stability.

a. Ecological Succession Article
http://regentsprep.org/regents/biology/units/ecology/ecological.cfm

b. Ecological Succession Video and Article
http://education-portal.com/academy/lesson/ecological-succession-from-pioneer-to-climax-communities.html#lesson

To put together what you have learned from the above articles and video, use Think Pad.

1. Words: Describe in one or two sentences the meaning of the video and articles.
2. Picture: Draw a picture showing concepts based on the article/video.
3. Connections to life: Write or illustrate how the text might apply to real life situation in the contemporary world.
4. Symbols: Draw one or more symbols that ~~might~~ capture the key themes of the article/video.
5. Use the template below for your answer.

WORDS	**PICTURE**
Connection to Life	**SYMBOLS**

PROCESS QUESTIONS:

1. What is ecological succession?
2. How is ecological succession made possible?
3. What series of events take place during ecological succession?
4. How does ecological succession ensure the stability of an ecosystem?

Human beings are part of the ecosystem. One group of humans within the ecosystem is the indigenous peoples. Find out how these groups of people contribute to the stability of the ecosystem.

ACTIVITY NO. 11: ARTICLE READING ON INDIGENOUS PEOPLE

DESCRIPTION: You are going to research on the indigenous peoples of the Philippines. Find out how these groups of people contribute to the stability of the environment.

Click on the links below on :

a. Indigenous Knowledge for biodiversity conservation

http://www.jstor.org/discover/10.2307/4314060?sid=21106407508673&uid=3738824&uid=2&uid=4

b. Indigenous Knowledge System and Survival of the Indigenous Peoples in the Philippines

https://talamdan.wordpress.com/2007/10/01/indigenous-knowledge-system-and-survival-of-the-indigenous-peoples-in-the-philippines/

To show your understanding of the articles, use the POW+Tree organizer:

http://education.wm.edu/centers/ttac/resources/articles/teachtechnique/continuingthepartnershipgooddayplan/index.php

Write an essay below to summarize the article:

PROCESS QUESTIONS:

1. What are the contributions of indigenous people to the environment?
2. How could they contribute to the stability of the ecosystem?
3. In your own little way how are you going to apply the knowledge you gained from indigenous people?

ACTIVITY NO. 12: ONLINE QUIZ ON ECOSYSTEM

DESCRIPTION: This is an online quiz on ecosystem. Click on the link and take the quiz. In case you had difficulty answering some questions, go back to the previous lesson. Retake the quiz after. Record your answers in your notebook or notepad.

Online Quiz

http://easyscienceforkids.com/ecosystems-quiz-fun-free-interactive-general-knowledge-quiz-for-kids/

ACTIVITY NO. 13: SELF CHECK

DESCRIPTION. Find out how well you are progressing in this lesson. Put a smiley on the appropriate column:

 smileys- you are going great!

