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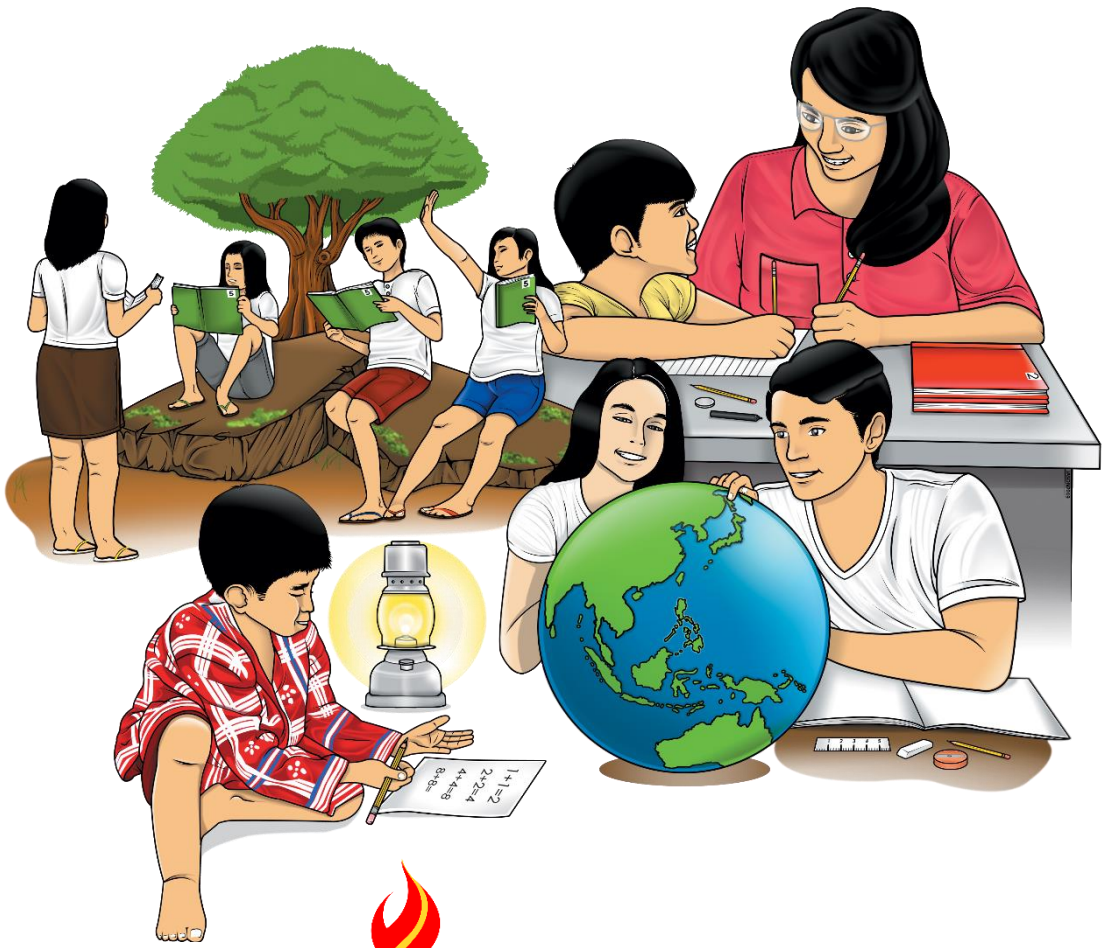
DEPARTMENT OF EDUCATION

Science

Quarter 1- LIVING THINGS
Module 5: Ecosystem: Life Energy



ALTERNATIVE DELIVERY MODE
ADM

Science – Grade 9
Alternative Delivery Mode
Quarter 1: Living Things
Module 5: Ecosystem: Life Energy
First Edition, 2020

Published by the Department of Education
Secretary: Leonor Magtolis Briones
Undersecretary: Diosdado M. San Antonio

Development Team of the Module

Writers:	Jennifer P. Gecomo, Margie R. Soriano, Merry Chris T. Tabligan
Editor:	Loreta E. Santos
Reviewers:	Lucinda S. Concepcion, Marilou B. Cortes, Elvira P. Emerenciana, Jerick N. Escober, Jaquilyn A. Floriano, Richard S. Galang, Myla D. German, Bryan James B. Llaguno, Merbelyn R. Maligat, Saldy B. Sanchez, Loreta E. Santos, Merry Chris T. Tabligan
Language:	Astrid E. Arevalo, Elvira P. Emerenciana, Nova V. Tarcena
Design and Layout:	Edgardo Q. Reyes Jr., Mark Joseph Y. Samarita, Ana Lisa M. Mesina
Management Team:	Malcolm S. Garma Genia V. Santos Dennis M. Mendoza Micah S. Pacheco Josefina M. Pablo Manolo C. Davantes Jr. Dalisay E. Esguerra Hilda C. Valencia

Printed in the Philippines by _____
Department of Education – National Capital Region
Office Address: Misamis St. Bago Bantay, Quezon City
Telefax: (632)8929-0153
E-mail Address: depedncr@deped.gov.ph

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Quarter 1- LIVING THINGS
Module 5: Ecosystem: Life Energy

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

What I Need to Know

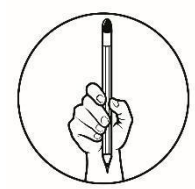
This module was designed and written with you in mind. It is here to help you master Ecosystem: Life Energy. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

The module focuses on achieving this learning competency:

Differentiate basic features and importance of photosynthesis and respiration. S9LT-lg-j-31

After going through this module, you are expected to:

1. Relate physical plant characteristics (chloroplast, pigments, stomata, etc.) to their functions;
2. Differentiate light dependent/light independent reaction in terms of the raw materials, processes and end product;
3. Explain the factors that affect the rate of photosynthesis;
4. Describe the parts of mitochondrion;
5. Explain how cell release energy from food;
6. Describe the Krebs cycle;
7. Explain the electron transport chain;
8. Differentiate photosynthesis and respiration in terms of cell structures involved, raw materials, end product and energy requirement.



What I Know

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which structure makes plants capable of producing their own food?
   A. chloroplast
   B. mitochondria
   C. stomata
   D. thylakoid

2. Which structure allows carbon dioxide to enter a plant system?
   A. Chloroplast
   B. Mitochondrion
   C. Stomata
   D. Thylakoid

3. Which pigment is responsible for the green color of plants?
   A. Carotene
   B. Chlorophyll
   C. Mesophyll
   D. Xanthophyll

4. Which organisms can undergo photosynthesis?
   I. Phytoplanktons
   II. Blue-green algae
   III. Amoeba and Paramecium
   A. I and II only
   B. I and III only
   C. II and III only
   D. I, II and III

5. A farmer is experiencing a problem in growing his crops. Most of the leaves of the crops are turning yellow. Which of the following will likely result from the yellowing of the leaves of the crops?
   A. It will increase the production of the food
   B. It will decrease the production of the food.
   C. The production of food can stay the same.
   D. none of the above

6. Which is the primary product of light-independent reactions?
   A. ATP
   B. Water
   C. Oxygen
   D. Glucose

7. Which best describes light-independent reactions?
   A. They create energy rich ATP and NADPH
   B. They are the first phase of photosynthesis.
   C. They use carbon dioxide to make proteins
   D. They utilize the energy stored in ATP and NADPH

