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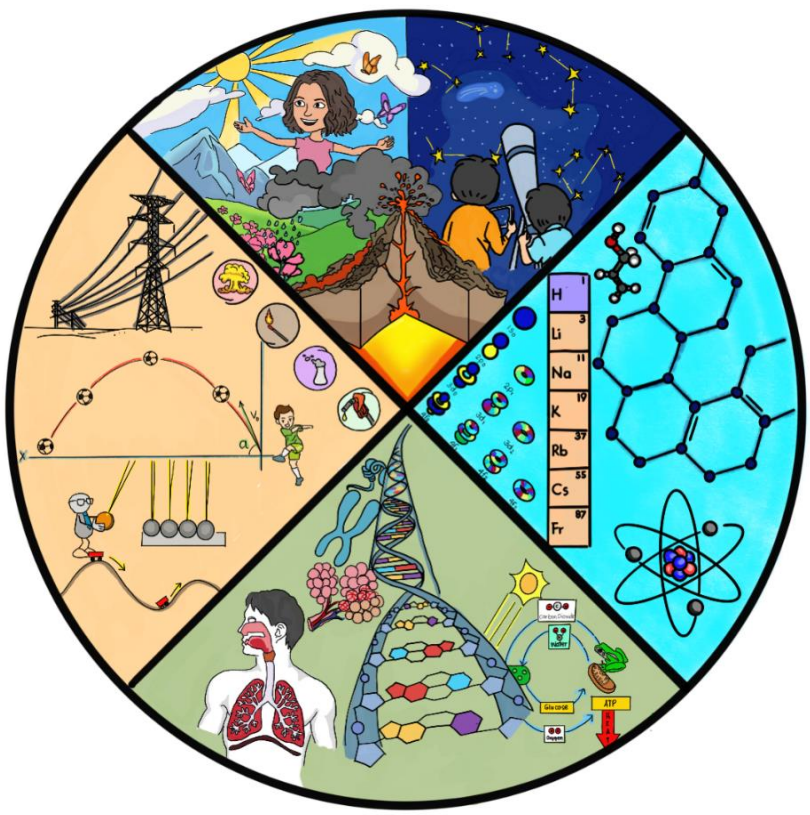
Department of Education
National Capital Region
SCHOOLS DIVISION OFFICE
MARIKINA CITY

Science

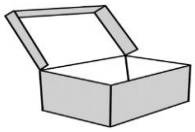
Quarter 1 – Module 5

Basic Features of Photosynthesis and Cellular Respiration



Samuel P. Songcayauon

City of Good Character
DISCIPLINE • GOOD TASTE • EXCELLENCE



What I Need to Know

The purpose of this module is to help you understand the process of photosynthesis and cellular respiration.

This module contains the following lessons:

- Lesson 1: Photosynthesis
- Lesson 2: Cellular Respiration

After going through this module, you should be able to **differentiate basic features and importance of photosynthesis and respiration. S9LT-lg-j-31**

Specifically, you are expected to:

- relate physical plant characteristics (chloroplasts, pigments, stomata, etc.) to their functions;
- differentiate Light Dependent and Light Independent Reaction in terms of the raw materials, processes and end product;
- conduct investigations that will show that plants are capable of making food;
- explain the factors that affect the rate of photosynthesis;
- describe the parts of the mitochondrion and explain how cell release energy from food;
- describe and explain the Krebs Cycle and the Electron Transport Chain;
- differentiate photosynthesis and respiration in terms of structures involved, raw materials, end product and energy requirement; and
- design and conduct investigation that plants can manufacture their own food.

What I Know

Read and understand each item carefully and encircle the letter corresponding to the word or group of words that completes the sentence.

1. What function does chlorophyll play in the process of photosynthesis?
   A. it captures light energy from the sun
   B. it breaks down water molecules
   C. it breaks down CO_2
   D. it forms ATP

2. Which are required to start the light-dependent reaction of photosynthesis?
   A. CO_2 and chlorophyll
   B. light and water
   C. ATP
   D. oxygen

3. The light-dependent reaction of photosynthesis occurs in the _____while Calvin cycle occurs in _____.
   A. grana: thylakoid
   B. grana: stroma
   C. thylakoid: grana
   D. stroma: thylakoids

4. Why is water necessary in photosynthesis?
   A. it reacts with CO_2 to form sugar
   B. it aids in the transport of ATP
   C. it transfers energy during NADP production
   D. it is used in the production of H+, e and O_2

5. In the food making process, plants absorb water (H_2O) and Carbon dioxide (CO_2) to released oxygen (O_2) and produce glucose ($C_6H_{12}O_6$). In which part of photosynthesis is oxygen released?
   A. Calvin cycle
   B. Dark reaction
   C. Light-dependent reaction
   D. Light independent reaction

6. Which is not the product of photosynthesis?
   A. carbon dioxide
   B. glucose
   C. ATP
   D. Water

7. Which is not needed by the cell to start Calvin cycle?
   A. oxygen
   B. Ribulose biphosphate
   C. ATP
   D. NADPH

8. What function does mitochondrion play in the process of respiration?
   A. it captures light energy from the sun
   B. it breaks down water molecules
   C. It produces ATP from glucose
   D. It forms ATP from water

9. Which are required to start the process of cellular respiration?
   A. CO_2 and chlorophyll
   B. Oxygen and glucose
   C. ATP and $NADPH_2$
   D. Oxygen and Water

10. Which of the following does not happen during cellular respiration?
    A. energy in a form of ATP is produced
    B. breakdown of glucose into pyruvate
    C. breakdown of glucose into ATP and NADPH
    D. Krebs cycle release carbon dioxide

11. Aerobic respiration will not occur in the absence of_____.
    A. ATP
    B. oxygen
    C. glucose
    D. light

12. During the anaerobic respiration in the human body, the pyruvate molecules from glycolysis react with NADH in order to produce _____?
    A. carbon dioxide
    B. ethanol
    C. lactic acid
    D. oxygen

13. Which products of grape fermentation are essential for wine production?
    A. ATP and ethanol
    B. Lactic acid and NADH
    C. ATP and Carbon dioxide
    D. Carbon dioxide and ethanol

14. Which stage of cellular respiration produces the greatest number of ATP?
    A. Fermentation
    B. Krebs cycle
    C. Glycolysis
    D. Electron transport chain

15. During a strenuous exercise, you feel soreness of your muscles. This happens because the muscle cells_____?
    A. switch to lactic acid fermentation
    B. switch to aerobic respiration
    C. lower the production of pyruvic acid
    D. lower the production of ATP