 smileys- you are on task

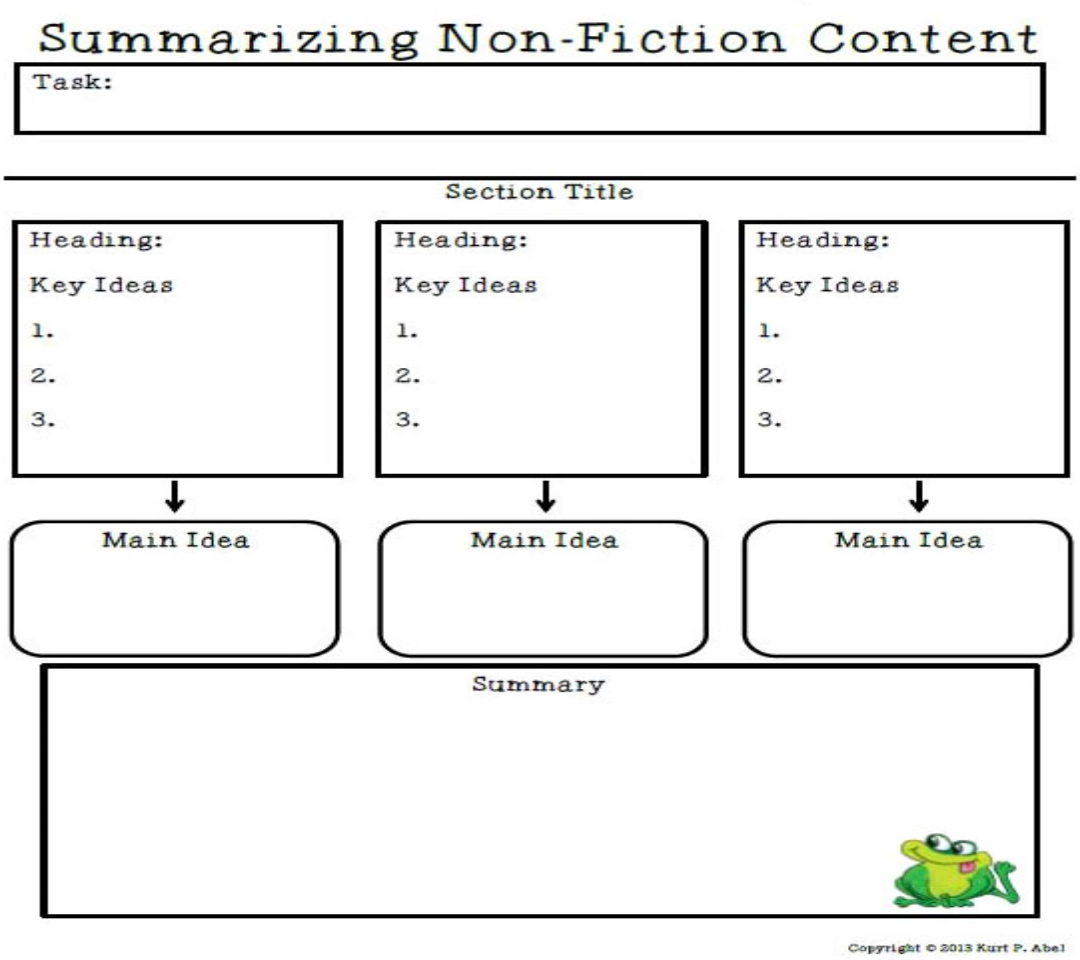
 smileys- try working hard

 smileys- review the lessons

 smiley- you still have a chance. Go back and be determined this time.

Learning Competency	*Self-rating No. of smileys*
Describes the flow of energy and matter in ecosystems.	
Explains how species diversity increases the probability of adaptation .	
Explains the relationship between population growth and carrying capacity.	

To summarize one's learning from this unit, complete the organizer below:



https://www.pinterest.com/able4cable/summarizing/

End of Firm Up

In this section, the discussion was about basic concepts of ecosystems.

Go back to the previous section and compare your initial ideas with the discussion. How much of your initial ideas are found in the discussion? Which ideas are different and need revision? What new learning goal should you now try to achieve?

Now that you know the important ideas about this topic, let's go deeper by moving on to the next section.

Go back to the previous section and compare your initial ideas with the discussion. How much of your initial ideas are in the activities and discussion? Which ideas need revision?

Now that you know the important ideas about this topic Let Us go deeper by moving on to the next section.

DEEPEN

Your goal in this section is to extend your understanding of the stability of the ecosystem and how human activities affect it.

ACTIVITY NO.14: ECOLOGICAL SUCCESSION, BIODIVERSITY AND STABILITY

DESCRIPTION: Study the diagram on the site provided.

http://upload.wikimedia.org/wikipedia/commons/4/41/Forest_succession_depicted_over_time.png

PROCESS QUESTIONS:

1. What is ecological succession?
2. Name the organisms involved in the process.
3. Describe the diversity of organisms as climax forest is reached.
4. Infer what factors contribute to the stability of the ecosystem at the last stage of succession.
5. Does this prove that succession leads to a stable ecosystem? Explain.

ACTIVITY NO.15 : HUMAN ACTIVITIES THAT AFFECT THE STABILITY OF THE ECOSYSTEM

DESCRIPTION: Read the following articles. Compare the two articles and explain how humans affect the environment.

Human Activities that affect the environment
http://www.ecokids.ca/pub/eco_info/topics/biodiversity/human_activities.cfm

Nicaragua's Indigenous Peoples Protect their Forests Even Without Government Support
http://www.wri.org/blog/2014/11/nicaragua%E2%80%99s-indigenous-peoples-protect-their-forests-even-without-government-support

PROCESS QUESTIONS:

1. What are the impacts of human activities to the ecosystem?
2. How is the stability of the ecosystem affected by these activities?
3. In contrast to the harm that humans do to the environment, what do the indigenous people do? Explain.

ACTIVITY NO. 16: INDIGENOUS KNOWLEDGE (IK)

DESCRIPTION: In this activity, you will research on the contributions of Indigenous knowledge to the stability of the ecosystem. Areas that you can research on will be on agriculture or herbal medicine. Choose the specific knowledge that you want to study. After the research, make an oral presentation using VOKI to highlight the contribution of IK to the stability of the ecosystem.

Use the link below to proceed to the Voki website.
http://www.voki.com/

Click the Let's Get started button and follow the directions below:

a. Select your speaking avatar.
b. Change the look, clothing and accessories.
c. Add your own voice through phone, microphone or upload a file.
d. Choose a background.
e. Publish and share to your teacher and friends.

PROCESS QUESTIONS:

1. What IK did you research on?
2. In what way can IK contribute to the stability of the ecosystem?
3. Can IK contribute to the issues on sustainable ecosystem? Cite concrete examples.