8. Which is TRUE about light dependent reaction?
   I. Glucose is produced. Reduced NADP is oxidized.
   II. ATP and NADPH are produced.
   III. This occurs in the thylakoid of the chloroplast.
   A. I and II only B. II and III only C. I and III only D. I, II, III

9. Which of the following describes the process that releases energy by breaking down food molecules in the presence of oxygen?
   A. cellular respiration
   B. electron transport chain
   C. Krebs cycle
   D. photosynthesis

10. When cells break food into chemical energy, it undergoes three major processes: glycolysis, Krebs cycle and electron transport. Which of these processes provide the most number of ATP molecules?
   A. Glycolysis
   B. Krebs cycle
   C. Electron transport chain
   D. none of these

11. Oxygen is essential in cellular respiration. What is the role of oxygen in the electron transport chain?
   A. It forms water
   B. It releases an electron
   C. It serves as the final acceptor
   D. It provides a high energy proton

12. Which of the following is cycled out by the chloroplast and mitochondrion?
   A. Sugar, water, oxygen, and ATP.
   B. Sugar, water, sunlight, and oxygen.
   C. Carbon dioxide, water, oxygen, and ATP
   D. Carbon dioxide, water, sugar, and oxygen.

13. Which of the following are the products of cellular respiration?
   A. Oxygen and glucose
   B. Water, oxygen, and ATP
   C. Carbon dioxide and water
   D. Water, carbon dioxide, and ATP

14. Which shows the correct equation for cellular respiration?
   A. $6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$
   B. $12CO_2 + 12H_2O \longrightarrow C_6H_{12}O_6 + 12O_2$
   C. $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + ATP$
   D. $C_6H_{12}O_6 + 12O_2 \longrightarrow 12CO_2 + 12H_2O + ATP$

15. Maria wants to compare the process of photosynthesis and cellular respiration. Which of the following should Maria use to best demonstrate the process of photosynthesis and cellular respiration when compared?
   A. similar process
   B. opposite process
   C. energy-storing process
   D. energy-releasing process

Lesson 1 Ecosystem: Life Energy

In the previous module, you have learned how changes in the environment may affect the extinction of the different organisms. In this module, you will learn that all organisms need the energy to sustain life. You will focus on how the organisms obtain energy from the food and how they produce energy.

Here are some key questions for you to ponder after finishing this module:

1. Why are plants called great food providers?
2. What are the parts of the plants involved in photosynthesis and respiration?
3. What are the major stages in photosynthesis?
4. What part of the cell is involved in cellular respiration?
5. What is the difference between photosynthesis and respiration?

What's In

Let's recall your understanding of the concepts of photosynthesis and cellular respiration. Identify the word based on the given description. Write your answer on a separate sheet of paper.

1. The total chemical processes taking place within the living system.

2. The green coloring matter of plants.

3. It is an activity that occurs at the cellular and molecular level.

What's New

Match the phrases below with the term that best fits them from inside the box. Write the letter of the correct answer on a separate sheet of paper.

A. NADP	D. PGAL
B. NAD	E. FAD
C. ATP	F. ADP

_____1. Adenosine diphosphate

_____2. Adenosine triphosphate

_____3. Nicotinamide adenine dinucleotide

_____4. Flavin adenine dinucleotide

_____5. Phosphoglyceraldehyde

_____6. Nicotinamide adenine dinucleotide phosphate

What is It

Photosynthesis and Cellular Respiration

On Earth, life is solar-powered. The main producers like, plants, algae, certain protists, and some prokaryotes capture light energy from the sun for their needs and to provide energy for almost all life forms. These producers are considered as self-feeders or autotrophs because they produce their own food and sustain themselves without consuming other organism in order to survive. If we look at the hierarchy of food chain, we can see that plants are in the bottom parts which are considered as primary source of food for all consumers like animals including humans. If plants manufacture energy for animals to use, they should have a way to recharge their nutrients. That is why plants have cell parts such as cell wall, large vacuoles, and chloroplast. These structures help plants to harness and store their energy through the process called photosynthesis.

Photosynthesis is the process by which plants use light energy from the sun and carbon dioxide to produce glucose, the sugar molecules and oxygen that they use for growth and nourishment. Primarily, photosynthesis takes place in the leaves, which are the main organs for photosynthesis.

The parts of the leaves and its functions are shown in the figure below:

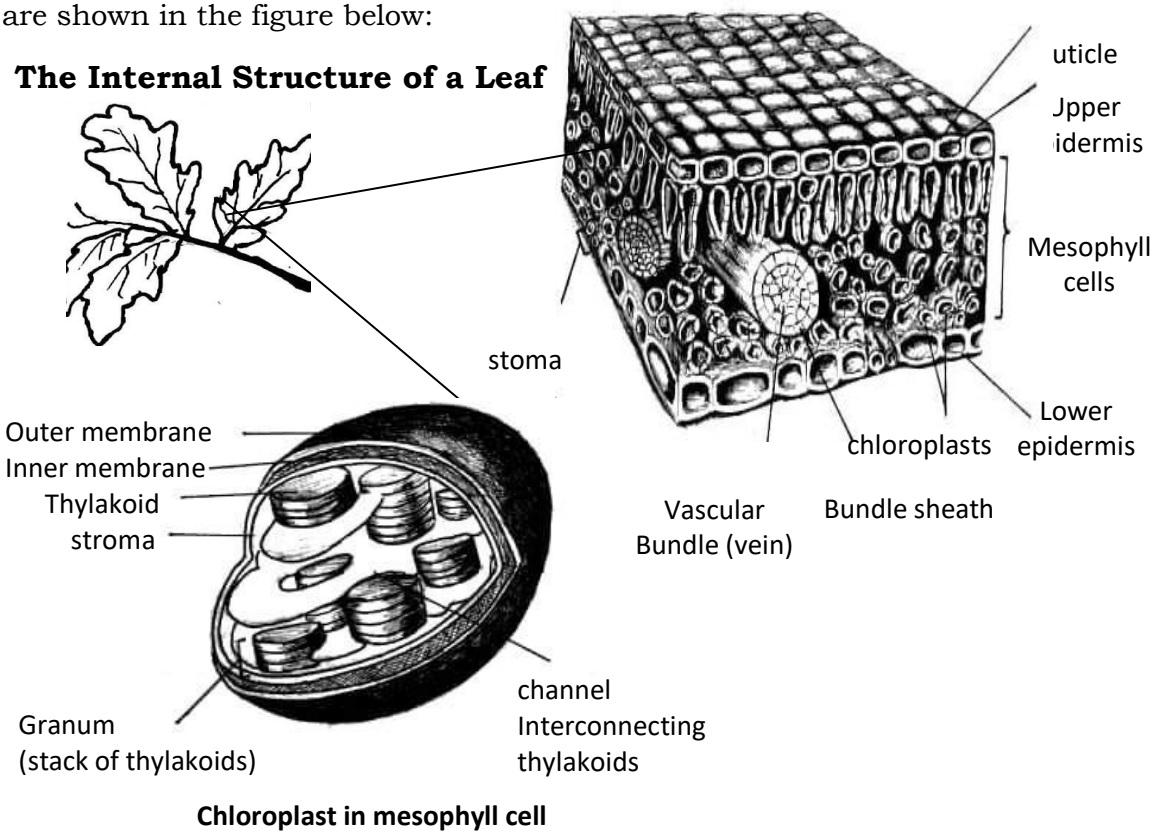


Figure 1. The internal structure of a leaf.

