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

DepED
DEPARTMENT OF EDUCATION

2017

LEARNING MODULE

Science G9| Q1

Respiratory and Circulatory Systems Working With The Other Organ Systems

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

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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 9

Module No.1: Respiratory And Circulatory Systems Working With The Other Organ Systems

Lesson1: Respiratory and Circulatory Systems Working with the Organ Systems

Introduction and Focus Questions

http://2.bp.blogspot.com/-Lt0H2v5j-BM/Tx--jnyOkcI/AAAAAAAAIdA/PSzPYc31wVk/s1600/RomiGarduce_Everest.jpg

Romi Garduce is the first and only Filipino to have scaled the famous *Seven Summits* or the seven highest peaks in each of the seven continents. Of course, one of these is the world-famous Mount Everest. It took Romi 2 months to finally take a selfie as he waved the Philippine flag on the peak of Mount Everest, literally, the top of the world.

In many of his photos as he neared the summit, one can see that he and his group used oxygen masks connected to the oxygen tanks that they carried. According to experts, the air is so thin at 31,000 feet. *This is the same altitude shared by most commercial flights while on a cruise mode.* In such conditions, breathing becomes difficult because the amount of oxygen is dramatically low compared to that at sea level. Every cell in the body requires oxygen to function properly. Have you ever wondered how oxygen from outside the body finds its way to each one of our cells?

In this module, you will find out how oxygen, just like every other nutrient, is delivered to each cell in the body. Remember to search for the answer to the following question: **How can nutrients flow well in our body?**

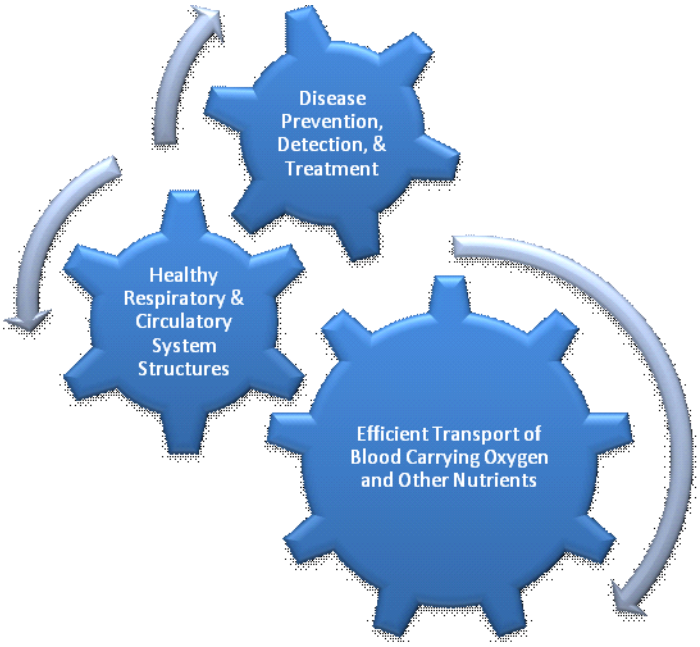
MODULE COVERAGE:

In this module, you will go through the following lesson:

Lesson No.	Title	You'll learn to…	Estimated Time
Lesson 1	Respiratory and Circulatory Systems Working with the Other Organ Systems	• Identify the different structures of the circulatory and respiratory systems that work together to transport oxygen-rich blood and nutrients to the different parts of the body. • Identify measures that lead to prevention, detection, and treatment of diseases affecting the circulatory and respiratory systems. • Conduct an information dissemination activity on effective ways of taking care of the respiratory and circulatory systems based on the data gathered from school or local health workers.	15 hrs.

Concept Map of the Module

Here is a simple map of the lessons you will cover in this module:



Expected Skills

To do well in this module, 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.

1. Determine the compound that leaves the cells as a waste product of respiration which then joins the bloodstream.
    a. ammonia.
    b. carbon dioxide.
    c. carbon monoxide.
    d. hydrogen chloride.

2. When the diaphragm relaxes, it pushes up on the lungs and
    a. drives CO_2 out of the body.
    b. enhances movement of O_2.
    c. facilitates lung expansion.
    d. slows down blood flow.

3. Almost all substances found in our bodies dissolve in water. This is the reason why _____ is comprised mostly of water.
    a. blood
    b. cholesterol
    c. fat
    d. sap

4. A regular intake of fatty foods leads to fat deposition in our blood vessels. What is the likely effect of such a diet in our circulatory system?
    a. Fat allows blood to easily slide on it which facilitates blood flow.
    b. Low blood pressure can be expected because of the interaction between blood and fat.
    c. High blood pressure results from the faster movement of blood caused by fat deposits.
    d. The diameter of the blood vessel becomes smaller and makes blood flow difficult.

5. Your biology teacher said that carbonic acid forms in the blood if present in excessive amounts. In a classroom activity prepared by your teacher, you were asked to do deep breathing exercises. As you exhale,
    a. accumulated CO_2 in the alveoli are moved out of the body.
    b. accumulated O_2 outside the alveoli are moved out of the body.

c. only through photosynthesis will we be able to get the needed CO_2.
d. only through the thylakoid membrane will we be able to get the needed CO_2.

6. Basti will be joining a 10-kilometer fun run. He finds it challenging not just because of the distance but also because of the chosen terrain. Most participants will find it even more challenging if they do not have much physical activity because
   a. blood flow is slowed by poorly warmed up muscle groups in the arms.
   b. gas exchange does not occur in their respiratory system.
   c. their ability to warm up is less than the other runners.
   d. they have low endurance and would easily tire.

7. A handful of cities in the Philippines have effectively banned smoking in public. Health experts have repeatedly emphasized that cigarette smoking directly harms the respiratory system in many ways which include
   a. increasing the flow of CO_2 towards the lungs.
   b. making the airways smaller and irritated (*as seen in coughing*)
   c. slowing the flow of phlegm from the larynx to the bronchi.
   d. transferring beneficial nutrients from the body to the cigarette smoke.

8. Your science teacher made you watch a video animation of the circulatory system of a long-time smoker. The video did not have audio as well as subtitles. From what you know in other videos of the circulatory system, blood was represented using red or blue colors depending on where it is found. For this particular video, blood entering and leaving the lungs was blue. You know that oxygen turns blood into a bright red color. From this fact, one can infer that
   a. blood can now be pumped faster around the body.
   b. oxygen will be replenished if blood is pumped to the lungs.*
   c. there is more oxygen in the right atrium.
   d. this will not lead to yawning because of the amount of oxygen still present.

9. In the past, city dwellers who have visited Benguet province would always talk about what they consider as “fresh air” in the said mountain province. From this, one can infer that
   a. higher altitudes would have more oxygen.
   b. less people compete for air that is beneficial to our blood.
   c. the quality of the respiratory system has effects on our own health.
   d. there are people who equate cold climate with fresh air.

10. My mother is known in our village for growing very beautiful flowers in our garden. I would normally see her in the morning “talking” to the flowers as if she was talking to her friends. Some plant lovers “talk” to their plants and claim that it makes their plants healthier. If their plants appear healthy, the most logical reason for this would be that

a. a person talking to plants would be better off talking to other people.
b. as the person speaks, CO_2 needed by plants is released.
c. pests can be removed by the person to keep the plant healthy.
d. talking to plants removes stress and promotes its growth.

11. Climbing Mt. Everest is no easy feat, not only is it the highest peak in the world, but the challenge becomes even greater because of interplay among factors found in the region. One of these is the high altitude which results to thinner air. The lack of oxygen in such conditions leads to
    a. decreased energy production in the mitochondria.
    b. elevated levels of oxygen in the matrix of the mitochondria.
    c. increased levels of carbon dioxide produced during respiration.
    d. limited diffusion of water is expected in the thylakoid.

12. In the final question of the Inter-school science quiz bee that you were part of, it focused on the efficient transport of substances in the body. You knew that it depended on the condition of the respiratory and circulatory systems. The instruction of the quiz master was to choose among the following statements the one which was incorrect. Going over the statements again, you should choose
    a. Asthma patients are given O_2 in the hospital because narrowed airways conduct air poorly.
    b. Boys who smoke are less prone to lung problems because they are physiologically stronger than girls.*
    c. Doctors would give diuretics to a hypertensive patient because frequent urination can lower blood pressure.
    d. For every instance that a person coughs, this is an assurance that the respiratory system is still functioning normally.

13. Your father is a pulmonologist, a doctor who specializes in lung conditions. You got to see him treat one patient in the clinic who seemed so sickly and was always coughing. His skin did not have that healthy color that you normally see in others. Your father said that he had COPD (Chronic Obstructive Pulmonary Disease); he was having difficulty breathing when he is not coughing. Gas exchange in the lungs can be affected by the following except
    a. ability of the lungs/alveoli to expand.
    b. concentration of gases between the alveoli and capillaries.
    c. number of normally functioning alveoli.
    d. production of mucus in the walls of the bronchi.*

14. My grandmother would have a purplish color when she's having a severe asthma attack. Her normal color would be back once she has been given proper medical attention that would enlarge her airways. This could mean that
    a. doctors can fix skin color and return it to normal.

b. such a condition facilitates delivery of oxygen to the body.
c. the blocked airways are caused by phlegm.
d. the presence of oxygen is responsible for the normal body color.

15. Yosi Kadiri was a mascot created by the Department of Health years ago for a campaign against cigarette smoking. Your batch has been assigned to raise awareness on healthy practices for the respiratory system to grade 1 students in your school for the Science week. Unfortunately, the nearby health office has run out of Yosi Kadiri materials that you could use for your assigned task. What could be your best option?
    a. draw different versions of Yosi Kadiri for the kids.
    b. give flyers that show the parts of the respiratory system.
    c. perform a skit where Yosi Kadiri gets kicked out of a community.*
    d. show a poster of a cigarette with all the chemicals it contains.

16. Your PE teachers record how many rounds students can do in a 12-minute run around the soccer field. The following can encourage other students to perform healthy practices for the respiratory system except
    a. post pictures of those with the best records in the school bulletin board
    b. present graphs on how each class fared compared to others and have some healthy competition
    c. propose to the PE department head incentives for classes who show marked improvements after a month
    d. record videos of the sickly participants as they run around the field

17. The heart is the major organ of the circulatory system; proper exercise done regularly will keep it strong and healthy. If you were to do a survey in school, most of them are likely to tell you the following reasons why they don't do exercise except for
    a. it would be the muscles that benefit from exercise and not the heart.
    b. exercise is required only for athletes.
    c. teenagers don't need to do exercise yet as they are still healthy.
    d. they are too busy and don't have time for exercise.

18. Zamboanga City has tricycles as the main mode of transport within the city. According to the local health worker, there is still a rise in respiratory cases in the city specially among children up to age 16 even though a smoking ban has been implemented the past 2 years. As a student, what can you do to verify the information from the local health worker?
    a. conduct a survey as to how many respondents would cover their nose when on the road
    b. go to every classroom and ask how many are cigarette smokers
    c. make and distribute flyers containing information on the harmful emissions of tricycles
    d. prepare a video clip clearly explaining the effects of tricycle emissions to our respiratory systems

19. A new and fatal medical condition was introduced by the Department of Health because of the nearing Christmas season; it has been dubbed “Holiday Heart Syndrome.” The condition is said to be predominant among the young adults up to those who are still at a working age. You have not heard of this condition. Your teacher asked you to infer what might be involved in it through the use of a collage. He will look for the following pictures as he assesses your work in terms of content except for
    a. cross-section diagram of the heart.
    b. lack of sleep.
    c. partying.
    d. unhealthy diet.

20. Aerobic exercises are those done continuously for at least 30 minutes. These strengthen the heart and allow it to have stronger and more efficient contractions. Such exercises also allow the body to obtain more oxygen for the body. The following statements are false except
    a. aerobic exercises can easily tire out the heart muscles and lead to tissue death.
    b. blood stays longer in the lungs to obtain oxygen because of the strong heart contractions.
    c. efficient carbon dioxide disposal can be achieved through short burst exercises.
    d. the availability of more oxygen will lead to more efficient glucose breakdown for respiration.

EXPLORE

http://www.globaltimes.cn/Portals/0/attachment/2011/49ce8f7c-7da3-4641-8443-f7fb234b6f53.jpeg

Have you heard of CPR?
If not, it stands for **C**ardio**P**ulmonary **R**esuscitation. It is an emergency technique that has been developed to allow trained individuals to revive patients or victims who are close to dying or have lost consciousness. This technique zeroes in on "bringing back to life" the heart and the lungs; the Latin word *cardio* refers to the heart, while *pulmo* refers to the lungs. The fact that these two organs had to be revived would indicate that they perform vital roles for us.Do they need to work together that's why they should be revived simultaneously? The heart pumps blood throughout the body, while the lungs are in charge of getting gases like oxygen and carbon dioxide moving in and out of our bodies. Why is it important to continuously receive oxygen? Why must blood be pumped nonstop in our bodies? **How can nutrients flow well in the body?**

ACTIVITY 1: VIDEO VIEWING

Follow this link: http://video.about.com/firstaid/How-to-Perform-Hands-Only-CPR.htm in order to have a better idea of what CPR is about and how it can turn around potentially life-threatening situations.

Process Questions:

1. What ideas on CPR did you learn after watching this video?
2. **How can CPR help in making nutrients flow well in the body?**

ACTIVITY 2: VIDEO ANALYSIS

Mr. Bean is known for his hilarious antics. In the video that you are about to watch, pay close attention as he tries to revive the man who just suffered a heart attack. Click on the link below to view the video:

http://vimeo.com/65441617 - Mr. Bean's Attempt to Provide CPR

Process Questions:

1. Every Mr. Bean episode is expected to be comical; in relation to CPR, what made this particular episode funny?
2. **How can CPR ensure nutrients to flow well in the body?**

ACTIVITY 3: ELICITING PRIOR KNOWLEDGE THROUGH I-R-F CHART

What were your initial answers to the questions posed in the previous activity, **How can nutrients flow well in our body?**

Summarize your answers to the question, and your thoughts and ideas in the first column of the IRF Chart. When you are finished, click on "Submit."

HOW CAN NUTRIENTS FLOW WELL IN OUR BODY?		
Initial	**R**evised	**F**inal

End of Explore

You just tried finding out how the respiratory and circulatory 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 care for the heart and lungs.

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

FIRM-UP

Let's continue this module by gathering your thoughts about the processes involved in the circulatory and respiratory systems. Your goal in this section is to learn and understand the efficient transport of blood carrying oxygen and other nutrients. You will determine and relate the different factors that are at work during their formation.

ACTIVITY 4: WEBPAGE READING

Read the articles below by following the links provided. These articles present in a student-friendly way how the heart and lungs perform their lead roles for the circulatory and respiratory systems, respectively.

http://kidshealth.org/teen/your_body/body_basics/heart.html# - What the Heart & Circulatory System Do

http://kidshealth.org/teen/your_body/body_basics/heart.html# - *Lungs and Respiratory System: What They Do*

Process Questions:

1. Why is it important that the heart and lungs are kept healthy?

2. Do you think the heart and lungs should work together when they perform their functions? Why?
3. ***How can nutrients flow well in the body?***

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 5: VIDEO VIEWING

You now know that the heart and lungs need to work together to distribute vital materials to the body. Learn more about the heart and the lungs and the rest of the system by viewing the videos found in the following links:

http://www.teachertube.com/viewVideo.php?video_id=256514 – Respiratory System (*starting at 4:50 mark*)

http://sumanasinc.com/webcontent/animations/content/humanheart.html - Blood Flow through the Human Heart

Process Questions:
1. What are the two types of circulation? Differentiate the two according to purpose.
2. Describe how oxygen gets distributed to the cells of the body.
3. Describe how nutrients get distributed to the cells of the body. Is there any difference between how oxygen and nutrients are distributed? Explain.

ACTIVITY 6: ONLINE QUIZ (Formative Assessment - *K*)

Review the terms and concepts learned in the previous activity by taking the online quiz found in the link below.

http://kidshealth.org/kid/htbw/CSquiz.html - Online Quiz on the Circulatory System

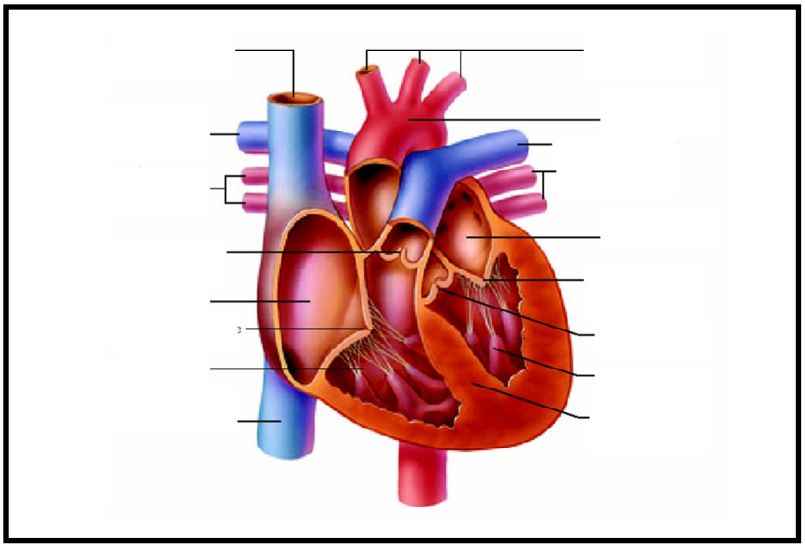
http://kidshealth.org/kid/htbw/RSquiz.html - Online Quiz on the Respiratory System

How did you perform in the quiz? Look at the items you missed. Go back to your notes and review the terms or concepts you missed.

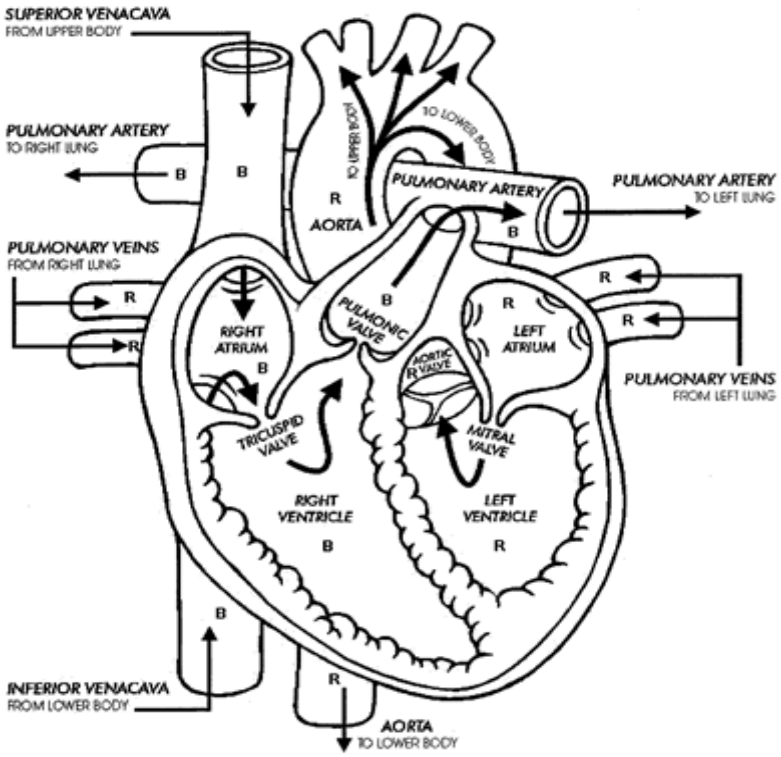
ACTIVITY 7: FLOW DIAGRAM

Summarize what you learned so far by tracing the path of blood from the heart to the lungs to the rest of the body.

Use the space provided below:



Answer Key:



ACTIVITY 8: REVISING PRIOR KNOWLEDGE THROUGH I-R-F CHART

Go back to the question: **How can nutrients flow well in the body?**

Write your revised answers to this question in the R column of the IRF chart. When you are finished, click on "Submit."

HOW CAN NUTRIENTS FLOW WELL IN OUR BODY?		
Initial	**Revised**	**F**inal

End of Firm-Up

In this section, the discussion was all about the processes involved as the respiratory and circulatory systems perform their functions.

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.

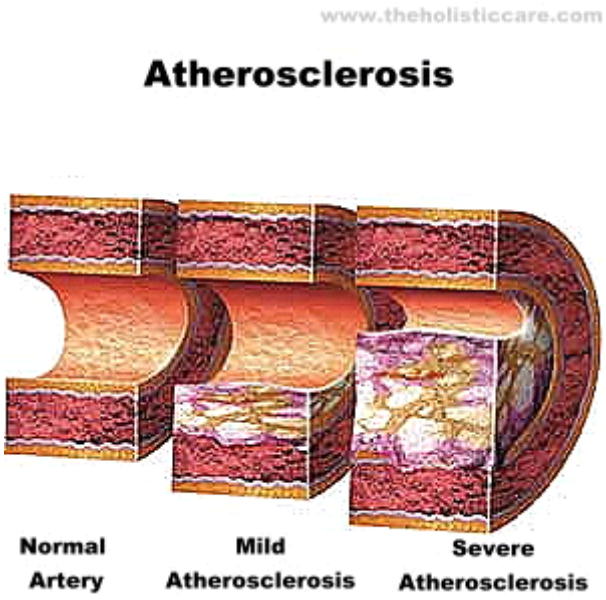
DEEPEN

Cardiovascular disease (CVD, or heart-related condition) is said to be the number one cause of death among Filipinos. Closely coming in at second is smoking. Do you know someone who may have a heart condition, hypertension, or a health concern related to the circulatory or respiratory system? The statistics provided by the Department of Health (DOH) as well as the World Health Organization (WHO) show that 30% of deaths in the country are due to a combination of heart and lung conditions. This is definitely a growing concern in the country as the number of Filipinos with such health issues continues to grow and affect even the younger members of the population. With the serious consequences that it can bring, have you paid attention to how such conditions develop? Have you considered the likelihood that you and your family can be predisposed to it? Have you ever thought of finding a way to avoid these health problems?
Your goal in this section is to take a closer look at formation and development of these conditions. You will determine and relate the different factors that are at work during their formation.

ACTIVITY 9: PICTURE ANALYSIS

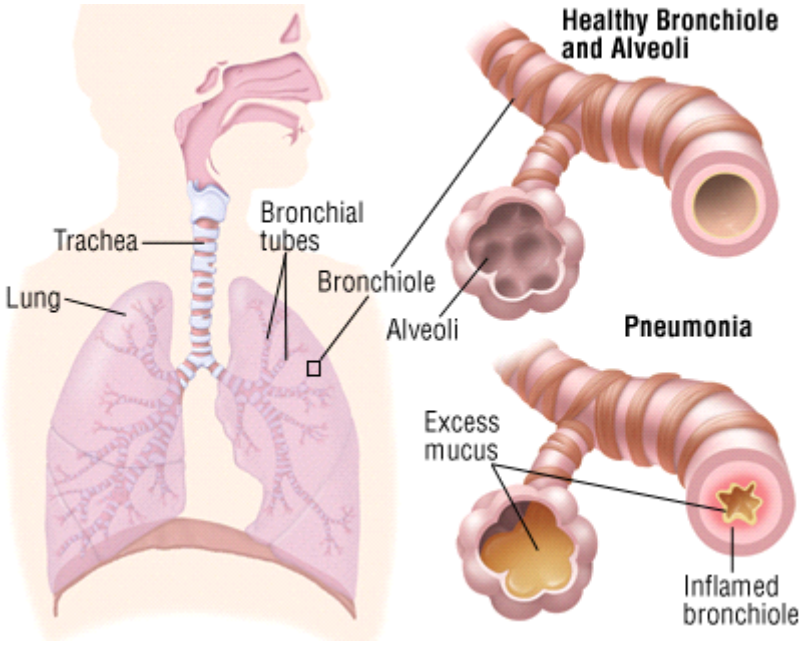
Using the pictures found below, infer the likely consequences of these sample circulatory and respiratory conditions.

A. Atherosclerosis – build up of plaque inside the blood vessels



http://www.pharmafoodsprofessional.com.au/assets/images/Atherosclerosis.jpg

B. Bronchitis – involves swelling of bronchioles as well as mucus build up in the alveoli



http://medimoon.com/wp-content/uploads/2012/09/Pneumonia1.jpg

ACTIVITY 10: VIDEO VIEWING: TREATMENT OF A CIRCULATORY CONDITION

Click on the following links below to get an idea of the treatment that is carried out in blood vessels that are partially or fully blocked by plaques or blood clots.

http://www.youtube.com/watch?v=xY60G6_tRM4 – Balloon Angioplasty and Heart Disease: Demo Using Balloons

http://www.youtube.com/watch?v=N7nghr9TpSU – Coronary Artery Angioplasty

After viewing these videos, try to provide answers to the process questions below:

1. How can the procedure remedy the problem of blocked blood vessels?
2. Why must certain patients with circulatory conditions undergo angioplasty?
3. **How can nutrient-carrying blood circulate well in the body?**

ACTIVITY 11: VIDEO VIEWING OF SMOKING-INDUCED PNEUMONIA

After viewing this video, you will use a graphic organizer to show your understanding of how certain respiratory conditions caused by smoking may affect gas exchange.

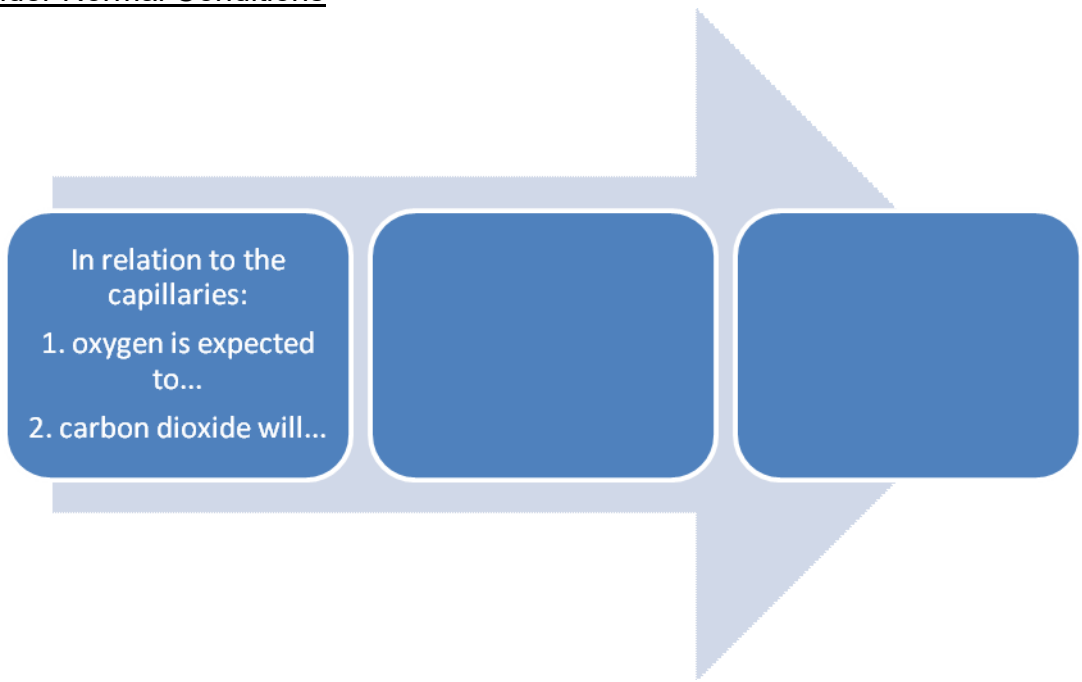
Click on the link below to watch the video:
http://www.youtube.com/watch?v=aKduNgfePLU – Smoking-Induced Pneumonia

After watching, try to find the answers to the following questions:

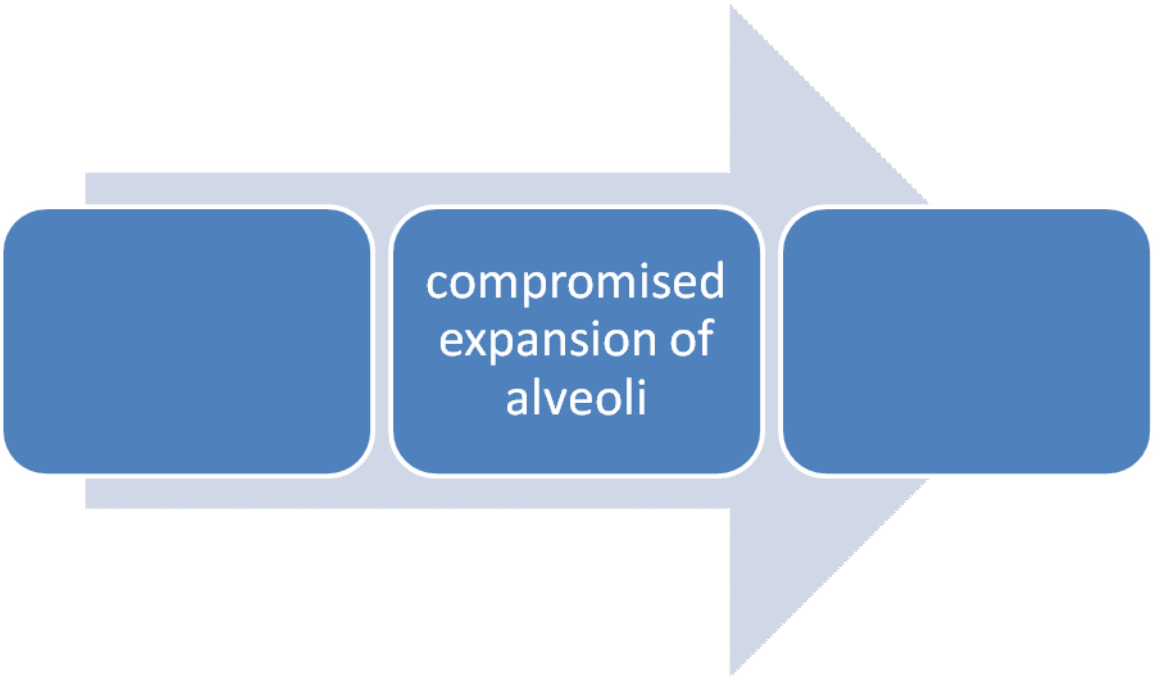
1. How would you describe pneumonia?
2. How does it affect the gases present in the lungs?
3. **What might disrupt the free flow of substances, like oxygen and carbon dioxide, in the body? Discuss.**

Using the flow diagrams or sequence charts below, show the sequence of events involved in gas exchange in conjunction with the flow of blood into and out of the heart during normal conditions and when there is a respiratory/circulatory condition.