Lesson 1 Photosynthesis

What's In

Activity 1.1. What I Know About Photosynthesis

A. Write three observations/ideas about the illustration on a separate sheet of paper.

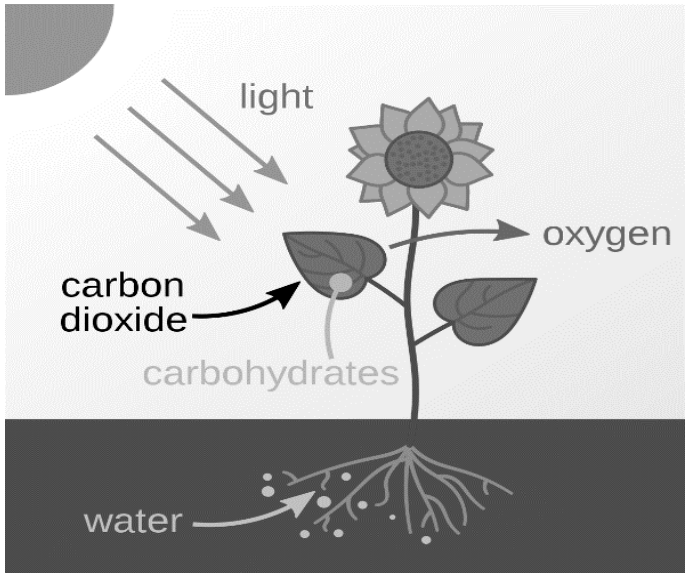


Figure 1. Photosynthesis
https://bit.ly/3qtJKcB

B. Write AGREE if the statement is correct and DISAGREE if it is incorrect.

_____1. All organisms can make their own food.
_____2. A violet mayana plant cannot make its own food.
_____3. Carbon dioxide is required for food making process.
_____4. Leaves are the only location for food making process.
_____5. Food making process will not occur in the absence of light.

What's New

Activity 1.2. Analyze the illustration below and answer the questions that follow.

Figure 2. Mechanism of Photosynthesis
https://bit.ly/3h0dGK3

Guide Questions:

1. Based on the image, the plant performs food making. Do you think this process will be performed by other organisms? Why?

   _____

2. What is the role of sunlight in the food making process?

   _____

3. Where does carbon dioxide come from?

   _____

4. What do you think is the important role of water in the food making process of plants?

   _____

Activity 1.3. Identify the raw materials and the products needed by photosynthesis by writing the names of the compound involved in the chemical equation below. Write your answers on a separate sheet of paper.

$$CO_2 + H_2O \longrightarrow C_6H_{12}O_6 + O_2$$

1 2 3 4

GUIDE QUESTIONS:

1. Based on the chemical equation above, which do you think are the raw materials?

   _____

2. From the same equation above, which are the products?

   _____

Factors	Role/ Location
1. Chlorophyll	• Found on the surface of each thylakoid • Captures light energy from the sun • Activated by light during light dependent reaction
2. Water	• Splits into hydrogen ion, oxygen, and electrons during photolysis. • Source of oxygen released in food making • Provides electron lost in Photosystem II
3. ADP to ATP	• Source of energy for biological processes • Carries the energy received from sunlight
4. NADP to NADPH	• Stands for nicotinamide adenine dinucleotide phosphate (NADP) • Electron carrier that accepts a pair of high-energy electrons and transfers them, to another molecule.
5. Carbon Dioxide	• Provides the carbon needed to make glucose in food making.

Activity 1.4. Study the table below and the structure of the chloroplast.

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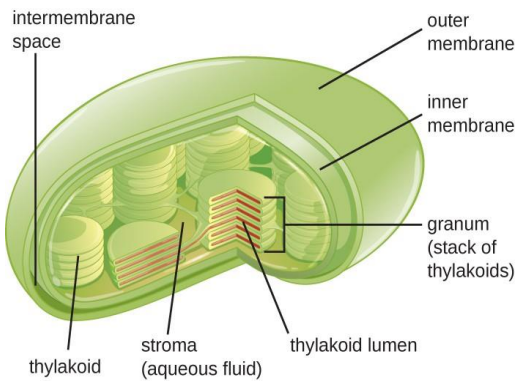


Figure 3. Chloroplast
https://bit.ly/3h0eYon

Guide Questions:

1. What are the parts of the chloroplast?

   _____

2. What is the role of the chloroplast in the leaves?

   _____

3. What is the role of NADPH?

   _____

4. What do you think will happen if any one of the factors mentioned in the table above is not present?

   _____

ACTIVITY 1.5. Understanding Light-dependent Reaction Phase.

Objective:

1. Identify the raw materials and the products of light- dependent reaction.

What to do:

1. Study the illustrations below.

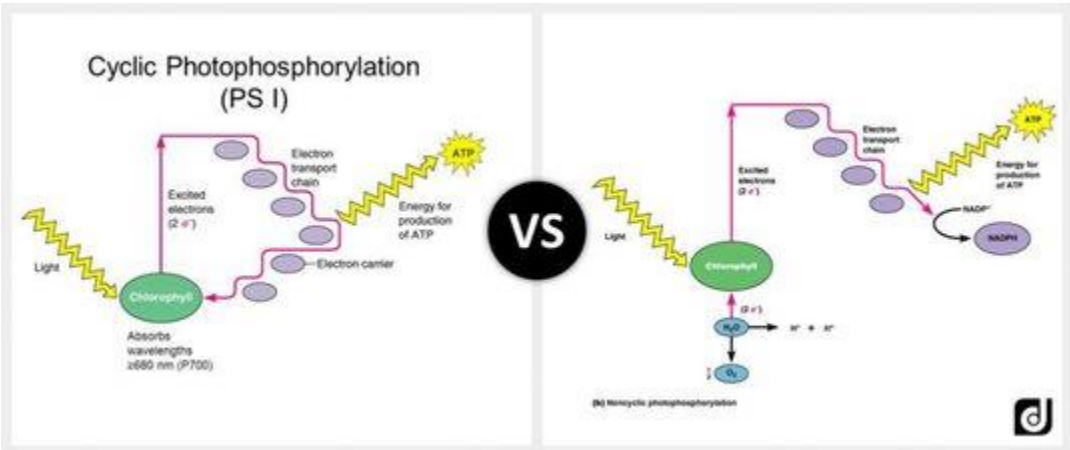


Figure 3. Cyclic Photophosphorylation vs. Non-Cyclic Photophosphorylation
https://bit.ly/3dm86zA

2. Using illustrations, A and B above as your reference, fill-out the table with the correct information. Write your answers on a separate sheet of paper.

Process	Requirements	Major event	Products
Cyclic			
Non-cyclic			

Guide Questions:

1. What is the main source of energy used in the two processes?

_____

2. Which part of light dependent reaction is ATP produced?

_____

3. What is the role of NADP in the process?

_____

4. What is photophosphorylation?

_____

5. What is the difference between cyclic and non-cyclic photophosphorylation?

_____

What Is It

Photosynthesis is the food-making process which converts light energy from the sun into chemical energy in food. The process requires molecules of water and carbon dioxide in the presence of sunlight and chlorophyll to produce the food (glucose) and release the by-product oxygen.

Organisms which contain chlorophyll like algae and plants can perform photosynthesis. The chlorophylls of the chloroplast are the green pigment which absorbs the light energy from the sun. Inside the chloroplasts are disc shaped structures called thylakoids which contain chlorophylls. Thylakoids are stacked to form a granum. Not all organisms which can perform photosynthesis possess chloroplasts. If chlorophylls are present in any part of the organism, food making can take place.