In the figure, you can see the **epidermis**, the outermost layer which secretes a waxy substance called the cuticle. This **cuticle** helps retain water inside the leaf cells. At the lower epidermis, you will see some openings. Each opening is called **stoma** (stomata). This is where carbon dioxide enters, and oxygen passes out. Around the stoma is a pair of bean-shaped cells called **guard cells**. The guard cell is an epidermal cell with chloroplast that regulates the opening and closing of the stomata. Between the upper and lower epidermis, you can see layers of cells. This is called **mesophyll layer**, which is composed of palisade cells that are arranged like columns and spongy cells which are loosely arranged cells. These cells have organelles known as **chloroplast** that contains green pigments which trap energy from the sun. The chloroplast is enclosed by a double membrane namely an outer membrane and an inner membrane. Between these membranes is a space called **stroma**, which is the liquid part of the chloroplast. Embedded in the stroma is a complex network of stacked sacs. Each stack is called a granum (plural: grana). Each of those flattened sacs is called these thylakoids that contains green-colored pigments called chlorophylls that absorb light.

Understanding the Food-making Process in Plants

Photosynthesis begins when the green pigment chlorophyll, found in the chloroplast, absorbs the light energy in the form of sunlight. Plant leaves are mostly

green colored because chlorophyll absorbs all other colors and reflects green light. The raw materials like carbon dioxide enter the plant leaves' tiny opening called the stomata. Plants absorb dissolved water and nutrients in the soil through their vascular tissues, which are composed of xylem and phloem that are responsible for the transport of water and food to the different parts of the plant. The equation used to explain photosynthesis is as follows:

$$\underset{6CO_2}{\text{Carbon dioxide}} + \underset{6\,H_2O}{\text{water}} \xrightarrow{\text{Sunlight}} \underset{C_6H_{12}O_6}{\text{glucose}} + \underset{6O_2}{\text{oxygen}}$$

The light –dependent reaction and the Calvin cycle

Photosynthesis involves many steps, but it can be divided into two stages: the light-dependent reaction and the Calvin cycle.

1. Light-dependent Stage

The Light-dependent reaction stage occurs in the **thylakoid membrane** and requires a continuous supply of light. During this reaction, light energy is absorbed by the chlorophyll and converted into chemical energy. The chlorophyll is composed of two units of light-absorbing molecule, namely the **Photosystem II** (PSII) and **Photosystem I** (PSI). Take note that the two photosystems are named for the order of which they were discovered, not for the order in which they participate in the photosynthesis. The light-dependent reaction begins when PSII receives light energy. This light energy is transferred to a chlorophyll reaction center, causing electrons in the reaction center to become energized. The energized electrons escape PSII and move to an electron acceptor molecule, located in the electron transport chain. To replace the lost electrons in PSII, water is split, releasing oxygen, two hydrogen ions, and two electrons. The excited electrons continue to move from photosystem II to photosystem I through the electron transport chain. A protein in the electron transport chain pumps hydrogen ions from the stroma into the thylakoid space.

As electrons move between these two photosystems, they lose energy. Photosystem I absorb light and re-energize the electron. The chemical called NADP (nicotinamide adenosine triphosphate) accepts the electron and hydrogen, and becomes NADPH, which is a high energy molecule. As the H+ ions continue to build up inside the thylakoid, ATP synthase allows the H+ ions to travel from the thylakoid to the stroma by diffusion and captures the energy of their movement by spinning and stores that energy in ATP (adenosine triphosphate). An enzyme found in the thylakoid membrane uses energy of electrons from both PSII and PSI to create more ATP and to stop the production of NADPH. It is important to maintain the right proportions of NADPH and ATP, which will be used in next phase of photosynthesis.

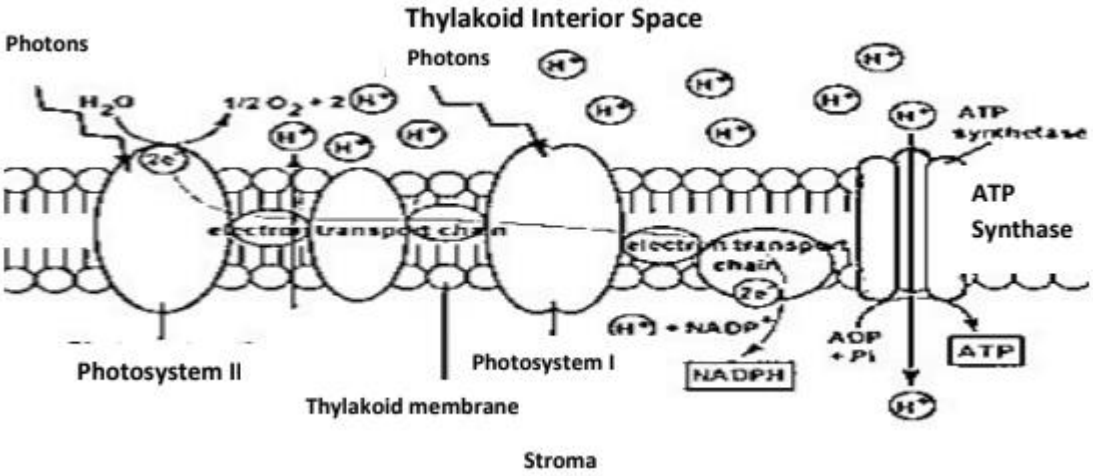


Figure 2. The light –dependent stage of photosynthesis which includes Photosystem I and II.

2. Light-independent reaction or Calvin Cycle

The second stage of photosynthesis is the light-independent reaction or Calvin cycle which occurs in the stroma of the chloroplast. This series of complex reactions can be divided into three phases:

a. Carbon fixation

In this process the carbon dioxide (CO_2) is captured in the atmosphere and diffuses into the stroma of a chloroplast, where they encounter molecules called the RuBP (Ribulosediphosphate), which is a five-carbon sugar molecule. The enzymes used in this reaction is called rubisco, and the results of the reaction is an unstable 6-carbon molecule that splits into two 3-carbon molecules called 3 phosphoglyceric acid (3PGA).

b. Carbon dioxide (CO_2) reduction

This process is called carbon dioxide reduction phase, because we are adding electrons and energy to carbon dioxide molecule. When phosphoglycerate (3PGA) engages with ATP (from light dependent reaction) it becomes biphosphoglycerate (BPGA). This BPGA combines with NADPH, which carries a high energy electron that got enhanced by light energy and is carrying a hydrogen proton. The NADPH is going to donate that high energy electron and hydrogen to BPGA and convert it into phosphoglyceraldehyde (PGAL). A carbohydrate ADP and NAD^+ return to the thylakoid, to be converted back to ATP and NADPH by light reaction. One of the 3PGA molecules is set aside as the building block for glucose while majority of the 3GPA molecules move forward into the third phase of Calvin cycle.

c. Regeneration of RuBP

In this phase RuBP molecules is formed using ATP that combine with the 3GPA molecules. This RuBP combine with additional carbon dioxide molecules to form the glucose molecule. This cycle has to turn six times, each turn of cycle adds only one carbon atom for the incoming carbon dioxide.