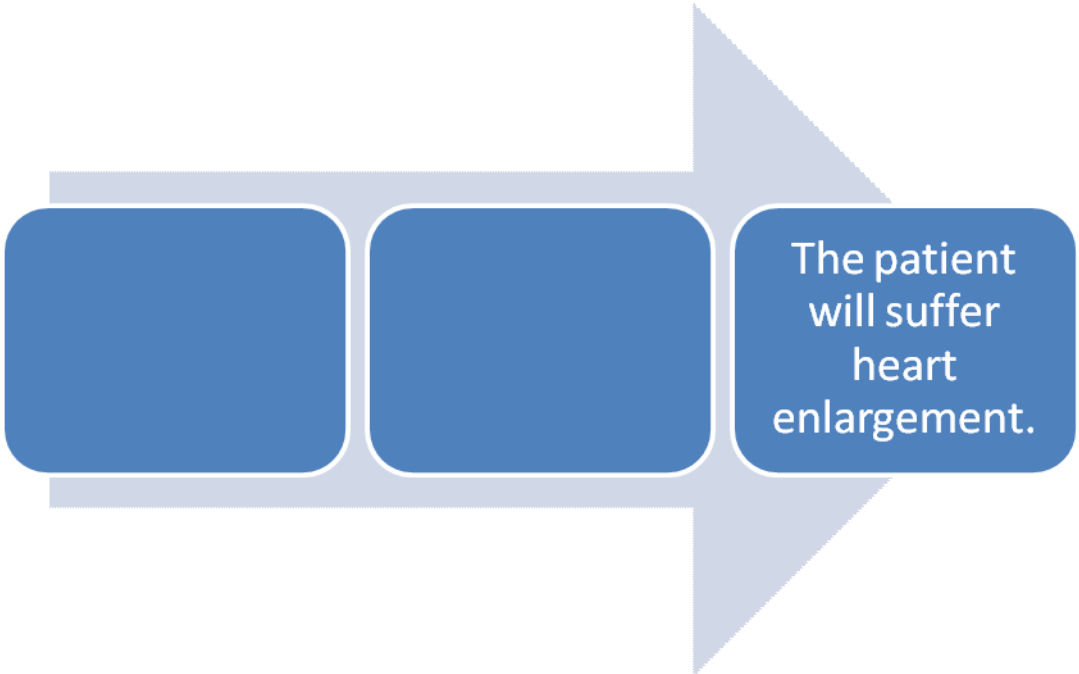
Under Normal Conditions



With Pneumonia



With Atherosclerosis



Exercise 1

Obtain the respiratory and pulse rates of your batch mates after jogging around the football field for 10 minutes, tabulate and make a graph of the data. Give your observations regarding the relationship of these data.

Rubric scoring guide for Exercise 1
3 pts: Data was plotted using the appropriate graph and the written observation was clear and correct.
2 pts: Data was plotted using the appropriate graph; the written observation was incorrect.
1 pt: Data was plotted using the appropriate graph, no observation given.
0 pt: Data was plotted using the wrong graph and no observation was given.

Exercise 2

Consider the following before proceeding to making a concept map:

A. Photosynthetic organisms are responsible for the 21% of O_2 in the atmosphere. O_2 comes as a waste product in the food-making process of these organisms. Cities with poor environmental conservation programs have been reported to have high incidences of respiratory patients in the last 2 decades. It was common to hear about patients with asthma or hypoxia.
B. The doctor who visited our school mentioned in his talk about the condition called *hypoxia.* According to him, poorly functioning hearts lead to such a condition where there is a lack of O_2 in the tissues. *What is the most likely diagnosis?*
C. In a role play activity that you did in class, your classmates who acted as certain molecules were shown to move from areas of high concentration to areas where there is less of it. You were told that oxygen and carbon dioxide undergo similar movements in our tissues.

Construct a concept map showing the relationship among the following concepts: *blood, air, respiration, heart, oxygen, and carbon dioxide.*

How can nutrients flow well in the body?

Rubric scoring guide for Exercise 2
3 pts: Generalization about the different cases was correct; justification of concept relationships is clearly shown by using the appropriate linking words.
2 pts: Generalization about the different cases was correct; justification of concept relationships not clearly shown because of linking words used.

1 pt: Generalization was correct; justification of concept relationships not shown because of inappropriate linking words used.
0 pt: No generalization was made; no justification of concept relationships was made.

ACTIVITY 12: MAKE YOUR OWN COMIC STRIP

Learn about how we can control and prevent respiratory diseases. Read the article by clicking on this link:

http://www.gmanetwork.com/news/story/285476/publicaffairs/pinoymd/the-truth-about-asthma-no-cure-but-can-be-controlled - Article on Asthma

Process Questions:
1. Can asthma be cured? Why or why not?
2. Can it be controlled? How?

Create a comic strip about how asthma can be controlled.

1.

ACTIVITY 13: WEBPAGE READING: *Exercise is not Always Good.*

People have the tendency to join the bandwagon, whether it's cellular phones, social networking sites, food supplements, or even the choice of a college program. This does not exclude even joining fun runs or doing exercises. It's not unusual to see people - specially the elderly - pushing themselves to do strenuous exercises, which could unfortunately, do more harm to their bodies than good. *Why is this so?* The reason for this is that we have always associated exercise with healthy living.

Go to the following links to discover how exercise can possibly have adverse effects on some people.
http://www.nlm.nih.gov/medlineplus/ency/patientinstructions/000094.htm - Being Active When You Have Heart Disease

http://www.dailymail.co.uk/health/article-2262441/Exercise-Yes-CAN-fit-good-Why-exercise-harmful-heart.html - Yes, You Can Be Too Fit For Your Own Good: Why Exercise May Be Harmful to the Heart

Process Questions:
1. Did the idea of exercise being harmful to your health ever cross your mind? How did you look at exercise prior to reading this
2. article?

2. **How can improper exercise prevent nutrients from flowing well in the body?**

End of Deepen

In this section, the discussion was about the consequences of unhealthy circulatory and respiratory system, and how these can be cured or prevented.

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 14: STRENGTHENING NEW KNOWLEDGE THROUGH I-R-F CHART

Go back to the question: **How can nutrients flow well in the body?**

Write your final answers to this question in the F column of the IRF chart. When you are finished, click on “Submit.”

HOW CAN NUTRIENTS FLOW WELL IN OUR BODY?		
Initial	**R**evised	**Final**

ACTIVITY 15: TRANSFER TASK: *BE CAREFUL WITH YOUR HEART*

TASK

This coming February, it will again be the celebration of the global "*Heart Month.*" In line with this together with your barangay's thrust for a better health program, you have been tasked to encourage members of the school community to take care of their health, in particular, that of the heart and organs closely associated to it. With the theme: "*The Restless Heart, No Rest Since Birth,*" you will make a PowerPoint presentation which you will use as you do your room to room visit within the school. Your presentation will be evaluated based on content, organization, graphics or animations used, and clarity.

RUBRIC FOR TRANSFER TASK

STANDARDS SCALE → ↓	Content	Organization	Appropriateness of Graphics or animations used	Clarity
Outstanding 4	Provides exhaustive and reliable background information about the topic; Information provided is clearly relevant to the objective of the presentation	Details of the presentation are placed in a logical and interesting order and it effectively keeps the interest of the audience.	Graphics or slide transitions used are not only appropriate to the target audience, but also effectively kept the interest of the audience.	Followed the direction of using only a maximum of 15 slides; slides are not cluttered with information (*maximum of 8 lines per slide*).
Satisfactory 3	Provides accurate background information; Information provided is related to the objective of the presentation	Details are placed in a logical order, thereby helping the audience understand the presentation without difficulty.	Graphics/animations used are appropriate to the target audience.	Followed the direction of using only a maximum of 15 slides; slides are not cluttered with information (*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.	Some graphics/animations used are inappropriate to the target audience which can also lead to confusion and inattentiveness.	Some slides are cluttered with text (*10 lines or more*), number of slides used exceeded 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.	No graphics or animations were used in the presentation.	Slides were cluttered with text which led to audience losing interest in the presentation.

End of Transfer

How did you find the performance task? How did the task help you see the real world use of the topic? Write a **reflective journal** of your experiences and the things you learned about the task.

You have completed this lesson. Before you go to the next lesson, you have to answer the following post-assessment questions.

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.

1. The _____ of red blood cells allows the transport of carbon dioxide and oxygen.
    a. hemoglobin
    b. shape
    c. size
    d. number

2. The very thin walls of the _____ allow gas exchange from the alveoli of the lungs with the blood.
    a. arterioles
    b. capillaries
    c. veins
    d. vena cava

3. Whenever we _____, this would _____ the concentration of oxygen and allow it to diffuse into the blood.
    a. exhale; increase
    b. exhale; decrease
    c. inhale; decrease
    d. inhale; increase

4. Bear Grylls of the tv show Man Vs. Wild used to be a member of the British Royal Army. In one episode, he took his pulse rate and it registered at 50 beats per minute. When you heard this, you curiously took your own pulse rate and found it to be at 77 beats per minute. What is probably the best explanation for this?
    a. A bigger heart requires fewer contractions per minute because of thicker cardiac muscles.
    b. An efficiently-working heart does not need to contract as much as those that are not well-conditioned.
    c. The younger a person is, the higher the pulse rate that can be expected.
    d. TV show hosts are subjected to a lot of lighting which lowers their pulse rates.

5. Your teacher gave you a webpage reading activity about the small intestine. You learned that most of the digestion and absorption takes place in that section of the digestive tract. It is in the small intestine where food stays the longest to maximize both digestion and absorption. Some people who have a high-meat diet are likely to develop small intestines that perform poorly and eventually lack nourishment. For someone like you with no digestive health issues, what might be the likely explanation as to how the needed nutrients reach the rest of the body?
    a. digestion of these nutrients takes place where it is needed
    b. each cell can manufacture the needed nutrients and transport these to nearby tissues
    c. nutrients are brought into the tissues by specialized white blood cells
    d. there are blood vessels adjacent to the small intestine to carry the nutrients

6. Methane is continuously made in the Payatas dumpsite because of the non-stop burning of garbage. Among those who scavenged in the area, what might be the most likely medical condition that they could suffer from?
    a. dehydration from too much garbage smoke
    b. diarrhea or other intestinal problems
    c. respiratory conditions like asthma
    d. scratches and bruises

7. Triathletes could run, swim, and bike for hours during competitions. To succeed in such athletic events, one has to do the following except
    a. abdominal muscle strengthening.
    b. breathing exercises.
    c. high repetition exercises.
    d. low intensity exercises.

8. In our hometown in Bulacan, it is common for us to eat chicharon (pork cracklings) and serve the same to our guests during the town fiesta when there is partying and drinking. What might be the common emergency medical incidences in our town specially during such occasions?
    a. constipation
    b. hypertension (high blood pressure)
    c. hypotension (low blood pressure)
    d. lack of sleep

9. Glucose is the sugar that is found in the blood when not stored in the liver. It is the same sugar monitored by those with diabetes because of possible health consequences. One example would be sluggish blood flow because blood “thickens” with elevated glucose levels. What can be expected of one’s blood pressure in such conditions?
    a. Blood pressure will be elevated.
    b. Blood pressure will become lower.

c. Blood pressure will remain the same.
d. Blood pressure will retain glucose levels.

10. Tetralogy of Fallot is a heart condition in newborns wherein a natural hole between the ventricles did not get plugged before they were born. If the condition is not treated, the likelihood of dying early is great. One of the signs easily noticeable with these infants would be a bluish tinge on their skin because
    a. high concentrations of oxygen are found in the heart.
    b. lung function is made inefficient by the hole in the heart.
    c. oxygen is not efficiently delivered to the tissues.
    d. the hole in the heart makes it difficult for the heart to pump blood.

11. Sometimes blood can have too much acid if there are high concentrations of carbon dioxide as this could form carbonic acid. Such conditions would therefore require the following except
    a. a mechanism that prevents accumulation of CO_2 in the blood.
    b. an efficient functioning of obtaining O_2.
    c. more red blood cells to carry CO_2 to the lungs.
    d. training in high altitude locations for thinner air.

12. You have heard of *metabolism* in the past. Your teacher clearly explained that this complex chemical reaction in the body is what allows you to keep a healthy body and do your daily routines. If _____ is present, our bodies are able to make more _____ molecules. An alternative energy-making pathway - *though less efficient* – is glycolysis.
    a. ADP; O_2
    b. CO_2; glucose
    c. glucose; O_2
    d. O_2; ATP

13. Utah is a city that has a very high elevation above the sea compared to other American cities. Why should it not be surprising to see visiting athletes using oxygen tanks during NBA games?
    a. A lot of them find it hard to breathe in very crowded stadiums.
    b. There is lack of O_2, therefore, harder to make energy.
    c. They are not used to the cold climate in Utah.
    d. They train in elevated cities that are not cold.

14. Gas exchange or internal respiration is dependent on the following except
    a. gas concentration differences between the blood and lungs.
    b. elasticity of the walls of the alveoli.
    c. excessive mucus production to diffuse gases.
    d. proper breathing exercises.

15. This February will be the celebration of "*Heart Month*." In line with this, a competition will be held to choose which flyer can be given away to parents in your school based on entries made by grade 9 students. You would keep in mind to have the following in your brochure except for
    a. a simplified diagram of the heart when one leads an unhealthy lifestyle.
    b. blood flow from the heart to the lungs showing gas exchange.
    c. diet that is appropriate for one's age and lifestyle.
    d. table of activities and diet and how each can be good for the heart.

16. Your track and field teammate told you that he has been asked by the coach to join the 10K run instead of the 100-meter dash. These are totally different events even though they both involve running. Because of these differences, different trainings can also be expected. These differences will not include the following except
    a. deep breathing exercises.
    b. short burst running.
    c. strengthening of shoulder muscles.
    d. taking of medications that narrow the airways.

17. You are the only one in your house who is not into cigarette smoking. After you were given time to research about second hand smoking, your teacher asked you to prepare a short report as to why you are also in danger of having respiratory problems even though you don't smoke. Your report is likely to include the following except for
    a. age of those who smoke in your family.
    b. harmful chemicals found in cigarettes.
    c. how the airways react to cigarette smoke.
    d. why people cough upon inhaling smoke.

18. My older brother has hypertension. He believes that getting into sports would improve his condition. From what you have learned from your Biology and PE classes, you could suggest the following to be helpful activities except for
    a. biking.
    b. jogging.
    c. swimming.
    d. table tennis.

19. Many people flock to the hot spring swimming pools of Los Banos especially during the Christmas break. They believe these waters have therapeutic effects for those with health issues. From what you have learned in class, those with hypertension should be careful because
    a. blood vessels tend to expand in warm water which abruptly lowers blood pressure.
    b. blood with oxygen cannot diffuse into the lungs when the body is submerged in warm water.
    c. the excitement in swimming pools might overwork the heart.

d. warm waters can further elevate their already high blood pressure.

20. Prolonged exposure to the sun during relief and rescue operations in Tacloban led to the hospitalization of some volunteer relief workers because
    a. it might have elevated one's temperature and blood pressure.
    b. it might have led to skin cancer for those with small amounts of melanin in the skin.
    c. too much heat can cause a person to overhydrate and kill cells because of hypertonicity.
    d. UV radiation is known to affect DNA and cause weakness.

GLOSSARY OF TERMS USED IN THIS LESSON:

alveoli – air sacs found at the end of bronchioles, site of gas exchange

aortic valve – flap of tissue found in the aorta, prevents blood from returning to the left ventricle

arteries – blood vessels that carry blood away from the heart

asthma– constricted/narrowed airways caused by allergens or physical activity

atherosclerosis – a condition where plaque deposits result to narrowed blood vessels, usually associated with hypertension

atria – upper chambers of the heart that receive blood from the systemic or pulmonary circulation, divided into right and left halves

bronchi – major airways that branch from the trachea to the left and right lungs

capillaries – smallest blood vessels which allow gas exchange or diffusion of nutrients/wastes into and out of the tissues
cardiopulmonary resuscitation (CPR) – an emergency medical procedure meant to allow the heart and the lungs to function properly through chest compressions

chronic bronchitis –a lung condition characterized by difficulty in breathing due to excessive mucus production

hypertension – also known as high blood pressure, pertains to blood pressure with a value higher than 135/85 mmHg

pneumonia – a lung condition wherein the alveoli are filled with fluid which leads to poor gas exchange

pulmonary circulation – movement of oxygen-poor blood from the right ventricle for oxygenation in the lungs then returned to the left atrium

pulmonary valve – prevents blood pumped by the right ventricle from returning as it moves towards the lungs

semilunar valve – separates the left atrium from the left ventricle, ensures that blood will not return to the right atrium once in the left ventricle

systemic circulation – movement of oxygen-rich blood that will be delivered from the left ventricle to the rest of the body then returned to the right atrium

trachea – cartilaginous tube that serves as the airway connecting the nose and mouth with the bronchi, also known as windpipe

tricuspid valve – flap of tissue preventing blood from the right ventricle from going back to the right atrium

veins – blood vessels that carry blood towards the heart

ventricles – lower chambers of the heart that receive blood from their corresponding atria; the left is bigger and thicker compared to the right half

REFERENCES AND WEBSITE LINKS USED IN THIS LESSON:

http://2.bp.blogspot.com/-Lt0H2v5j-BM/Tx--jnyOkcI/AAAAAAAAIdA/PSzPYc31wVk/s1600/RomiGarduce_Everest.jpg - RomiGarduce in Mt. Everest

http://www.globaltimes.cn/Portals/0/attachment/2011/49ce8f7c-7da3-4641-8443-f7fb234b6f53.jpeg- CPR demonstration

http://video.about.com/firstaid/How-to-Perform-Hands-Only-CPR.htm- CPR guidelines

http://vimeo.com/65441617 - Mr. Bean's Attempt to Provide CPR

http://kidshealth.org/teen/your_body/body_basics/heart.html# - What the Heart & Circulatory System Do

http://kidshealth.org/teen/your_body/body_basics/heart.html# - *Lungs and Respiratory System: What They Do*

http://www.teachertube.com/viewVideo.php?video_id=256514 – Respiratory System

http://winesurprises.com/wp-content/uploads/2013/12/the-heart-diagram-without-labels.jpg - Heart Diagram Without Labels

http://sumanasinc.com/webcontent/animations/content/humanheart.html - Blood Flow through the Human Heart

http://kidshealth.org/kid/htbw/CSquiz.html - Online Quiz on the Circulatory System

http://kidshealth.org/kid/htbw/RSquiz.html - Online Quiz on the Respiratory System

http://www.pharmafoodsprofessional.com.au/assets/images/Atherosclerosis.jpg - Atherosclerosis illustration

http://medimoon.com/wp-content/uploads/2012/09/Pneumonia1.jpg- Pneumonia & Chronic Bronchitis

http://www.youtube.com/watch?v=xY60G6_tRM4 – Balloon Angioplasty and Heart Disease: Demo Using Balloons

http://www.youtube.com/watch?v=N7nghr9TpSU – Coronary Artery Angioplasty

http://www.youtube.com/watch?v=aKduNgfePLU– Smoking-Induced Pneumonia
http://www.gmanetwork.com/news/story/285476/publicaffairs/pinoymd/the-truth-about-asthma-no-cure-but-can-be-controlled - Article on Asthma

http://www.nlm.nih.gov/medlineplus/ency/patientinstructions/000094.htm - Being Active When You Have Heart Disease

http://www.dailymail.co.uk/health/article-2262441/Exercise-Yes-CAN-fit-good-Why-exercise-harmful-heart.html - Yes, You Can Be Too Fit For Your Own Good: Why Exercise May Be Harmful to the Heart

Lesson 2: Flow of Energy and Matter in Ecosystems

INTRODUCTION AND FOCUS QUESTION(S):

Do you think it is possible for life on Earth to continue even without humans?

Albert Einstein said,

"Remove the bee from the earth and at the same stroke you remove at least one hundred thousand plants that will not survive."

This popular quote is based on the premise that *Earth is Better off Without Humans*. According to a theory, *if the bee disappeared off the surface of the globe, man would only have four years of life left. No more bees, no more pollination, no more plants, no more animals, no more man.*

In this module, you will find out why other living things depend on plants for their food and energy and how plants are able to manufacture their own food. Just how are plants able to manufacture their own food? What are the necessary raw materials involved in the process of manufacturing and utilizing food? These are some of the important questions that you will seek to answer in this module.

LESSONS AND COVERAGE:

In this lesson, you will examine this question when you take the following topics:

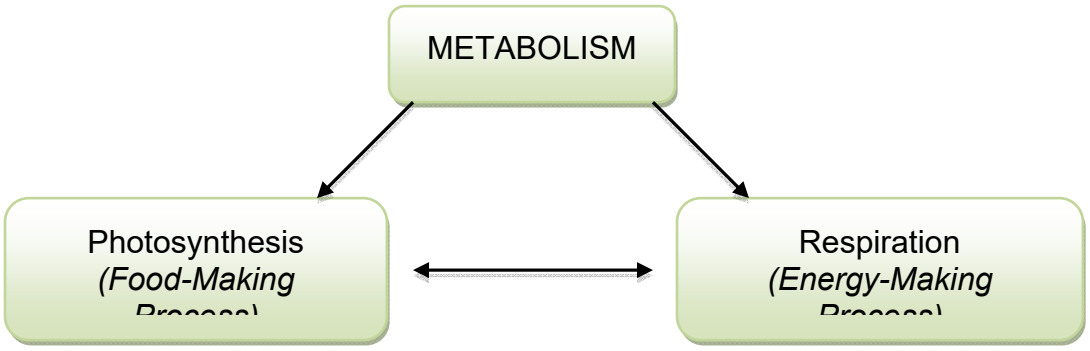
1. Metabolism
2. Photosynthesis
3. Respiration

In these topics, you will learn the following:

Topic 1	Recognizes the unique features of metabolism as a process that happens inside a living body.
Topic 2	Differentiates basic features and importance of photosynthesis and respiration.
Topic 3	Identifies patterns at which photosynthesis and respiration are connected or related to each other. Design and conduct an investigation to provide evidence that plants can manufacture their own food.

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

(A) 1. Which of the following does NOT show a metabolic process?
a. A flowering plant that does not move.
b. Bacteria replicating inside your intestines.
c. A butterfly inside a frame that does not show any signs of decomposition.
d. A person in a state of coma for 10 years.

(A) 2. Which of the following is a common by-product that is involved in both photosynthesis and respiration?
a. carbon dioxide
b. oxygen
c. ATP
d. glucose

(A) 3. Cell respiration uses _____ and produces _____.
a. carbon dioxide, glucose
b. glucose, oxygen
c. oxygen, carbon dioxide
d. ATP, oxygen

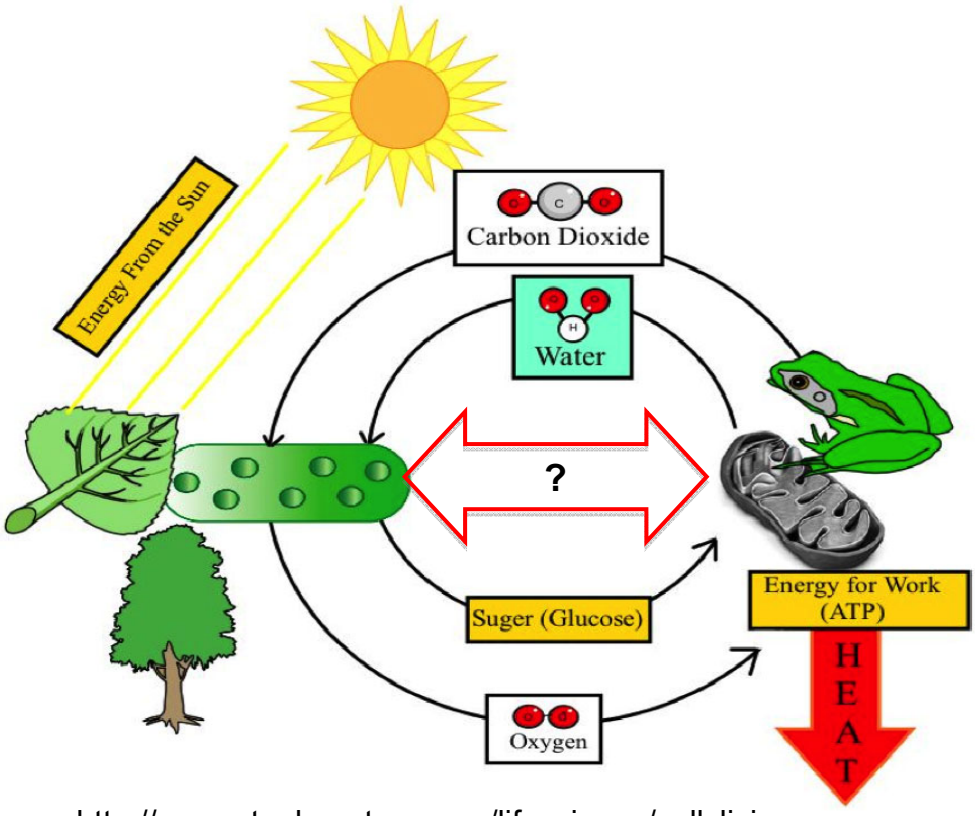
(A) 4. Your hobby is to collect different species of aquarium fish. You have already grown 3 species of fish in your 6-liter capacity aquarium. You added 5 more species inside. One morning, you notice that three of them look weak and seem like they are catching their breath towards the upper portion of the aquarium. What do you think is happening to your pets?
a. there is no more enough space in your aquarium
b. your pets are not compatible to be occupying the same aquarium
c. the oxygen inside the aquarium is not enough to support them
d. your pets are sleeping

(A) 5. Your hobby is to collect different species of aquarium fish. You have already grown 3 big species of fish in your 8-liter capacity aquarium and you added 5 more species inside. One morning, you notice that three of them look weak and seem like they are catching their breath towards the upper portion of the aquarium. What can you do to prevent your fish from suffocation?

a. add more plants inside the aquarium
b. decorate your aquarium
c. add filter to your aquarium
d. just allow some of your fish to die so that others can survive.

(A) 6. How is oxygen-carbon dioxide cycle related to the process of photosynthesis and cell respiration?
a. Plants produce oxygen during photosynthesis and animals use oxygen for internal respiration.
b. Plants produce carbon dioxide during photosynthesis and uses oxygen during cell respiration.
c. Photosynthesis is the breaking down of food and respiration is the production of food.
d. Animals produce oxygen which the plants need for photosynthesis.

(A) 7. Study the structure and the process that happen in the given diagram below. What would be an appropriate statement to be written inside the arrow?
a. Plants contain chloroplasts that are necessary to utilize carbon dioxide from the mitochondria to create oxygen and food.
b. Animals require oxygen to create their own food inside the mitochondria, and in the process, carbon dioxide is released.
c. Plants utilize the products of a metabolism that happens inside the mitochondria of animal cells only.
d. Animals contain chloroplasts and mitochondria.



http://www.stephsnature.com/lifescience/cellslivingn

(A) 8. Unlike most animals, plants are capable of performing both photosynthesis and cell respiration. What would best explain this ability of plants of performing both of these metabolic processes?
   a. Plants can utilize the energy from the sun.
   b. Chloroplast and Mitochondrion are both present inside a plant cell.
   c. Plants require water to perform its functions.
   d. Plants inhale oxygen from the atmosphere that drives these metabolic processes.

(M) 9. Read the following cases below and answer the question that follows.
   I. In 2011, Batangas, Cavite, and Laguna experienced a large-scale Bangus and Tilapia fish kill that almost paralyzed the industry of fish agriculture and market. Gov. Vilma Santos of Batangas, said that this is due to overpopulated fish pens in Laguna de Bay and Taal Lake. Another factor that she has mentioned is carbon dioxide suffocation due to the very low supply of oxygen in these bodies of water. This low supply of oxygen is the culminating effect of sudden increase in water temperature and the lack of plants that produce this gas.
   II. In one experiment, you kept a plant inside a dark room. After two days you noticed that the plant became dull and withered. You decided to put back the plant outside the room and allow it to receive

sunlight. After another two days, you noticed that the plant has regained its color and rigidity.

III. A genetic engineer has created a mutant butterfly that has chloroplast-containing cells in its proboscis, where it can receive sunlight. This new trait has helped the butterfly live longer than the wild-type species.

Which of the following statements is TRUE in all of the given cases above?

a. Plants contain chloroplasts that, in the presence of sunlight, enable them to produce their own food and along with this process is the production of oxygen gas.
b. Animals are dependent to plants for their food.
c. Plants are dependent on animals.
d. Chloroplast is not found in animals, in effect, animals are dependent on plants for their food.

(M) 10. Read the following cases below and answer the questions that follow.

I. Phycoerythrin is an accessory photoreceptor pigment found in the Rhodophyta ("red algae"). Phycoerythrin is associated with chlorophyll in the Rhodophyta, and enables them undergo photosynthesis efficient even in deep water where blue color predominates. The longer wavelength red portion of the spectrum that activate green chlorophyll pigments do not penetrate the deeper water of the photic zone, so green algae cannot survive at depth where red algae thrive.