The leaves are the main area for photosynthesis. The leaf has mesophyll layers in between the upper and lower epidermis. Each epidermis has stomata which allows the carbon dioxide to enter and the oxygen to leave. Stomates are guard cells which regulate the gas exchange in the leaves. When the guard cells absorb water, it becomes turgid and opens. When it loses water, it becomes flaccid and closes. Lower epidermis has more stomates than upper epidermis.

The mesophyll layers are the palisade and the spongy. Photosynthesis occurs more on the palisade with closely packed parenchyma cells. The spongy layer is loosely arranged to allow gas to move.

Photosynthesis is divided into two phases. The light dependent phase and the light independent phase. The light dependent phase occurs in the thylakoids of the chloroplast. It requires the presence of light energy and water. This part produces ATP and NADPH needed for the next phase of photosynthesis.

The absorption of light in the light dependent phase or light reaction involves two photosystems: P_I and P_{II}. The photosystems contain light harvesting pigments and proteins. The light harvesting pigments passes the energy to the reaction center. P_{II} contains the reaction center P_{680} and the P_I contains the reaction center P_{700}.

When the light energy strikes the leaves, chlorophylls in photosystem II capture the energy and passes it to the P_{680} reaction center. The energy excites the electrons of the chlorophyll and moves to a series of electron acceptors. The lost electron is replaced by the electron from the water due to photolysis (the splitting of water into H ion, electron, and oxygen due to the heat from the sun)

The same event occurs in photosystem II. The high energy electron ejected out and moves to a series of electron acceptors. In the $P_{II,}$ the lost electrons are replaced by electrons from water while in $P_{I,}$ the lost electrons are replaced by the electrons from $P_{II.}$ The final electron acceptor in the process is $NADP^-$ to produce NADPH. It is very important to remember that the movement of energy in both photosystems is simultaneous since electrons in both P_{680} and P_{700} are activated by the energy received from the sun.

As the high energy electron moves from one acceptor to another, it loses energy. This released energy is used to produce ATP in the presence of the enzyme ATP synthase. The production of ATP can be of two ways. Cyclic Photophosphorylation and Non-cyclic Photophosphorylation. In the non-cyclic photophosphorylation, the electron moves from the $P_{II.}$ to $P_{I,}$ until the last electron acceptor $NADP^{-.}$ In this process ATP and NADPH are produced. In the cyclic photophosphorylation, the electrons follow a cyclic path in producing ATP.

It is important to remember that in light-dependent reaction, the following events occurred: 1. activation of the electron in the chlorophylls of P_{680} and P_{700}; 2. photolysis; and 3. Photophosphorylation: Non-cyclic and Cyclic. The raw material is water, and the products are ATP and NADPH. Oxygen is a by-product.

The light-independent phase of photosynthesis occurs in the stroma of the chloroplasts. It is also called Calvin Cycle or Dark reaction. This process occurs once the products of the light-dependent reaction are available.

The Calvin cycle has four main steps: carbon fixation, reduction phase, carbohydrate formation, and regeneration phase. Energy to fuel chemical reactions in this sugar-generating process is provided by ATP and NADPH, chemical compounds which contain the energy plants have captured from sunlight.

Carbon fixation. Carbon in the molecule of carbon dioxide (CO_2) is fixed from an inorganic to an organic molecule. An enzyme Rubisco combines carbon

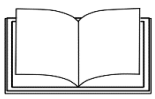
dioxide and RuBp to produce an organic molecule with six carbon organic compound.

Reduction Phase. the six-carbon compound is reduced into phosphoglyceric acid (3-PGA) and further converted into phosphoglyceraldehyde (G3P) using electrons supplied by ATP and NADPH, then ATP and NADPH are converted to ADP and $NADP^+$, respectively.

Carbohydrate Formation. The G3P will be converted into glucose. Two G3Ps are needed to make one glucose. For every turn of the cycle, only one carbon dioxide molecule is needed to produce one G3P, thus six carbon dioxide molecules are needed to make two G3P for one glucose molecule and the rest for regeneration.

Regeneration Phase. The G3Ps produced in the cycle are used to make glucose and regenerate RuBP. Three more molecules of ATP are used in these regeneration reactions.

It is important to remember that the Calvin Cycle uses six carbon dioxides to produce one glucose. In the process, ATPs and NADPH from the light reaction are used to fix the carbon dioxide and produce glucose and regenerate the RuBP. It is called light independent phase because it is not directly powered by light.



What's More

Let's compare Light-Dependent and Light-Independent Reaction Phase of Photosynthesis.

Activity 1.6. A Comparison on the Two Phases of Photosynthesis

Phases of Photosynthesis	Raw Materials	Products	Location
Light-dependent			
Light-Independent			

Guide Questions:

1. How important is photosynthesis in the balance of nature?

   _____

2. In which molecule in the light dependent phase does oxygen come from?

   _____

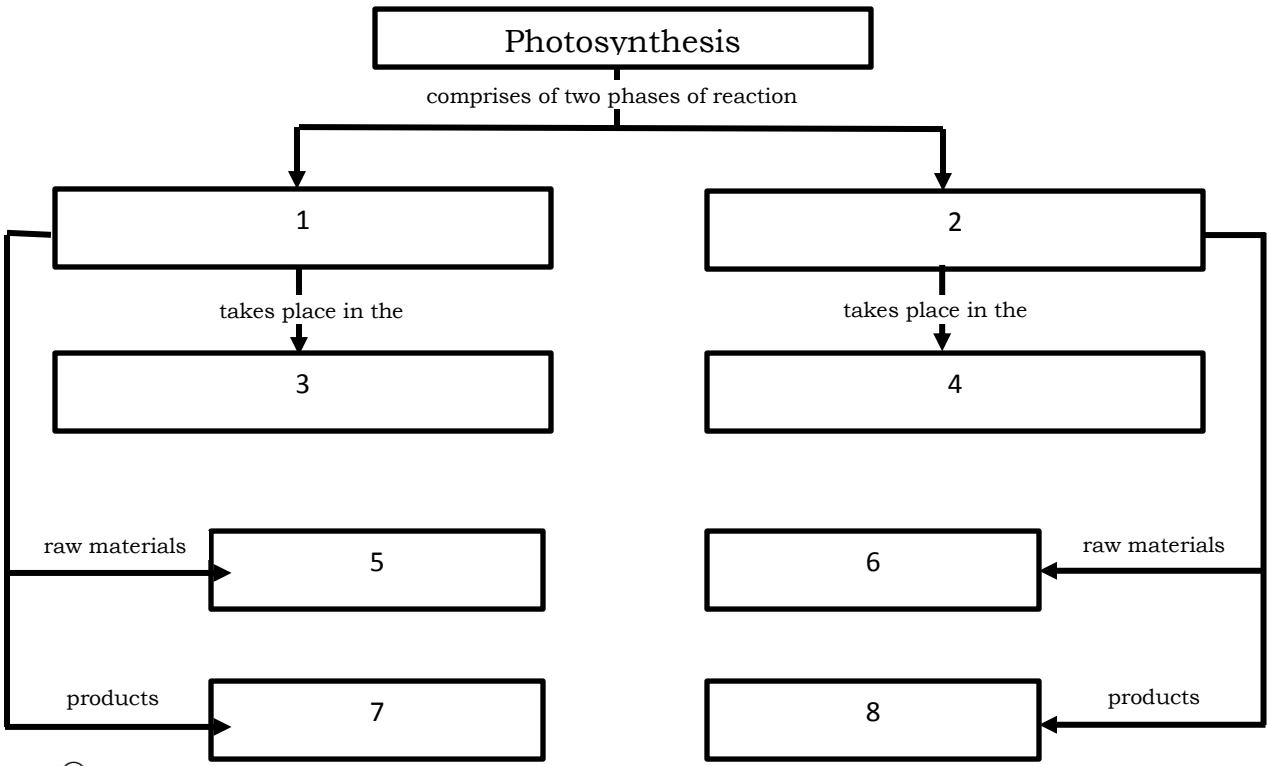
3. What human activity can be performed to help maintain the balance of oxygen and carbon dioxide in your surroundings?