ACTIVITY NO.17: YOUR OPINION MATTERS

DESCRIPTION: Early on you read about the Honking Plane Emergency. At the end of the activity you were asked whether you favor that hunting of the Canadian Geese be legalized. Now is your chance to elaborate on your opinion through this activity.

Click to this link and read the article again.

Honking Mess
http://books.google.com.ph/books?id=edTsIG--n5QC&pg=PA413&lpg=PA413&dq=honking+mess&source=bl&ots=hkbY6I7Dwh&sig=emov7aM0gLY5nsRUD17nMiBNeh&hl=en&output=html_text

After reading use the planning sheet below to organize your thoughts on the questions: Should hunting of the non-migrant Canadian geese be legalized?

DEFENDS PLANNING SHEET*

Author: _____ Date _____

My quantity goal for this essay _____

My quantity goal for this essay _____

D=Decide on your position.

My position: _____

E= Examine the reasons for your position.

For my position	Against my position
1.	1.
2.	2.
3.	3.

Have I listed reasons for and against? If yes proceed.
F= Form a list of points that explain each reason.
Have I listed ideas that explain each lesson? If yes proceed.
Place an arrow (→) next to ideas which I must elaborate or support with evidence.
E= Expose your position in the first sentence. If yes proceed.

Write your topic statement below:

_____

_____

N=Note each reason and supporting points.

Did I organize the ideas and supporting points for each reason of argument? If yes proceed.
Did I include examples that elaborate upon each reason for argument? If yes proceed.
Make sure I chose at least ____ opposing arguments to use. If yes proceed.

D=Drive home the position in the last sentence.

Write your last sentence below:
For errors and correct. S=Search
Self-talk statements:

* Adapted from University of Kansas Special connections: Genre-focused planning instruction at http:/www.specialconnections.ku.edu/cgi-bin/cgiwrap/speccon/main.php?cat=instruction&section=writing/genre

PROCESS QUESTIONS:

1. Were you able to write your argument for or against hunting of non-migrant Canadian geese?
2. Are you happy with your argument? Explain.
3. What situation in the Philippines calls for a similar situation?

You have just expressed your ideas on issues affecting the stability of ecosystems. Now, it is time that you prepare yourself to transfer your learning in meaningful output. To begin, perform the next activity.

ACTIVITY NO. 18: A WRITESHOP

DESCRIPTION: A forum was being conducted on feature, scientific and blog writing. As an invited speaker of this writers' workshop, you are going to present through a PowerPoint presentation on how these forms of media are written or developed.

PROCESS QUESTIONS:

1. How does a blog differ from scientific report and feature writing?
2. What is the advantage of one over the other?
3. Which is your preferred medium? Explain.

ACTIVITY NO.19: PUTTING THINGS TOGETHER

DESCRIPTION: In the previous section, we looked at different articles on biodiversity . Let's put together in the table below our answers to the essential question that we asked for each video/situation.

	Article 1	Article 2	Article 3
ESSENTIAL QUESTION: How is a stable ecosystem attained?	Biodiversity and Ecosystem Stability http://www.nature.com/scitable/knowledge/library/biodiversity-and-ecosystem-stability-17059965 A stable ecosystem is attained _____ _____	Carrying Capacity http://www.gov.mb.ca/conservation/sustain/carcap.pdf A stable ecosystem is attained _____ _____	Absence of wolves causes imbalance in US ecosystem, say scientists http://www.theguardian.com/environment/2009/jan/29/endangered-habitats-washington-state A stable ecosystem is attained_____ _____

PROCESS QUESTIONS:

1. Compare your answers above. What is common among the answers that you have written?
2. What is different in the answers? What influences stability of the ecosystem?
3. Since variations are present, how will one be able to know which variation to do, show or use?

   How is a stable ecosystem attained?

   Give several examples to justify your answer. Email your answer to your teacher.

ACTIVITY NO. 19: SELF CHECK

DESCRIPTION. Find out how well you are progressing in this lesson. Put a smiley on the appropriate column:

 smileys- you are going great!

 smileys- you are on task

 smileys- try working hard

 smileys- review the lessons

 smiley- you still have the chance. Go back and be determined this time.

Learning Competency	*Self-rating No. of smileys*
Describes the flow of energy and matter in ecosystems.	
Explains how species diversity increases the probability of adaptation .	
Explains the relationship between population growth and carrying capacity.	

End of Deepen

In this section, the discussion was about biodiversity and the human impact to the ecosystem.

What new realizations do you have about the topic? What new connections have you made for yourself? What helped you make these connections?

Now that you have a deeper understanding of the topic, you are ready to do the tasks in the next section.

TRANSFER

Your goal in this section is apply your learning to real life situations.

You will be given a practical task which will demonstrate your understanding.

Proceed to the next activity.