II. Cyanobacteria are aquatic and photosynthetic unicellular organisms that can manufacture their own food. They often form colonies which are large enough to see. Scientists believe that these bacteria give rise to modern plants. The similarity in their genetic material proves that the chloroplasts within plant cells are actually cyanobacteria that have evolved to be dependent on plant cells. Because they are photosynthetic and aquatic, cyanobacteria are often called "blue-green algae" because of the chlorophyll-like pigment that they contain.

III. Charophycean algae is the closest algal relative of land plants. Botanists believe that land plants evolved from this species over 500 million years ago. This organism has pigments similar to land plants such as chlorophyll a and b, carotenes, and xanthophylls. Furthermore, this aquatic algae exhibits cellulosic cell-wall components and stores carbohydrates in the form of starch.

a. Photosynthesis happens in both terrestrial and aquatic ecosystems.
b. Photosynthesis is driven by different types of lightabsorbing pigments.
c. Different organisms would have different ways of doing photosynthesis.
d. Plants are the only group of organisms that can produce their own food through photosynthesis.

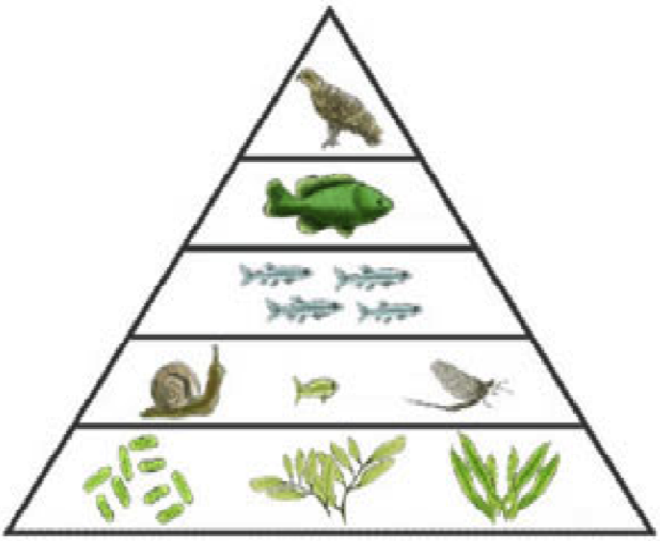
(M) 11. Read the following articles/models below then identify the unifying idea among the three texts.

I. The colorful and diverse coral formations that we see underwater in Tubbataha are actually colonies of hundreds to thousands of individual but genetically identical polyps. Coral polyps are invertebrates, part of a large group of animals called Cnidaria, which also includes jellyfish and sea anemones.
Although corals can use stinging cells on their tentacles to catch small fish or plankton, most get the bulk of their energy and nutrients from zooxanthellae, photosynthetic algae that live within the coral.

II. Pea aphids may have an unprecedented ability to harvest sunlight, and use the energy for metabolic purposes. It would make it the only species of animal known to have photosynthesis-like powers.
It comes down to carotenoids, which are a type of pigment used in animals for crucial functions like vision, bone growth and vitamin production. All known animals obtain these by eating the plants, algae and fungi that naturally synthesize the orange-red compounds. Back in 2010, University of Arizona biologist researchers Nancy Moran and Tyler Jarvik discovered that pea aphids can make their own carotenoids, like a plant. “What happened is a fungal gene got into an aphid and was copied,” said Moran in a press release.

(http://www.wired.com/wiredscience/2012/08/green-aphid-photosynthesis/)

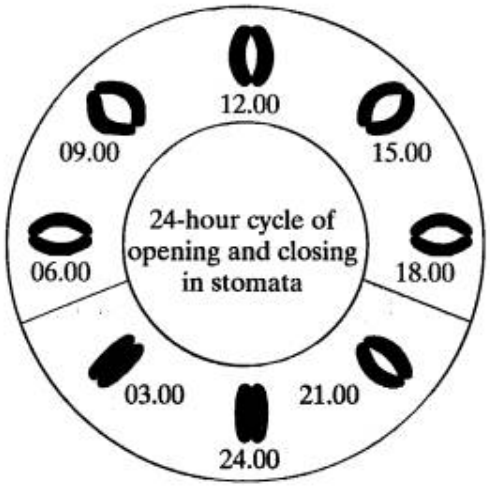
III.



http://www.learner.org/courses/essential/life/session7/closer5.ht

a. Animals can indirectly utilize the energy from the sun in making their own food.
b. Animals are more structurally complex than plants because of the presence of more structures in their body.
c. Animals are dependent on plants for their food.
d. Plants are solely dependent on animals for their nutrition.

(M) 12. The illustration below tracks a bean plant's stomata in a 24-hour cycle. Why do you think it is beneficial for the plant to partially close its stomata on a hot, dry afternoon?

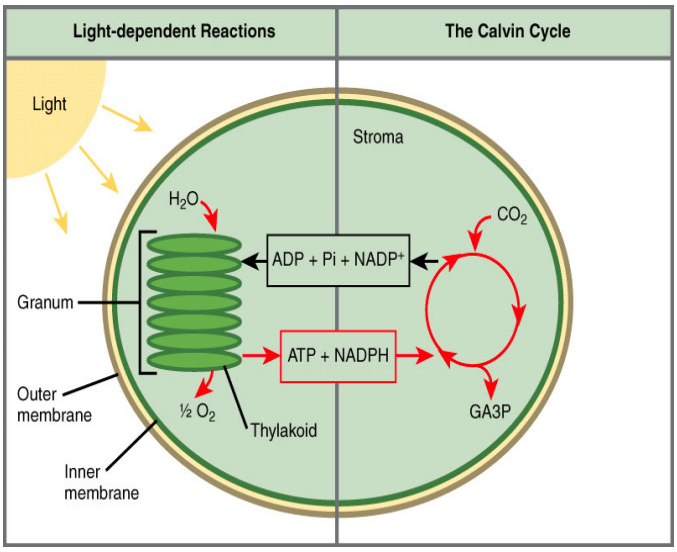


a. So that carbon dioxide will not escape from the leaves when it is heated.
b. To prevent oxygen from entering the stomata.
c. To prevent water from escaping out of the plant through the stomata.
d. To reduce the light that is entering the stomata.

(M) 13. The rate of photosynthesis of aquatic plants in a test tube is determined by collecting and measuring the amount of oxygen that goes out from the water. If bicarbonate, the source of CO2 for aquatic plants, is added to the water, the rate of oxygen evolution increases. If CO2 is fixed by the Calvin cycle but oxygen is evolved by the light reactions, how can an increase in CO2 supply increase the rate of oxygen evolution?
a. The CO2 is broken down into carbon and oxygen during the light-independent stage.
b. It is the bicarbonate that is reacting with water that causes the release of oxygen. These oxygen molecules are then goes out of the water.
c. Increase in CO2 causes the more efficient production of water in the Calvin cycle. And the more water molecule is present, the more oxygen gas is produced. The process of photolysis in the light-dependent stage causes the increase in oxygen gas.
d. Increase in CO2 causes a faster use of ATP and NADPH that are produced from the light-dependent stage where O2 is being produced from water. This use of ATP and NADPH produces ADP + Pi and NADP. These molecules are then recycled to the light-dependent stage and then the cycle goes on.

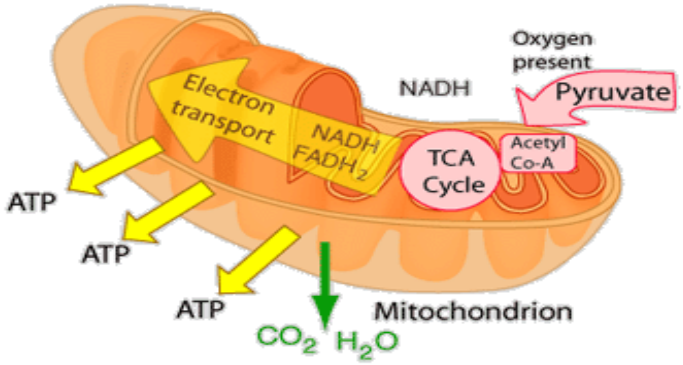
(M) 14. Study the following diagrams. Which of the choices below can be inferred from these diagrams?

I.



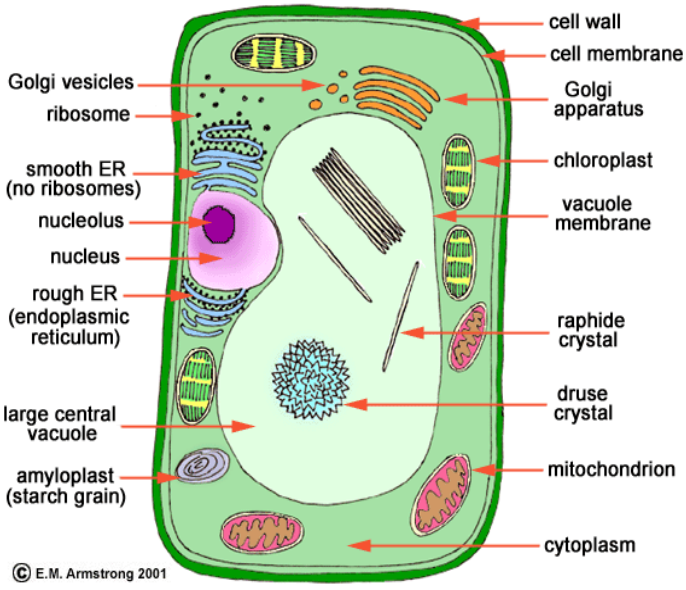
Photosynthesis takes place in two stages: light dependent reactions and the Calvin cycle. Light-dependent reactions, which take place in the thylakoid membrane, use light energy to make ATP and NADPH. The Calvin cycle, which takes place in the stroma, uses energy derived from these compounds to make GA3P from CO2.

II.



Cell respiration takes place in three stages when oxygen is present inside the mitochondria: the glycolysis, TCA (Tricarboxylic Acid Cycle) or the Krebs cycle, and the Electron Transport chain. The end products are water and carbon dioxide.

III.



Structures inside the Plant Cell.

a. Photosynthesis also happens in the mitochondrion found only in plants. Therefore, plants do not need carbon dioxide to make energy.
b. Plant cells contain both chloroplast and mitochondria. Therefore, they require both oxygen and carbon dioxide for their metabolism.
c. Plants are capable of using carbon dioxide and water to make its own food.
d. Plants cells contain more organelles than animal cells. This is the reason why they can do more metabolic functions than animals.

(T) 15. Read the following conclusions based on an explorative experiment about the importance of water to plants of three biology students. Determine which of the three students provide/s the most accurate and in depth investigation about the given hypothesis below.

Hypothesis: Taller plants require more water to survive than smaller ones.

Precy: After doing an experiment for two weeks, using two plants of the same species and sizes, it has been found out that Plant A requires more water than Plant B. This is because of the fact that there is more excess water draining from the pot of Plant B. The two plants were planted in the same soil type. They also received the same amount of sunlight within the entire experiment.

Jackie: After doing an experiment for two weeks, using two plants of the same species coming from the same garden but with different sizes, it has been found out that the taller plant requires more water than the smaller plant. When given the same amount of water for two weeks, putting all factors that affect the growth of plant constant (e.g. soil quality, sunlight, location), the smaller plant was able to stay alive while the taller plant died.

Patrick: After doing an experiment for two weeks, using the same species of plant coming from two different donors in the community, it has been found out that the size did not significantly influence the amount of water required by the plant. This is because both of the plants were able to survive when given the same amount of water and sunlight.

a. Precy
b. Jackie
c. Patrick
d. All of them have designed a good experiment that would generate an accurate proof about the hypothesis.

(T) 16. You are a marine biologist investigating on a new species of seaweed you have discovered growing on the seabed around the Spratly Island. Since this new species is yellow-green in color, you hypothesize that it can also undergo photosynthesis like most green plants do. What is the best way for you to gather evidence about your hypothesis without doing any harm to your newly discovered seaweed?

a. Take out a portion of the seaweed and a sample of sea water and put them together in a jar. Then count the number of bubbles coming out from the seaweed during the entire duration of the investigation.
b. Pull out the entire seaweed from the sealed then place it inside a sealed plastic bag. Then observe if there is a change with the volume of the plastic bag due to the gas coming out from the seaweed.
c. Without pulling out the seaweed from the seabed, allow the jar to cover the entire seaweed. Observe any changes with the level of water inside the jar. Pay attention to the initial amount of gas bubble upon covering the seaweed.
d. Cover the seaweed with a metal sheet so that it will not be reached by the sunlight. Observe if there will be changes with the overall structure of the seaweed.

(T) 17. Manuel has learned from his Biology class that plants only need carbon dioxide, water, and sunlight to manufacture their own food. As a very curious student, he tested this new learning by doing an experiment as to whether oxygen is also necessary for the plant to survive. He placed a small herbaceous plant inside a jar with enough supply of water. To remove free oxygen gas inside the jar, he placed inside a lighted candle and waited until the fire ceased. To incorporate carbon dioxide inside the jar, he allowed a pack of dry ice (solid carbon dioxide) to sublime inside the closed container. After the set-up had been completed (considering that no air from the surrounding environment has entered the jar while the dry ice is being delivered inside), he placed the jar under the sunlight. After one week, the plant inside the jar did not die.
Manuel therefore concluded that oxygen is not necessary for the plant tosurvive. His teacher was not convinced with his conclusion. Instead, she suggested a way to improve the procedure he has employed in his experiment. Why do you think Manuel's teacher was not convinced with his conclusion?

a. Though the initial free oxygen was removed, the plant was producing oxygen during the initial process of photosynthesis.
b. Not all plants use oxygen to survive.
c. Plants can adapt to its surrounding. If oxygen is not available, it will use other gases to be able to utilize its food.
d. none of the above

(T) 18. Your group prepared a proposal for your exploratory experiment project on measuring the effect of the presence of aquatic animals in amount of oxygen released by aquatic plants. Your plan is to put up an aquarium containing a fish with a submerged aquatic plant inside an inverted test tube. However, when our teacher saw your proposal she advised your group to improve on your research design. According to her, your conclusion might not be so accurate if you will not add another set up that will serve as the reference point or the point of comparison as you discuss the result of your experiment. What is your teacher trying to say? How can you improve on your research design?

a. Set-up another aquarium with no aquatic plant and see if the fish will still survive.
b. Set-up another aquarium with more plant and see the effect on the health of the fish.
c. Set-up another aquarium with no fish and see the effect on the amount of oxygen released.
d. Set-up another aquarium with more fish and see if there is a change with the amount of oxygen released.

(T) 19. Atmospheric levels of CO2 are increasing. We know most of the sources of atmospheric CO2, such as fossil fuel combustion, deforestation, and the oxidation of organic matter in farm soils. Thus, we can estimate world CO2 production with some accuracy. However, we do not know where all this CO2 goes. Some is retained in the atmosphere and some dissolves in the ocean, but there is a significant amount of CO2 that is not accounted for. Where do you think this CO2 is going?

a. This is the carbon dioxide inside the body cells of humans. It can be tested by getting the average amount of carbon dioxide being exhaled by a normal person and multiplied it to the total population of the world.
b. This is the carbon dioxide that is being converted into glucose. This can be tested by isolating a plant inside a jar and supply it with only carbon dioxide, sunlight, and water.
c. This is the carbon dioxide that is absorbed by the land. Measure the amount of dissolved carbon dioxide in the soil every week for one year. Then check for any change with the amount of carbon dioxide.
d. The carbon dioxide is being released into the outer space because of the ozone layer disruption.

(T) 20. Tropical rain forests cover only about 3% of Earth's surface, but they are estimated to be responsible for more than 20% of global photosynthesis. It seems reasonable to expect that the lush growth of jungle foliage would produce large amounts of oxygen and reduce global warming by reducing carbon dioxide. But in fact, many experts now believe that rain forests make little or no net contribution to global oxygen production or

reduction of global warming. Using your knowledge of photosynthesis and cellular respiration, explain what the basis of this hypothesis might be.

a. There will be no net increase in the amount of oxygen because the area covered by the rain forests is too small in relation to the polluted areas in the world. Once plants release carbon dioxide, it is converted into carbon dioxide by the pollutants in the atmosphere.
b. Photosynthesis, aside from it produces oxygen, it is also producing the same amount of carbon dioxide in the atmosphere. Therefore, there is no net change in the amount of oxygen in relation to the amount of carbon dioxide in the atmosphere.
c. Plants contain both chloroplasts and mitochondria. While they are using carbon dioxide and water during photosynthesis to produce oxygen and glucose, they are also consuming oxygen to utilize energy from glucose during cellular respiration that releases back the carbon dioxide in the atmosphere.
d. Plants never release carbon dioxide and consume oxygen for their metabolism.

EXPLORE

Do you think it is possible for the life on Earth to continue even without humans? Let's find out and start this module by gathering your thoughts about different processes that are happening inside a living organism.

ACTIVITY NO. 1: ARTICLE ANALYSIS

Read the article entitled *Researchers find evidence of photosynthesis-like process in aphids* by clicking on the link provided below. The article presents an interesting perspective about a certain animal that can produce energy in a process unique from other animals.

Researchers find evidence of photosynthesis-like process in aphids
By Bob Yirka
April 21, 2012

http://phys.org/news/2012-08-evidence-photosynthesis-like-aphids.html

Go back to the following statement from the article:

"In plants, algae and some types of bacteria and fungi, sunlight is converted to chemical energy in a process we all know as photosynthesis; in that process water and carbon dioxide are also converted to oxygen."

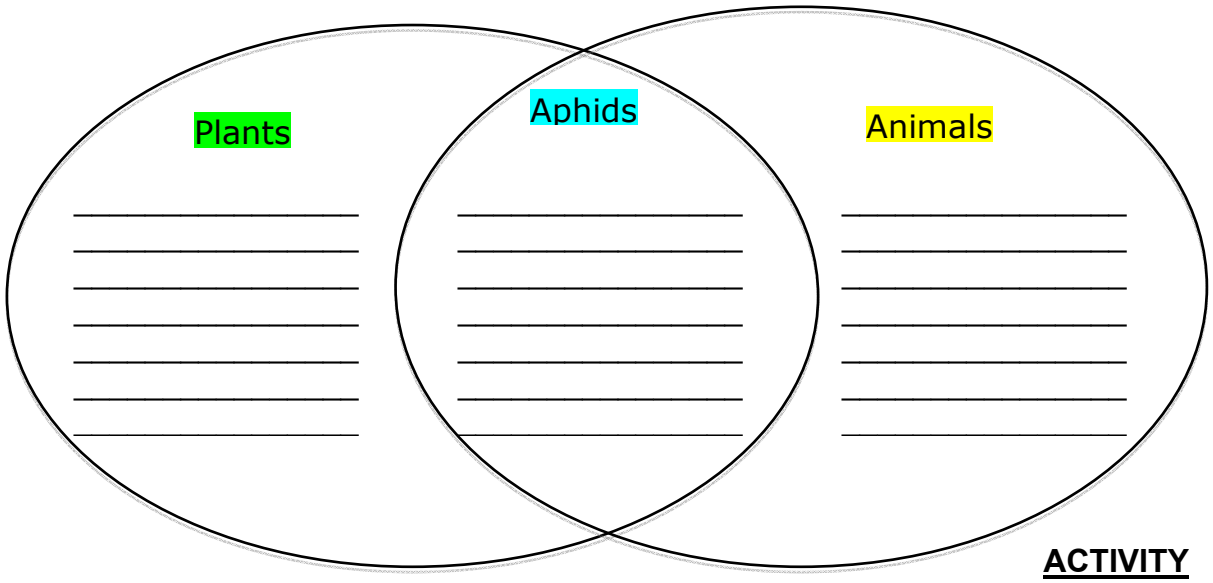
"This the authors explain in their paper published in Scientific Reports, suggests the insects might be able to directly convert sunlight to energy, which would make it the only animal able to do so."

Process Questions:

1. In what ways do plant aphids differ from other animals?
2. In what ways are plant aphids similar to plants, algae, and some bacteria?

ACTIVITY NO. 2: VENN DIAGRAM

Let's summarize what you have learned from the text by completing the Venn diagram. List all the characteristics of aphids that are stated in the text. What are the characteristics that aphids display that are similar to animals and plants?



ACTIVITY NO. 3: ELICITING PRIOR KNOWLEDGE THROUGH K-W-L CHART

What were your initial answers to the questions posed in the previous activity? What have you learned so far from the article? How are plants able to manufacture their own food?

To summarize your answers to the questions, and your thoughts and ideas regarding photosynthesis in the first column (*What I Know*) of the given K-W-L chart. Then in the second column (*What I Want to Know*), write the questions you have about photosynthesis that you want to find answers to as you go through this module. Leave the third column (*What I Learned*) blank for now.

PHOTOSYNTHESIS		
What I **K**now	What I **W**ant to Know	What I **L**earned

.

End of EXPLORE:

You gave your initial ideas on photosynthesis. You started to explore the answers to the following questions:

- *How do plants manufacture their food?*
- *What are the necessary materials needed for plants to manufacture their food?*

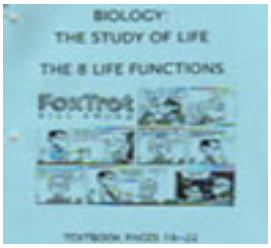
Let's now find out what the answers are by doing the next part.

FIRM-UP

Your goal in this section is to learn and understand key concepts of metabolism. You are going to investigate metabolism as exemplified by Photosynthesis and Respiration.

ACTIVITY NO. 4: Web Page Reading- Characteristics of Living Things

DESCRIPTION: Let's start by reading the text entitled "The 8 Life Functions" by clicking the website below. Using your notepad, answer the questions that follow.



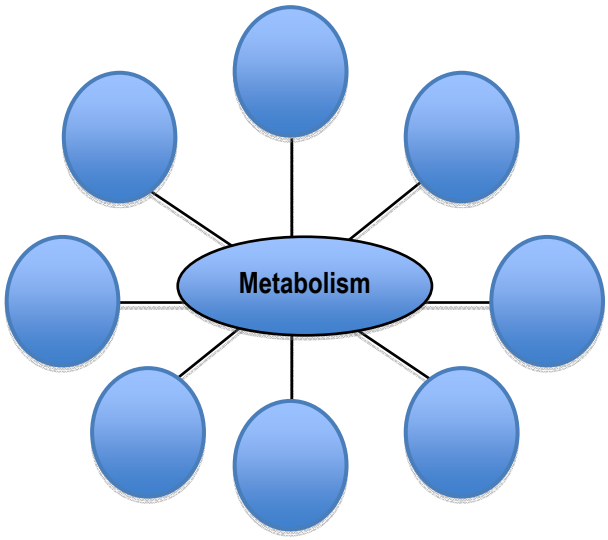
PROCESS QUESTIONS:

The 8 Life Functions
http://www.goldiesroom.org/Note%20Packets/01%20Life%20Functions/00%20Life%20Functions%20Packet--WHOLE.htm

1. What does the article say about metabolism?
2. Is Photosynthesis a form of metabolism? Explain your answer.

ACTIVITY NO. 5: METABOLISM FOR *LIVING*

DESCRITPION: Below is a Map of Main Idea about Metabolism. Fill in the details in order to complete the main idea.



Now that you learned that Metabolism is a characteristic that is unique to living organisms, we will now focus on two different metabolic pathways that are very well related with each other.

ACTIVITY NO. 6: VIDEO ANALYSIS

DESCRIPTION: In this activity, we will be investigating Photosynthesis and Respiration by focusing on the "in" and "out" of these two processes. To start with, let's watch videos about these two processes by clicking the hyperlinks below.

A. Photosynthesis

Description: Let us now look closer to the actual processes that are happening during the food-making process of plants.

http://science.howstuffworks.com/life/29603-assignment-discovery-photosynthesis-video.htm

B. Cellular Respiration

Description: Now let us compare Photosynthesis to cellular respiration.

http://dsc.discovery.com/tv-shows/other-shows/videos/assignment-discovery-shorts-06-07-07-08-cellular-respiration.htm

Process Questions:

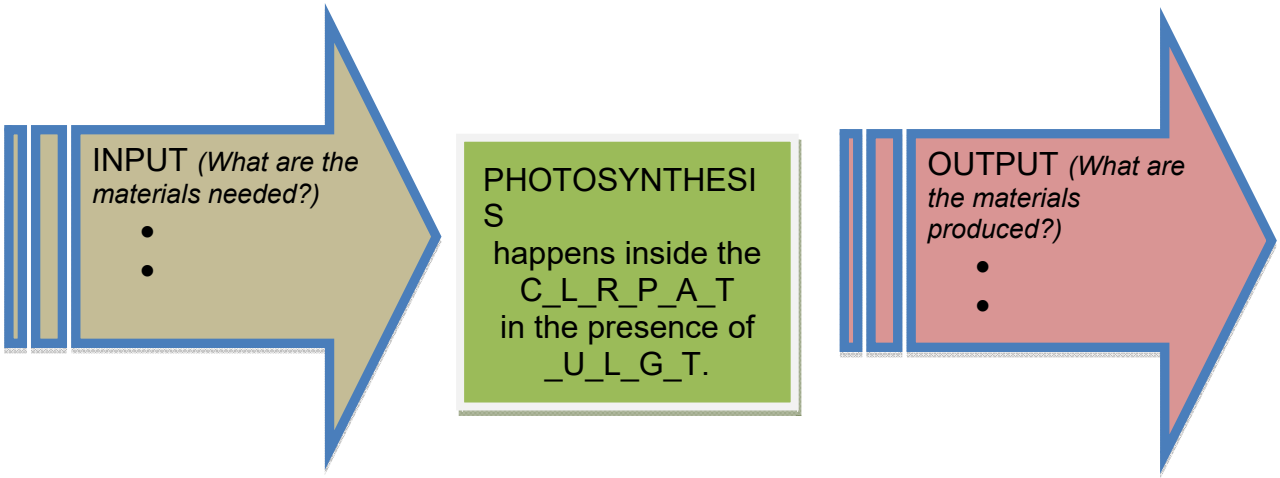
1. Why is Photosynthesis an ANABOLIC process?
2. Why is Respiration a CATABOLIC process?

3. Why do you think, unlike plants, animals cannot utilize the energy from the sun?
4. What anabolic and catabolic processes are happening inside the human body?

<u>ACTIVITY NO. 7:</u> WHAT GETS "IN", MUST COME "OUT"

DESCRIPTION: Go back to the video and pay attention to the different molecules needed and produced in both photosynthesis and respiration. Fill in the necessary information inside the chart.

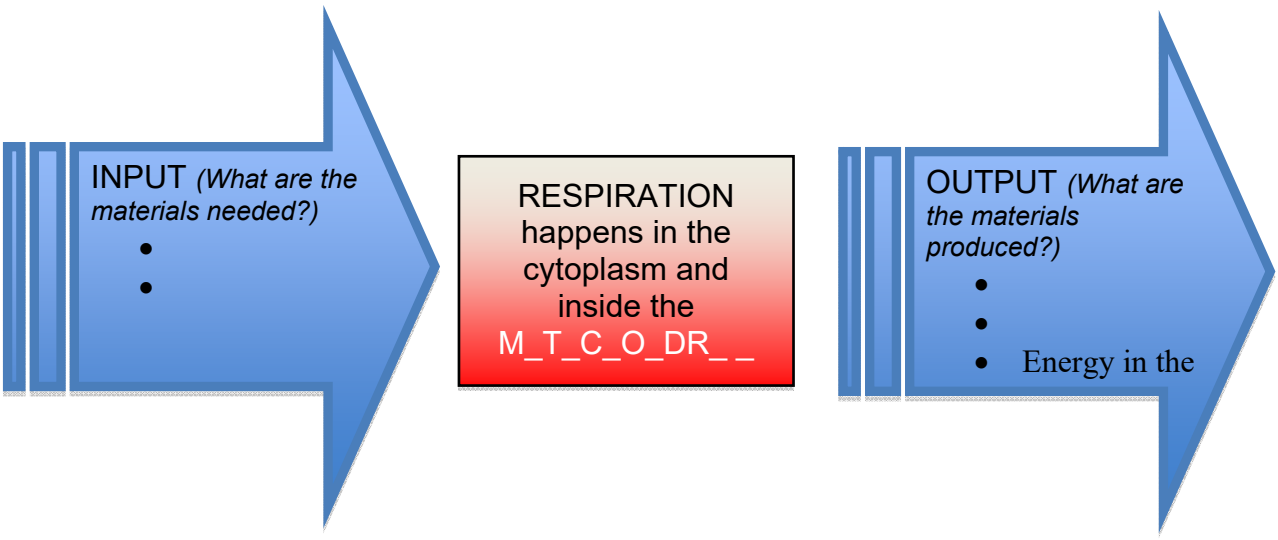
A. INPUT→ OUTPUT Chart of Photosynthesis



PROCESS QUESTIONS:

1. Why do you think this process is called PHOTOSYNTHESIS?
2. Aside from the INPUT materials, what are other necessary structures are involved in this process?

B. INPUT→ OUTPUT Chart of Respiration



PROCESS QUESTIONS:

1. Why do you think this process is called RESPIRATION?
2. Aside from the INPUT materials, what are other necessary structures involved in this process?
3. How are photosynthesis and respiration related in terms of their different INPUT and OUTPUT?

ACTIVITY NO. 8: WEBSITE READING and ANIMATION VIEWING

Description: For further explanation on these two types of metabolism, go to the websites listed below. Read the discussions and watch the video animation of the two processes.

Hartnell College Biology Tutorials: Photosynthesis Tutorial
http://www.hartnell.edu/tutorials/biology/photosynthesis.html

Hartnell College Biology Tutorials: Cellular Respiration Tutorial
http://www.hartnell.edu/tutorials/biology/cellularrespiration.html

ACTIVITY NO. 9: Quiz: Photosynthesis and Cellular Respiration.