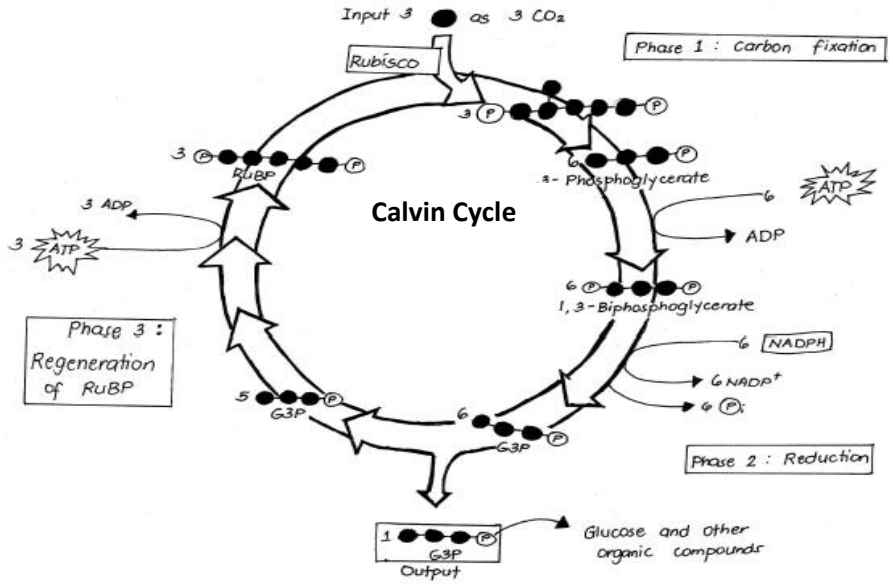


Figure 3. The three phases of light-independent reaction or Calvin cycle.

Cellular respiration

To perform our daily task, cells in our body require transfusions of energy from outside sources, which they get from the food we eat. But, how do cells harvest the energy stored in food? With the help of enzymes, during digestion the food that we eat is digested to simple forms. These digested foods (glucose, amino acids, fatty acids, and glycerol) are absorbed by the cells from the walls of our small intestines, and will be diffused in the blood, which will be circulated to every single cell in our body. However, for cells to perform this process, stored energy must be first converted into ATP through the process of cellular respiration.

Cellular respiration is the process of extracting energy in the form of ATP from the glucose in the food you eat. It occurs in all living organisms both autotrophs and heterotrophs. Organisms release stored energy in food by breaking down glucose into carbon dioxide, water, and energy (ATP) in the presence of oxygen. In equation form, cellular respiration can be expressed as:

Glucose + Oxygen ⟶ Carbon dioxide + water + ATP

$C_6H_{12}O_6$ $6O_2$ $6\ CO_2$ $6H_2O$

The process of cellular respiration may produce ATP with or without the presence of oxygen. Most eukaryotes perform aerobic respiration, which depends on oxygen to produce ATP. In eukaryotic cells, mitochondria house most of the metabolic equipment for cellular respiration. However, some eukaryotic cells resort

to an alternative method, anaerobic respiration when oxygen is unavailable. This type of cellular respiration occurs in the cytoplasm of the cells. Under aerobic respiration, there are three stages involved: glycolysis, Krebs cycle (named after Sir Han Adolf Krebs, a British biochemist), and electron transport chain.

Understanding the Three Stages of Aerobic Cellular Respiration:

1. Glycolysis

The word glycolysis means "splitting of sugar" and this exactly describes what happens during this process. Glucose, a six-carbon sugar, is split into two three-carbon sugar molecules called the pyruvate to produce two ATPs to start the activation process. Glycolysis occurs in the cytoplasm of the cells which includes series of chemical reactions catalysed by a specific enzyme.

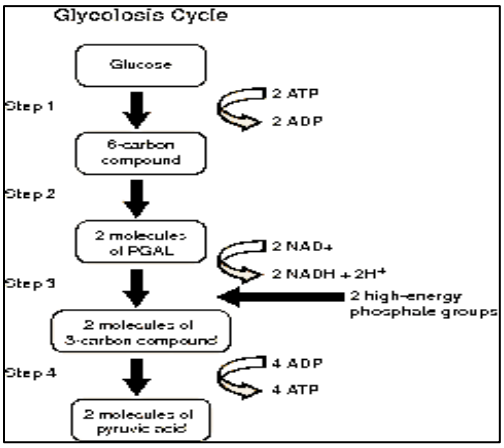


Figure 4: Summary of Glycolysis Cycle

Understanding the Structure of Mitochondria

The structure of the mitochondrion is the key to the process of aerobic respiration, especially the Krebs cycle and electron transport. Mitochondria have an inner and outer membrane, with an inter-membrane space between them. The **outer membrane** of that mitochondrion contains proteins known as porins, which allow movement of ions into and out of the mitochondrion. The area inside the inner membrane is called **matrix**, which contains proteins, cytosol and mitochondrial DNA. The **inner membrane** contains enzymes essential for cell respiration. The **cristae,** which are folded section of the inner membrane, increase the surface area available for energy production via oxidative phosphorylation.