   _____

What I Have Learned

FLOW CHART: Complete the flow chart of Photosynthesis using the terms written in the word box below.

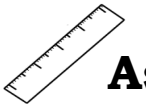
ATP	Light-dependent	Sunlight
Carbon dioxide,	Light-independent	Water
Chlorophyll	NADPH	Stroma
Grana	Oxygen	Hydronium ion
Glucose	PGA	



What I Can Do

Fill out the table below with activities on how you can lessen the occurrence of global warming. The first one is done for you.

Advocacy	Activity	Person/s Involved
Example: 3 R's	Sorting	Barangay officials, Eco-waste management, Students, Family members
1.		
2.		



Assessment

Read and understand each item carefully and encircle the letter corresponding to the word or group of words that completes the sentence.

1. What function does chlorophyll play in the process of photosynthesis?
   A. it captures light energy from the sun
   B. it breaks down water molecules
   C. It breaks down CO2
   D. It forms ATP

2. Which are required to start the light-dependent reaction of photosynthesis?
   A. CO_2 and chlorophyll
   B. Light and water
   C. ATP
   D. Oxygen

3. Why is water necessary in photosynthesis?
   A. It reacts with CO_2 to form sugar
   B. It aids in the transport of ATP
   C. It transfers energy during NADP production
   D. It is used in the production of H+, e- and O_2

4. In the food making process, plants absorb water (H_2O) and Carbon dioxide (CO_2) to release oxygen (O_2) and produce glucose ($C_6H_{12}O_6$). In which part of photosynthesis is oxygen released?
   A. Calvin cycle
   B. Dark reaction
   C. Light-dependent reaction
   D.Light independent reaction

5. Which is not the product of photosynthesis?
   A. Carbon dioxide B. Glucose C. ATP D. NADPH

Additional Activities

Using an Oslo paper, compose a **slogan** on the importance of plant in maintaining life on earth. You can post your output in any social media platform as a form of environmental awareness campaign in protecting and preserving our environment. Make sure to consider the rubrics for assessment given below in making the slogan.

Criteria	Good (3)	Very Good (4)	Excellent (5)
1.Relevance to the issue			
2.Rhyme rating			
3.Over-all impact			

Lesson 2 Cellular Respiration

What's In

What I know about Oxygen-Carbon Dioxide Cycle

Analyze the cycle and answer all the questions below.

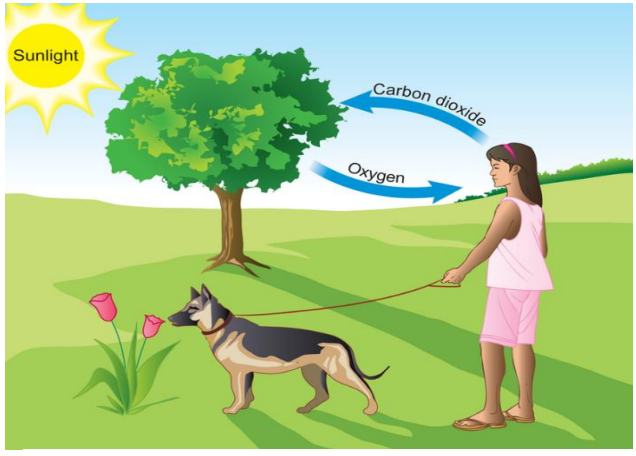


Figure 4. Plant – Animal Symbiosis
https://bit.ly/3dm86zA

Guide Questions:

1. Based on the diagram, what is the source of oxygen that we breathe in the cycle?

   _____

2. What process is involved in the production of oxygen?

   _____

3. Which gas in the diagram is released by the animals?

   _____

4. What kind of ecological relationship is demonstrated by the plants and the animals in the diagram?

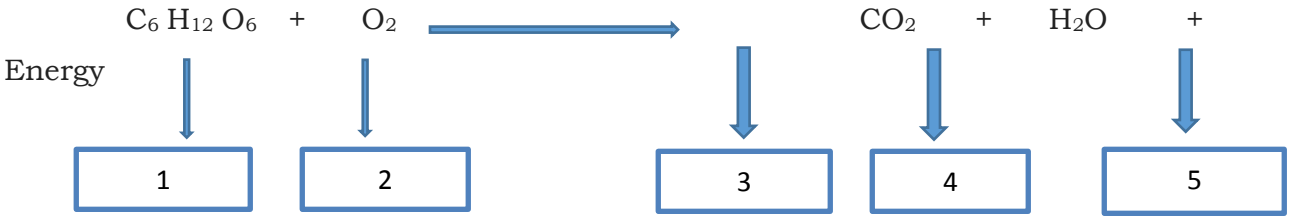
   _____

What's New

Activity 2.1: The Cellular Respiration's Chemical Equation

Let us try to examine the summarized chemical equation of cellular respiration. What you need to do is to complete the word equation by naming the substances involved in the process. Write your answers on a separate sheet of paper.

Chemical Equation



Guide Questions:

1. In which side of the chemical equation are the raw materials found?

_____

2. What are the raw materials needed by the cell to start cellular respiration?

_____

3. List down all the products of the cellular respiration.

_____

Activity 2.2: The Mitochondrion

This time let us analyze the image of the mitochondrion.

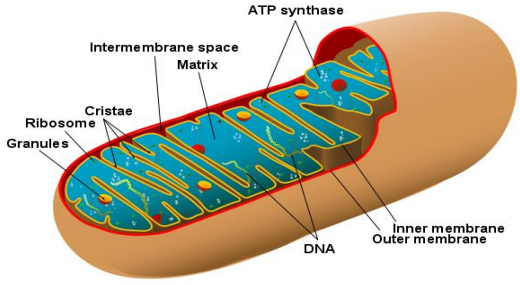


Figure 5. The Powerhouse of the Cell
https://bit.ly/3dlDduS

Guide Questions:

1. What part of the cell is shown above?

_____

2. What is the reason why it is called the powerhouse of the cell?

_____

3. Mitochondrion is made up of folds of membrane. What is the term given to the folds?

_____

Activity 2.3 Stages of Cellular Respiration

Analyze the diagram of the stages of cellular respiration below and answer the questions that follow.