ACTIVITY NO. 20: NOW I KNOW

DESCRIPTION: In this activity, you will go back to the KWL chart and write your answer to the What I have learned column.

How is a stable ecosystem attained?

Answer the "What I have learned column" of this chart.

What I know	*What I want to know*	*What I have learned?*

PROCESS QUESTIONS:

1. How does your answer to the last column differ from the first column?
2. Are all questions listed under the second column answered? If not review all the readings and videos in the previous activities

ACTIVITY NO. 21: A REPORT ON INDIGEOUS KNOWLEDGE

TASK DESCRIPTION:
In the upcoming celebration of the World's Indigenous People's Day, your local office of the National Commission on Indigenous Peoples is tasked to write a report on indigenous knowledge that promotes biodiversity resulting to a stable ecosystem.

As a blogger, you will write a blog. As a newspaper writer, you will write a newspaper article. As a feature writer, you will feature a well- known IP in your community. Your work will be judged according to content, organization and impact.

PROCESS QUESTIONS:

1. How did you find the activity?
2. How could indigenous knowledge be protected?
3. What could be the future of indigenous knowledge in our country?

The following rubric will be used to grade your work:
Rubric on a report/blog/feature article on Indigenous People's Contribution to Biodiversity and Ecosystem Stability

CRITERIA	Exemplary 4	Accomplished 3	Developing 2	Beginning 1	SELF - RATING	TEACHER 'S RATING
Content	Provides exhaustive and reliable background information about the indigenous peoples' contribution to biodiversity and ecosystem stability; Information provided is clearly relevant to the objective of the article.	Provides accurate background information; Information provided is related to the objective of the article. .	Provides unrelated background information; Some information are not relevant to the objective of the article. .	No background information Information is not relevant to the objective of the article.		

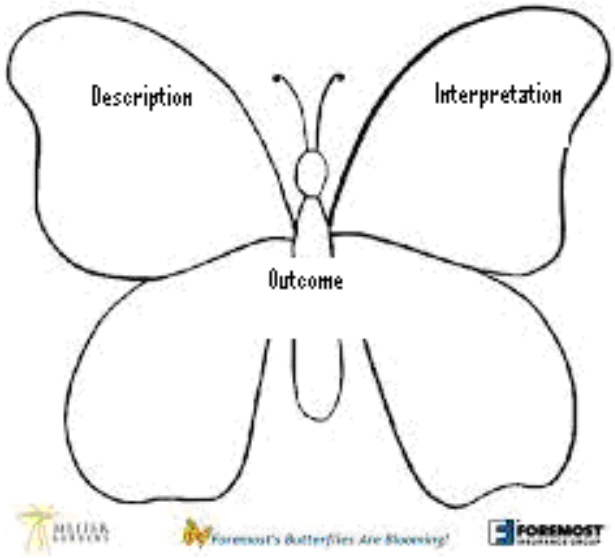
Organization	Details of the article are placed in a logical order and they effectively keep the interest of the reader.	Details are placed in a logical order, thereby helping the audience understand the article without difficulty.	Some information are logically sequenced. Some pieces of information are out of place.	The pieces of information are not organized.		
Clarity of message	Message is easily understood and stimulates further reading.	Message is clear and encourages the reader to continue reading.	Message is not so clear and there is little stimulation for further reading that is provided.	Message is confusing and causes discouragement on the part of the reader to continue reading.		
				OVERALL RATING		

ACTIVITY NO. 22: REFLECTION JOURNAL

DESCRIPTION: Finally, write a reflection journal about your learning. Use the following guide:

How do we structure reflective writing?

1. Description (don't make this too long). Use these guide questions:
   What is it? What happened? Why am I talking about it?
2. Interpretation
   What is important, relevant, interesting, or useful?
3. Outcome
   What have I learned from this?
   How will it influence my future? Use the organizer below.



End of TRANSFER:

In this section, your task was to write a report/blog/ article on indigenous people.

How did you find the performance task? How did the task help you see the real world use of the topic?

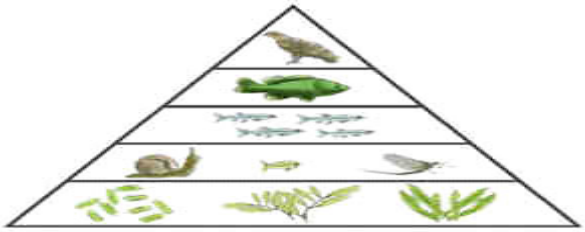
You have completed this lesson. Before you go to the next module, you have to answer the following posttest.

You have completed this lesson. Before you go to the next lesson, you have to answer the following post-assessment.

POST-ASSESSMENT

Click on the letter of the answer that you think best answers the question. Click on “Submit” to see your score. If you do well, you may move on to the next module. If your score is not at the expected level, you have to go back and take the module again.

For item number 1 refer to the diagram below.