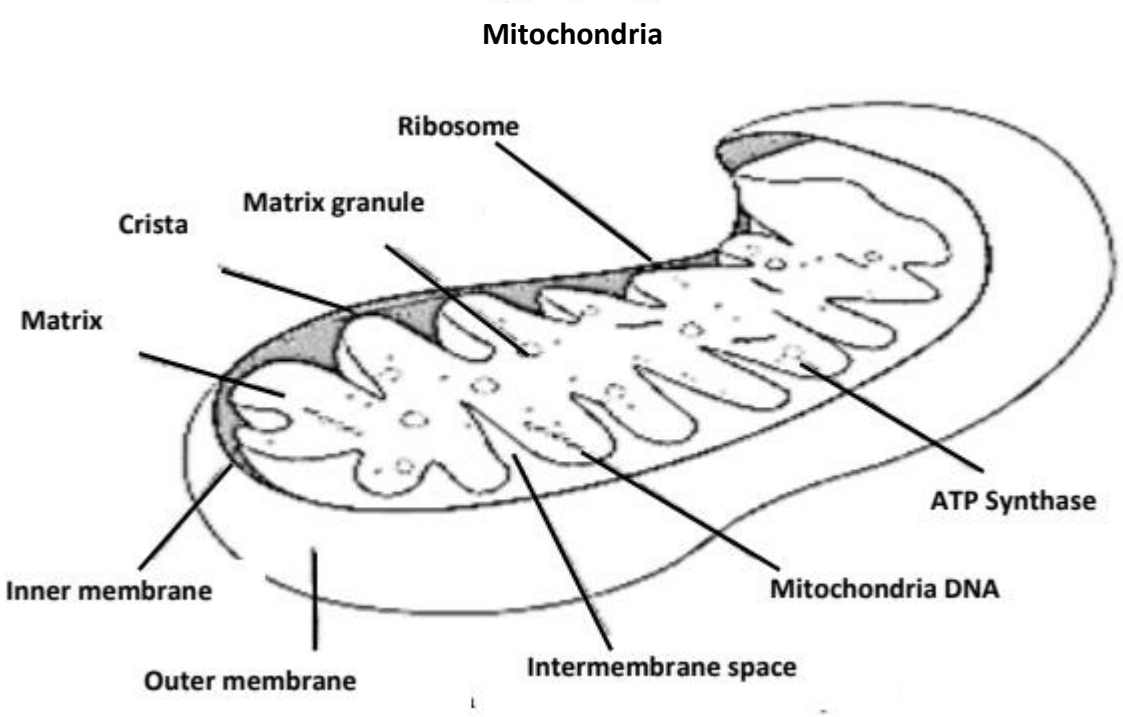


Figure 5: Structure of Mitochondrion

2. Krebs Cycle

The Krebs cycle is the second stage in cellular respiration. When oxygen is present, pyruvate undergoes aerobic respirations, which are produced in glycolysis, leaves the cytoplasm and enters the mitochondrial matrix. Before the transitional stage begins, pyruvate, which has three carbon atoms, is split apart and combined with an enzyme known as CoA, which stands for coenzyme A. The product of this reaction is acetyl-CoA, a two-carbon molecule. The third carbon from pyruvate combines with oxygen to form carbon dioxide, which is released as a waste product. High-energy electrons are also released and captured in NADH. The following shows the steps involved in the Krebs cycle:

Step1. Acetyl-CoA combines with four-carbon compound (oxaloacetate) to form citric acid, which has six carbon atoms.

Step 2. Series of reactions that release energy goes after the six-carbon acids formed. This release energy is captured in molecules of NADH, ATP, and FADH_2, another energy carrying compound.

Step 3. The four carbon molecule regenerates, this molecule is needed for the next turn of the cycle. Two turns are required because glycolysis produces two pyruvate molecules when it splits glucose.

After the cycle is completed, the original glucose molecule has been broken down completely into six of its carbon atoms that have combined with oxygen to form carbon dioxide. The energy from its chemical bonds has been stored in a total of 16 energy-carrier molecules. These molecules are 4 ATPs, 10 NADH, and 2 FADH_2.

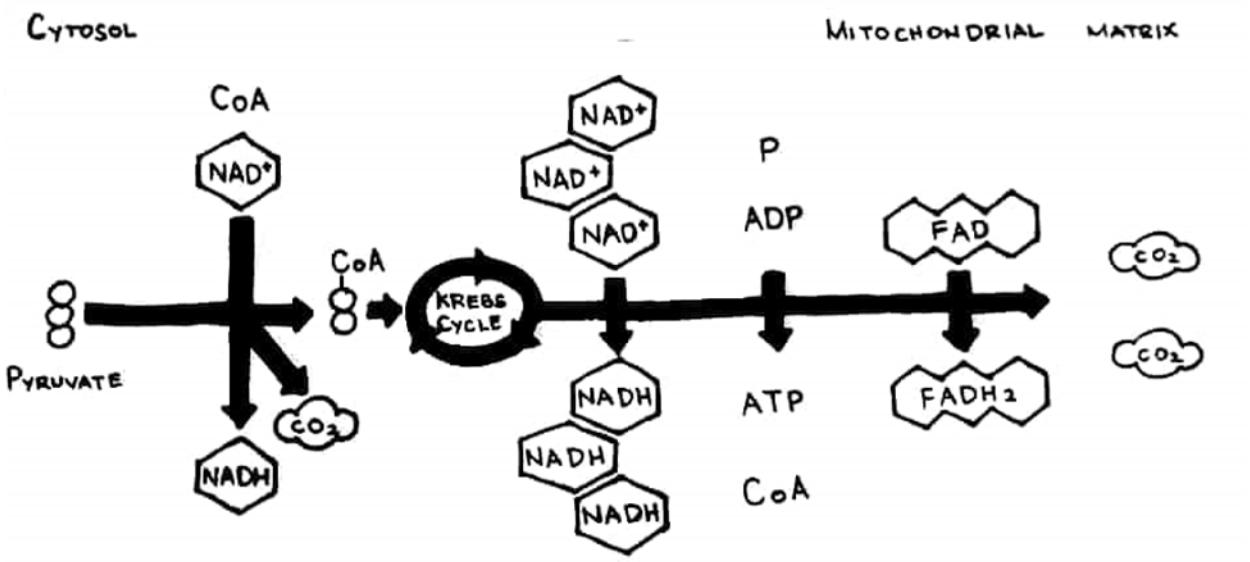


Figure 6. The Krebs Cycle

3. Electron Transport Chain

Electron transport chain (ETC) is the final stage of aerobic respiration. It is located on the inner mitochondrial membrane. The energy stored in it release within to reduce hydrogen carriers in order to synthesize ATP, this process is called oxidative phosphorylation.

In ETC process, the electrons undergo through a chain of proteins that increases its reduction potential and causes a release in energy. The ETC proteins in a general order are complex I, complex II, coenzyme Q, complex III, cytochrome C, and complex IV.

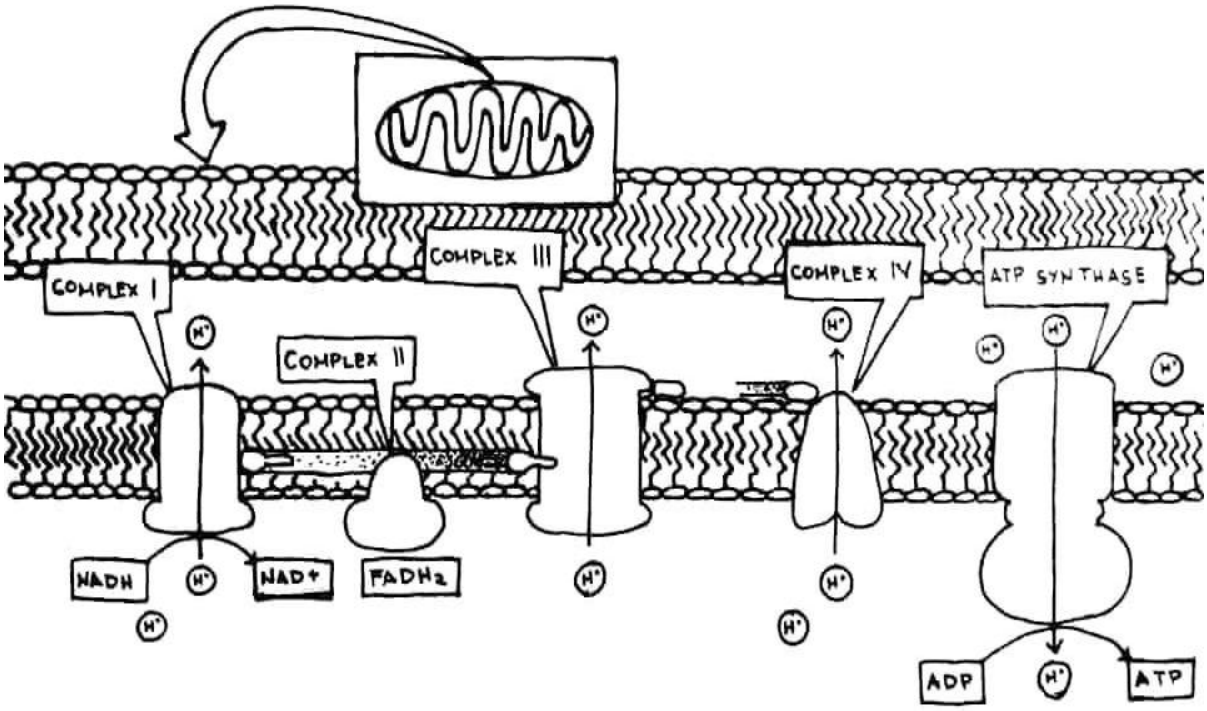
Electrons go to complex I and four protons pumped from matrix to inter-membrane space. Coenzyme Q picks up electron from complex I and complex II and transport to complex III. After that, four protons pumped from matrix to inter-membrane space, carrier C transports electrons to complex IV. Then, two protons pumped from matrix to inter-membrane space, formation of H2O (20% of water in body). ATP synthase action pumps protons from inter-membrane space to matrix, produces ATP from ADP + Pi + energy.