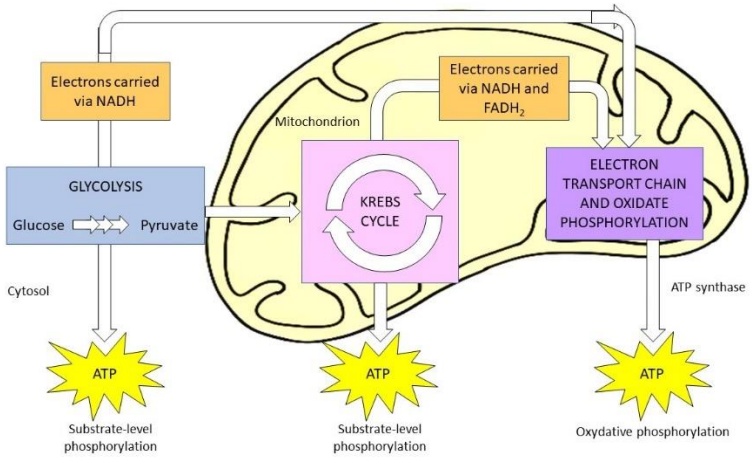


Figure 6. The Major Stages of Cellular Respiration

Guide Questions:

1. How many stages are there in cellular respiration? Enumerate in chronological order.

_____

2. Which of the stages takes place inside the mitochondrion?

_____

3. What stage of cellular respiration occurs outside the mitochondrion?

_____

4. What stages in the diagram releases energy?

_____

5. What organic substance is used to start Glycolysis?

_____

What Is It

The equation above summarizes the process of cellular respiration. The food that we eat are digested and broken down into glucose. This glucose releases energy in the presence of oxygen.

When we examine the equation for cellular respiration, the raw materials are glucose and oxygen. This is an example of respiration in the presence of oxygen (aerobic respiration). It needs the presence of oxygen to produce carbon dioxide, water, and ATP. This process is composed of three major stages such as Glycolysis, Krebs cycle and Electron transport chain. Each stage produces energy in a form of ATP and the highest energy is produced in electron transport chain.

The whole process of Cellular respiration is summarized into three major events.

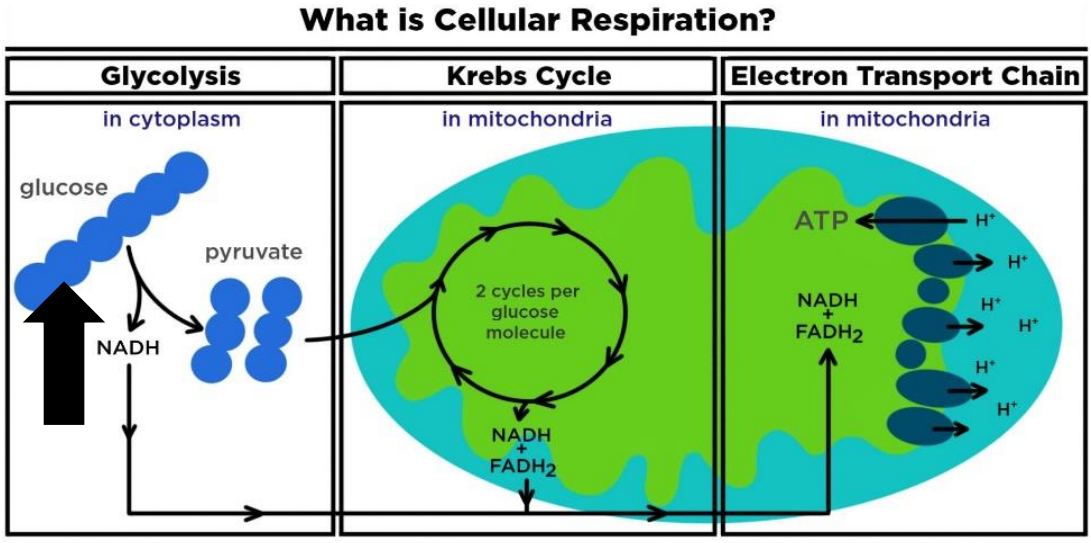


Figure 6a. Glycolysis (Cellular Respiration)

The arrow pointed at the first stage of cellular respiration is **GLYCOLYSIS.**

Cellular respiration starts with **glycolysis.** It is the process by which one glucose molecule (C_6 H_{12} O_6) is broken down to form two molecules of pyruvate, ATP and NADH. It occurs in the **cytoplasm** of cells.

Glycolysis may occur with or without oxygen. In the absence of oxygen, glucose is broken down into pyruvate, ATP and the NADH. But the pyruvate reacts with NADH to produce **lactic acid in animals and ethanol and carbon dioxide in plants and yeast.** In the presence of oxygen, the pyruvate proceeds to the Krebs cycle. Remember that at the end of Glycolysis, two pyruvates, two NADH and two net ATPs.

The second stage of cellular respiration is **KREBS CYCLE.** This occurs only in the presence of oxygen and acetyl CoA.

The Acetyl CoA is formed prior to Krebs Cycle. The pyruvate from glycolysis is oxidized by CoA (Coenzymes A) and becomes Acetyl Coenzyme A, a molecule with two (2) carbon atoms. In this process, two NADH and two carbon dioxides are released for every pyruvate. This preparation occurs in the mitochondrion.

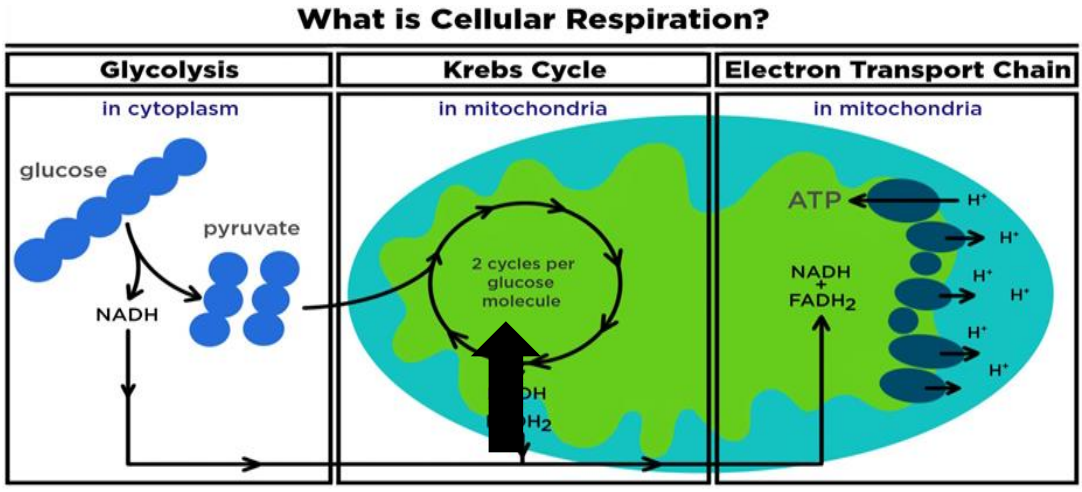


Figure 6a. Krebs Cycle (Cellular Respiration)

The Krebs Cycle, also called citric acid cycle takes place in the matrix of the mitochondrion. The Krebs cycle starts when two (2) carbon molecule, Acetyl CoA combines with oxaloacetic acid (4 carbon molecule) and becomes citric acid six (6) carbon molecules. As the cycle progresses, oxidation occurs and carbon is lost in the form of carbon dioxide. The H^- ion is taken by NAD^- and to produce NADH as well as $FADH_2$. Remember that one turn of the cycle produces one ATP, two carbon dioxides, three NADH, and one $FADH_2$. The NADH and $FADH_2$ will proceed to the electron transport chain.