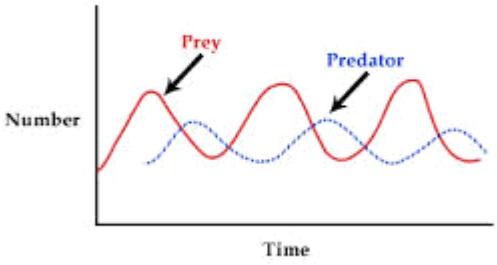
A 1. If 90 000kj of energy is available to the primary producers, what will be the amount available to the tertiary consumer?

A. 90 kj
B. 900 kj
C. 9000 kj
D. 90000 kj

A 2. Which of the following statements is true?

A. The main source of energy on Earth comes from the sun and other stars in the universe.
B. Energy follows a straight path as it passes from one trophic level to the next.
C. In terms of elements or nutrient, the Earth is an open system.
D. The Earth is a closed system for both energy and nutrient.

A 3. Consider the graph below. Why is the number of predator not greater than the prey at any given time?

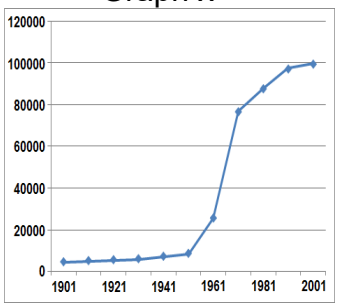


A. For the predator-prey relationship to continue.

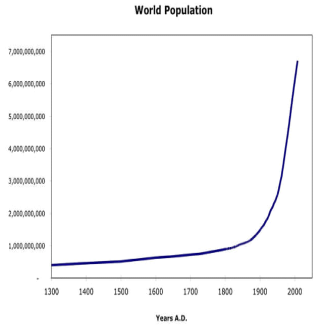
B. For the prey species to continue reproducing.
C. To ensure the survival of the predator.
D. To ensure the survival of the prey species.

A 4. Study the graphs below, which graph shows an ecosystem that has an infinite amount of resources?

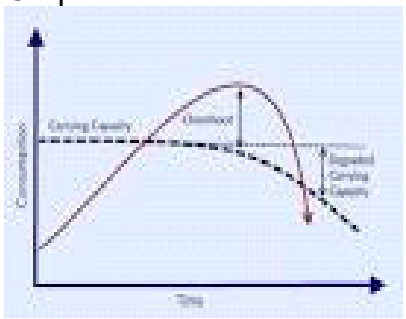
Graph x



Graph y



Graph z



http://www.studyblue.com/notes/note/n/ehs-3060-study-guide-2012-13-zimeri/deck/9725320

http://cdn5.coachingtohappiness.com/wp-content/uploads/2010/09/world-population-graph.jpg
http://www.paulchefurka.ca/Overshoot_2.jpg

A. x
B. y
C. z
D. x and y

A 5. Which of the following statements is true?

x

Y

Z

A. Ecosystem X is more stable than Ecosystem Y.
B. Ecosystem Y is more stable than ecosystem Z.
C. Ecosystem Y is unstable and needs more input like fertilizers and pesticides.
D. X, Y and Z ecosystems are unstable and need constant input of fertilizers and pesticides.

A 6. Read the article below:

Big on Figs

The sun has barely risen over the sea, but its hot rays are already bathing the steamy forests of Tangkoko Nature Reserve on Sulawesi Island in Indonesia. The morning is heralded by a cacophony of wild calls and screeches in the forest canopy above me. It seems every animal in this small reserve is converging on an enormous fig tree. I have been watching this tree for weeks, and now its entire burden of fruit - between 400,000 and 600,000 figs - is ripening all at once. The bounty attracts birds and mammals from all directions to partake in a feeding frenzy.

But why, in a forest that harbors hundreds of different types of fruiting trees, is this fig so irresistible to so many forest creatures?

Tests revealed that figs are an important natural source of calcium, critical for strong bones and eggshells, blood clotting and numerous cell functions. Figs have, on average, nearly three times more calcium than nonfig fruits and contain calcium levels higher than minimum dietary requirements for growing primates. Several fig species contain enough calcium to support a hen laying 300 eggs a year. The results were so exciting that Ellen tested fruits from South America and Africa and found that Tangkoko was not unique-the pattern held around the world.

At last, we had found the answer to the question that brought me to Tangkoko. I now knew that figs are irresistible to so many forest denizens not only because they are plentiful and provide enormous quantities of food year-round, but because these succulent fruits in all their various sizes, shapes and colors provide an essential nutrient.

http://mboard.pcaarrd.dost.gov.ph/forum/viewtopic.php?id=13312

Based on the article, which of the following is true?

A. Fig tree is a keystone prey that provide nutritious food to the different species of animals in the forest.
B. The different species of organisms in the forest feed on fig trees.
C. The fig is an umbrella species providing shelter to different forest organisms.
D. The forest is stable because of the fig trees.