At this point, the breakdown of glucose is complete and there are new ATP molecules made. The twelve carrier molecules produced (10 NADH+ 2 $FADH_2$) carry H_2 from the dehydrogenation process that transpired. At the same time, carbon from glucose is carried by the carbon dioxide product.

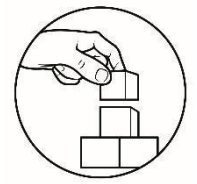
During the process, electrons are transferred from electron donors such as NADH and $FADH_2$ to electron acceptors such as O_2. These reactions release energy that is used to form ATP.

Electrons (H_2+) that are removed from these reduced H_2^+ acceptors are transferred through a series of acceptors of lower energy levels coenzyme to cytochromes. Cytochromes are a class of proteins that function as electron transporters. As electrons are flown down the energy stairs, enough energy is

released to phosphorylate ADP to ATP. Finally, O_2 accepts H_2^+. This results in the formation of H_2O, another by-product.



The electron transport chain is a series of protein complexes located at the inner membrane of the mitochondria.

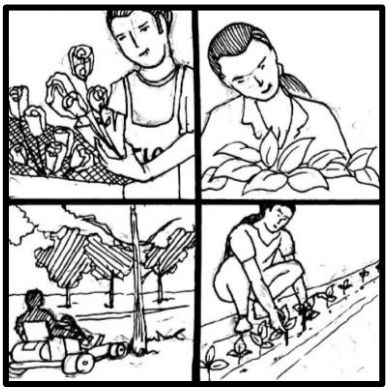


What's More

Activity 1 Leaves on Me!

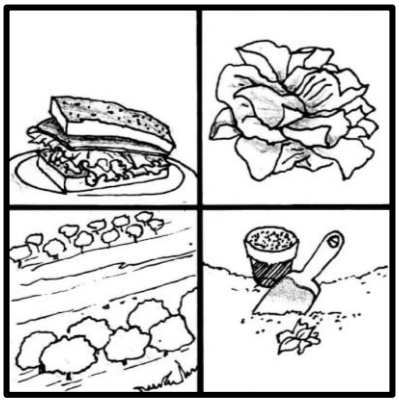
Determine the correct term for each number using the four pictures as clues to decode them. Write your answer on a separate sheet of paper.

1.



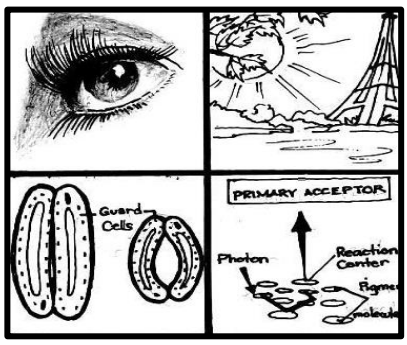
P				T	
N	L	R	P	O	A

2.



		E		F	
E	L	T	P	A	S

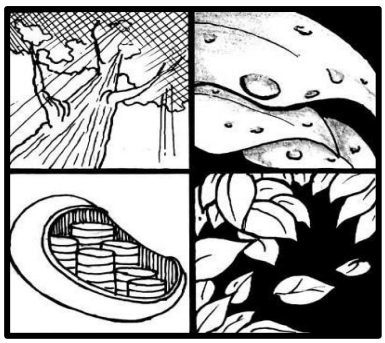
3.



	T			A		

O	V	A	T	A
S	M	V	G	L

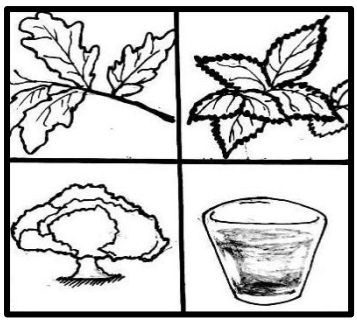
4.



	H			R						T

C	S	O	A	P
A	L	O	O	L

5.



C	H	L	O				H			L

C	O	L	R	C	C	P	Y	Y	L

Activity 2 Lights Off, Lights On

Write **ON** if the process pertains to light-dependent reaction and writes **OFF** if the process pertains to the light-independent reaction. Write your answer on a separate sheet of paper.

_____1. It is also known as the dark reaction of photosynthesis.

_____2. Primary acceptor of carbon is Photosystem I and II.

_____3. Site of the process is in the stroma.

_____4. Photolysis of water does not occur.

_____5. Process type is both cyclic and non-cyclic processes.

_____6. It is a release of oxygen that gives off aldehydes and hydrogen upon dehydrogenation.

_____7. It is a process that converts solar energy into chemical energy.

_____8. It is a light dependent process.

_____9. Process type is cyclic only.

_____10. Primary acceptor of carbon is Rubiscobisphosphate.

Activity 3 Your Rate Will Change Me

Determine the factors that affect the rate of photosynthesis to identify the term described by the clue given for each number. Write your answer on a separate sheet of paper.

1.

- ✓ I change high and low; well it depends on the weather.
- ✓ I measure myself using a thermometer.
- ✓ People define me as the measurement of hotness and coldness of a substance.

_ _ _ _ _ _ _ _ _ _ _

2.

- ✓ Oxygen is my friend.
- ✓ I'm a substance released by the factories and vehicles.
- ✓ You release me when you exhale.

_ _ _ _ _ _ _ _ _ _ _ _ _

3.

- ✓ I occupy 70% of the earth's surface.
- ✓ You can't live without me.
- ✓ I'm one of the materials needed for photosynthesis.

_ _ _ _ _

4.

- ✓ Without me, the world is very dark.
- ✓ You see things because of my presence.
- ✓ I have a different spectrum or colors.

_ _ _ _ _

5.

- ✓ Sometimes I feel acidic.
- ✓ Sometimes I feel base.
- ✓ You can rely on me in getting the right scale.

_ _ _ _ _

Activity 4 Power! Power!

Identify the parts of the mitochondrion based on their descriptions in each box. Choose your answer below and write your answer on a separate sheet of paper.