The final stage of cellular respiration is **ELECTRON TRANSPORT CHAIN**

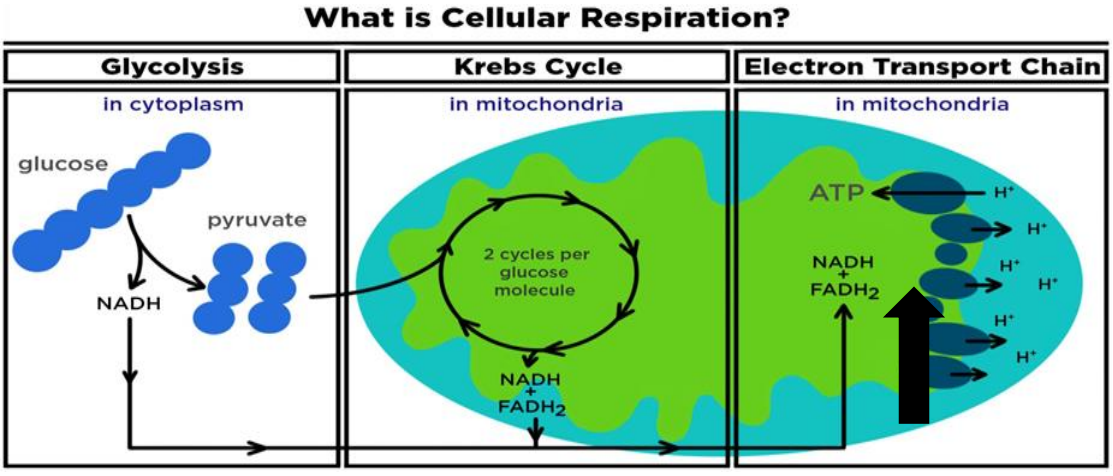


Figure 6a. Electron Transport Chain (Cellular Respiration)

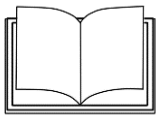
The electron transport chain is the final step of cellular respiration. It occurs in the cristae, a series of folds inside the mitochondrion.

The electron transport chain receives the electrons carried by NADH and $FADH_2$. The electrons move from a series of electron acceptors. The final electron

acceptor in this stage is oxygen. In the process, the protons are pumped from the matrix of the mitochondria to the intermembrane space. The movement of the protons allowed the formation of ATP. ATP formation is aided by the enzyme ATP synthase. For every molecule of NADH, three ATPs are formed and for every $FADH_2$, two ATPs are formed.

(Note: The NADH from Glycolysis: 2 ATPs only since it is from the cytoplasm)

It is important to remember that cellular respiration can be aerobic (occurs with oxygen) or anaerobic (without oxygen). More ATPs are formed in the aerobic respiration since the presence of oxygen allowed the production of more NADH and $FADH_2$ which carries the electrons to the Electron transport chain. The ETC produces 32 ATPs. The total amount of ATP starting from Glycolysis until the last stage is 36 ATPs in organisms with mitochondria.



What's More

During the start of the lesson on cellular respiration, the Oxygen-Carbon Dioxide Cycle was introduced. The gas exchange was carried out by plants and animals. Similarly, photosynthesis and cellular respiration are processes that are interdependent to each other because the products of one are the raw materials of the other. Let us summarize the relationship of Photosynthesis and Respiration using the balanced equations below.

Photosynthesis

$$6\ CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 6\ O_2.$$

Respiration

$$C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O + ATP$$

Using the equation above, complete the table below.

Table.3 Relationship between Photosynthesis and Respiration.

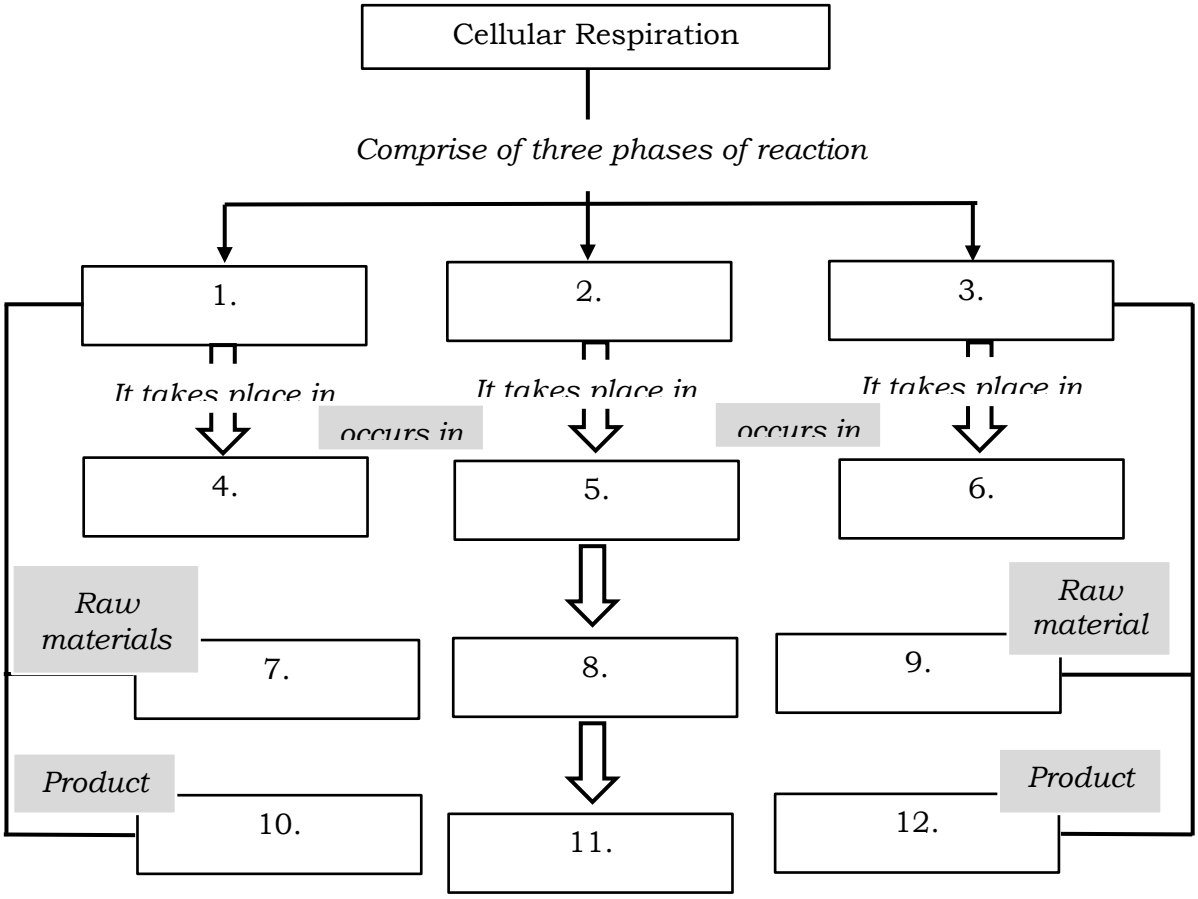
Process	Raw materials	Products	Energy Produced	Cell Organelle
Photosynthesis				
Respiration				

What I Have Learned

FLOW CHART: Fill out the rectangular shape objects with word or group of words to complete the flow chart. Use the words written in the box below.