Let us test what you have learned from the previous activities. Go to the websites listed below.

Photosynthesis Quiz:
http://www.hartnell.edu/tutorials/biology/photosynthesis%20quiz/photosynthesisquiz1.html

Cellular Respiration Quiz

http://www.hartnell.edu/tutorials/biology/cellularrespirationquiz/cellularrespirationquiz1.html

ACTIVITY NO. 10: Let's Make A Sandwich!
Complete the analogy below by using the INPUT you have listed in the activity above. An initial pair is given to help you accomplish this task.

Example:

Photosynthesis	*Sandwich*	*HINT*
Glucose *(A sugar subunit)*	Sandwich Meal	The finished food product.
Photosynthesis	*Sandwich*	*HINT*
	Stove	This is the source of energy for the food making process.
	Bread	Just like the bread, it is the basic source of carbon in the food making process.
	Oil	This INPUT is also in liquid form and initially receives the energy from the source.
	Frying pan	Just like the frying pan, this absorbs the energy from the source.

ACTIVITY NO. 11: LET IT BURN!
Description: In this activity, you will be able to picture out how plants are utilizing the sugar they have created during the process of photosynthesis to perform other functions. Similar to your previous activity, you will be completing analogy patterns. We will be comparing the process of cell respiration to automobile combustion. An initial pair is already given to help you complete this activity.

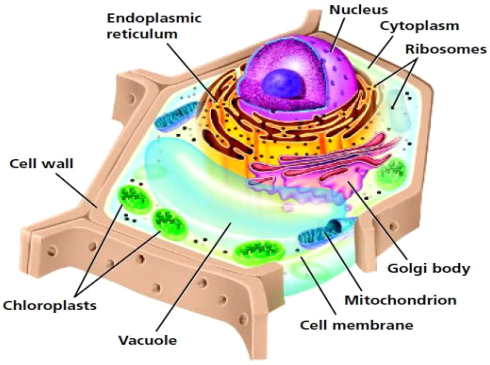
Cell Respiration	*Automobile*	*HINT*
Gas Piston	Mitochondria	This is where the process is happening.
Cell Respiration	*Automobile*	*HINT*
	Gasoline/Diesel	This is the chemical energy that is used in the process.
	Oxygen	Gas requirement for the "burning" process to occur.
	Smoke	Gas that is released as a waste material.
	Mechanical (movement)	Energy that is produced from the chemical energy.

ACTIVITY NO. 12: PLANTS CAN CREATE AND BREAK!

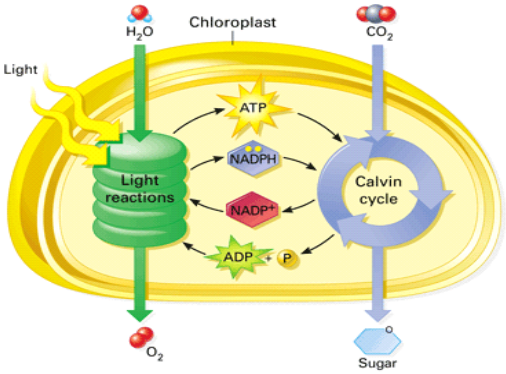
DESCRIPTION: At this point, you are now clear with the different raw materials (INPUT) needed and the different products (OUTPUT) produced in both photosynthesis and respiration.

Let's start by analyzing the illustrations below.

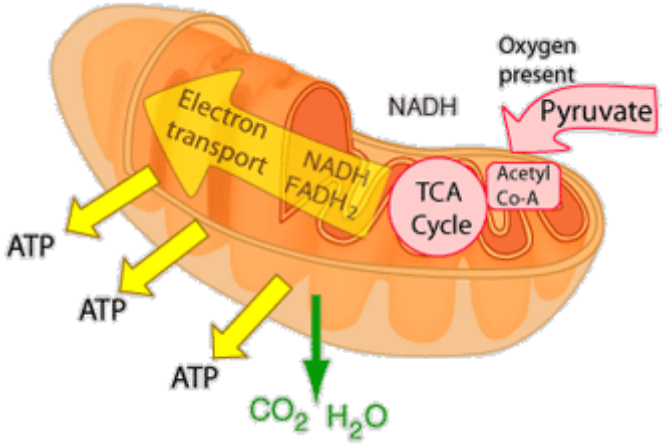
I. _____



II. _____



III. _____



PROCESS QUESTIONS:

1. What is being shown in each of the diagram above?
2. Looking at the different structures inside a typical plant cell, what can we infer about the metabolic processes that can happen inside it? Justify your answer.
3. What would happen if the same processes happen in animals and humans? Are metabolic processes the same for all organisms? Explain.

ACTIVITY NO. 13: Let's Practice!
DESCRIPTION: At this point let's test how well you are doing in this module by answering an online exercise. Kindly *Print Screen* the Test Results that will be flash on the screen as a proof that you have accomplished this exercise. Kindly E-mail your test results to your teacher.

You can start the practice exercise by clicking the link below:
http://www.softschools.com/quizzes/science/photosynthesis/quiz388.html

How did you fare with this practice exercise? To answer this, let's go back and check your K-W-L chart. Fill in the first column. What do you know now about the process by which plant manufacture its own food?

ACTIVITY NO. 14: Revisiting K-W-L Chart
Now that you have gathered enough information about how Photosynthesis and Cell Respiration occur, reflect on what you know about how plants manufacture and utilize their food. Complete the K-W-L chart.

PHOTOSYNTHESIS		
What I **K**now	What I **W**ant to Know	What I **L**earned

PROCESS QUESTION:
Are there changes in your K-W-L chart? If so, upload your new learning in the *Discussion Forum* in your OHSP account.

ACTIVITY NO. 15: QUIZ

DESCRIPTION: You are now ready to do the *real thing*, below is a link that will lead to a Word Document File. Download this file then answer by highlighting the letter of the correct answer. E-mail your test paper to your teacher.

http://www.ck12.org/biology/Photosynthesis/quiz/Photosynthesis-Quiz/

ACTIVITY NO. 16: MY LEARNING CHECKLIST

DESCRIPTION: Below are the target skills that we aim to acquire. Write a check under YES if you are able to learn the skill. Otherwise, put a check under the NO column. Click the SUBMIT button after completing the table.

OUR TARGET	YES	NO
1. Metabolism is only for living things.		
2. Photosynthesis is the food-making process of plants and other organisms that can convert solar energy to chemical energy or food.		
3. Plants have chloroplasts and mitochondria that allow them to make their own food and utilize this food as energy source.		
4. The final steps of respiration happen inside the mitochondrion.		
5. Photosynthesis uses carbon dioxide and water to produce glucose (sugar) and oxygen.		
6. Respiration uses glucose and oxygen to produce energy, water, and carbon dioxide.		
7. Photosynthesis and respiration are reverse processes.		

ACTIVITY NO. 17: SELF ASSESSMENT – 3-2-1 CHART
It's now time for you to do an assessment of your progress in this module. Accomplish this 3-2-1 chart then send to your teacher through the OHSP portal.

3 Things You Learned	
2 Things That Need to be Clarified	
1 Thing You Want to Explore More	

End of FIRM UP:

Now that you understand the basic requirements about the flow of energy and matter of living organism, your goal in this section is to take a closer look at some aspects of the topic. Let us apply these basic concepts in real-life situations happening around us.

DEEPEN

Your goal in this section is to look closer into the process of Photosynthesis as it happens to different organisms. You will also be investigating why photosynthesis is evidence of evolutionary relationship of among autotrophs.

ACTIVITY NO. 18: SITUATIONAL ANALYSIS 1: "Photosynthesis In Different Perspectives"
DESCRIPTION: Read carefully the situations below. Then answer the questions that follow.

SITUATION 1:

Thieving Slugs
Taken From *The Scientist*
By David Smith
January 1, 2013

Elysia chlorotica is an inch-long, algae-sucking sea slug that hangs out in salt marshes along the east coast of North America, where it dines on the filamentous photosynthetic alga, *Vaucheria litorea*. Using a horny, ribbonlike structure, *Elysia* punctures a hole in the *Vaucheria* cells, slurps up the alga's plastids *(chloroplast)*, sequesters them within its own digestive cells just beneath the epidermis, and feeds on the sugars they produce—a strategy fittingly dubbed kleptoplasty, "klepto" is a Greek word which means *thief* and "plasty" which would refer to *chloroplast* which captures the energy from the sun. *Elysia* can survive for months on the photosynthetic products of the stolen *Vaucheria* chloroplast. What is even more impressive, the chloroplasts remain functional within *Elysia* for almost a year, after which the crafty slug feeds on some more *Vaucheria* to replenish the stock.

PROCESS QUESTIONS:

1. What part *Vaucherialitorea* cell does *Elysiachlorotica* get?
2. What metabolic process can *Vaucherialitorea* do that *Elysiachlorotica* cannot do?
3. How does *Elysiachlorotica* benefit from *Vaucherialitorea* plastids?
4. What have you learned about the metabolic process that is happening in green sea slugs?

SITUATION 2:

Algae Can Take Energy From Other Plants

By Olga Blifernez-Klassen, Viktor Klassen, AnjaDoebbe, KlaudiaKersting, Philipp Grimm, Lutz Wobbe, and Olaf Kruse.
Science Daily
November 20, 2012

Until now, it was believed that only worms, bacteria, and fungi could digest vegetable cellulose and use it as a source of carbon for their growth and survival. Plants, in contrast, engage in the photosynthesis of carbon dioxide, water, and light. In a series of experiments, Professor Dr. Olaf Kruse and his team cultivated the microscopically small green alga species Chlamydomonas reinhardtii in a low carbon dioxide environment and observed that when faced with such a shortage, these single-cell plants can draw energy from neighboring vegetable cellulose instead.

The alga secretes enzymes (so-called cellulose enzymes or cellulase) that 'digest' the cellulose, breaking it down into smaller sugar components. These are then transported into the cells and transformed into a source of energy: the alga can continue to grow.

'This is the first time that such a behavior has been confirmed in a vegetable organism', says Professor Kruse. 'That algae can digest cellulose contradicts every previous textbook. To a certain extent, what we are seeing is plants eating plants'. Currently, the scientists are studying whether this mechanism can also be found in other types of alga. Preliminary findings indicate that this is the case.

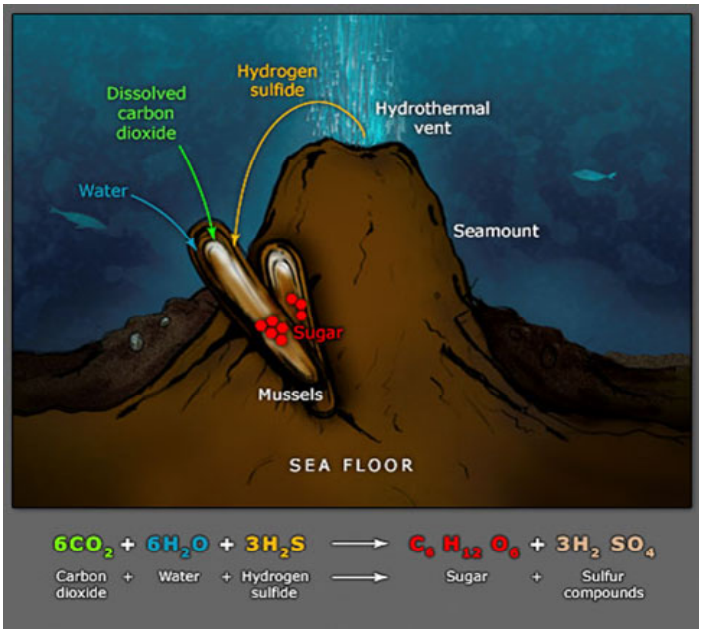
In the future, this 'new' property of algae could also be of interest for bioenergy production. Breaking down vegetable cellulose biologically is one of the most important tasks in this field. Although vast quantities of waste containing cellulose are available from, for example, field crops, it cannot be transformed into biofuels in this form. Cellulose enzymes first have to break down the material and process it. At present, the necessary cellulose enzymes are extracted from fungi that, in turn, require organic material in order to grow. If, in future, cellulose enzymes can be obtained from algae, there would be no more need for the organic material to feed the fungi. Then even when it is confirmed that algae can use alternative nutrients, water and light suffice for them to grow in normal conditions.

PROCESS QUESTIONS:

1. What is the usual way of algae to manufacture its own food and energy?

2. Read the highlighted statement above. What is unusual about this species of algae?
3. What new thing did you learn about metabolism?

SITUATION 3:
Story: Sea Floor – Photosynthesis and Chemosynthesis
By Te Ara– The Encyclopedia of New Zealand



Photosynthesis is the process by which plants use the sun's energy to make sugar (glucose) for food. Plants absorb energy from sunlight, take in carbon dioxide from the air through their leaves, take up water through their roots, and produce glucose and oxygen. Photosynthesis takes place on land and in shallow water where sunlight can reach seaweeds.

Chemosynthesis is the process by which food (glucose) is made by bacteria using chemicals as the energy source, rather than sunlight. Chemosynthesis occurs around hydrothermal vents and methane seeps in the deep sea where sunlight is absent. During chemosynthesis, bacteria living on the sea floor or within animals, such as mussels and tubeworms, use energy stored in the chemical bonds of hydrogen sulfide and methane to make glucose from water and carbon dioxide (dissolved in sea water). Pure sulfur and sulfur compounds are produced as by-products.

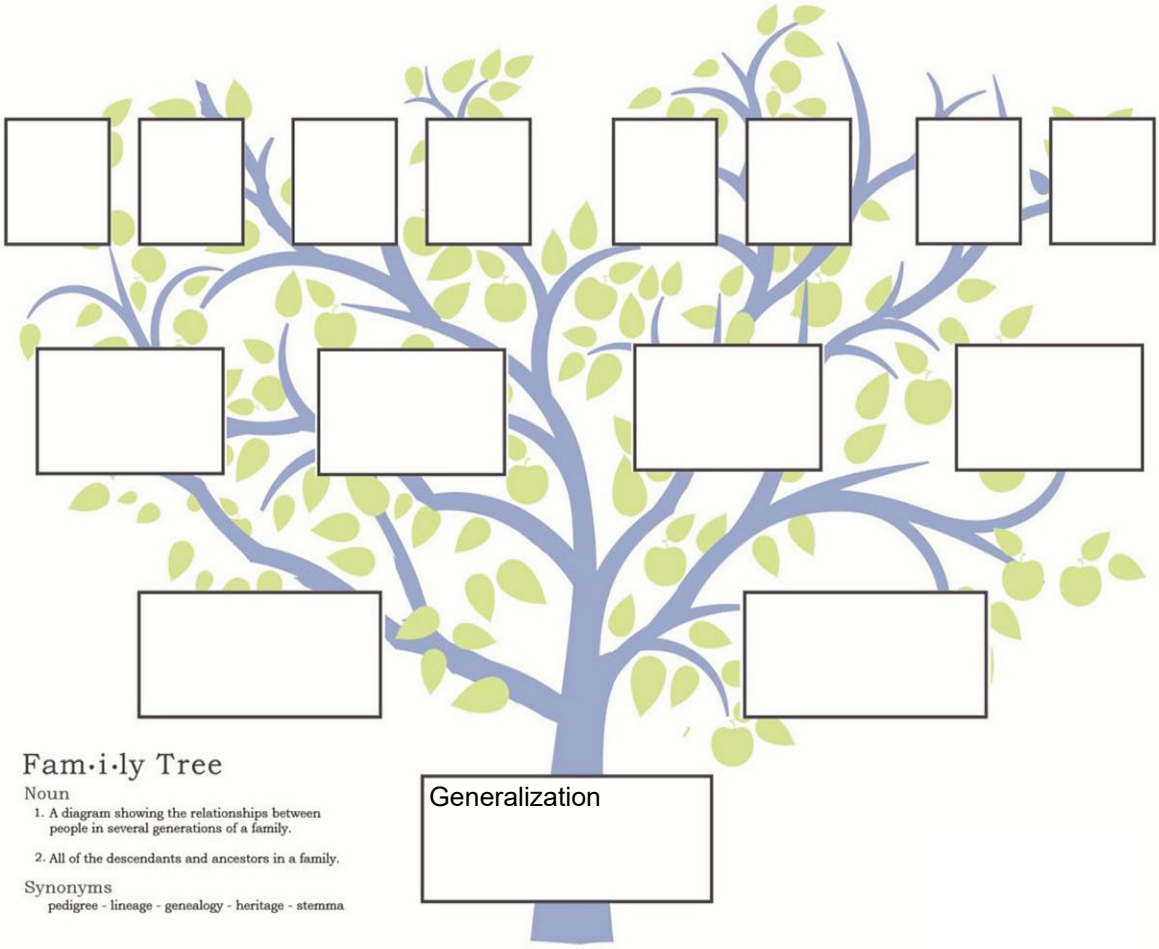
At right, mussels and tubeworms around a vent are releasing hydrogen sulfide gas. The chemical equation given here for chemosynthesis is just one of a number of possibilities.

PROCESS QUESTIONS:

1. What natural circumstances triggered these hydrothermal vent bacteria to undergo Chemosynthesis?
2. Why do you think most of these hydrothermal bacteria dwell inside the body of sea floor animals like mussels? What are the beneficial impacts brought by these two species to each other?
3. What new thing or things did you learn about metabolic processes?

ACTIVITY NO. 19: Making Generalization

Now that you are able to answer the process questions, go back to the three articles, what unifying concept or GENERALIZING idea about the food-making process can you infer based from your answers? Complete the FAMILY TREE Chart below to help you generalize the terms and concepts from the text. Use the following categories: *Location, Raw materials, Products, General process.*



Process Questions:

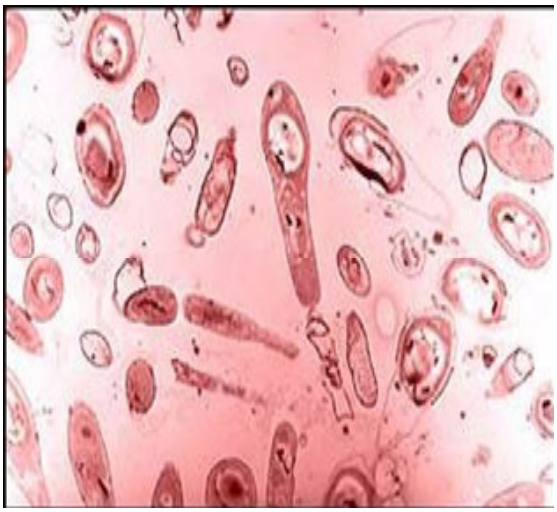
1. How are the different organisms adapted to their habitat in terms of their food making process?
2. How is the plant's food-making process similar with these organisms' food-making process?

Now that you know how plants manufacture their own food through the metabolic process called photosynthesis, it is about time for you to explore on other organisms that carry out the same process to survive.

In this section, you will be reading articles that explain how important photosynthesis is in initiating and sustaining life on Earth. Read the articles below and answer the discussion questions that follow. Keep in mind that photosynthesis is the process happening inside the chloroplast of the plants by which carbon dioxide and water are used to produce sugars (glucose) and oxygen in the presence of solar energy.

ACTIVITY NO. 20: Situational Analysis Part 2: "The Origin of the Chloroplast: The History of Life"

SITUATION 1:
Title: Bacteria
Written by: Jim Keener
Published by RedColony.com



Bacteria. Mars. You might not see much of a relationship between the two terms. But according to leading scientists from the Mars Society and other organizations, bacteria are as important to Mars as bacteria in our stomachs or in our medicine or even our beer. They played a leading role in the first ecosystem on Earth and will do so again on the red planet. The simple fact is that without bacteria, Mars will never be terraformed.

Bacteria can be supplied with Carbon, Oxygen, Hydrogen, Nitrogen, and Phosphorus, the basic components in biochemistry and all in abundance on Mars. Carbon can be found in the copious supply of carbon dioxide in the atmosphere. Oxygen can be found almost anywhere, mainly in carbon dioxide, aluminum oxide, iron oxide (rust), water, or the very little bit in the present Martian atmosphere. Hydrogen could be found in underground aquifers of water, two miles underground. Nitrogen can be found in the Martian soil and so can phosphorus. These amounts should be sufficient to substance our bacteria and then later, plants and animals.

There are several types of bacteria. There are aerobic bacteria that require oxygen to survive, and anaerobic bacteria that can live with or without oxygen. Obviously on Mars with very little oxygen present, anaerobic bacteria will be the bacteria of choice. Next are heterotrophic bacteria that use other organisms for

energy and autotrophs that produce their own food through photosynthesis. With sunlight readily available on the surface, autotrophs will most likely be used. Utilizing the Keener Black Chlorophyll theory, black bacteria would absorb much more energy than green ones. The red planet would become the black planet as billions of bacteria covered the entire surface.

So what would they do on the surface? They could pump water up from underground aquifers by the same way we drink water upside-down. By releasing diatomic Oxygen (O_2, the kind we breathe) into the atmosphere, they would be making mars livable. On the other hand, if we would prefer, we could pump Triatomic Oxygen (O_3, ozone) to heat the planet, or even a combination of both. Bacteria could also pump other Greenhouse gases into the atmosphere. They could also be used in life support to purify water and air.

They could be used as a building material or could mine deep underground like they already do here on earth. Coral is a good example of a hard covering material manufactured in the depths of the ocean. If we laminated coral-like bacteria together in different layers I think we could build with them, like a growing concrete. They could also mine iron and aluminum for our use. We could use it as a building material or sell it on Earth as Mars' first trading export.

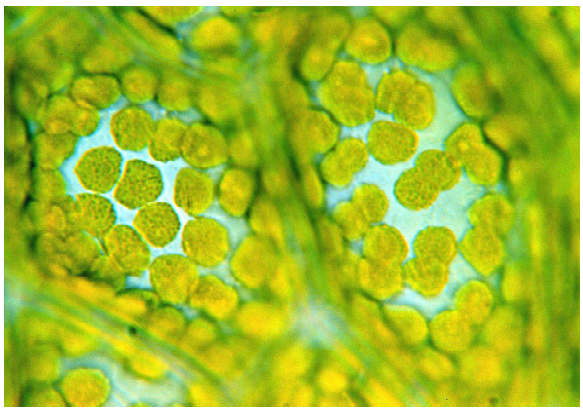
We could manufacture bacteria DNA to accomplish any of these tasks using biological engineering. This is a technique long used that stems back from the days when a horse and donkey were first combined to produce a stronger, more efficient mule. When combining traits from different organisms with bacterial DNA we would be doing the same thing. We would have to make bacteria divide and grow at a set pace, so as not to overrun the planet with our creations. Kim Stanley Robinson, an American novelist, suggests manufacturing a "suicide gene" that would kick in whenever a bacteria reproduced x amount of times. In addition, we would have to make them interlock, like moss, and cling to the rocks, ground, and/or something so not to be blown away during a Martian dust storm.

One of the Surveyors sent to the moon was imperfectly sterilized. When we landed on the moon the Apollo astronauts brought back pieces of the craft and found that when fed on Earth, the Bacteria started to grow and thrive. Bacteria are the most adaptive and hardy organism known to man, and I see no reason why we could not make them survive on Mars.

Discussions Questions:

1. Go back to the highlighted portion of the article, using the different descriptions on the different type of bacteria, how would you classify plants and animals? Explain your answer.
2. Can life be possible without Photosynthesis? What is the importance of photosynthesis to life?

SITUATION 2:
Titile: Are Biologists Watching an Evolutionary Leap: One Life Form Absorbing Another?
Written by: Ashley P.Taylor
Published by: Discover Magazine



More than 1.6 billion years ago, one cell engulfed another and put it to work. More specifically, a eukaryotic cell, the sort of cell that contains distinct structures with different functions, took in a blue-green bacterium that could do something it could not: use sunlight to make sugars. The ancient eukaryote then reproduced the bacterium in all of its cells, making it a permanent part of the intracellular environment. What was once an independent microbe was now the chloroplast: the cellular structure, or organelle, that plant cells use to photosynthesize. They've been together ever since, an absorption known as endosymbiosis.

Nor, scientists think, were chloroplasts the only parts of cells that were once bacteria: Mitochondria, organelles that produce energy in plant and animal cells, got their start the same way, and some other organelles may have, as well. Now researchers have found another useful bacterium that they think is on its way to becoming a modern organelle of another eukaryotic cell—this time, an alga rather than a plant or animal. Studying this relationship would allow scientists to witness endosymbiosis in action, something they had long theorized but never seen.

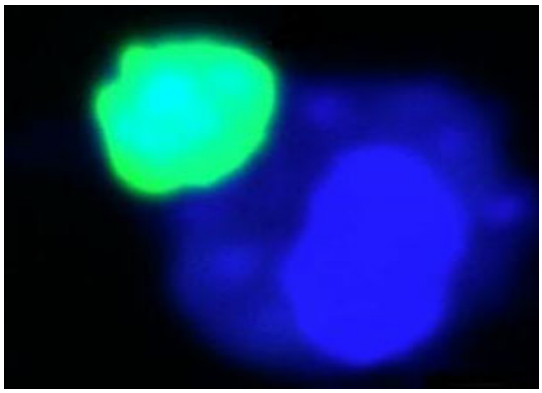
The alga and the bacterium met in the ocean, and forged a relationship based on nutrient exchange, researchers report in Science. The alga draws energy from sunlight and produces sugars, which the bacterium uses as fuel. In return, the bacterium processes nitrogen gas into ammonium, which the alga needs. This transfer can occur because the bacterium and the alga live close together, as the scientists know through microscopy and by the fact that the two cell types stayed together during a cell sorting experiment.

In the future, scientists predict, the two will be inseparable; the alga will engulf the bacterium, the bacterium will lose its individual identity and, instead, live as an organelle within the algal cell. The rest will be history.

Discussions Questions:

1. What theory would best describe the highlighted portion of the text?
2. How did endosymbiosis between an alga and a bacterium start?
3. What are the similarities between a blue-green bacterium and a chloroplast?

SITUATION 3:
Title: Zoologger: The cyanobacteria destined to be organelles
Written by: Andy Coghlan
Published by: New Scientist



Every so often biology unveils an organism that demonstrates evolution in action. More rarely, it offers up a twofer. Deep in the world's oceans, biologists have found a species of cyanobacterium that may be midway the process of becoming an organelle within a species of algae.

Candidatus* Atelocyanobacterium *thalassa *is a cyanobacterium like no other. Its streamlined genome shows that it excels at grabbing nitrogen from the water and turning it into a form (ammonium) that organisms can handle. But it lacks the genes for photosynthesis that other marine cyanobacteria use to generate their food. Unusually for a cyanobacterium, it must rely on another organism for its food.*

"It was hard to see how it could ever be a free-living organism," says Jonathan Zehr at the University of California, Santa Cruz. With his colleagues, Zehr has now identified that mystery second organism. It's a tiny type of algae called a ***prymnesiophyte****.*

What makes the marriage exciting from an evolutionary viewpoint is that it could turn out to be an example of a halfway stage towards the cyanobacterium eventually becoming an organelle within the alga – a huge evolutionary step for both organisms. Zehr's team demonstrated through delicate experiments that the cyanobacterium is closely enough associated with the alga that the two remain together during cell sorting – but filtering can separate the pair.

That suggests the cyanobacterium lives on the surface of the alga, perhaps in little depressions. This distinguishes it from other cyanobacteria that also have formed symbiotic relationships with algae. Most famously, one photosynthetic cyanobacterium found its way inside an alga billions of years ago, ultimately becoming the first chloroplast – the organelles where all plants fix carbon through photosynthesis.

Zehr speculates that some undiscovered algae may already have fully assimilated nitrogen-fixing bacteria like Candidatus Atelocyanobacterium thalassa. If such an alga exists, it would be the first member of the plant kingdom discovered that could fix its own nitrogen without relying on external organisms. "What we've

found is a model for the beginning stages of how organelles may have evolved on Earth," he says.

And that could have implications for agriculture. It would make sense to genetically engineer staple crops to fix their own nitrogen and reduce the need for expensive and environmentally damaging fertilizers. Yet while some plants, including legumes, can rely on terrestrial root bacteria to provide them with ammonium, researchers have struggled to generate crops that can do the same. The signals that pass between the root bacteria and legumes are just too complex to interpret and copy.

"The cyanobacterium provides a different model for how you might create interactions with plants," says Zehr. Ultimately, then, the research could potentially lead to a new way to feed the world – not a bad outcome from filtering seawater.