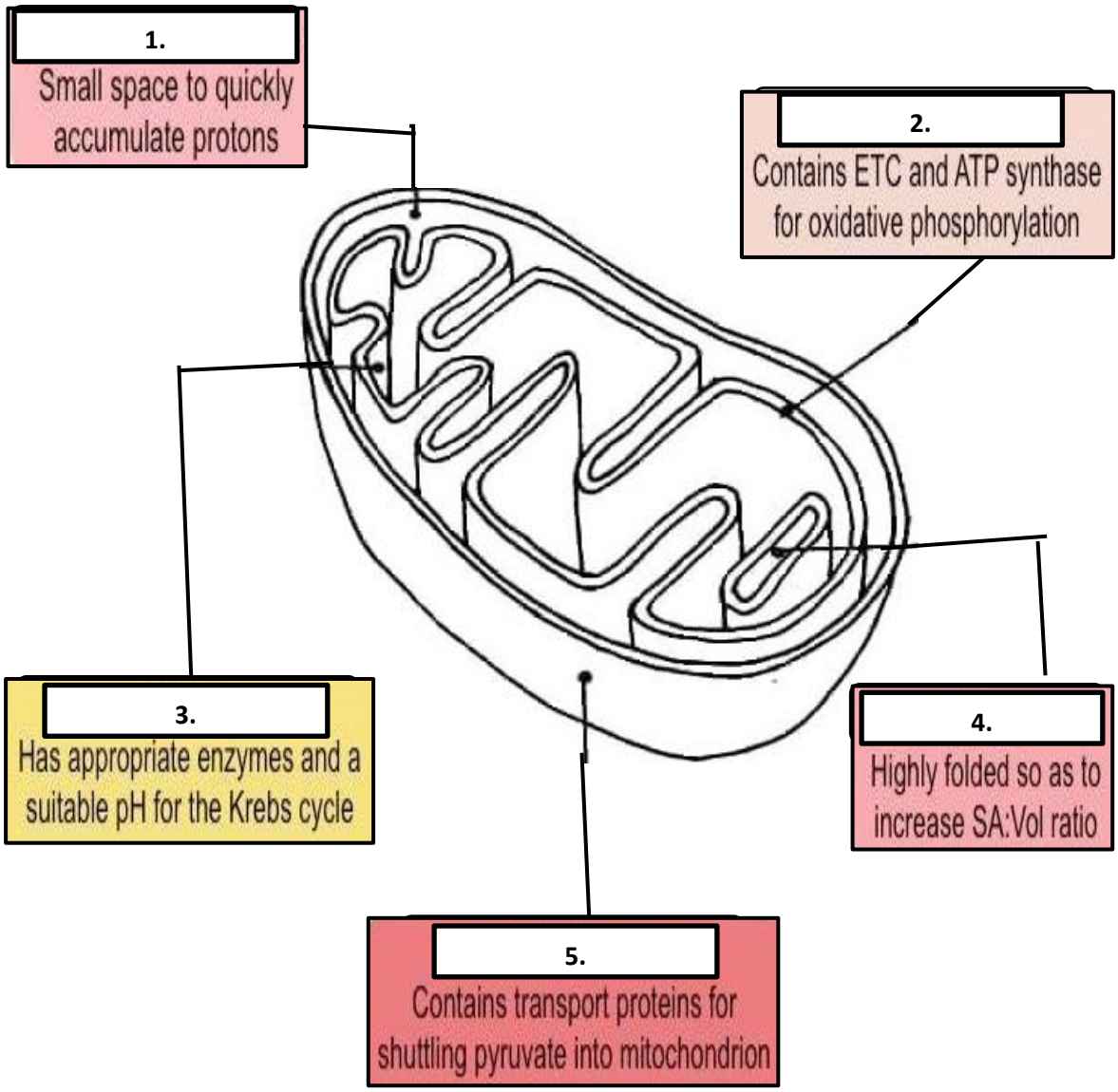


Figure 1 the Mitochondrion

Outer membrane

Matrix

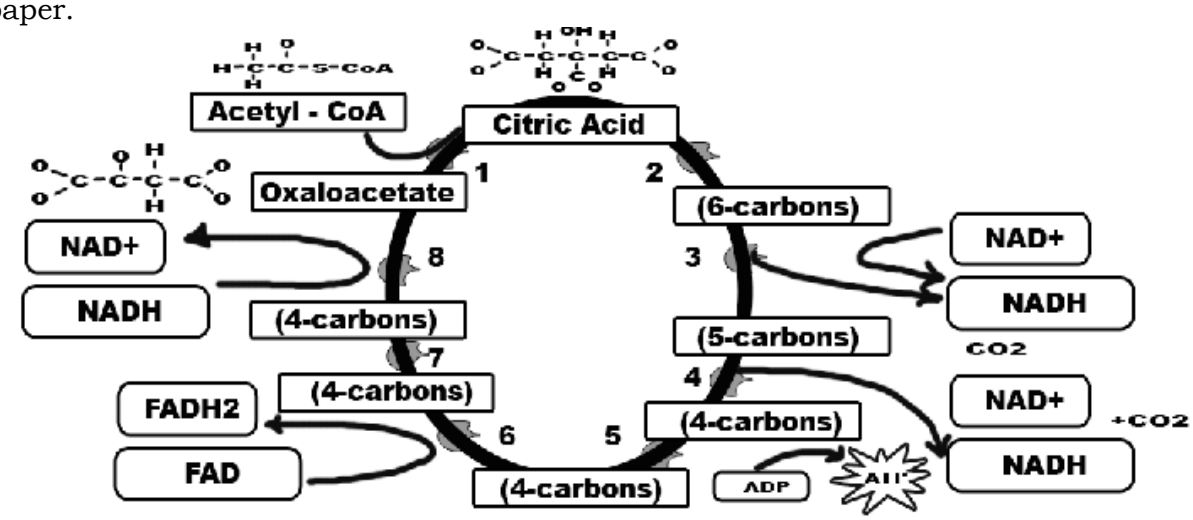
Cristae

Intermembrane space

Inner membrane

Activity 5 Rated K (Krebs Cycle)

Analyze the illustration of the Krebs cycle below. Fill in the blanks with the correct answers from the box opposite each cycle. Copy and answer on a separate sheet of paper.



Pyruvate Oxidation

_____ enters the mitochondrion from the cytoplasm. One _____atom is removed via decarboxylation and _____ is removed using _____. Coenzyme A becomes attached to the remaining carbon atoms, creating _____, which then enters the Krebs cycle.

- carbon
- NAD+
- hydrogen
- Acetyl-CoA
- Pyruvate

Krebs cycle

_____ enters the cycle and then combines with _____ to make the _____ compound citrate. During the eight steps of the Krebs cycle, citrate undergoes a number of reactions, releasing CO2 and ____ in a number of steps. _____ is eventually converted into oxaloacetate so it can be used again during the Krebs cycle.

- oxaloacetate
- Acetyl-CoA
- ATP
- six-carbon
- citrate

Products of the Krebs cycle

1. ____ is released as waste.
2. _____ and _____ move to the next stage of cellular respiration.
3. Energy is released in the form of ATP. A glucose molecule produces two molecules of ATP because two molecules of _____ are created from each molecule of _____.