A 7. After watching a video, Camille realized that a hectare of mangrove could have an ecological value of Ph 1 000 000 a year. This value is based on the amount of charcoal and wood products the mangrove could provide; the protection the mangrove provides to the coral reef; the number of fishes that lay eggs under the roots of the mangrove; and the fresh air provided by the photosynthetic activities of the mangrove. In order to take more from the mangrove ecosystem, Camille's community could

A. Convert the mangrove forest to a fish pen to have more fish.
B. Leave the mangrove forest as is, because it could provide more in the future.

C. Provide protection and more propagation of mangroves trees.
D. Sell the mangrove to those interested to use it for charcoal industry.

A 8. Study the pictures below:

http://www.unisdr.org/files/2114_VL108012.pdf

How do the two pictures show activities that minimize human impact to the environment?

Key:

a. Both activities are supported by the government and local communities.
b. Both activities enlist the youth.
c. Both are activities that promote biodiversity.
d. One picture protects aquatic habitat while the other restores damaged terrestrial ecosystem

A. a and b
B. b and c
C. c and d
D. a and d

M 9. Read the following paragraph, then answer the following question:

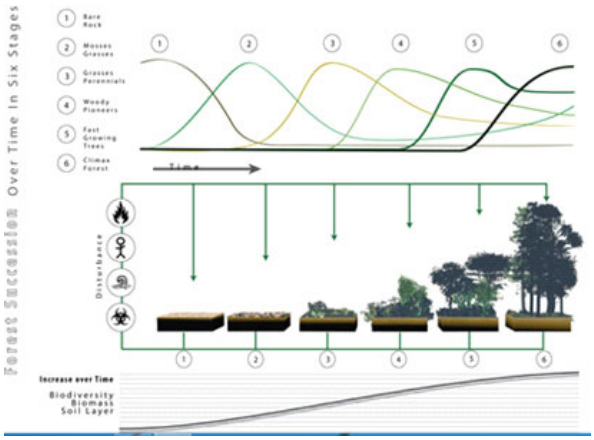
A general principle of caring for the forest is that high biodiversity provides stability and resiliency to it, especially with regard to pests. A diversity of tree species provides some assurance that pest outbreaks will not kill all of the trees, largely because most native pests have some degree of host specificity. Diverse forests also will contain habitats and conditions suitable for the many natural factors that help keep pest populations and levels of damage within acceptable levels.

Which of the following is true?

A. A diverse forest is more vulnerable to pests than a forest with one tree species.

B. Damage to a diverse forest is minimal when attacked by pests because pests are host- specific.*
C. Forests are stable ecosystems and are also vulnerable to pests.
D. Monoculture such as plantations would have the least pest because man can control them through pesticides.

M 10. Study the diagram below.



http://upload.wikimedia.org/wikipedia/commons/4/41/Forest_succession_depicted_over_time.png
The illustration above gives three pieces of information. What one big idea can be drawn from these pieces of information?

A. Adaptation and biodiversity could be attained when man provides ways for ecological succession to happen.
B. In a natural ecosystem without man's intervention, organisms adapt to changes in the ecosystems that brings about its diversity and then to its stability.
C. Succession occurs in six stages and ends in a very diverse forest ecosystem.
D. This scenario rarely happens in a natural ecosystem.

M 11. Read the paragraph below then answer the question that follows.

There is mounting evidence that biodiversity increases the stability of ecosystem processes in changing environments, but the mechanisms that underlie this effect are still controversial and poorly understood. Here, we extend mechanistic theory of ecosystem stability in competitive communities to clarify the mechanisms underlying diversity–stability relationships. We first explain why, contrary to a widely held belief, interspecific competition should generally play a destabilising role. We then *Module : Ecosystems*

explore the stabilising effect of differences in species' intrinsic rates of natural increase and provide a synthesis of various potentially stabilising mechanisms. Three main mechanisms are likely to operate in the stabilising effects of biodiversity on ecosystem properties: (1) asynchrony of species' intrinsic responses to environmental fluctuations, (2) differences in the speed at which species respond to perturbations, (3) reduction in the strength of competition. The first two mechanisms involve temporal complementarity between species, while the third results from functional complementarity. Additional potential mechanisms include selection effects, behavioural changes resulting from species interactions and mechanisms arising from trophic or non-trophic interactions and spatial heterogeneity. We conclude that mechanistic trait-based approaches are key to predicting the effects of diversity on ecosystem stability and to bringing the old diversity–stability debate to a final resolution.
http://onlinelibrary.wiley.com/doi/10.1111/ele.12073/abstract

Consider the following situation:
After a fire, grasses grow immediately. After several grasses have died and the fertility of the soil was restored, dormant seeds sprouted giving rise to bush and grassland community.