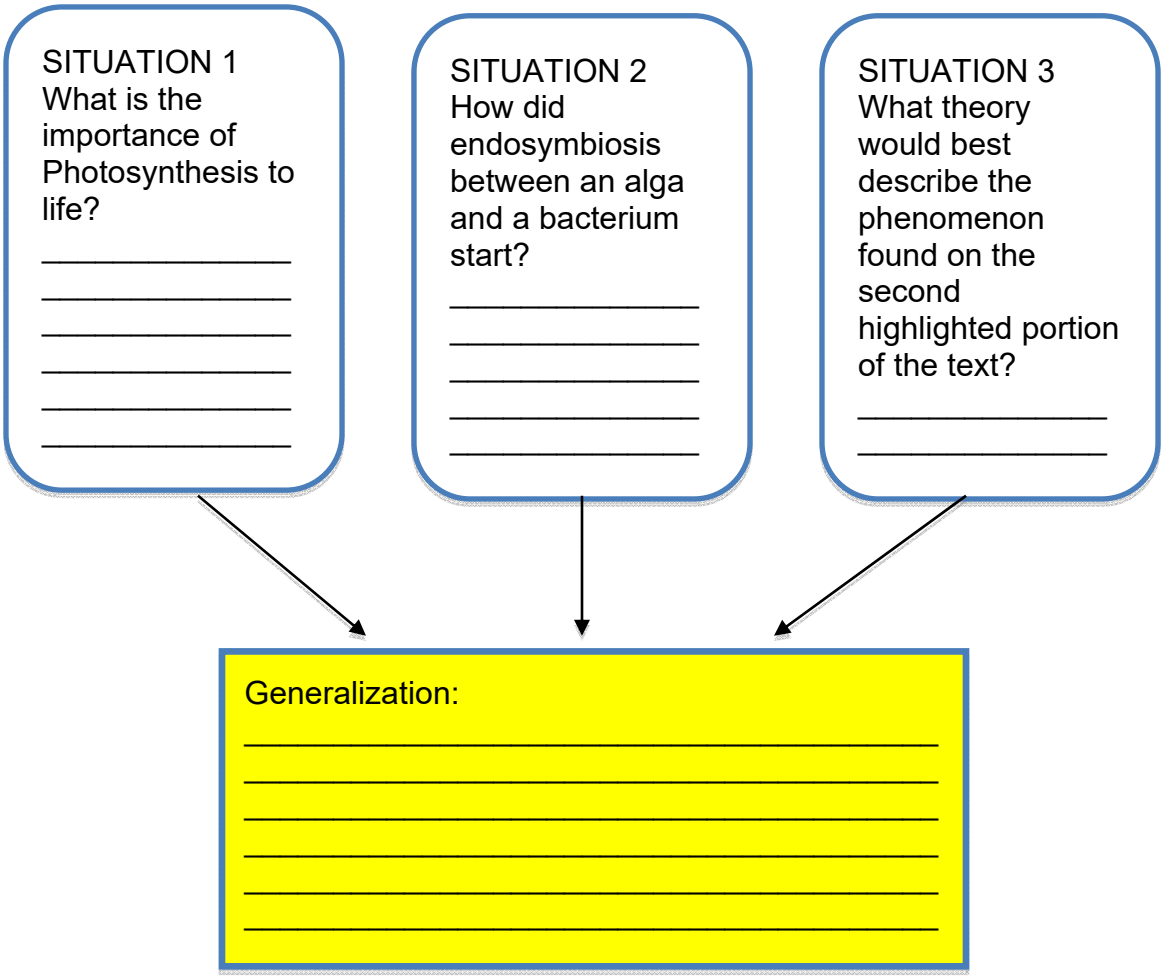
Discussions Questions:

1. According to the first highlighted portion of the text, what is unusual about this cyanobacterium?
2. How does *Candidatus Atelocyanobacterium thalassa* acquire its food?
3. What theory best describes the phenomenon found on the second highlighted portion of the text?

ACTIVITY NO. 21: MAKING GENERALIZATION

Let's find out what is common among the three articles above. Go back to the three situations and explain how they able support the working title of the activity: "The Origin of the Chloroplast: The History of Life"

Fill in the Organizational Chart below to help you answer this question. Use your answers on the discussion questions to make a generalization.



ACTIVITY NO. 22: LET'S INVESTIGATE!

At this point, you have fully understood the how photosynthesis and cell respiration work inside a living system. Now, we will be investigating on these processes by looking at concrete evidences of their occurrences.

To start with, let us analyze given data gathered from an experiment. Click on the link below then answer the questions found in this Experiment worksheet. Type in your answers in your Notepad and then E-mail it to your teacher afterwards.

Title: Photosynthesis Experiment Worksheet
http://campuses.fortbendisd.com/campuses/documents/Teacher/2011%5Cteacher_20111116_0925.pdf

ACTIVITY NO. 23: LET'S INVESTIGATE!

You are now familiar to how experimental designs are made. The previous activity has also helped you understand how to construct hypothesis and construct experiments that would test it. Let us now apply what you have learned to this next activity.

Let's start by clicking on the link below.

Title: Cellular Respiration Virtual Lab- Carbon Transfer Through Snails and Elodea
http://lhsblogs.typepad.com/files/cell-respiration-virtual-lab.pdf
Note: Be sure you go to the specific site for which the experiment title is found. Strictly follow all audio and test prompt during the virtual laboratory activity. You may print your answers by clicking on the PRINT button every step of the way as your guide.

Watch the following videos to help you accomplish this task.
Photosynthesis Video: http://www.youtube.com/watch?v=2xNwZCk2CHY
Investigating Photosynthesis:
http://www.youtube.com/watch?v=KpgZG9T0y34

ACTIVITY NO. 24: Revisiting K-W-L Chart

Now that you have understood the process of photosynthesis, you may complete K-W-L table. How do you think plants manufacture their own food?

PHOTOSYNTHESIS		
What I **K**now	What I **W**ant to Know	What I **L**earned

ACTIVITY NO. 25: MY LEARNING CHECKLIST

DESCRIPTION: Below are the target skills that we aim to acquire. Write a check under YES if you are able to learn the skill. Otherwise, put a check under the NO column. Click the SUBMIT button after completing the table.

OUR TARGET	YES	NO
1. Photosynthesis is a critical component of Earth in sustaining all living organisms.		
2. Photosynthesis does not happen only to plants. It may also happen to certain microorganisms like cyanobacteria.		
3. Endosymbiosis Theory describes how Eukaryotic organisms like algae and plants started to perform photosynthesis after primitive cyanobacteria have become a part of their internal structures.		
4. Photosynthesis is divided into two stages: Light-dependent reactions, where photolysis occurs liberating oxygen and Light-independent reactions, where Carbon dioxide together with the by-products of Light-dependent reactions (ATP and NADPH) are used to produce sugar.		
5. Plants perform both photosynthesis and respiration.		
6. Photosynthesis and respiration are reverse processes.		
7. Animals depend for plants for oxygen and food supply.		

End of DEEPEN:

In this section, the discussion was about the ability of organisms to manufacture their own food depends on the structure and function relationship among its organelles.

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 practical tasks that will demonstrate your understanding.

ACTIVITY NO. 26: Designing an Experiment

About 20% of the land Earth's Ice-free land surfaces are already Anthropogenic (habituated by humans). On the other hands, only about 3% of the land is covered by Tropical Rainforests. Using these data, how would you be able to prove that there is an imbalance between oxygen and carbon dioxide in the Earth's Atmosphere?

(1) Construct a hypothesis about this topic.

Hypothesis:
_____
_____
_____
_____

(2) Then, design an experiment procedure that will provide you with data that will either prove or disprove your hypothesis. *You may add more steps if necessary*.

Step 1:
_____
_____
_____
_____
_____
_____

Step 2:
_____
_____
_____
_____
_____
_____

Step 3:

Step 4:

ACTIVITY NO. 27: TRANSFER TASK

You are a genetic engineer specializing on agricultural biotechnology who has just engineered a new mutant that could produce excessive amount of starch products by magnifying the gene that codes for glucose production. This new innovation aims to improve the Philippine's cornstarch industry.

You need to convince the secretary of agriculture that your mutant corn is more efficient in producing its own food than the wild-type corn by providing concrete evidences that the mutant corn produces more starch by designing an experiment that would differentiate the mutant strain of corn from the wild-type corn. And since your mutant corn are not yet ready for investigation because they are not yet fully grown, you will just be showing evidences that the wild-type corn is undergoing Photosynthesis as a basal data for comparison. The secretary of agriculture will only be convinced if your narrative report on the experiment you have conducted is comprehensive, organized, accurate, and has depth.

Criteria	4 EXCELLENT (40 pts.)	3 SATISFACTORY (30 pts.)	2 DEVELOPING (20 pts.)	1 BEGINNING (10 pts.)
Comprehensive (25%)	The presentation is extensively supported with insightful justifications, evidence, facts and ideas.	The presentation is adequately supported with valid justifications, evidences, facts and ideas.	Some important facts and evidences were lacking or erroneous.	Presentation was superficial and not comprehensive.
Accuracy of data (20%)	Data were presented in an interesting manner and are accurately presented with no errors.	The data were accurate and free from errors.	Some details from the experiment have some errors.	The data were not accurate and have a lot of errors.
Depth of Investigation (30%)	The experimental design is done in great detail to arrive at substantial and solid conclusion.	The experimental design is just enough to arrive at a substantial conclusion.	The experimental design is limited to arrive at a substantial conclusion	The experimental design lacks substance and is not align with the purpose of the study.

Organization (25%)	The experimental results and discussion flows smoothly and logically. Clear and compelling evidences gathered from the experiment support the conclusion.	The experimental results and discussions flow smoothly. Clear and substantial evidences support conclusion.	The experimental results and discussions flow smoothly but the conclusion lacks supporting evidences.	The experimental results and discussion is not organized. The conclusion is not supported with evidences.

End of TRANSFER:

In this section, your task was to design and construct an experiment that will concretize the evidences that photosynthesis is actually occurring by investigating the production of oxygen and glucose.

How did you find the performance task? How did the task help you see the real world use of the topic?

ACTIVITY NO. 28: AFFIRMING NEW KNOWLEDGE THROUGH K-W-L CHART

Now that you have completed the module, let us affirm what you have learned. Complete the K-W-L chart. How are plants able to manufacture their own food?

PHOTOSYNTHESIS		
What I **K**now	What I **W**ant to Know	What I **L**earned

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. Which of the following does NOT show a metabolic process?
   a. A cyanobacteria living in the deepest sea.
   b. An insect displayed in a museum.
   c. An Elodea growing inside an aquarium.
   d. Leaves that capture sunlight to manufacture sugar.

(A) 2. Which of the following is NOT a by-product of photosynthesis?
   a. carbon dioxide
   b. oxygen
   c. ATP
   d. Glucose

3. Photosynthesis uses _____ and produces _____.
   a. carbon dioxide, glucose
   b. glucose, oxygen
   c. oxygen, carbon dioxide
   d. ATP, oxygen

(A) 4. Your hobby is to collect different species of aquarium fish. You have already grown 4 big species of fish in your 6-liter capacity aquarium and you added 6 more species inside. One morning, you notice that three of them look weak and seem like they are catching their breath towards the upper portion of the aquarium. What do you think is happening to your pets?

a. your pets are sleeping
b. your pets are not compatible to be occupying the same aquarium
c. there is no more enough space in your aquarium
d. the oxygen inside the aquarium is not enough to support them

(A) 5. Your hobby is to collect different species of aquarium fish. You have already grown 3 big species of fish in your 8-liter capacity aquarium and you added 5 more species inside. One morning, you notice that three of them look weak and seem like they are catching their breath towards the upper portion of the aquarium. What can you do to prevent your fish from suffocation?

a. Transfer some of the fish in a different aquarium.
b. Decorate your aquarium
c. Add more chlorine to the aquarium.
d. Add more water to the aquarium.

(A) 6. Your brother, Kyle Manuel saw your notes about the flow of energy and matter through Photosynthesis and Respiration. He finds its very similar to what he has learned from his fourth grade lesson on Oxygen-Carbon Dioxide cycle. How do you explain to him the relationship between the flow of gases in the oxygen-carbon dioxide cycle and the structures involved in photosynthesis and respiration?

a. Plants manufacture their own food through anabolism – that is, converting carbon dioxide to simple sugar. During this process, oxygen is released that are inhaled by animals.
b. Plants manufacture their own food through catabolism – that is, converting oxygen to simpler sugars. During the process, excess oxygen is released for the consumption of animals.
c. Photosynthesis is the breaking down of food and respiration is the production of food.
d. Animals produce oxygen that plants need for photosynthesis.

(A) 7. Study the structure and the process that happen in the given diagram below. What would be the best title for this diagram?

a. Flow of Energy and Matter
b. Oxygen and Carbon dioxide Cycle
c. Water, Carbon dioxide, and Oxygen Cycle
d. Animal and Plant Cycle

(A) 8. What would best explain this ability of plants of performing both of these metabolic processes?
   a. Plants are eukaryotic unlike most organisms.
   b. Some plant cells contain both chloroplasts and mitochondria.
   c. Plants have learned to adapt to their environment.
   d. Plants inhale oxygen from the atmosphere that drives these metabolic processes.

(M) 9. Read the following cases below and answer the question that follows.

I. In one experiment, to show the effect of temperature to the solubility of gas solutes in liquid solvents, you boiled and immediately cooled a sample of tap. As soon as the water has achieved room temperature, you allowed three species of fish to swim into your water sample. After few minutes, all three fish died.

II. In another set-up, you did the same procedure as the first one but this time, you allowed ten healthy Elodea plants to grow inside the aquarium for three hours before you place the fish. You noticed that the fish survived.

III. In one experiment, you kept a terrarium inside a dark room. After two days you noticed that the plants inside became dull and withered while the some insects are already dying. You decided to put back the terrarium outside the room and allow it to receive sunlight. After another two days, you noticed that the plants have regained their color.

Which of the following statements is TRUE in all of the given cases above?
   a. Plants contain chloroplasts that, in the presence of sunlight, enable them to produce their own food and along with this process is the production of oxygen gas.
   b. Animals are dependent to plants for their food.
   c. Plants are dependent on animals.
   d. Chloroplast is not found in animals, in effect, animals are dependent on plants for their food.

(M) 10. Read the following cases below and answer the questions that follow.

I. Most plants contain inside their cells a green pigment called chlorophyll that actually reflects the green light. This pigment is specifically located in an organelle called chloroplast. This pigment makes plants capable of utilizing the energy from the sun. This energy drives the first stage of photosynthesis that is usually referred to as the Light-dependent reaction. The light-dependent reaction will

produce organic molecules that are used as either raw materials or energy source for the second stage of photosynthesis. This stage is usually called the Light-independent reaction or the Calvin cycle. The two stages of photosynthesis all happen inside the chloroplast.

II. Cyanobacteria are aquatic and photosynthetic, that is, they live in the water, and can manufacture their own food. Because they are bacteria, they are quite small and usually unicellular, though they often grow in colonies large enough to see. The other great contribution of the cyanobacteria is the origin of plants. The chloroplast with which plants make food for themselves is actually a cyanobacterium living within the plant's cells. Because they are photosynthetic and aquatic, cyanobacteria are often called "blue-green algae" because of the chlorophyll-like pigment that they contain. Cyanobacteria are relatives of the bacteria, not eukaryotes, and it is only the chloroplast in eukaryotic algae to which the cyanobacteria are related.

III. Phycoerythrin is an accessory photoreceptor pigment found in the Rhodophyta ("red algae"). Phycoerythrin is associated with chlorophyll in the Rhodophyta, and enables them undergo photosynthesis efficient even in deep water where blue color predominates. The longer wavelength red portion of the spectrum that activate green chlorophyll pigments do not penetrate the deeper water of the photic zone, so green algae cannot survive at depth where red algae thrive. (http://oceanexplorer.noaa.gov/facts/red-color.html)

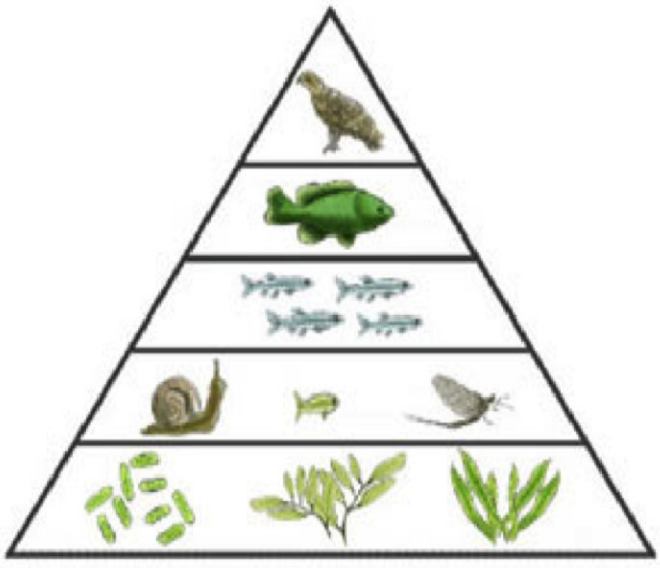
a. Photosynthesis happens in both terrestrial and aquatic ecosystems.
b. Photosynthesis is driven by different types of light-absorbing pigments.
c. Different organisms would have different ways of doing photosynthesis.
d. Plants are the only group of organisms that can produce their own food through photosynthesis.

(M) 11. Read the following articles/models below then identify the unifying idea among the three situations.

I. Coral polyps are invertebrates, part of a large group of animals called Cnidaria, which also includes jellyfish and sea anemones. Although corals can use stinging cells on their tentacles to catch small fish or plankton, most get the bulk of their energy and nutrients from zooxanthellae, photosynthetic algae that use sunlight to manufacture their own food.

II. Pea aphids may have an unprecedented ability to harvest sunlight, and use the energy for metabolic purposes. It would make it the only species of animal known to have photosynthesis-like powers.
It comes down to carotenoids, which are a type of pigment used in animals for crucial functions like vision, bone growth and vitamin production.
(http://www.wired.com/wiredscience/2012/08/green-aphid-photosynthesis/)

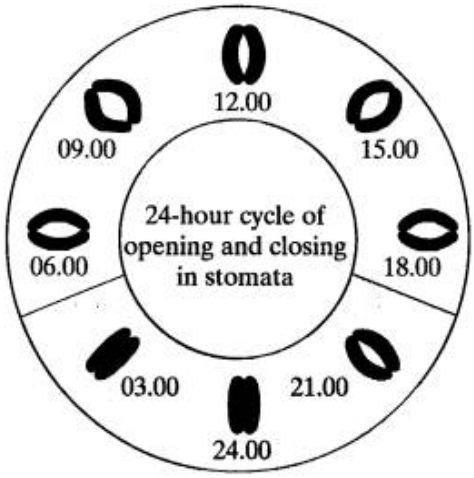
III.



http://www.learner.org/courses/essential/life/session7/closer5.ht

a. Sun is the ultimate source of all energy and food.
b. Animals are all dependent on plants.
c. Plants do not need animals to survive.
d. Even small animals are dependent on plants for their food.

(M) 12. Photosynthesis comes from the combination of two words, “photo” meaning light and “synthesis” meaning mixing. In relation to this, why do you think stomata reopen at 6:00 am as shown below?

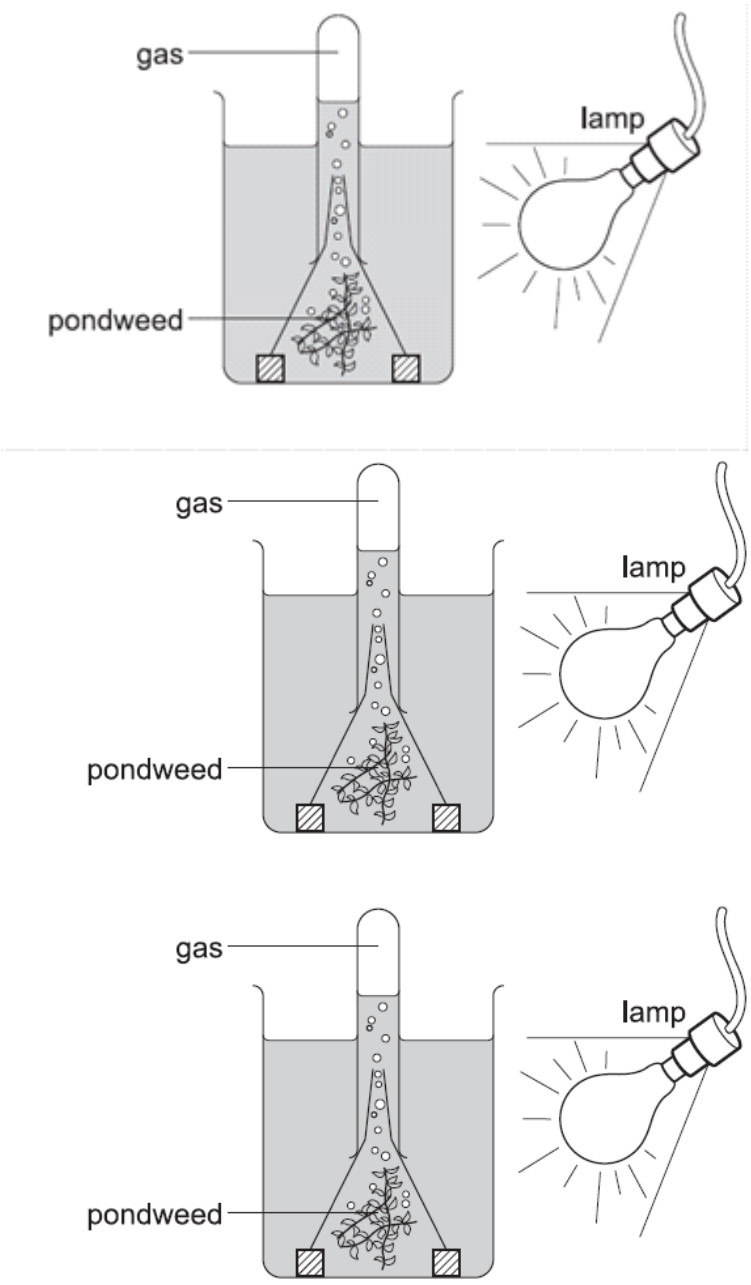


a. So that oxygen, a product of light-dependent reactions will be released.
b. So that excess carbon dioxide can exit.
c. So that water can enter the leaves.
d. So that carbon dioxide can enter the light-dependent reactions.

(M) 13. Which of the following statements accurately describes the relationship between photosynthesis and cell respiration?

a. Photosynthesis happens only in autotrophs while cell respiration only happens in heterotrophs.
b. Photosynthesis uses solar energy to convert inorganic molecules to energy-rich organic molecules while cell respiration breaks down organic molecules to synthesize ATP.
c. The primary function of photosynthesis is to use solar energy to synthesize ATP while cellular respiration functions to break down ATP and release energy.
d. Photosynthesis and cell respiration happens in separate, specialized organelles and the two processes cannot occur in the same cell at the same time. Photosynthesis captures the solar energy to convert inorganic carbon dioxide to organic sugar (glucose). Cell respiration, on the other hand, uses this chemical energy source to synthesize ATP. These two processes may happen in the same cell at the same time.

(M) 14. An investigation to find out the effects of the presence of light in the process of photosynthesis is conducted as shown in the illustration below. The rate of photosynthesis is measured as the volume of gas increases. Using your knowledge and understanding about photosynthesis and cell respiration, can you assume that the gas liberated by the plant is purely oxygen?



a. Yes, plants use carbon dioxide and water to manufacture their own food and oxygen is the only gas that is released as a waste product in this process.
b. Yes, plants tend to consume all the carbon dioxide in the experimental setup to manufacture their food. However, some oxygen gas is also used for cell respiration.
c. No, plants also releases excess carbon dioxide during the process of photosynthesis.
d. No, plants produce oxygen during photosynthesis and releases carbon dioxide in the process of cell respiration.

(T) 15. Read the following conclusions based from an explorative experiment on the function of chloroplast of three different biology students. Determine which of the three students provided the most accurate and in depth investigation about the given hypothesis below.

Hypothesis: Taller plants require more water to survive than smaller ones.

Lani : After doing an experiment for two weeks, using two plants of the same species and sizes, it has been found out that Plant A requires more water than Plant B. This is for the fact that there is more excess water draining from the pot of Plant B. The two plants were planted on the same soil type. They also received the same amount of sunlight within the entire experiment.

Luz – After doing an experiment for two weeks, using the same species of plant coming from two different donors in the community, it has been found out that the size did not significantly influence the amount of water required by the plant. This is because both of the plants were able to survive when given the same amount of water and sunlight.

Kris – After doing an experiment for two weeks, using two plants of the same species coming from the same garden but with different sizes, it has been found out that the taller plant requires more water than the smaller plant. Since when given the same amount of water for two weeks, putting all factors that affect the growth of plant constant (e.g. soil quality, sunlight, location), the smaller plant was able to stay alive while the taller plant died.

a. Lani
b. Kris
c. Luz
d. All of them have designed a good experiment that would generate an accurate proof about the hypothesis.

(T) 16. The graphs below show the effect of light intensity on the rate of photosynthesis at different carbon dioxide concentrations. Which of the following is the best interpretation of the graphs?

a. Sunlight is more important than carbon dioxide in photosynthesis. Photosynthesis is favored as light intensity increases.
b. The higher the carbon dioxide concentration, the higher the rate of photosynthesis. An increase in light intensity, on the other hand, only increases the rate of photosynthesis at the beginning and eventually approaches a plateau.
c. Too much sunlight does not induce an increase in the rate of photosynthesis when carbon dioxide concentration is low. Therefore, carbon dioxide concentration should increase as light intensity increases.
d. The rate of photosynthesis is directly proportional to light intensity and inversely proportional to carbon dioxide concentration.

(T) 17. When a mouse is placed under a glass jar, it eventually runs out of oxygen and dies. How could you prevent this from happening?

a. Add another mouse inside the jar.
b. Add a plant inside the jar.
c. Add candle to the jar
d. Fill the jar with smoke before adding the mouse.

(T) 18. The graph below represents the absorption spectrum of chlorophyll. The graph indicates that the energy used in photosynthesis is most likely obtained from which regions of the spectrum?
   a. yellow and orange red
   b. violet blue and green
   c. orange red and violet blue
   d. green and yellow

(T) 19. Why do you think animals, unlike plants, need to ingest food containing glucose in order to survive?
   a. All organisms require energy to survive. Autotrophs get their stored energy through photosynthesis. Animals can only acquire glucose through ingestion.
   b. The presence of mitochondrion in both plants and animals signify the need for glucose as a chemical energy source. However, between the two, only plants would have chloroplast containing chlorophyll that would manufacture glucose from carbon dioxide.
   c. All organisms have mitochondria that use glucose as an energy source.
   d. Both a and b

(T) 20. A green plant is kept in a brightly lighted area for 48 hours. What will most likely occur if the light intensity is then reduced slightly during the next 48 hours?
   a. The rate at which nitrogen is used by the plant will increase.
   b. Photosynthesis will stop completely
   c. The rate at which oxygen is released from the plant will decrease.
   d. Glucose production inside each plant cell will increase.

GLOSSARY OF TERMS USED IN THIS LESSON:

Algae - are a very large and diverse group of simple, typically autotrophic organisms, ranging from unicellular to multicellular forms, such as the giant kelp, that may grow up to 50 meters in length.

Anabolism – a form of metabolism by which simpler substances are synthesized to make more complex ones. A popular example is growth and polymerization of importance biomolecules such as polypeptides and nucleic acids. Usually, energy is consumed during the process.

Catabolism – a form of metabolism by which complex substances are broken down to simpler substances. Usually, energy is liberated during the process.

Chemosynthesis - is the process by which food (glucose) is made by bacteria using chemicals as the energy source, rather than sunlight.

Chlorophyll – A green pigment found in the chloroplast that enables them to capture the energy from the sun.

Chloroplast – A eukaryotic organelle that are usually found in plants and algae. This organelle enables organisms to manufacture their own food through photosynthesis.

Cyanobacteria – A primitive photosynthetic bacteria that is believed to initiate life on Earth by producing Earth's initial supply of oxygen. This organism is usually found in aquatic environments.

Elodea - Elodea is a rooted multi-branched perennial plant but can survive and grow as floating fragments. The dark green blade-like leaves (3/5 inch long and 1/5 inch wide) are in whorls of three with finely toothed margins. The flowers of Elodea have three white petals with a waxy coating that makes them float.

Endosymbiosis - The theory of Endosymbiosis explains the origin of chloroplasts and mitochondria and their double membranes. This concept postulates that chloroplasts and mitochondria are the result of years of evolution initiated by the endocytosis of bacteria and blue-green algae. According to this theory, blue green algae and bacteria were not digested; they became symbiotic instead.

Eukaryotic – Type of cell that contains internal membrane structures. This characterizes all plants, animals, protists, and fungi.

Hydrothermal vents - are areas on the sea floor where water heated by volcanic activity under the seabed gushes out. Unusually, the animal communities down here don't use the sun to get their energy. Instead, chemicals in the hot waters

form the basis of the food chain. Hydrothermal vent communities do, however, still rely on oxygen produced by photosynthesis in the sunlit zones.

Light-dependent reaction – This is the first stage of photosynthesis wherein sunlight is captured by the chlorophyll to reduce NADP and ADP in the presence of water to produce NADPH and ATP which will then be used for the final stage of photosynthesis.

Light-independent reaction – This is he second and final stage of photosynthesis wherein carbon dioxide are utilized to produce sugar. This reaction is also known as the Calvin cycle. ATP and NADPH that were produced during the first stage of photosynthesis drive this reaction. This is called Light-independent reaction because this does not require sunlight to occur.

Metabolism – is any chemical reaction that is happening inside a living system. Usually, this is driven by various enzymes and ATP.

Mitochondrion (plural: mitochondria) – This is a eukaryotic organelle that serves as the site of ATP production. According to the Endosymbiotic Theory, this organelle was once a unicellular bacteria.

Photosynthesis – This is the process by which autotrophs manufacture their own food with the use of inorganic sources in the presence of sunlight.

Prokaryotic – This is a type of cell that characterizes all bacteria. Organisms with this cell type do not have membrane bound organelles.

Thylakoid – This is a membrane-bound compartment inside chloroplasts and cyanobacteria. This is the site of light-dependent reactions.

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Lesson 3: Heredity: Inheritance and Variation Biodiversity

INTRODUCTION AND FOCUS QUESTION(S):

Many times you may have heard other people tell you that you have your mother's eyes or your father's height. While you know that these are characteristics you inherited from your parents, you also know that they did not literally give you their eyes, height, skin, hair, or any other traits. What, then, is actually inherited? How are these traits inherited? Do they follow a certain unique pattern?

In this module, you will learn more about the "hereditary factors" originally described by Gregor Mendel. You will also look at different patterns of inheritance and have a better understanding of variation.

This module will also cover an important concept that is related to genetic variation – biodiversity. In particular, you will study species extinction, a persistent threat to our biodiversity. You will explore answers to the following important questions: Why do species go extinct? How can species be saved from the threat of extinction?