Use the following words to complete the flow chart (Some words can be used twice)

2 ATP	Cytoplasm	Krebs cycle
32 ATP	Electron transport chain	Matrix
Acetyl CoA	FADH	NADH
Carbon dioxide	Glucose	Oxygen
CO_2	Glycolysis	Pyruvate
Cristae	H_2O	

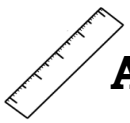


What I Can Do

The process of respiration can be carried out by plants, animals, and other microorganism to produce energy known as ATP. There are two ways by which cell can generate ATP, by way of aerobic and anaerobic or fermentation. However, aerobic pathways produced more ATP than anaerobic because the former process takes in the presence of oxygen while the other do not.

As part of your assignment, **research** on the following:

1. List down at least 5 products of fermentation that are available every day in the house.
2. List down examples of living organisms that can survive in an environment with low or without oxygen.



Assessment

Read and understand each item carefully and encircle the letter corresponding to the word or group of words that completes the sentence.

1. What function does mitochondrion play in the process of respiration?
   A. it captures light energy from the sun
   B. it breaks down water molecules
   C. it produces ATP from Glucose
   D. it forms ATP from water

2. Which are required to start the process of respiration?
   A. CO_2 and chlorophyll
   B. oxygen and glucose
   C. ATP and $NADPH_2$
   D. oxygen and water

3. What function does mitochondrion play in the process of respiration?
   A. it captures light energy from the sun
   B. it breaks down water molecules
   C. it produces ATP from Glucose
   D. it forms ATP from water

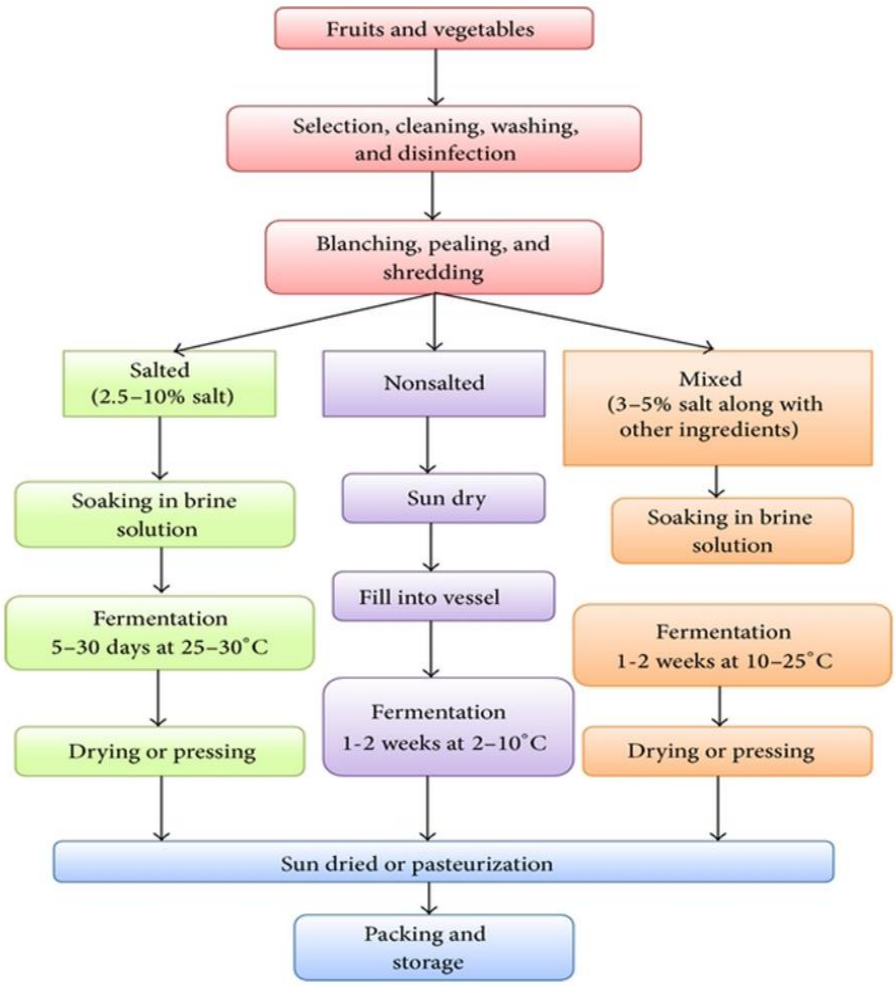
4. Which are required to start Krebs cycle?
   A. CO_2 and mitochondrion
   B. oxygen and glucose
   C. ATP and $NADPH_2$
   D. Acetyl CoA and oxygen

5. Which does not happen during anaerobic cellular respiration?
   A. energy in the form of ATP is produced
   B. breakdown of glucose into pyruvate
   C. pyruvate reacts with NADH
   D. Krebs cycle release carbon dioxide

Additional Activities

Make your own product of fermentation at home using fruit or vegetable. Choose any of the procedures in the diagram below. (Salted, Non-salted, or Mixed). After the prescribed days of fermentation look for at least three persons to evaluate your product by writing comments on the criteria provided in the table.

Procedure on how to perform Fermentation.



Reminders:

a. **Fruit fermenting** is different from vegetable **fermenting**. **Fruit** is made up of sugar, and the sugar affects the process. As the yeasts consume the sugar, alcohol is created as a byproduct.
b. How to prepare Brine solution: The basic ratio of **salt** to water for a **brine** is 4 tablespoons of **salt** per 1 quart (4 cups) of water.

RUBRICS FOR JUDGING THE PRODUCT

Rate the texture, flavor and aroma using a scale of 1-5. With five (5) being the highest and one (1) the lowest.

Evaluator / Criteria	Texture	Flavor	Aroma
1			
2			
3			

Posttest

Read each question carefully and encircle the letter of the correct answer.