What influences the stability of this ecosystem after the disturbance?

A. asynchrony of species' intrinsic responses to environmental fluctuations
B. behavioural changes resulting from species interactions
C. differences in the speed at which species respond to disturbances,
D. reduction in the strength of competition.

M 12. There are people who are skeptical on the role of biodiversity to the stability of the ecosystem. They argue that the Earth is for humans to develop and biodiversity can be relegated to zoos. They maintain that new species replace old ones, economic development provides the poor with jobs and the great wilderness can be converted to farmlands to better provide for the increasing human population. In contrast how do conservation biologists counter this way of thinking?
Key:

a. Biodiversity plays an important role in ecosystem stability.
b. The Earth must be maintained for future generations.
c. Natural resources on Earth can be renewed for future generations.

A. a
B. b
C. a and b
D. a, b and c

M 13. Here is a conservation account made by a conservationist group:

Community leaders and key informants were gathered in three communities in Mount Kitanglad Range Natural Park to develop a conservation plan to sustain the conservation of their forest. These communities live close to two eagle nesting sites within the protected area. Based on the extent of forest left within the protected area, we estimate that there are two more eagle territories that could be found.
Results of conservation planning revealed that the community preferred community-based ecotourism projects such as bird-watching and nature-trekking. Community reforestation was also prioritized. Focus groups identified poverty and the rapid increase of population as the ultimate drivers of forest degradation. However, they stressed that the issue can be mitigated by implementing alternative rural livelihood projects, including assistance with sustainable farming technologies and non-timber forest product (NTFP)-based enterprises such as handicraft-making and marketing (http://www.peregrinefund.org/projects/philippine-eagle).

What is the most basic principle why the Philippine eagle has to be conserved?

A. Its conservation will provide livelihood for the community.
B. It is the pride of the Filipinos being a well-known species.
C. It plays a very important role in maintaining balance in the forest ecosystem.
D. There are four nesting sites found in the community.

M 14. The loss of sharks could contribute to the destruction of one of the planet's most under-appreciated sources of carbon storage — seagrasses. While sharks are often sensationalized as voracious predators, it's their actual prey that poses a risk to seagrasses, according to FIU researchers.

"Seagrasses around the world are under considerable threat — from pollution to dredging and changes in water quality," said Mike Heithaus, interim dean of FIU's College of Arts & Sciences and a marine biology researcher who specializes in sharks. "Now, it appears that the loss of sharks, especially tiger sharks, can cause collapses of seagrass ecosystems as well."
As global efforts are under way to conserve sea turtles, shark populations are suffering from overfishing, which is creating an imbalance of the two animals in the world's oceans. The focus of the research is about sustaining the delicate food chain balance. In this case, sharks, turtles and seagrasses must all be preserved in concert. To not do so, could trigger an ecosystem collapse.
http://news.fiu.edu/2014/08/imbalance-of-sharks-and-sea-turtles-challenges-

Infer why the absence of sharks will cause ecosystem collapse?

A. In the absence of sharks the turtle population will increase which will result to the overgrazing of the sea grass.
B. The seagrass will grow abundantly causing algal bloom.
C. The sharks are source of food for the ecosystem.
D. The turtle population will decrease tremendously without shark meat.

T 15. You are an editor of a nationally circulated magazine. As a theme for the incoming issue, you want to highlight the work of budding writers related to biodiversity. Who among the contributors below will have a greater chance to have his work published in your magazine?

A. Basil elaborated on the passion of the Mangyans to own the land that they are tilling.
B. Czarina wrote on the success story of an Ifugao who finished college through a scholarship grant.
C. Prince wrote on how a Mangyan tribe in Mindoro successfully opposed loggers in their area.
D. Queenie expressed great satisfaction that the indigenous people in the locality received their landownership certificates.

T 16. As municipal agriculturist, you are faced with the option of choosing native species of cow over imported ones. The imported ones could provide the most amount of milk that your constituent needs. Which of the following will be your basis for your advice?

Key:
a. Imported breed provides greater profit
b. Native species do not need more antibiotics and expensive feeds to maintain.
c. Native species are more resistant to disease and pests.
d. Introduced species will compete with native species.

A. a and b
B. b and c
C. c and
D. b, c and d

T 17. The janitor fish has invaded the marshland of Agusan del Sur. From a pet shop commodity and as a cute little pet, it has somehow found its way to the marshland. From a point of view of an ecologist, predict the next event after the janitor fish is introduced to the marshland ecosystem.
A. Fish catch of fishermen will increase in the marshland.
B. Other native species will grow abundantly in the marshland together with the janitor fish.
C. The janitor fish will increase in population without a natural predator displacing native species.
D. The janitor fish will rid the marshland of pollutants making the ecosystem stable.