LESSON AND COVERAGE:

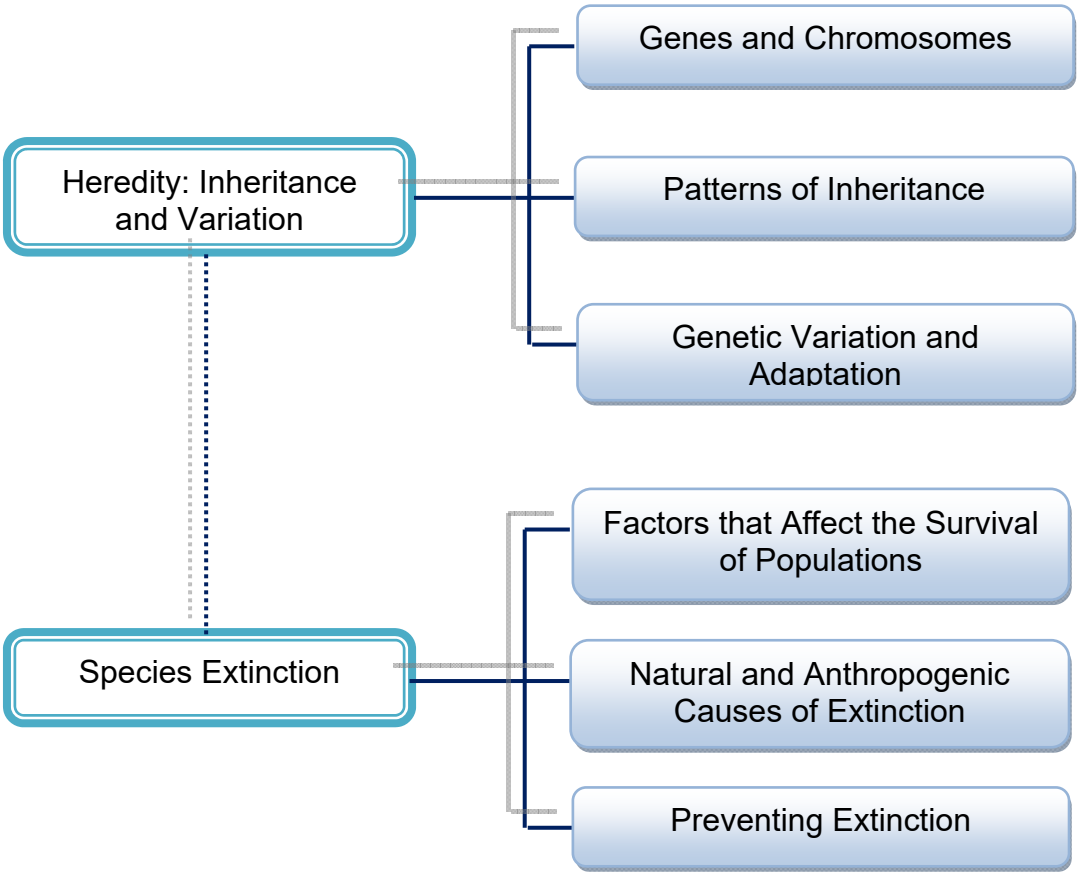
In this lesson, you will examine this question when you take the following topics:

1. Heredity: Inheritance and Variation
2. Species Extinction

In these topics, you will learn the following:

1	• Describe the location of genes in chromosomes. • Explain the different patterns of non-Mendelian inheritance. • Infer patterns of inheritance involved in different situations.
2	• Identify the different factors that affect the survival of populations. • Relate species extinction to the failure of populations to adapt to abrupt changes in the environment.

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 lesson. 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 lesson.

(A) 1. Which one is not a probable cause of extinction of species?
   A. Introduction of alien species
   B. Habitat alteration
   C. Creation of wilderness areas
   D. Overhunting

(A) 2. Mario's thinning hair is like that of his father. This characteristic of baldness is influenced by
   A. crossing-over.
   B. linked genes.
   C. mutation.
   D. sex chromosomes.

(A) 3. Red-green color blindness is caused by a recessive gene found in the X-chromosome. Can two normal parents produce a color-blind son?
   A. No
   B. Yes, at all times
   C. Yes, if the female parent is a carrier
   D. Yes, if the male parent is a carrier

(A) 4. Which of the following populations is most likely to go extinct?
   A. A large population with high genetic variability
   B. A moderate-sized population with high fecundity and wide offspring dispersion
   C. A very small population in an unstable environment
   D. All would be equally likely to go extinct

(A) 5. It is believed that about 90% of the land area of the Philippines was once covered with forest. This has now been reduced to less than 20% and, if the current rate of deforestation is maintained, no forest cover shall remain within the next decade. Scientists are looking at tropical deforestation rates as parameters to estimate species extinction rates in the Philippines. This best illustrates which of the following?
   A. An ecosystem cannot survive without producers.
   B. Many species are endangered due to habitat loss.
   C. Species go extinct even before they are discovered.
   D. Tropical forests are great carbon sinks.

(A) 6. Due to global warming, what changes are taking place in the Arctic that puts polar bears, whales, walruses, and seals in serious danger of going extinct?

A. The polar ice cap is melting causing rise in sea levels and flooding that affects all species.
B. The polar ice cap is rupturing threatening low-lying areas with contamination of water supplies.
C. The polar ice cap is shrinking affecting the feeding and migration patterns of species.
D. The polar ice cap is thinning making the Arctic warmer which affects the weather patterns.

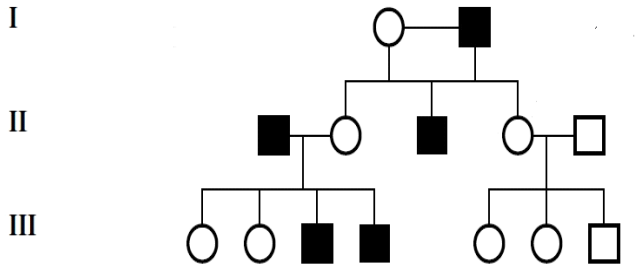
(M) 7. Arielle is in urgent need of blood transfusion. Her blood type is A; that of her sister is AB, and her brother, B. Who among the following can donate blood to Arielle?

A. Her brother
B. Her sister
C. One of her parents
D. No one from the family

(M) 8. Suppose that a certain genetic disorder is caused by a dominant gene found in the X chromosome. Can two parents suffering from the said genetic disorder have normal daughter?

A. No
B. Yes, if the female is a carrier
C. Yes, if the male is a carrier
D. Yes

(M) 9. Refer to the pedigree of a certain trait given below:



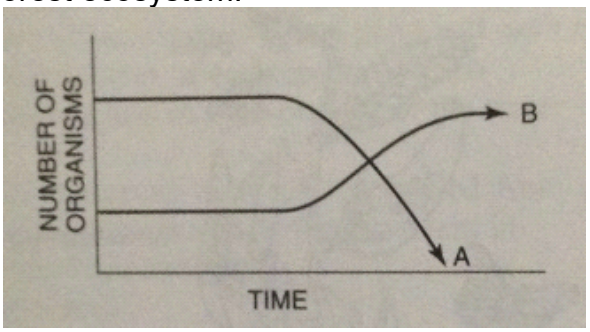
Based from the pattern of inheritance, what kind of gene controls the trait?

A. Codominant
B. Epistatic
C. Recessive
D. Sex-linked

(M) 10. Which population is most likely to exhibit an evolutionary response to a change in its environment?

A. A population in which all organisms are genetically identical and has high reproductive rate
B. A population in which the effect of competition is increased by lack of behavioural adaptation
C. A population which has high genetic variability
D. A population which is on an isolated island

(M) 11. The graph below shows the changes in two populations of carnivores in a forest ecosystem.



A possible reason for these changes is that

A. Population A has higher reproductive rate and adaptive capacity than Population B.
B. Population A consumed the members of Population B.
C. Population B competed more successfully for food than Population A did.
D. The habitat was stricken by a natural calamity.

(M) 12. Your friend tells you, “It doesn’t matter so much anymore if species go extinct, as long as we have already identified the genus of each species before it goes extinct.” What would you say to convince your friend that species extinction does matter?

A. Species extinction damages the balance of ecosystem, bringing harm to humans like us.
B. Species extinction lowers the biological diversity, affecting ecosystem function and services that humans benefit from.
C. Species extinction lowers the profit that countries gain from tourism.
D. Species extinction may cause dramatic changes in the environment which will eventually affect us.

(T) 13. Some scientists estimate that the current global extinction rate is about 30,000 species per year. If there are currently 10,000,000 species on Earth, how long will it take to destroy all of Earth's biodiversity?

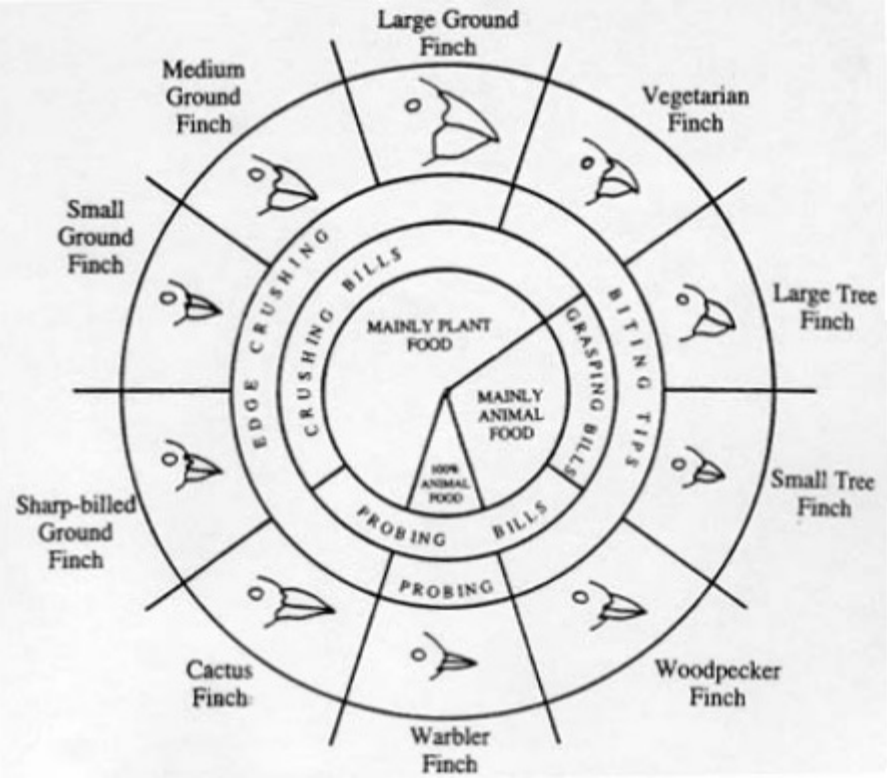
A. Less than 100 years
B. Between 100 and 300 years
C. Between 300 and 500 years
D. Between 500 and 700 years

(T) 14. Some scientists estimate that the current global extinction rate is about 30,000 species per year. If there are currently 10,000,000 species on Earth, how long will it take to destroy all of Earth's biodiversity?

If you are to share the data to a group of students, which of the following is the best way to present?

A. Through a graph
B. Through a research
C. Through a timeline
D. Through a video

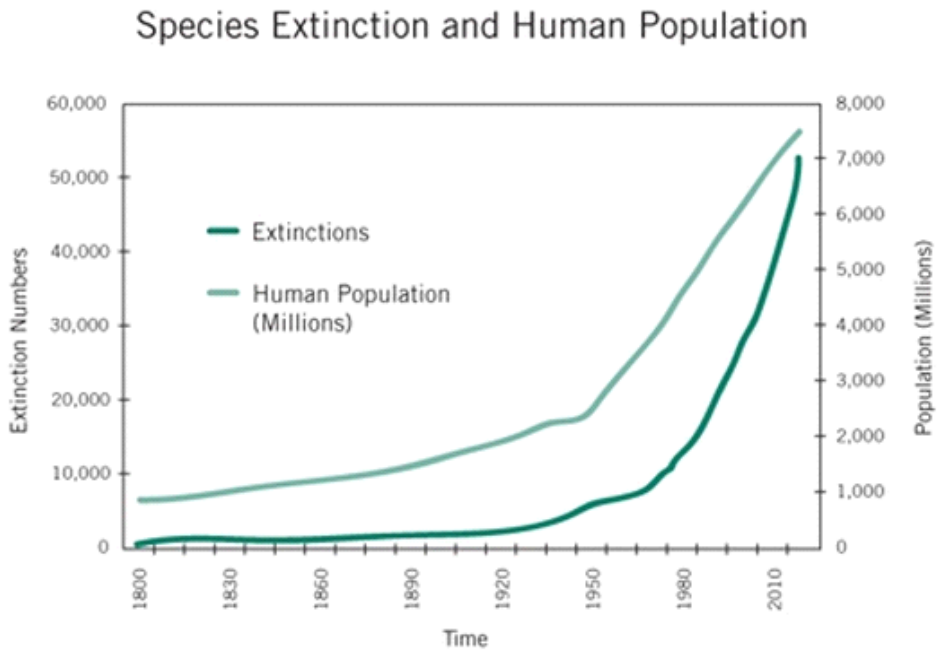
(T) 15. You are a scientist investigating the causes of species extinction. Like Charles Darwin, you would like to gain a lot of insights from what happened in Galapagos Island. Refer to the chart found below taken from Galapagos: A Natural History Guide:



A major environmental change occurs in the Galapagos Island that eliminates most of the plants that produce small seeds. What remained are plants that produce large seeds with thick, hard coverings. In terms of food gathering, which finch species had the greatest adaptive advantage under the changed set of conditions?

A. Large ground finch
B. Small ground finch
C. Large tree finch
D. Small tree finch

(T) 16. Refer to the graph given below:



After analyzing this graph, what will be your best recommendation?

A. Examine the feeding and mating behaviour of the species that are facing high risk of extinction.
B. Focus on factors that are mainly causing species extinction such as invasive species and natural calamities.
C. Humans should live in such a way that will allow for enough room and resources for other species to survive.
D. Keep the human race at a level where it has enough food and clean water to survive.

(T) 17. Refer to the following data about the five worst mass extinctions in history:

EXTINCTION EVENT	PROBABLE CAUSES
Ordovician-Silurian extinction	Drop in sea levels as glaciers formed followed by rising sea levels as glaciers melted.
Late Devonian extinction	Triggered by another glaciation event on Gondwana, which is evidenced by glacial deposits of this age in northern Brazil
Permian-Triassic extinction	Comet or asteroid impact led to this extinction; Others think that volcanic eruption, coating large stretches of land with lava from the Siberian Traps, which are centered around the Siberian City of Tura, and related loss of oxygen in the seas were the cause of this mass extinction; Still other scientists suspect that the impact of the comet or asteroid triggered the volcanism.
End Triassic extinction	Massive floods of lava erupting from the central Atlantic magmatic province triggering the breakup of Pangaea and the opening of the Atlantic Ocean; the volcanism may have led to deadly global warming.
Cretaceous-Tertiary extinction	Impacts of several-mile-wide asteroid; Yet, some scientists believe that this mass extinction was caused by gradual climate change or flood-like volcanic eruptions of basalt lava from the Deccan traps west-central India.

Having studied this information, could the Earth be experiencing a sixth mass extinction?

A. No, all extinctions are caused by massive, natural phenomena
B. No, biodiversity nowadays is richer than ever
C. Yes, we are losing species at an alarming rate due to global warming and climate change
D. Yes, species go extinct faster than the normal rate due to human activities that trigger global warming, climate change, and rising sea level

(T) 18. Can we “resurrect” extinct species? If you are a researcher for a Science journal and you want to investigate on this issue, who among the following will you interview to get the most plausible answer?

A. Cytologist
B. Geneticist
C. Paleontologist
D. Taxonomist

Topic 1: HEREDITY: Inheritance and Variation

EXPLORE :

In the previous grade, you learned how Gregor Mendel described the passing of traits from one generation to the next. His principles laid the foundation for the study of inheritance. The potential combinations of offspring from two parents of known genotype can now be determined. Traits can more easily be predicted.
Still, an important question remains. Do all organisms pass on their traits this way? Learn more about Mendel's "hereditary factors" and the other inheritance patterns they may follow.

Let's start the module by gathering your thoughts about the inheritance of traits.

ACTIVITY NO. 1.1: CASE ANALYSIS

Hemophilia is a bleeding disorder characterized by slow blood clotting process. People with this condition experience prolonged bleeding following an injury, surgery, or having a tooth pulled. In severe cases, bleeding occurs after minor trauma or even without an injury. Hemophilia is an inherited disorder.

Discover how this trait is inherited as you go through this module. For your inquiry, consider this case:

N.T. is a healthy 38-year-old woman married to a healthy 40-year-old man. Their first child is a boy with hemophilia. Their second child is a girl who is normal. Their youngest is another boy, again with hemophilia.
N.T. had a maternal uncle who had died in childhood from hemophilia and a brother who had bleeding problems as a child but these were resolved during his adolescence.

Process Questions:
1. Is there an obvious pattern in the cases of hemophilia presented in the given situation?
2. Is there any irregularity in the inheritance of hemophilia in N.T.'s family? Why or why not?

3. If N.T. and her husband will have a fourth child, will the child suffer from hemophilia? Why do you say so?
4. *What do you think are the factors that influence how **traits** are inherited?*

ACTIVITY NO. 1.2: ELICITING PRIOR KNOWLEDGE THROUGH I-R-F CHART

In the previous activity, you were asked to think about the factors that influence the inheritance of traits. ***How are traits inherited?***

What are your initial answers to this question?
Summarize your answers to the question, and your thoughts and ideas in the first column (Initial) of the IRF Chart. When you are finished, click on "Submit."

How are traits inherited?		
Initial	Revised	Final

End of EXPLORE:

You gave your initial ideas on the inheritance of traits by answering the IRF 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. This project is scientific investigation about genetic variation and adaptation.
We will start by doing the next activity.

FIRM UP:

Your goal in this section is to learn and understand key concepts about inheritance: the chromosomal basis of inheritance and the non-Mendelian

patterns of inheritance. The competencies you are to learn are listed in the checklist below. Monitor your accomplishment in these competencies.

CHECKLIST OF COMPETENCIES	
	Describe the location of genes in chromosomes.
	Explain the different patterns of non-Mendelian inheritance.
	Infer patterns of inheritance involved in different situations.

ACTIVITY NO. 1.3: RELATING MENDELIAN PRINCIPLES TO CHROMOSOMES AND GENES

Part I. Review of Mendelian Principles

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

Review your knowledge of Mendelian genetics by exploring the following links:

http://www.wiley.com/college/test/0471787159/biology_basics/animations/mendelianInheritance.swf - Mendelian Inheritance

Questions:
1. What are "hereditary factors?"
2. What are the principles that Mendel formulated after his experiments with pea plants?

http://www.sumanasinc.com/webcontent/animations/content/mendel/mendel.html - Mendel's Experiments Animation

Questions:
By following Mendel's laws and principles, you can predict the traits of the offspring given the phenotypes and genotypes of their parents.
Test your skill in using Punnett square and solving genetic problems by answering the following:

1. When Mendel crossed a homozygous tall pea plant (TT) with a homozygous short pea plant (tt), what offspring was produced?

	T	T
t	Tt (tall)	Tt (tall)
t	Tt (tall)	Tt (tall)

2. In dogs, there is hereditary deafness caused by a recessive gene, **d**. Predict the offspring for the following crosses: DD and dd; Dd and dd.

	D	D
d	Dd (not deaf)	Dd (not deaf)
d	Dd (not deaf)	Dd (not deaf)

	D	d
d	Dd (not deaf)	dd (not deaf)
d	Dd (not deaf)	dd (not deaf)

Process Question:
What are the important conclusions made by Mendel? Make a list of these conclusions.

Let us go back to the N.T.'s case presented at the start of the lesson:

N.T. is a healthy 38-year-old woman married to a healthy 40-year-old man. Their first child is a boy with hemophilia. Their second child is a girl who is normal. Their youngest is another boy, again with hemophilia.
N.T. had a maternal uncle who had died in childhood from hemophilia and a brother who had bleeding problems as a child but was resolved during his adolescence.

Process Questions:
1. How do you think would Gregor Mendel explain why N.T. and her husband had 2 hemophiliac sons when both of them are healthy?

2. How do you think is this trait inherited? Explain using the principles of Mendel.

Part II. Mendelian Genetics and Chromosomes

Mendel discovered that the *hereditary factors* are passed from the parent to the offspring. However, he did not specify where these factors are found. The work of cytologists paved the way to the discovery of the physical basis of Mendelian inheritance.

In 1875, cytologists were able to work out the process of **mitosis**, and the process of **meiosis** in 1890.

Review your knowledge of mitosis and meiosis by exploring the following links:

http://www.pbs.org/wgbh/nova/body/how-cells-divide.html - Interactive Comparison of Mitosis and Meiosis

http://learn.genetics.utah.edu/content/begin/tour/mitosis.swf - Comparison of Mitosis and Meiosis

Now let us focus on meiosis or the division of reproductive cells. View the animation found in this link:
http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter28/animation__how_meiosis_works.html - Animation of Meiosis

Process Questions:
1. Which parts of the cell are involved in cell division?

2. Describe the behavior of chromosomes during meiosis.

3. Do you notice any similarity between the behavior of chromosomes during meiosis and the behavior of *Mendel's hereditary factors*? Explain.

Exercise 1.

You were given this question in the previous activity: *Do you notice any similarity between the behavior of chromosomes during meiosis and the behavior of Mendel's hereditary factors?*

Let's confirm your answers by completing this table:

Go back to the list you made about Mendel's conclusions about heredity. Summarize them and write in the first column of the table below. Then, recall how you described the behavior of chromosomes during meiosis in the previous activity.
Complete the table below to compare Mendel's description of hereditary factors and the behavior of chromosomes during meiosis. Once you are done, click "Submit."

MENDELIAN GENETICS	CYTOLOGY
What are the conclusions made by Mendel about heredity?	*What do studies show about the behavior of chromosomes during meiosis?*

Look for similarities between your entries under "Mendelian Genetics" and "Cytology." Highlight or take note of these similarities.

Refer to this table. Were you able to spot these similarities?

MENDELIAN GENETICS	CYTOLOGY
What are the conclusions made by Mendel about heredity?	*What do studies show about the behavior of chromosomes during meiosis?*
• Hereditary factors occur in pairs. • Hereditary factors segregate such that the offspring receives only one of each pair from the parent (Law of Segregation).	• Chromosomes occur in pairs in diploid cells (homologous chromosomes pair up during prophase I). • Homologous chromosomes separate during Anaphase I such that each reproductive cell bears only one of the pair in diploid cells (reproductive cells are therefore haploid).

• The offspring receives an allele from each of the parent, thus restoring the hereditary factor pair.	• Fertilization restores the diploid condition.

What seems to be the relationship between ***Mendel's hereditary factors*** and ***chromosomes?***

Walter Sutton and Theodor Boveri in 1902 linked genetics and cytology as they noticed the following:

- Chromosomes and *hereditary factors* are both paired in diploid cells.
- Homologous chromosomes separate and allele pairs segregate during meiosis.
- Fertilization restores the paired condition for both chromosomes and genes.

ACTIVITY NO. 1.4: WEBPAGE READING: CHROMOSOMAL BASIS OF INHERITANCE

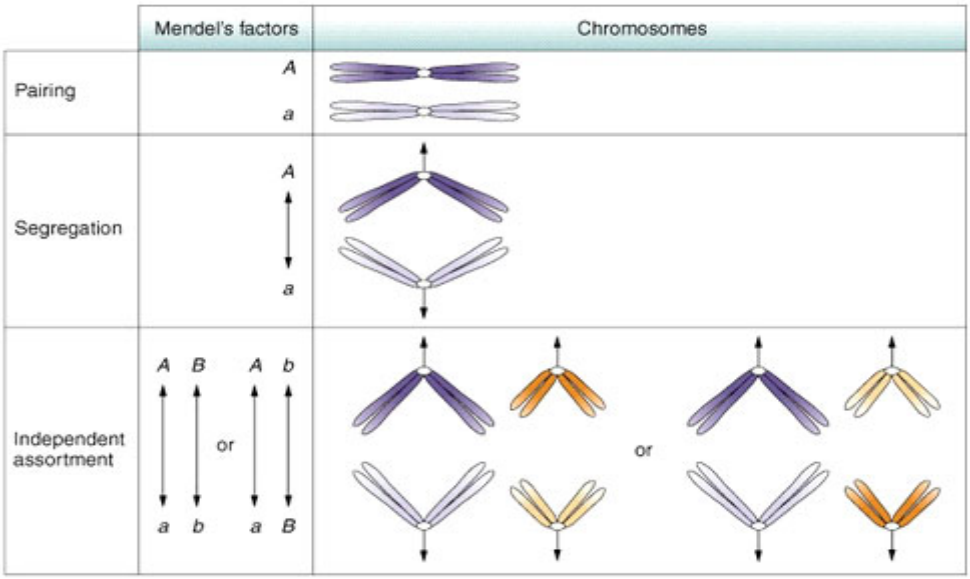
Where are the "hereditary factors" of Mendel located? Where are they found inside the cell? Are they all over our body, maybe in our blood? Hence the common remark *"Nasa dugo nila ang ganyang katangian"* or *"Nasa dugo lang yan!"*

The **chromosome theory of inheritance** provides answers to these questions. Find out by studying about the chromosomal basis of inheritance. Read and explore the following links:

http://www.course-notes.org/Biology/Outlines/Chapter_15_The_Chromosomal_Basis_of_Inheritance - Chromosomal Basis of Inheritance

http://www.tutorvista.com/content/biology/biology-iii/heredity-and-variation/chromosome-theory-inheritance.php - Chromosome Theory of Inheritance

The diagram below shows the comparison between Mendel's factors and chromosomes.



http://www.mun.ca/biology/desmid/brian/BIOL2250/Week_Two/1GeneW2.html

Process Questions:

1. How do we now call Mendel's hereditary factors?
2. Where are these hereditary factors located?
3. What are the physical carriers of genetic information?
4. What then do we really inherit from our parents?

Time to go back to N.T.'s case:

N.T. is a healthy 38-year-old woman married to a healthy 40-year-old man. Their first child is a boy with hemophilia. Their second child is a girl who is normal. Their youngest is another boy, again with hemophilia.
N.T. had a maternal uncle who had died in childhood from hemophilia and a brother who had bleeding problems as a child but was resolved during his adolescence.

Process Question: As you learn about chromosomes, can this shed light to this case? How?

ACTIVITY NO. 1.5: TOUR OF THE BASICS: GENES AND CHROMOSOMES

Now that you understand the genes and chromosomes as the physical basis of inheritance, you will now get to know these structures in more detail.

Part I. Get to know the difference between **genes**, **DNA**, and **chromosome**s by taking this "tour of the basics."

http://learn.genetics.utah.edu/content/chromosomes/intro/ - What is a Chromosome?

1. What are the components of a **chromosome**?
2. What can we learn from looking at our chromosomes?

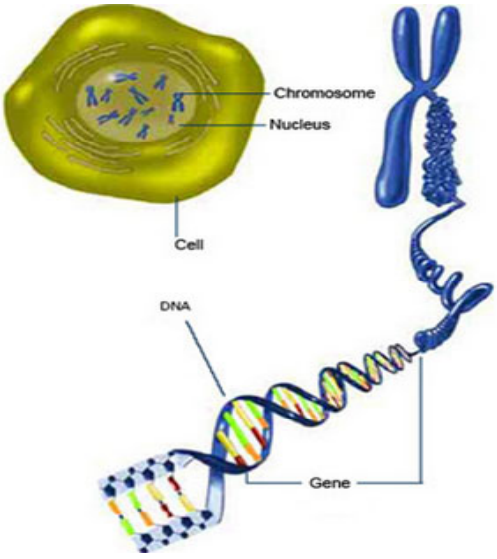
http://learn.genetics.utah.edu/content/molecules/dna/ - What is DNA?

1. What is the important role that the DNA plays in determining the traits of an organism?

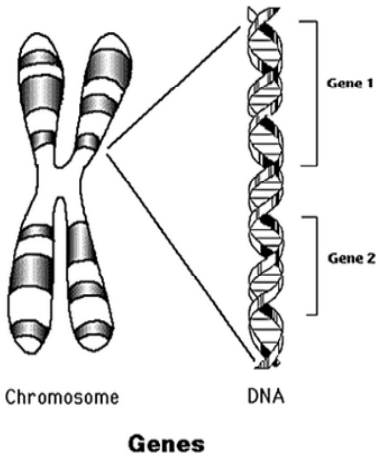
http://learn.genetics.utah.edu/content/molecules/gene/ - What is a Gene?

1. What is the difference between genes, DNA, and chromosomes? Make a diagram to show this difference. Click on "Compare" to check your work. Does your diagram look like the given diagrams? Make a comparison.

COMPARE



http://www.bristol.k12.ct.us/pa



Genes

http://www.accessexcellence.or

2. What are the roles that genes and chromosomes play in heredity?
3. *How do we inherit traits?*

Part II. Locating Genes in Chromosomes

In the previous activity, you saw the difference between genes, chromosomes and DNA. Have a better visualization of the actual position of genes in the different chromosomes of a human body through an interactive feature.

Do you know how many chromosomes are found in the nucleus of human cells? There are a total of 46 chromosomes in our nucleus – 22 pairs of **autosomes** and 1 pair of **sex chromosomes**.

There are genome researchers who accomplishes the daunting task of analyzing what genes are controlling certain traits, what genes are found in each of the chromosomes, and other meaningful things about the **genome**.

In this interactive feature, you'll get to see a microscopic view of some of what they've found on our 24 chromosomes, including the locations of about 200 different genes, especially those that have been associated with disease:

http://www.pbslearningmedia.org/asset/tdc02_int_hglandmarks/ - Chromosome Viewer

Process Question:
1. What will happen if an organism inherits a defective or incomplete set of chromosomes?