1. Which are required to start the light-dependent reaction of photosynthesis?
   A. CO_2 and chlorophyll
   B. light and water
   C. ATP
   D. Oxygen

2. Why is water necessary in photosynthesis?
   A. it reacts with CO_2 to form sugar
   B. it aids in the transport of ATP
   C. it transfers energy during NADP production
   D. it is used in the production of H+, e and O_2

3. In the food making process, plants absorb water (H_2O) and Carbon dioxide (CO_2) to released oxygen (O_2) and produce glucose ($C_6H_{12}O_6$). In which part of photosynthesis is oxygen released?
   A. Calvin cycle
   B. Dark reaction
   C. Light-dependent reaction
   D. Light independent reaction

4. A leaf exposed to the sun was submerged in denatured alcohol and was boiled in water bath. After rinsing the leaf with water, drops of iodine solution were added. The leaf turns bluish black. This change indicates that _____ is present in the leaf.
   A. lipids
   B. protein
   C. starch
   D. minerals

5. Which pathway correctly describes the flow of electrons in photosynthesis?
   A. NADPH--------H_2O----------O_2
   B. NADPH --------Chlorophyll----------CO_2
   C. H_2O----------CO_2----------O_2
   D. H_2O----------NADPH ----------Calvin cycle

6. Which is not the product of photosynthesis?
   A. carbon dioxide
   B. glucose
   C. ATP
   D. Water

7. Which is not needed by the cell to start Calvin cycle?
   A. oxygen
   B. Ribulose biphosphate
   C. ATP
   D. NADPH

8. What function does mitochondrion play in the process of respiration?
   A. it captures light energy from the sun
   B. it breaks down water molecules
   C. it produces ATP from Glucose
   D. it forms ATP from water

9. Which are required to start the process of respiration?
   A. CO_2 and chlorophyll
   B. oxygen and glucose
   C. ATP and $NADPH_2$
   D. oxygen and water

10. Which do not happen during aerobic cellular respiration?
   A. energy in a form of ATP is produced
   B. breakdown of glucose into pyruvate
   C. breakdown of glucose in the presence of oxygen
   D. Krebs cycle produces ATP from NADH

11. Cellular respiration will not occur in the absence of_____.
   A. ATP
   B. oxygen
   C. glucose
   D. light

12. During the anaerobic respiration in the human body, the pyruvate molecules from glycolysis react with NADH to produce _____?
   A. carbon dioxide
   B. ethanol
   C. lactic acid
   D. oxygen

13. Which stage of cellular respiration produces the greatest number of ATP?
   A. fermentation
   B. Krebs cycle
   C. Glycolysis
   D. Electron transport chain

14. During a strenuous exercise, you feel the soreness of your muscle. This happens because the muscle cells_____?
    A. switch to lactic acid fermentation
    B. switch to aerobic respiration
    C. lower the production of pyruvic acid
    D. lower the production of ATP

15. Which material is cycled out by the chloroplast and mitochondrion?
    A. carbon dioxide, water, oxygen, ATP
    B. carbon dioxide, water, sugar, oxygen
    C. sugar, water, oxygen, ATP
    D. sugar, water, sunlight, and oxygen

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Answer Key

Lesson 1: Photosynthesis

What I Know

1. A	6. A	11. B
2. B	7. A	12. C
3. B	8. C	13. D
4. D	9. B	14.D
5. C	10. C	15. A

What 's In

A. Answers may vary.
1. The sun gives light energy.
2. Carbon dioxide is absorbed by the leaf.
3. Oxygen is released from the leaf.
4. Water is absorbed by the roots.
5. The leaf has carbohydrates.

B.
1.Disagree 2. Disagree 3. Agree 4. Disagree
5. Disagree

What's New

Activity1.2
1. No, only organisms with chlorophyll can produce their own food.
2. Sunlight is the main source of energy
3. Carbon dioxide come from animals and other combustion/burning activities.
4. The role of water is to provide oxygen (O) released by organisms in making food.

Activity1.3
1. Carbon dioxide
2. Water
3. Glucose
4. Oxygen

Guide Questions:

1.Carbon dioxide and water
2.Glucose and oxygen

Activity 1.4
1. inner and outer membrane, stroma, thylakoid, granum
2. It absorbs light energy
3. It carries electrons
4. Photosynthesis will not occur.

Activity 1.5

Process	Requirements	Major event	Products
Cyclic	Chlorophyll, Light energy ADP Water	Excitation of electrons Movement of electron from one acceptor to the next Production of ATP Photolysis	ATP Oxygen
Non-cyclic	Chlorophyll, Light energy ADP Water	Excitation of electrons Movement of electron from one acceptor to the next Production of ATP Production of NADPH Photolysis	ATP Oxygen NADPH

Activity1.5 Guide Questions
1. Sun
2. Cyclic and non-cyclic
3. Final electron acceptor
4.It is the process of producing ATP in the presence of light
5. The cyclic process produces ATP in a circular path it does not produce NADPH while non-cyclic phosphorylation produces ATP in one-way path with the production of NADPH

What's More

Activity 1.6. A Comparison on the Two Phases of Photosynthesis

Phases of Photosynthesis	Raw Materials	Products	Location
Light-dependent	Water	ATP, NADPH	Thylakoid membrane
Light-Independent	Carbon dioxide	Glucose	Stroma

Guide questions:

1. It produces food.
2. Water
3. Answers may vary. Plant trees, reduce burning

What I Have Learned

FLOWCHART
1.light dependent
2.light independent
3.thylakoid membrane
4.stroma
5.water
6. carbon dioxide, ATP, NADPH
7. ATP and NADPH
8. Glucose

What I Can Do

Answers may vary.

Assessment

1. **A**
2. **B**
3. **D**
4. **C**
5. **A**

Answer Key

Lesson 2: Cellular Respiration

What's In

1. Plants
2. Photosynthesis
3. Carbon dioxide
4. Mutualism

What's New

Act. 2.1

1. Glucose
2. Oxygen
3. Carbon dioxide
4. Water
5. ATP

Guide Questions

1. Reactants
2. Glucose and oxygen
3. Carbon dioxide, water and ATP

Act. 2.2

1. Mitochondrion
2. It produces energy
3. Cristae
4. Matrix

Act. 2.3

1. Glycolysis, Krebs Cycle, Electron Transport Chain
2. Krebs Cycle, Electron Transport Chain
3. Glycolysis
4. Glycolysis, Krebs Cycle, Electron Transport Chain
5. Glucose

What's More

Process	Raw materials	Products	Energy Produced	Cell Organelle
Photosynthesis	Water, carbon dioxide	Glucose and oxygen	ATP and chemical energy	Chloroplast
Respiration	Glucose and oxygen	Water and carbon dioxide	ATP	mitochondrion

What I have Learned

1. Glycolysis
2. Krebs Cycle
3. Electron Transport Chain
4. Cytoplasm
5. Matrix of Mitochondria
6. Cristae
7. Glucose/Oxygen
8. Acetyl CoA
9. NADH and $FADH_2$
10. 2 ATP/Pyruvate/NADH
11. Carbon dioxide, NADH, $FADH_2$, 2 ATP
12. 32 ATP/Water

What I Can Do

1. Answers may vary. Soy sauce, kimchi, cheese, miso, vinegar
2. Answers may vary. Bacteria and yeast

Assessment

1. **C**
2. **B**
3. **C**
4. **D**
5. **D**

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