T 18. Read the following article:

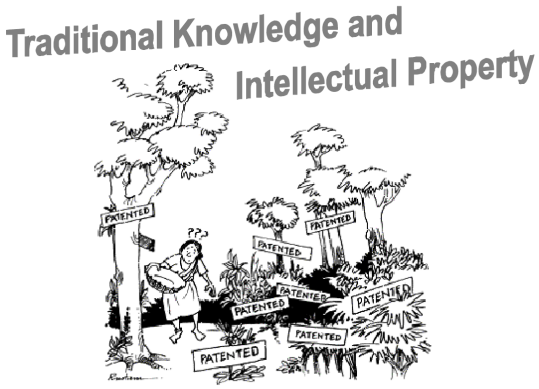
> The Philippine Eagle Foundation and The Peregrine Fund (TPF) with financial support from the "Wildlife Without Borders" program of the U.S. Fish and Wildlife Service, began the project "Philippine Eagle Conservation in Mindanao, Philippines" in 2012 with the goal to stop deforestation and eagle persecution in at least 21 Philippine Eagle nesting territories on Mindanao Island. This project operates under the umbrella of a National Species Action Plan that aims to defy the extinction of the Philippine Eagle, the country's national bird.
>
> If you were the director heading this conservation effort, which of the following will you ask your team to do?

Key:

a. community-based conservation
b. inform the international community of the aim of the project.
c. measuring the species' spatial requirements
d. public education
e. understanding their nesting habitat requirements

A. a and b
B. b and c
C. b, c and e
D. a, c, d and e

T 20. One concern of indigenous people at present is the ongoing patenting of local species and other resources as exemplified by the caricature below.



If you were to write an article on this concern, what would you write?

A. Encourage more patenting of local species.
B. Patenting of local flora and fauna will ensure the continuous income of the indigenous people.

C. The indigenous people will be free of the burden of caring for the environment and pass on the responsibility to the multinational industries who are more capable of caring for the environment.
D. The patenting of local flora and fauna by multinational industries may result to the loss of local biodiversity.

GLOSSARY OF TERMS USED IN THIS LESSON:

Biodiversity - variety of life within an area.

Biogeochemical cycle - movement of a chemical through the biological and geological living and nonliving parts of an ecosystem.

Carrying capacity - number of individuals that the resources of an environment can normally and persistently support.

Ecosystem - collection of organisms and nonliving things, such as climate, soil, water, and rocks, in an area.

Indigenous knowledge - traditional knowledge unique to a locality

Key stone species - organism that has an unusually large effect on its ecosystem.

Population - all of the individuals of a species that live in the same area.

REFERENCES AND WEBSITE LINKS USED IN THIS LESSON:

1. http://www.marbef.org/wiki/Disturbances,_biodiversity_changesand_ecosystem_stability
   This is a website on biodiversity.
2. http://books.google.com.ph/books?id=edTsIG--n5QC&pg=PA413&lpg=PA413&dq=honking+mess&source=bl&ots=hkbY6I7Dwh&sig=emov7aM0gLY5nsRUD17nMiBNeh&hl=en&output=html_text
   This is the link to the article, the Honking Mess.
3. http://www.youtube.com/watch?v=1CPlo9Ra2W0
   This is an Intro to Ecosystem
4. http://www.youtube.com/watch?v=NJplkrliUEg
   Ecological pyramids
5. http://www.youtube.com/watch?v=ScizkxMlEOM
   The transfer of energy- the 10% rule
6. https://www.youtube.com/watch?v=8qMgdEBNBOE
   Flow of Matter and Energy
7. http://www.nature.com/scitable/knowledge/library/biodiversity-and-ecosystem-stability-17059965
   Biodiversity
8. http://education-portal.com/academy/lesson/what-is-population-density-definition-lesson-quiz.html#lesson
   Population size and density
9. http://fpe.ph/indigenous-communities.html/view/where-are-indigenous-peoples-distributed-in-the-philippines
   Where are Indigenous Peoples Distributed in the Philippines?

10. http://www.jstor.org/discover/10.2307/4314060?sid=21106407508673&uid=3738824&uid=2&uid=4

Indigenous Knowledge System and Survival of the Indigenous Peoples in the Philippines

11. http://www.gov.mb.ca/conservation/sustain/carcap.pdf
Carrying Capacity Activity

12. http://education.seattlepi.com/factors-affect-carrying-capacity-environment-6190.html
What Factors Affect the Carrying Capacity of an Environment?

13. http://www.gov.mb.ca/conservation/sustain/carcap.pdf
Carrying capacity Activity

14. http://education.seattlepi.com/factors-affect-carrying-capacity-environment-6190.html
What Factors Affect the Carrying Capacity of an Environment?

15. http://easyscienceforkids.com/ecosystems-quiz-fun-free-interactive-general-knowledge-quiz-for-kids/
Online Quiz

16. http://www.voki.com/ Voki website