Genes on chromosomes determine what traits the organism will possess. In the next activity, learn about the different ways or patterns by which particular genes are inherited.

ACTIVITY NO. 1.6: NET EXPLORATION: PATTERNS OF INHERITANCE

How are traits inherited?

Mendel concluded that there are two allelic forms of a gene, or two versions of a trait. For example, seed color is either yellow or green, flower position is axial or terminal, plant height is either tall or short, etc.

However, why are there now a lot of colors for roses, orchids, and many other flowers? Hair color is not limited to black or blonde; there's white, brown, or red, and each even comes in different shades. Why are there spotted cats or cows?

Why are there characteristics or diseases that seem to be inherited only by males in the family?

Many genetic studies and researches came after Mendel. Because of these, it was found that there are patterns of inheritance that deviate from some of Mendel's laws.

In this activity, find out about these patterns of inheritance as you explore different websites. Always go back to the focus question: *How are traits inherited?*

Remember N.T.'s case? You may finally piece together the information to explain her family's case as you go through this next lesson.

Part I. NON-MENDELIAN PATTERNS OF INHERITANCE

Explore the following sites:
http://anthro.palomar.edu/mendel/mendel_3.htm - Non-Mendelian patterns of inheritance

Process Question: What are the patterns that do not follow the simple rules of Mendelian Inheritance?

A. ***Dominant alleles do not always mask the recessive alleles: Exceptions to Mendel's Principle of Dominance***

http://www.biologycorner.com/bio2/genetics/notes_incomplete_dominance.html - Incomplete Dominance and Codominance

Process Question: What is the difference between **incomplete dominance** and **codominance**?

In order to better differentiate how codominance and incomplete dominance works on certain traits, Practice solving problems that involve these patterns through the worksheet found in this link:

http://biologycorner.com/worksheets/genetics_codominance.html#.Uvb0GmIvRPc – Practice: Codominance and Incomplete Dominance

B. ***Mendel studied genes for which only two alleles are known. But many genes have more than two different alleles.***

http://evolution.about.com/od/Evolution-Glossary/g/Multiple-Alleles.htm - Multiple Alleles

http://learn.genetics.utah.edu/content/inheritance/blood/ - Genes and Blood Type

Process Question: Why is the presence of **multiple alleles** a deviation from Mendel's principles?

C. **One Gene = One Trait: Is this always the case??**

http://www.ib.bioninja.com.au/higher-level/topic-10-genetics/103-polygenic-inheritance.html - Polygenic Inheritance

http://www.bbc.co.uk/bitesize/ks3/science/organisms_behaviour_health/variation_classification/revision/3/ - Continuous and Discontinuous Variation

Process Questions:
1. What is the difference between continuous and discontinuous variation?
2. Why are polygenic traits following a bell-shaped curve or normal distribution?

D. ***Nature vs. Nurture: What role does the environment play in the expression of a trait?***

http://www.bbc.co.uk/bitesize/ks3/science/organisms_behaviour_health/variation_classification/revision/4/ - Inherited and Environmental

Process Question: Are all the traits we have right now due to genetics? Why or why not?

Synthesis Question*: What are the different ways that a trait may be inherited and expressed?*

Complete this table for your note-taking:

Non-Mendelian Inheritance	Sample Situation	Description
Incomplete Dominance	Crossing homozygous red with homozygous white snapdragons produces heterozygous offspring that have pink flowers.	

Codominance	The roan coat in cattle is a mixture of red and white hair and happens to individuals with heterozygous genotype.	
Multiple Alleles	The human ABO blood groups have three possible alleles: A (I^A), B (I^B), and O (i).	
Polygenic Inheritance	Eye color is a trait that results from the additive effect of many genes.	

*How do you think are you doing so far? Feel free to **email** your questions and concerns to the teacher.*

Exercise 2.

After going through the different sites, do the following quizzes:

http://anthro.palomar.edu/practice/mendqui3.htm - Practice Quiz

http://www.marietta.edu/~spilatrs/biol101/spilassign/Nonmendelian%20assignment.doc – Non-Mendelian Genetics Practice Problems

Try also this blood typing game:
http://www.nobelprize.org/educational/medicine/bloodtypinggame/game/index.html - the Blood Typing Game

Part II. SEX-RELATED INHERITANCE

In the previous activities you learned that the chromosomes may be classified as autosomes or sex chromosomes (X or Y). Whichever type of chromosome it, it still carries genes.
Get to know the difference of sex chromosomes with autosomes by exploring the following tutorials:

http://learn.genetics.utah.edu/content/chromosomes/typesauto/ - Autosomal DNA

Process Question: How many pairs of autosomes do humans have? Why do autosomes come in pairs?

http://learn.genetics.utah.edu/content/chromosomes/typesx/ - X chromosome DNA
http://learn.genetics.utah.edu/content/chromosomes/typesy/ - Y chromosome DNA

Process Questions:
1. How are males and females different in terms of their sex chromosomes?
2. How is sex determined in humans?

Find out if your answer is correct by watching the animation found in this link: http://www.learnerstv.com/animation/animation.php?ani=9&cat=Biology – Specialized chromosomes determine gender

Genes that are found in the sex chromosomes give rise to traits that are **sex-linked**.

Read information about sex-linked inheritance in this link:
http://anthro.palomar.edu/biobasis/bio_4.htm

Process questions:
1. How is sex-related inheritance different from the other patterns of inheritance that you've studied? Why does this type of inheritance matter?

2. *How are sex-linked traits inherited?*

*How do you think are you doing so far? Feel free to **email** your questions and concerns to the teacher.*

Exercise 3.

After going through the different sites, practice solving problems through this website:
http://www.biology.arizona.edu/mendelian_genetics/problem_sets/sex_linked_inheritance/01Q.html

ACTIVITY NO. 1.7: REVISING PRIOR KNOWLEDGE THROUGH I-R-F CHART

Go back to the focus question ***How are traits inherited?***

What are now your revised answers to this question?

Summarize your answers to the question, and your thoughts and ideas in the second column (Revised) of the IRF Chart. Compare your new ideas with your initial ideas. When you are finished, click on "Submit."

How are traits inherited?		
Initial	**Revised**	Final

Do you also now have revised insights on N.T.'s case of hemophilia?

N.T. is a healthy 38-year-old woman married to a healthy 40-year-old man. Their first child is a boy with hemophilia. Their second child is a girl who is normal. Their youngest is another boy, again with hemophilia.
N.T. had a maternal uncle who had died in childhood from hemophilia and a brother who had bleeding problems as a child but was resolved during his adolescence.

With all the patterns of inheritance you have learned in the previous activities, which do you think best applies to N.T.'s case? What makes you say so?

Confirm your answers in the next section.

End of FIRM UP:

In this section, the discussion was about the chromosomal basis of inheritance and the different patterns of inheritance.

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? Go back to your checklist of learning competencies and see how much you've accomplished:

CHECKLIST OF COMPETENCIES	
	Describe the location of genes in chromosomes.
	Explain the different patterns of non-Mendelian inheritance.
	Infer patterns of inheritance involved in different situations.

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

DEEPEN :

Now that you have learned about the different patterns of inheritance, it's time for you to look more deeply, analyze, and assess some genetic conditions. You are also going to learn more about **variation**, which arises largely due to genetic inheritance.

Your goal in this section is to take a closer look at these aspects of the topic.

ACTIVITY NO. 1.8: ASSESSING GENETIC CONDITIONS

Study the information found in the following links. Refer to the information in order to make an analysis and assessment of the given case:

N.T. is a healthy 38-year-old woman married to a healthy 40-year-old man. Their first child is a boy with hemophilia. Their second child is a girl who is normal. Their youngest is another boy, again with hemophilia.
N.T. had a maternal uncle who had died in childhood from hemophilia and a brother who had bleeding problems as a child but was resolved during his adolescence.

If you are N.T.'s genetic counsellor and she asked you about the risk of having a fourth child with hemophilia, what will be your answer? How will you explain your answer to her?

http://ghr.nlm.nih.gov/handbook/inheritance/inheritancepatterns - What are the different ways in which a genetic condition can be inherited?

http://ghr.nlm.nih.gov/handbook/inheritance/riskassessment - If a genetic disorder runs in my family, what are the chances that my children will have the condition?

Solution to N.T.'s case:

*Hemophilia is controlled by a **recessive** gene found in the X chromosome. N.T. does not have hemophilia but she possesses the gene for it; she is a carrier. This can be represented by the genotype X^HX^h, where H is the normal gene and h is the gene for hemophilia.*
Only their sons can have this disorder when they inherit the X^h chromosome from their mother. Their daughters will never have the disorder, but there is a 50% probability that they can be carriers like N.T.
As for their fourth child, if the child is going to be a girl, there is no chance that she will have hemophilia. If the child is a boy, there is 50% chance of him acquiring the disorder.

Exercise 4:
Situation Analysis. Make an assessment of the given genetic conditions:

1. Fragile X syndrome is a condition that causes a range of developmental problems that lead to learning disabilities and cognitive impairment. They may have Attention Deficit Disorder (ADD) which impairs their ability to maintain attention and focus on specific tasks. Approximately one-third of individuals with Fragile X syndrome have features of autism-spectrum disorders that affect communication and social interaction.

   Fragile X syndrome is an example of X-linked dominant inheritance.

   a. If the father has Fragile X syndrome, whom will he pass the disorder – to his sons or daughters? Explain.

   How will the situation change if it's the mother who has the disorder?

   b. Fragile X syndrome occurs in approximately 1 in 4,000 males and 1 in 8,000 females. However, males are usually more severely affected by this disorder than females. Come up with an explanation for this.

2. Red-green color blindness is the most common form of color blindness. Mark Zuckerberg, the creator of the social networking site Facebook, is red-green color blind. That was said to be the reason why the dominant color of *Facebook* is blue; this is the color that is easiest for him to see.

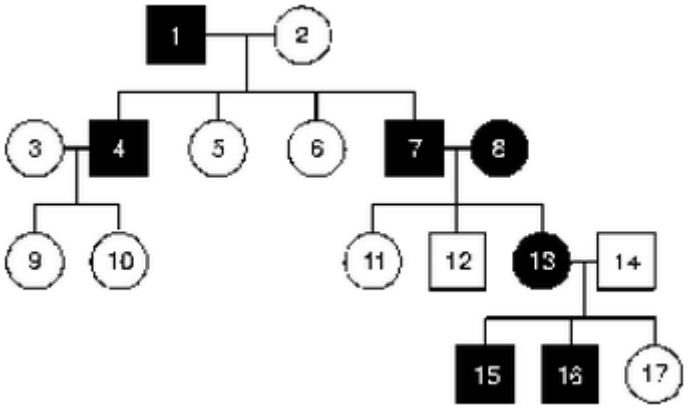
   This condition is caused by a recessive gene found in the X chromosome.
   a. Can a normal daughter have a color-blind father? a normal father? a color-blind mother? a normal mother? _____

   b. Can two normal parents have a color-blind son? a color-blind daughter? _____

   c. Can two color-blind parents have a normal daughter? a normal son? _____

d. A brother and sister are both color-blind, is it possible for them to have a normal brother? a normal sister? _____

3. A pedigree is a diagram that makes it easier to visualize relationships within families, particularly large extended families. Pedigrees are often used to determine the mode of inheritance of genetic diseases.
In a pedigree, squares represent males and circles represent females. Shaded symbols represent those who possess the trait. Horizontal lines connecting a male and female represent mating. Vertical lines extending downward from a couple represent their children. Subsequent generations are therefore written underneath the parental generations and the oldest individuals are found at the top of the pedigree.
Refer to this given pedigree:



a. What seems to be the pattern of inheritance in the given case?
_____

b. Could this trait be sex-linked? Why or why not?
_____

4. Mitochondrial diseases are genetic disorders caused by mutations in DNA found in the mitochondria. Examples of such diseases are Leber's hereditary optic atrophy, myoclonic epilepsy with Ragged Red Fibers, and mitochondrialencepalopathy (a form of dementia).

a. Who can cause mitochondrial inheritance, the father or the mother? Explain.

Generalization Questions:

1. Based on the above situations, what are the different ways in which a trait or a genetic condition can be inherited?

2. How can we predict inheritance patterns?

3. Why are these predictions or estimation of chances of inheritance *helpful*?

Communicate with your classmates and share insights on this activity through the **discussion forum.**

ACTIVITY NO. 1.9: ARTICLE ANALYSIS (GENETIC VARIATION AND ADAPTATION)

Due to **variation** in characteristics that are inherited from the parents, living things exhibit individual differences. This variation is further influenced by environmental factors such as climate, diet, accidents, culture and lifestyle.

Clarify the sources of variation through this video:
http://learn.genetics.utah.edu/content/variation/sources/ - Sources of Variation

Process question: What are the different sources of genetic variation?

*Is it okay to be different? What good does it bring when one organism varies with another? Why is **genetic variation** important?*

Find answers to these questions as you read the following articles found in this link:

http://www.nps.gov/plants/restore/pubs/restgene/1.htm - Why is Genetic Diversity Important?
Topics:

1. Genetic diversity helps organisms cope with current environmental variability

2. Diversity within populations reduces potentially deleterious effects of breeding among close relatives.
3. Genetic diversity is the primary basis for adaptation to future environmental uncertainty

Process Questions:
1. Why do populations need to maintain genetic variation?
2. Why is genetic diversity important?

Read the following scenario:
The last wolves in Africa face a difficult road if they are going to survive. Just 500 Ethiopian wolves (Canis simensis) remain in the mountains of the country for which they are named. The animals now live in six fragmented populations located hundreds of kilometers apart from one another; three of these populations have fewer than 25 wolves each. According to a study published last month in ***Animal Conservation****, the Ethiopian wolf now suffers from low genetic diversity and a weak flow of genes between packs.*

- *Which do you think is the factor that led to low genetic diversity in the wolf population? Explain.*
- *What are the consequences of low genetic diversity?*

Communicate with your classmates and share insights on this case through the **discussion forum.**

ACTIVITY NO. 1.10: STRENGTHENING NEW KNOWLEDGE THROUGH I-R-F CHART

The focus question for this lesson is: ***How are traits inherited?***

What are your final answers to this question? Your answers should reflect your wider understanding of inheritance and variation.

Summarize your answers to the question, and your thoughts and ideas in the third column (Final) of the IRF Chart. Compare your new ideas with your previous ideas. When you are finished, click on “Submit.”

How are traits inherited?		
Initial	Revised	**Final**

End of DEEPEN:

In this section, the activities focused on predicting the patterns of inheritance and making assessment of various genetic conditions. Variation caused by inheritance, and the importance of this variation were also highlighted in this section.

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 :

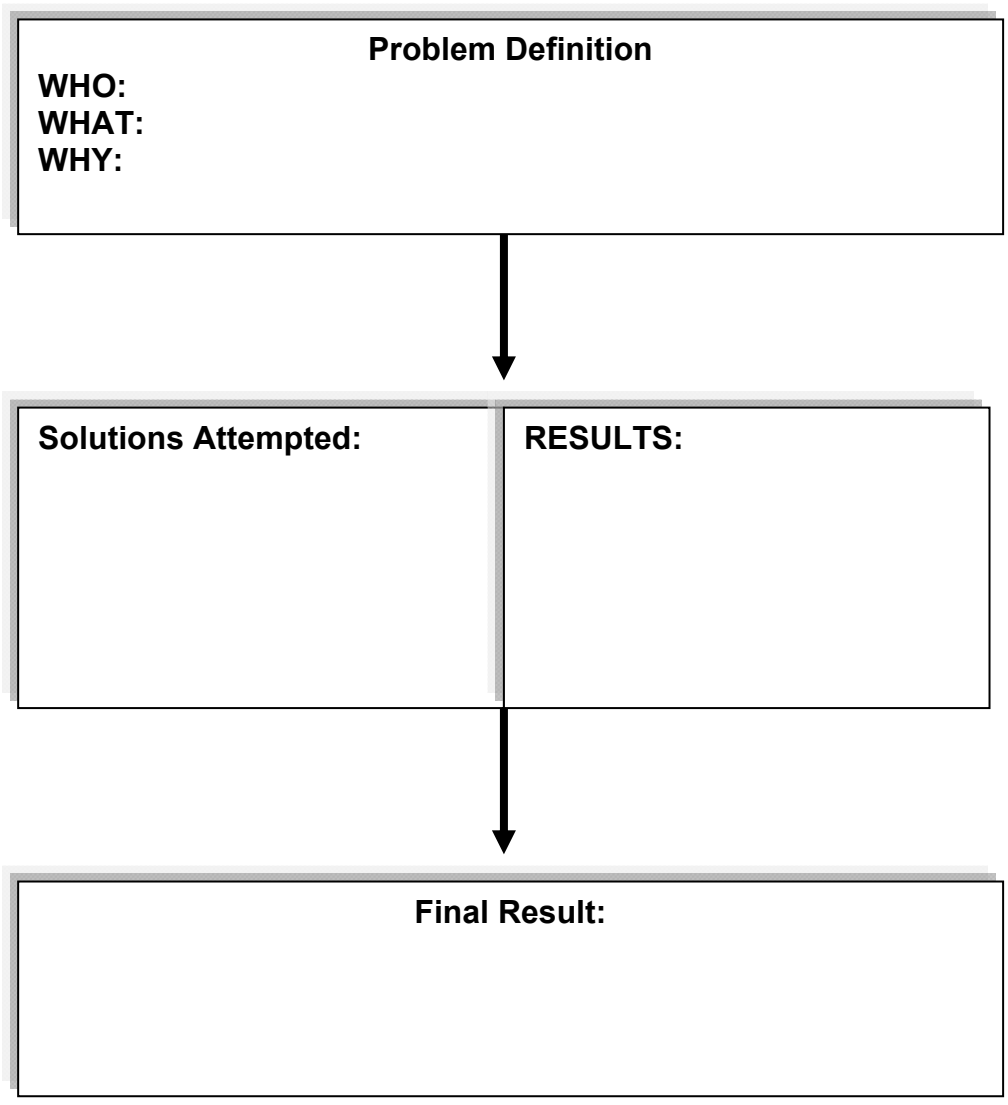
Your goal in this section is apply your learning to real life situations. You will be given a practical task which will demonstrate your understanding.

ACTIVITY NO. 1.11: SCIENTIFIC INVESTIGATION

Find a partner and research a problem related to inheritance and variation.

E-mail your chosen topic/problem/issue to your teacher. Wait for her feedback or approval.

Once your topic is approved, start investigating about it. For you and your partner's output, you should be able to complete this **problem-and-solution outline** and submit to your teacher.



Before submitting to your teacher, do a self-evaluation of your work by completing this checklist:

Criteria	YES	NO
I have a clear idea of what the problem or case is, who are involved, and why a problem or irregularity exists.		
My attempts at coming up with a solution involves *(you should answer "yes" in at least two)*: • Identifying the gene involved (is it dominant or recessive; autosomal or sex-linked, etc?) • Inferring the pattern of inheritance of the trait involved • Predicting outcomes for the next generations • Determining the sources of genetic variation • Investigating the causes and effects of low genetic diversity		
The results I came up with are based on careful research and investigation.		
The final result is a product of my best judgment of the preliminary results gathered.		
My scientific investigation is relevant and is informative to all who will read it.		

End of TRANSFER:

In this section, your task was to investigate on a problem or issue related to inheritance and variation.

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. You may now proceed to the next lesson.

Topic 2: Species Extinction

EXPLORE :

In the previous lesson you learned about chromosomes and patterns of inheritance. From one generation to the next, the chemical structure of the gene undergoes changes which lead to variation. Genetic variation is important because it influences the survival of a population. When a species fails to survive, it goes **extinct**.

Many scientists believe that we are currently experiencing mass extinction. What are the conditions and situations that led them to this conclusion? Why do species go extinct? Can extinction be linked with genetic variation? What can be done to prevent extinction? These are questions that you will try to answer as you take this module.

Let's begin by revisiting your understanding of extinction.

ACTIVITY NO. 2.1: NEWS CLIP ANALYSIS

The Philippine Eagle (*Pithecophaga jefferyi)*, also known as monkey-eating eagle, is considered to be one of the largest, rarest, and powerful birds in the world. The eagle is **endemic** to the Philippines, and can be found on four major islands: eastern Luzon, Samar, Leyte, and Mindanao. Its existence is said to be the "perfect barometer" of the state of the Philippine forests. Sadly, the Philippine eagle is now critically endangered, a status that when taken for granted may lead to extinction.

Read the following news clips:
http://globalnation.inquirer.net/14735/near-extinct-philippine-eagle-shot-dead - Near-extinct Philippine Eagle Shot Dead

http://www.abs-cbnnews.com/nation/regions/01/25/14/endangered-philippine-eagle-killed-falling-branch - Endangered Philippine Eagle Killed by Falling Branch

Process Questions:
1. What problem may be brought by the events reported in the news clip?
2. How can this contribute to the extinction crisis?
3. *How do you think can species be saved from the threat of extinction?*

<u>ACTIVITY NO. 2.2:</u> ELICITING PRIOR KNOWLEDGE THROUGH I-R-F CHART

As you go through this lesson, always consider these focus questions: ***Why do species go extinct? How can species be saved from the threat of extinction?***

What are your initial answers to these questions?
Summarize your answers to the question, and your thoughts and ideas in the first column (Initial) of the IRF Chart. When you are finished, click on "Submit."

Why do species go extinct? How can species be saved from the threat of extinction?		
Initial	Revised	Final

End of EXPLORE:

You gave your initial ideas regarding extinction.

Find out how others would answer the above and compare their ideas to your own. As yougo through the succeeding activities, you will find out if your ideas are correct. You will also learn other concepts which will equip you as you complete the transfer task found at the end of this lesson. The task is to create a multimedia presentation that shows relevant information and data you gathered about extinction, as well as some recommendations.

We will start by doing the next activity.

FIRM-UP

UP:

Your goal in this section is to learn and understand the different causes of species extinction, both natural and anthropogenic.

*Complete the first two columns (GOALS Columns) of this **learning log*** to keep you guided as you accomplish your goals:

LEARNING LOG

GOALS		ASSESSMENT OF GOALS	
Unit Goals ***(Goals prescribed by the curriculum)***	**My Personal Goals** *(How can I personalize the goals prescribed by the curriculum?)*	**My Personal Assessment**	**Teacher's Assessment**
• **Identify the different factors that affect the survival of populations.** • **Relates species extinction to the failure of populations to adapt to abrupt changes in the environment.**			

In summary, what have I achieved from this module?

ACTIVITY NO. 2.3: NET EXPLORATION

Part I. THREE LEVELS OF BIODIVERSITY

You have just finished studying heredity and variation in the previous lesson. Find out how genetics can be one of the factors that influence biodiversity by studying the different levels of biodiversity.

Do you know how rich Philippine biodiversity is? Check out this page to have an idea:
http://mea.denr.gov.ph/index.php?option=com_content&view=article&id=113&Itemid=205 – Philippine Biodiversity: Status and Threats

Go to the interactive found in this link:

http://tdcms.ket.org/knh/biothreelevels.html - Three Levels of Biodiversity

Exercise 5.

Differentiate the three levels of biodiversity through the *contrast-and-compare matrix.* Use the data for Philippine biodiversity as examples to show the difference between the three levels. Think of *three* attributes that you may use to compare and contrast the three levels.

Attributes	Genetic Diversity	Species Diversity	Ecosystem Diversity
Attribute 1:			
Attribute 2:			
Attribute 3:			

Process Questions:
1. Why is biodiversity important?
2. Why are some species better than others at adapting to environmental changes?
3. What happens if the biodiversity in an area is threatened?

4. Do you think our biodiversity is now threatened? Why?

Part II. SPECIES EXTINCTION – THE FACTS

In the previous activity, you learned about the importance of biodiversity at all three levels and you thought about the possible consequences if the biodiversity is threatened.

When we lose a species due to **extinction**, this event will definitely affect the biodiversity at all levels (genetic, species, and ecosystem). However, it was also long established that extinction is a natural event, maybe even a routine in geological perspective. Most species that have ever lived have gone extinct.

What's alarming is that currently, research says that species are lost at a rate that is never before observed in Earth's history. This accelerated rate of extinction is said to be anthropogenic or caused by humans.
According to the *Center for Biological Diversity*, extinction as a natural phenomenon occurs at a natural "background" rate of about 1 to 5 species per year. Scientists estimate that we're now losing species at 1,000 to 10,000 times the background rate, with literally dozens going extinct everyday. (Visit http://www.biologicaldiversity.org/programs/biodiversity/elements_of_biodiversity/extinction_crisis/ for more details about the extinction crisis.)

Learn about the natural and anthropogenic causes of extinction by exploring the following sites:

- http://cmsdata.iucn.org/downloads/species_extinction_05_2007.pdf - Species Extinction - The Facts

Process Questions:
1. What are the natural causes of extinction?
2. What are the anthropogenic causes of extinction?

- http://www.biologicaldiversity.org/programs/biodiversity/elements_of_biodiversity/extinction_crisis/ - The Extinction Crisis
- https://www.pbs.org/wgbh/evolution/library/03/2/l_032_04.html - The Current Mass Extinction
- http://wwf.panda.org/about_our_earth/biodiversity/biodiversity/ - How many species are we losing?

Process Question: Describe the rate at which we are currently losing species. How did we get to such rate?

- http://www.salon.com/2013/12/17/the_great_dying_redux_shocking_parallels_between_ancient_mass_extinction_and_climate_change_partner/ - "Shocking parallels between ancient mass extinction and climate change"
- http://www.dailytech.com/Evolution+Losing+Race+with+Climate+Change+Species+May+Not+be+Able+to+Adapt/article31936.htm - Evolution Losing Race with Climate Change, Species may not be able to adapt

Process Questions:
1. What are the effects of climate change to the environment? to living things?
2. Why is climate change said to be driving the current mass extinction?
3. Can species easily adapt to climate change? Support your answer with data from the readings.

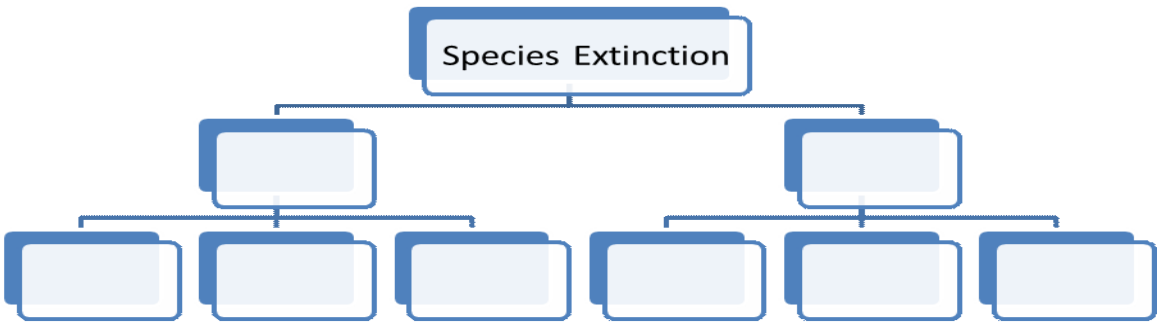
- http://news.nationalgeographic.com/news/2013/12/131216-conservation-environment-animals-science-endangered-species/ - 20,000 Species Are Near Extinction: Is it Time to Rethink How We Decide Which to Save?

Process Questions:
1. *In general, why do species go extinct?*
2. Why does extinction matter?
3. Can we prevent extinction? Explain.

*How do you think are you doing so far? Feel free to **email** your questions and concerns to the teacher.*

ACTIVITY NO. 2.4: DRAWING GENERALIZATIONS

Show the different causes of extinction through a network tree or organization chart:



Add shapes and levels to the chart if you need to add more information. Then, come up with a generalization as to why species go extinct.

Generalization:

Upload your chart and your generalization to your OHSP account and compare with your classmates. Share insights through the **discussion forum.**

Exercise 6.

Read the following excerpt:

Smaller sea ice season means less time for polar bears to hunt
http://wwf.panda.org/about_our_earth/aboutcc/problems/impacts/species/polar_bears/

The effects of reductions in sea ice extent and thickness, shorter periods of maximum ice extent, as well as changes in sea ice dynamics and structure, may vary in different areas of the Arctic, but all have the potential to negatively influence the condition and reproductive success of polar bears and their prey.

The time bears have on the ice is their best season – hunting seals and fish is easy, and they restore their body fat and fitness. But this crucial time for storing up energy for the warm season is becoming dangerously limited.

As the periods without food lengthen, the overall body condition of polar bears decline. This is particularly serious for bears that are pregnant, or nursing young, and for the cubs themselves.

Task:
Make an estimate of the polar bears' chances of survival. Show it graphically by putting a mark in the given continuum with *extinction* on the far left and *survival* on the far right.

Extinction ⟷ **Survival**

Support your answer with estimations found in this suggested reading: http://www.actionbioscience.org/environment/derocher.html - Polar Bears and Climate Change.

ACTIVITY NO. 2.5: REVISING PRIOR KNOWLEDGE THROUGH I-R-F CHART

Consider again these focus questions: ***Why do species go extinct? How can species be saved from the threat of extinction?***

What are your revised answers to these questions?
Summarize your answers to the questions, and your thoughts and ideas in the second column (Revised) of the IRF Chart. When you are finished, click on "Submit."

Why do species go extinct? How can species be saved from the threat of extinction?		
Initial	**Revised**	Final

End of FIRM UP:

In this section, the discussion was about the natural and anthropogenic causes of extinction.

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? Go back to your *learning log* and do self-monitoring of your accomplishment of the listed goals.

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

DEEPEN :

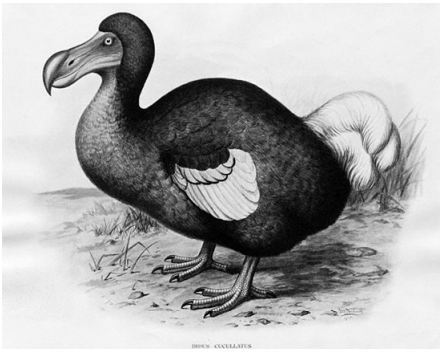
The mass extinctions recorded in history have occurred before the species of humans existed. It is almost impossible for scientists to observe every species in every habitat and monitor their extinction rates. Still, we are able to get accurate information about species extinction all around the world.

In this section, you will be identifying patterns and formulating generalization from related studies about extinction. These are some skills that scientists use to study about the different aspects of extinction.

ACTIVITY NO. 2.6: IDENTIFYING PATTERNS AND SEQUENCE OF EVENTS

Part I:
Read the following article:

The Dodo Bird – A Lesson in Extinction



http://www.davidreilly.com/dodo/images/gallery/engraving_of_dodo11534121.jpg

The dodo bird was first sighted around 1600 on Mauritius, an island in the Indian Ocean. It was extinct eighty years later. The Dodo's stubby wings and heavy, ungainly body tell us that the bird could not fly. Moreover, its breastbone was too small to suppor the huge pectoral muscles a bird this size would need to fly. Yet scientists believe that the Dodo evolved from a bird capable of flight. When an ancestor of the Dodo landed on Mauritius, it found a habitat with plenty of food and no predators. Because there was no reason for Dodos to leave the ground, they eventually lost their ability to fly. Other factors also contributed to the Dodo birds' extinction.

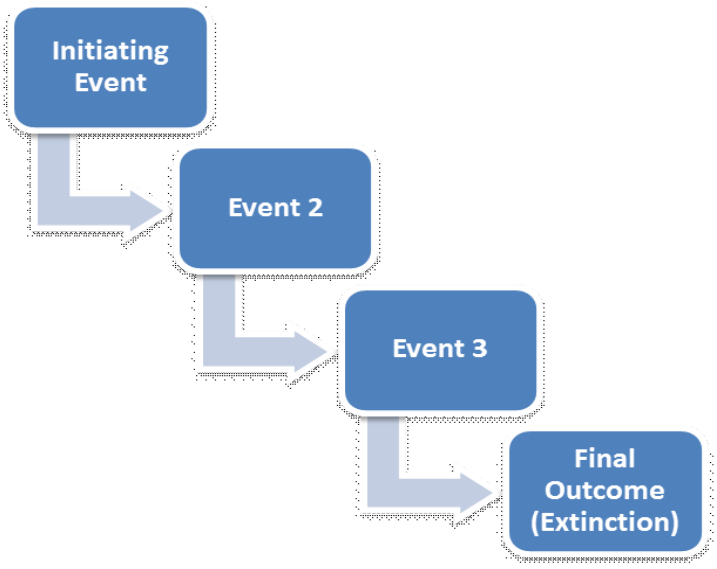
For example, many birds were eaten by the Dutch sailors who discovered them. However, the two most influential factors in terms of the Dodo birds' extinction were the destruction of the forest (which cut off the Dodo's food supply), and the animals that the sailors brought with them, including cats, rats, and pigs. These animals destroyed Dodo nests.

Scientists at the American Museum of Natural History and other institutions around the world have learned from the Dodo bird. They hope that the lesson of

the Dodo can help prevent the extinction of other forms of animal life and aid us in preserving the diversity of life on Earth.

Process Question:
1. What are the reasons why the dodo went extinct?

Identify the sequence of events that led to the extinction of the dodo bird. Summarize your answers through a *flow diagram* or *sequence chart:*



Add shapes and levels to the chart if you need to add more information.

When you have finished the diagram, compare it with this sample extracted ***pattern:***
1. Something was thriving in a specific environment.
2. This thing changed over time because of changes in its surroundings. Some of the changes actually limited it in some ways.
3. Yet another influence came along and cut off what it needed to survive and destroyed where it used to exist. Because of its limitations, there was no way it could move to a new place.
4. The thing no longer exists.

Part II: ARTICLE ANALYSIS

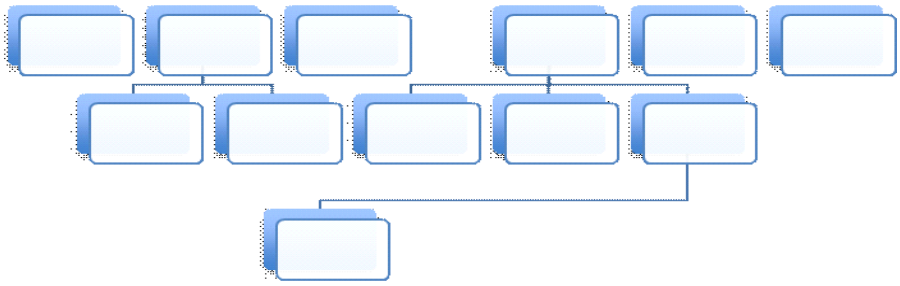
The following are some articles/webpages that give information about species that are reported to be extinct:

http://science.nationalgeographic.com/science/prehistoric-world/dinosaur-extinction/ - Dinosaur Extinction

http://www.environmentalgraffiti.com/history/news-thylacine-20th-centurys-most-famous-extinct-animal?image=0 - Extinct Animals: How the Tasmanian Tiger Became the 20th Century's Dodo

http://news.nationalgeographic.com/news/2007/08/070831-baiji-dolphin.html - "Extinct" River Dolphin Spotted in China

Summarize the different factors and events that led to the extinction events given in the articles. Use this *family tree* graphic organizer to show how multiple factors and events contribute to one outcome: extinction.



Then, extract a general pattern. Write this pattern in the box provided:

General Pattern:

Compare this pattern with the pattern that was formulated from the case of the dodo bird. *Did the cases follow the same pattern? Are there slight differences?* ***How do these patterns help you understand why species go extinct?***

How do you think are you doing so far? Feel free to ***email*** *your questions and concerns to the teacher.*

ACTIVITY NO. 2.7: SCIENTIFIC INVESTIGATION

It's now time for you to "level-up" your investigation skills!

You will have a thorough investigation of the five mass extinctions in history. You will gather existing data and information about the said extinctions.
From these data, draw-out patterns and determine common underlying causes.

For easier visualization of the data you have gathered, put them together by creating a **timeline.** Click on this link to find a sample geological timeline of earth's history: http://www.bbc.co.uk/nature/history_of_the_earth - History of Life on Earth

Use this Web 2.0 tool in making your own timeline:
http://www.tiki-toki.com/ - creative interactive multimedia timeline

The findings of the investigation together with supporting evidences will be reported through a PowerPoint presentation during your face-to-face encounter with your teacher.

Exercise 7.

Below is an assessment of your *understanding* of the topics discussed. The topics have a common theme: Climate change and Extinction. To give you a head start, you may want to watch this *Discovery News Playlist* featuring 12 different videos about climate change, global warming, and its effects to diversity:
http://news.discovery.com/earth/videos/global-warming-videos.htm - DNews Global Warming Videos

When you're done, read the given articles. Answer the corresponding questions.

Article 1:
Climate Change Threatens Genetic Diversity, Future of World's Caribou
http://www.sciencedaily.com/releases/2013/12/131216095540.htm

Questions:
1. Discuss the major environmental threats to the caribou.
2. How does climate change affect genetic diversity?

Article 2:
Disease, Not Climate Change, Fueling Frog Declines in the Andes
http://news.sfsu.edu/disease-not-climate-change-fueling-frog-declines-andes-study-finds

Question:

1. Discuss the most likely cause of declines in the Andes frog population. Support your answer with evidences gathered from the researches mentioned in the article

Article 3:
Evidence of Mass Extinction Associated With Climate Change 375 Million Years Ago Discovered in Central Asia
http://www.sciencedaily.com/releases/2013/12/131213092841.htm

Question:
1. Discuss the impact of climate change on extinction. Support your discussion with evidences.

Based from all the articles read, write a commentary on the problem of extinction. Justify and present evidences. E-mail your written output to your teacher.

ACTIVITY NO. 2.8: TAKING ACTION

How can species be saved from the threat of extinction?

This is a very important question that everyone should ask, answer, and take part in.

See how people from all over the world are trying to solve the crisis:
http://www.haribon.org.ph/ - Official website of Haribon Foundation

http://www.natureconservancy.ca/en/where-we-work/british-columbia/stories/de-extinction-or-conservation.html - De-extinction or nature conservation?

http://www.conservation.org/about/pages/about_us.aspx - Conservation International

How about you? What can you contribute to saving species from the threat of extinction? From the websites provided, choose an activity which you think you can do in your own community.

Learn more about your chosen activity/movement through research, observation, interview, or even immersion. Write a blog about your experiences in helping to save endangered species. Create your blog through www.blogger.com. *It is a free blogging site from Google; you can start writing your blog through your gmail account.*

Wait for your other classmates to upload theirs. Read at least two other stories and leave a comment for each.

ACTIVITY NO. 2.9: STRENGTHENING NEW KNOWLEDGE THROUGH I-R-F CHART

Consider again these focus questions: ***Why do species go extinct? How can species be saved from the threat of extinction?***

What are your final answers to these questions? Your answers should reflect your wider understanding of species extinction.
Summarize your answers to the questions, and your thoughts and ideas in the third column (Final) of the IRF Chart. When you are finished, click on "Submit."

Why do species go extinct? How can species be saved from the threat of extinction?		
Initial	Revised	**Final**

End of DEEPEN:

In this section, you investigated further the different cases of extinction – patterns, causes, and possible prevention.

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

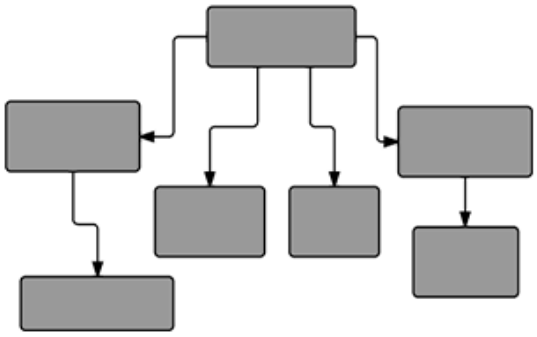
Now that you have a deeper understanding of the topic, you are ready to do the tasks in the next section.

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 of the topic.

ACTIVITY NO. 2.10: CONCEPT MAP

You're almost done with the module. Try to summarize everything you learned through a **concept integration map. See sample shown below.** Make the relationship between topic 1 (inheritance) and topic 2 (extinction) evident in your map.



Use this site, http://www.spicynodes.org/, to create your own concept map. Then upload your work or email to your teacher.

ACTIVITY NO. 2.11: PERFORMANCE TASK

As part of the joint programs to achieve United Nations' Millenium Development Goal (MDG) to ensure environmental sustainability, the United Nations Country Team (UNCT) in the Philippines organizes a forum entitled "Are We in the Middle of a Sixth Mass Extinction?"

You are one of the biologists invited to share your research/study on the said issue. You are to present, through multimedia presentation, a timeline of extinction events. From these data, draw out patterns, conclusions, and formulate recommendations in relation to biodiversity and species conservation.

Scientists and government leaders who will be attending the forum expect accurate data, convincing justification, and sound conclusions and recommendations.

Rubric:

CRITERIA	Outstanding 4	Satisfactory 3	Developing 2	Beginning 1
Accurate data	Presents high quality and varied data (timeline, photographs, charts, etc.) that are reliable and accurate	Presents data (timeline, photographs, charts, etc.) that are accurate	Some data (timeline, photographs, charts, etc.) are inaccurate	Presents data (timeline, photographs, charts, etc.) that are inaccurate and unreliable;
Justification	Evidences gathered from the data and relevant and updated information are presented clearly and concisely making the work reasonable and compelling. highly convincing	Evidences gathered from the data and relevant information are presented clearly and concisely making the work reasonable	Few evidences are presented and with very few references to the data; some information is not presented clearly making the work unconvincing in certain parts	Almost no evidences are presented and made no references to the data; many important information is presented in a confusing way. is not presented clearly making the work unconvincing
Sound Conclusions and Recommen-dations	Supports opinions and conclusions with strong arguments and evidence; Presents detailed, realistic, and appropriate recommendations supported by the information presented	Supports opinions and conclusions with reasons and evidence; Presents realistic, and appropriate recommendations supported by the information presented	Supports opinions and conclusions with limited reasons and evidence; Presents in some parts inconsistent recommendations which are not logically supported by realistic, and appropriate information	Supports opinions and conclusions with few reasons and limited evidence; Presents recommendations with little, if any, support from the information presented

End of TRANSFER:

In this section, your task was to make a multimedia presentation about extinction. How did you find the performance task? How did the task help you see the real world use of the topic?

Have a final assessment of your accomplishment of the goals for this lesson (Assessment of Goals, 3rd column). Then, give this form to your teacher so he/she can give his/her assessment of you. Finally, summarize what you have accomplished for this unit by filling up the bottom part of the learning log.

LEARNING LOG			
GOALS		**ASSESSMENT OF GOALS**	
Unit Goals ***(Goals prescribed by the curriculum)***	**My Personal Goals** *(How can I personalize the goals prescribed by the curriculum?)*	**My Personal Assessment**	**Teacher's Assessment**
In summary, what have I achieved from this module?			

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. Which of the following statements is true about chromosomes and genes?
   A. Chromosomes and genes are parts of the DNA.
   B. Chromosomes are found within genes.
   C. Genes have specific locations on chromosomes.
   D. Gene pairs segregate, homologous chromosomes do not.

(A) 2. If a population contains a range of phenotypes that fits a bell-shaped curve, what type of inheritance pattern is this?
   A. Codominance
   B. Incomplete Dominance
   C. Multiple Alleles
   D. Polygenic Inheritance

(A) 3. Based on the International Union for Conservation of Nature (IUCN) Red List, if a species is known only to survive in cultivation, in captivity, or as a naturalized population (or populations) well outside the past range, the species is said to be
   A. Critically Endangered
   B. Endangered
   C. Extinct
   D. Extinct in the Wild

(A) 4. A man is heterozygous for blood group B. If his wife is heterozygous for blood group A, what is the probability that their first child will have blood type AB?
   A. 0%
   B. 25%
   C. 50%
   D. 100%

(A) 5. Anne has a brother who has hemophilia. She is concerned about whether she will pass this trait to her offspring. If Anne's husband is not hemophiliac, is there a chance that Anne will have a son or daughter with hemophilia?
   A. No
   B. Yes, 25% chance
   C. Yes, 50% chance
   D. Yes, 100% chance

(A) 6. Extinction is more likely to happen in which of the following populations?
A. A population of specialist species
B. A population with high species richness
C. A population with wide geographic distribution
D. All would be equally likely to go extinct

(A) 7. The rarest member of the bear family, giant pandas live mainly in remote mountainous regions in central China, where they subsist almost entirely on bamboo. Despite their exalted status and lack of natural predators, why are there fewer than 1,600 pandas in the wild now (WWF)?
A. It is hard for pandas to adapt due to their large size.
B. They find it hard to adapt to cold and wet conditions.
C. Bamboo forests are being destroyed at a fast rate.
D. Pandas are very shy and solitary creatures.

(A) 8. Researchers from Illinois had observed that the collapse of the greater prairie chicken population was mirrored in a reduction in fertility. The population becomes so small that it may be approaching the extinction vortex. Given this information, which do you think can improve the condition of the greater prairie chicken population?
A. Develop their habitat
B. Increase the viability of the eggs
C. Introduce other chicken species
D. Provide more resources

(M) 9. Pseudohypertrophic muscular dystrophy is an inherited disorder that causes gradual deterioration of the muscles. Almost all of the cases occur in boys who are born to apparently normal parents. It usually results in death in the early teens.
Which of the following is the reason why this disorder is almost never seen in girls?
A. The disorder is controlled by a dominant gene in the X chromosome.
B. The disorder is controlled by a recessive gene in the X chromosome.
C. The disorder is controlled by a dominant gene found only in the Y chromosome.
D. The disorder is controlled by a recessive gene found only in the Y chromosome.

(M) 10. A rooster and a hen both have gray feathers. When mated, they produce 15 chicks, 6 are black and 8 are white. What is the explanation for the inheritance of these colors in chickens?

A. The black and white alleles are incompletely dominant, with heterozygotes being gray in color.
B. The black and white alleles are codominant, with heterozygotes being gray in color.
C. The inheritance of the gray feather color skips generation.
D. The gray feather color is not heritable.

(M) 11. A single tree, locked into its inherited genotype, has leaves that vary in size, shape, and greenness. Identical twins, which are genetic equals, accumulate phenotypic differences.
What do these say about the inheritance and expression of traits?
A. Many factors, both genetic and environmental, collectively influence phenotype.
B. Not all genes present in the organism's genome are expressed in the phenotype.
C. Traits are determined by the combined action of many different genes.
D. Traits are inherited through varied patterns, both Mendelian and Non-Mendelian.

(M) 12. In the Swedish south coast, a population of snakes has been isolated from other populations for at least a century. About 35 years ago, the population declined. There was also high incidence of deformed or stillborn offspring. In the year 1992, 20 adult males from another population were brought into the population which by then was reduced to only 10 males. After enough time had passed for outbred offspring to reproduce, there was a rapid and dramatic increase in the number of snakes in the population, and the proportion of stillborn offspring fell.

Prior to the addition of the 20 adult males, what had happened to the snake population that contributed to its decline?
A. The climatic conditions changed.
B. There was absence of prey.
C. There was great habitat destruction.
D. There was low genetic variation.

(M) 13. A researcher discovered that many vertebrate species ranging from mammals, reptiles, birds, and amphibians, adapt to different climates at a rate of only 1 degree Celsius per million years. The problem is that scientists estimate that global temperatures are going to increase by about 4 degrees Celsius by 2100.

What do these findings suggest?

A. Global temperatures are increasing at a rate that is beyond the control of humans.
B. Human activities are causing rapid changes to the environment; we have to act now.
C. It takes a million years for vertebrates to develop adaptations to the changes in the environment.
D. Species have to evolve 10,000 times faster in order to adapt to the expected climate change.

(M) 14. Few of us have crossed paths with a real, live endangered species today, one that is teetering on the brink of extinction. So, does it really matter if an animal goes extinct when we can still watch it on television or look it up on the internet?

Which response is correct?

A. “There are only some species that need our attention. Let us not allow them to go extinct.”
B. “Some extinction actually helps. If an agricultural pest or a disease-causing insect goes extinct, that shouldn’t hurt us.”
C. “The presence of these species makes us all rich.”
D. “If we lose a species due to extinction, that’s one less contributor to the intricate web of life.”

(T) 15. Conservation International, in their article entitled “How do we set our clock?” presented an estimate of the number of species that will face extinction between 2000 and 2050.

Given a conservative estimate of 4 million to 6 million species on Earth today, here are the values:

Midrange estimate: 25% of 5 million species = 1.3 million species, or roughly 1 every 20 minutes
Low estimate: 15% of 4 million species = 0.6 million species, or roughly 1 every 44 minutes
High estimate: 50% of 6 million species = 3 million species, or roughly 1 every 9 minutes

If you are to share the data to a group of students, which of the following is the best way to present?

A. Through a graph
B. Through a research
C. Through a timeline
D. Through a video

(T) 16. Your research group identified two primary causes of species extinction: habitat destruction and climate change.
You are tasked to give the best estimate of the number of species that can become extinct in the next 50 years. Your audience who are conservation advocates wants to know how much they need to prepare.

These are the data you gathered from independent studies about habitat destruction and climate change (www.conservation.org):

- Some 5% to 50% of species are predicted to face extinction due to habitat destruction alone between 2000 and 2050
- About 15% to 37% of species may face extinction between 2000 and 2050 due to climate change effects

If there are approximately 5 million species on Earth today, how many can we lose due to habitat destruction and climate change in about 50 years?

A. 200,000 species
B. 1.25 million species
C. 3 million species
D. 5 million species

(T) 17. Refer to the following data about the five worst mass extinctions in history:

EXTINCTION EVENT	PROBABLE CAUSES
Ordovician-Silurian extinction	Drop in sea levels as glaciers formed followed by rising sea levels as glaciers melted.
Late Devonian extinction	Triggered by another glaciation event on Gondwana, which is evidenced by glacial deposits of this age in northern Brazil
Permian-Triassic extinction	Comet or asteroid impact led to this extinction; Others think that volcanic eruption, coating large stretches of land with lava from the Siberian Traps, which are centered around the Siberian City of Tura, and related loss of oxygen in the seas were the cause of this mass extinction; Still other scientists suspect that the impact of the comet or asteroid triggered the volcanism.
End Triassic extinction	Massive floods of lava erupting from the central Atlantic magmatic province triggering the breakup of Pangaea and the opening of the Atlantic Ocean; the volcanism may have led to deadly global warming.
Cretaceous-Tertiary extinction	Impacts of several-mile-wide asteroid; Yet, some scientists believe that this mass extinction was caused by gradual climate change or flood-like volcanic eruptions of basalt lava from the Deccan traps west-central India.

If you are a conservation biologist presented with these data, what questions would you have asked?

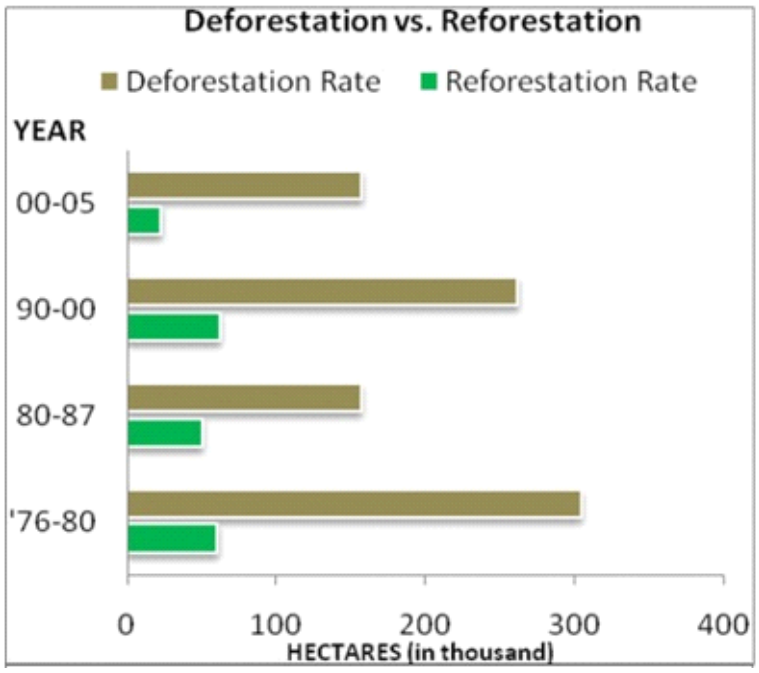
A. Is this true? What do the geological records tell?
B. What are the evidences to support these assumptions? Where can we investigate?
C. What are the species that went extinct? What are their taxonomic classifications?
D. Will this happen again? What can be done?

(T) 18. When it comes to preserving biodiversity, we can say that there now emerges two “schools of thought”: conservation biology and revival biology. The former focuses on preventing extinction by land conservation, restoration and enhancement of natural habitats. The latter gives priority on de-extinction or bringing back extinct organisms by cloning, selective breeding, or other applicable genetic procedures.

As an organization committed to protecting biodiversity, which is the best way to decide and come up with a common stand?

A. Come up with your own “school of thought.”
B. Hold a debate in one of your meetings: de-extinction vs. conservation?
C. Know which action other leading organizations are supporting and imitate them.
D. Weigh the pros and cons of each by analyzing and comparing related studies.

(T) 19. Below is a graph from the Forest Management Bureau that compares the deforestation and reforestation rates in the Philippines from 1976-2005:



As somebody who is concerned with biodiversity conservation, how will you make use of this information?

A. Announce that the calamities we experience today are attributed to deforestation.
B. Campaign to improve reforestation efforts by the government and private sectors.
C. Commend the efforts of the government and timber license holders to save our forests.
D. Warn that reforestation efforts tend to endanger the biodiversity of the forests.

(T) 20. A forum about the current extinction crisis is to be held in the Philippines. You are one of the biologists invited to share your research/study on the said issue. You are to present, through multimedia presentation, a timeline of extinction events. From these data, you will draw out patterns, conclusions, and formulate recommendations in relation to biodiversity and species conservation. If the forum will be attended by government leaders and fellow scientists, you have to make sure that your presentation has which of the following set of qualities?

A. Accurate data and powerful graphics
B. Accurate data and sound conclusions and recommendations
C. Feasible recommendations and long discussions
D. High quality information and interesting animations

GLOSSARY OF TERMS USED IN THIS LESSON:

adaptation Inherited characteristic of an organism that enhances its survival and reproduction in specific environments

autosome A chromosome that is not directly involved in determining sex; not a sex chromosome

chromosome A structure carrying genetic material, found in the nucleus of eukaryotic cells

chromosome theory of inheritance A basic principle in biology stating that genes are located on chromosomes and that the behavior of chromosomes during meiosis accounts for inheritance patterns

codominance The situation in which the phenotypes of both alleles are exhibited in the heterozygote because both alleles affect the phenotype in separate, distinguishable ways

continuous variation Variation within a population in which a graded series of intermediate phenotypes falls between the extremes

deoxyribonucleic acid, DNA A double-stranded, helical nucleic acid molecule consisting of nucleotide monomers with a deoxyribose sugar and the nitrogenous bases adenine, cytosine, thymine, and guanine

discontinuous variation Variation within a population in which few or no intermediate phenotypes fall between the extremes

ecosystem diversity The variety of ecosystems in a given region or area

evolution Descent with modification; the idea that living species are descendants of ancestral species that were different from the present-day ones; change in the genetic composition of a population from generation to generation

extinction The state or situation that results when a species died out completely or no longer exists

gene A discrete unit of hereditary information consisting of a specific nucleotide sequence in DNA or RNA

genetic diversity Total number of genetic characteristics in the genetic makeup of a species

genetic variation Variations in alleles of genes that occur both within and among populations

genome The genetic material of an organism or virus; the complete complement of an organism's or virus's genes along with its non-coding nucleic acid sequences

genotype The genetic make-up, or set of alleles, of an organism

inbreeding The breeding of related individuals within an isolated or a closed group of organisms

incomplete dominance A form of intermediate inheritance in which one allele for a specific trait is not completely dominant over the other allele

mitochondrial inheritance The transmission of the mitochondrial genome from mother to child

multiple alleles Any of a set of three or more alleles, or alternative states of a gene, only two of which can be present in a diploid organism

phenotype The physical and physiological traits of an organism, which are determined by its genetic make-up

polygenic inheritance An additive effect of two or more genes on a single phenotypic character

species A population or group of populations whose members have the potential to interbreed in nature and produce viable, fertile offspring, but do not produce viable, fertile offspring with members of other such groups

species diversity The number of different species within a specific region or area

trait Any detectable variant in a genetic character

REFERENCES AND WEBSITE LINKS USED IN THIS LESSON:

http://www.wiley.com/college/test/0471787159/biology_basics/animations/mendelianInheritance.swf - Mendelian Inheritance

http://www.sumanasinc.com/webcontent/animations/content/mendel/mendel.html - Mendel's Experiments Animation

http://www.pbs.org/wgbh/nova/body/how-cells-divide.html - Interactive Comparison of Mitosis and Meiosis

http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter28/animation__how_meiosis_works.html - Animation of Meiosis

http://www.nature.com/scitable/topicpage/developing-the-chromosome-theory-164 - Developing the Chromosome Theory

http://www.tutorvista.com/content/biology/biology-iii/heredity-and-variation/chromosome-theory-inheritance.php - Chromosome Theory of Inheritance

http://learn.genetics.utah.edu/content/chromosomes/intro/ - What is a Chromosome?

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

http://learn.genetics.utah.edu/content/molecules/gene/ - What is a Gene?

http://www.pbslearningmedia.org/asset/tdc02_int_hglandmarks/ - Chromosome Viewer

http://anthro.palomar.edu/mendel/mendel_3.htm - Non-Mendelian patterns of inheritance

http://www.biologycorner.com/bio2/genetics/notes_incomplete_dominance.html - Incomplete Dominance and Codominance

http://biologycorner.com/worksheets/genetics_codominance.html#.Uvb0GmIvRPc – Practice: Codominance and Incomplete Dominance

http://evolution.about.com/od/Evolution-Glossary/g/Multiple-Alleles.htm - Multiple Alleles

http://learn.genetics.utah.edu/content/inheritance/blood/ - Genes and Blood Type

http://www.ib.bioninja.com.au/higher-level/topic-10-genetics/103-polygenic-inheritance.html - Polygenic Inheritance

http://www.bbc.co.uk/bitesize/ks3/science/organisms_behaviour_health/variation_classification/revision/3/ - Continuous and Discontinuous Variation

http://www.bbc.co.uk/bitesize/ks3/science/organisms_behaviour_health/variation_classification/revision/4/ - Inherited and Environmental

http://anthro.palomar.edu/practice/mendqui3.htm - Practice Quiz on Non-Mendelian inheritance

http://www.marietta.edu/~spilatrs/biol101/spilassign/Nonmendelian%20assignment.doc – Non-Mendelian Genetics Practice Problems

http://www.nobelprize.org/educational/medicine/bloodtypinggame/game/index.html - the Blood Typing Game

http://learn.genetics.utah.edu/content/chromosomes/typesauto/ - Autosomal DNA

http://learn.genetics.utah.edu/content/chromosomes/typesx/ - X chromosome DNA

http://learn.genetics.utah.edu/content/chromosomes/typesy/ - Y chromosome DNA

http://www.learnerstv.com/animation/animation.php?ani=9&cat=Biology – Specialized chromosomes determine gender

http://anthro.palomar.edu/biobasis/bio_4.htm - Sex-linked inheritance

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