- glucose
- NADH
- pyruvate
- $FADH_2$
- CO_2

Activity 6 The Last Stage (ETC)

Using the figure below, arrange the proper sequence of the electron transport chain process. Use number **1** as the first event and **7** as the last event; write your answer on a separate sheet of paper.

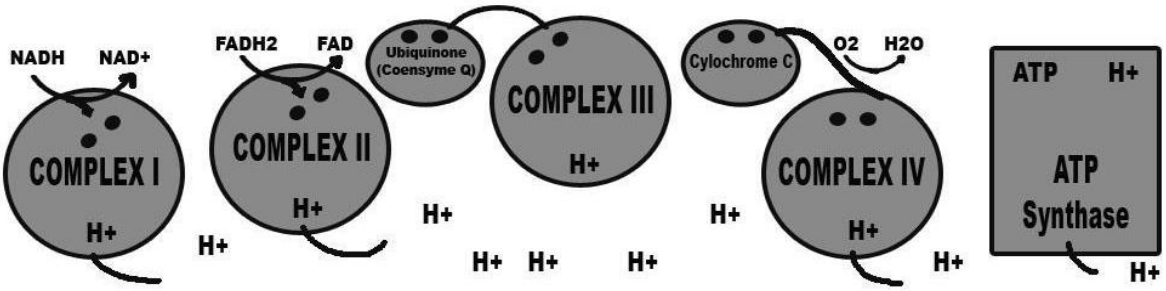


Figure 2 Electron Transport Chain

A.

Electrons from Complex I and Complex II are transferred to a carrier called ubiquinone Q. This molecule carries the electrons to Complex III.

B.

$FADH_2$ from glycolysis and Krebs cycle is oxidized to FAD by Complex II. It also releases H^+ ions into the intermembrane space and passes off electrons.

C.

In Complex I, NADH from glycolysis and Krebs cycle are oxidized to NAD+. It passes off 2 electrons and H+ ions are pumped into the intermembrane space.

D.

Complex III accepts the electrons brought in by ubiquinone Q and pumps more H^+ ions into the intermembrane space.

E.

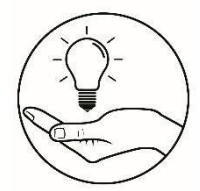
In Complex IV, a reaction with O_2 produces H_2O. More H^+ ions are pumped into the intermembrane space. By now, the concentration of H^+ ions is very high.

F.

H^+ ions need to cross the membrane to balance the concentration gradient. They use ATP Synthase to do this. As the ions pass through, the pump makes ATP.

G.

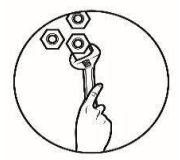
Electrons in Complex III are picked up by cytochrome C, another carrier molecule. This molecule carries the electrons to Complex IV.



What I Have Learned

Determine the word that correctly completes the statement. Write your answer on a separate sheet of paper.

1. In _____ plants capture light energy and convert it into chemical energy stored in food.
2. There are three things needed for photosynthesis to occur, these are water, _____, and light.
3. Photosynthesis occurs in the _____ found in the leaves of plants.
4. The two major stages in photosynthesis are _____ and Calvin cycle.
5. Cellular respiration is a metabolic pathway that breaks down _____ and produces ATP (adenosine triphosphate).
6. The reactions of cellular respiration can be divided into three stages, these are glycolysis, _____, and electron transport chain.
7. Cellular respiration in the absence of oxygen is called anerobic respiration. On the other hand, cellular respiration in the presence of oxygen is called _____ respiration.
8. The last two stages of cellular respiration occur in the _____.
9. Most of the ATP is produced in the stage of _____ in cellular respiration.
10. _____ is the final electron acceptor at the end of the electron transport chain, when water is formed.
11. During glycolysis, enzymes split a molecule of glucose into two molecules of _____.
12. During the Krebs cycle, energy is captured in molecules of _____ and FADH2.
13. _____is the molecule that enters the Krebs cycle.
14. In all three stages of aerobic respiration, up to _____ molecules of ATP may be produced from a single molecule of glucose.
15. The reactants of cellular respiration are oxygen and _____ while the products of cellular respiration water, carbon and ATP.



What I Can Do

I. Differentiate photosynthesis from cellular respiration by checking the column that correctly corresponds to its features. Copy and answer the table below on a separate sheet of paper.

COMPARATIVE FEATURES	CHOICES	PHOTO-SYNTHESIS	CELLULAR RESPIRATION
Occurs in	Plants		
	All living things		
	Algae		
	Photosynthetic bacteria		
Function/ Purpose	Release energy		
	Capture, convert and store energy		
Reactants	Water		
	Glucose		
	Oxygen		
	Carbon dioxide		
	Light energy		
Metabolic Process	Catabolic		
	Anabolic		
Location	Mitochondria		
	Chloroplast		
	Cytoplasm		
Source of Energy	Glucose		
	Sunlight		
Stages	Light- dependent Reactions		
	Calvin Cycle,		
	Glycolysis		
	Krebs cycle		
	Electron Transport Chain		
Products	Water		
	Oxygen		
	Glucose		
	Carbon dioxide		
Equation	$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$		
	$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$		

II. Guide Questions:

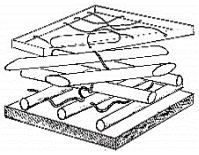
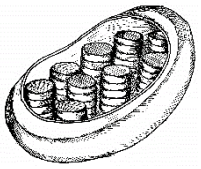
1. How are photosynthesis and cellular respiration dependent on each other?

2. How important are photosynthesis and cellular respiration?

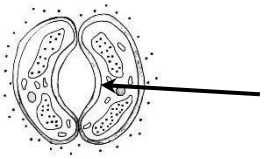
Assessment

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which structure makes plants capable of producing their food?

A.  B.  C.  D. 

2. What is the function of the structure where the arrow is pointing on the diagram below?



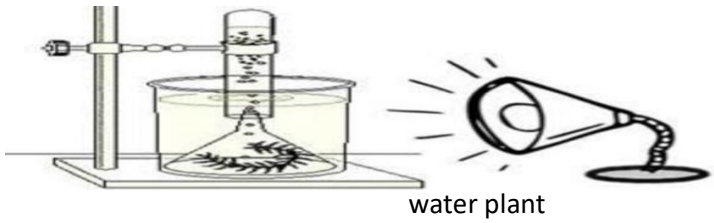
A. supplies energy to the stomata
B. absorbs carbon dioxide from the atmosphere
C. controls photosynthesis by controlling the amount of chlorophyll in plants
D. regulates the rate of transpiration by opening and closing the stomata

3. Which best describes light-independent reactions?
   A. They create energy-rich ATP and NADPH
   B. They are the first phase of photosynthesis.
   C. They use carbon dioxide to make proteins
   D. They utilize the energy stored in ATP and NADPH

4. Which is TRUE about light-dependent reaction?
   I. Glucose is produced. Reduced NADP is oxidized.
   II. ATP and NADPH are produced.
   III. This occurs in the thylakoid of the chloroplast.

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

For nos. 5 and 6 refer to the diagram below:

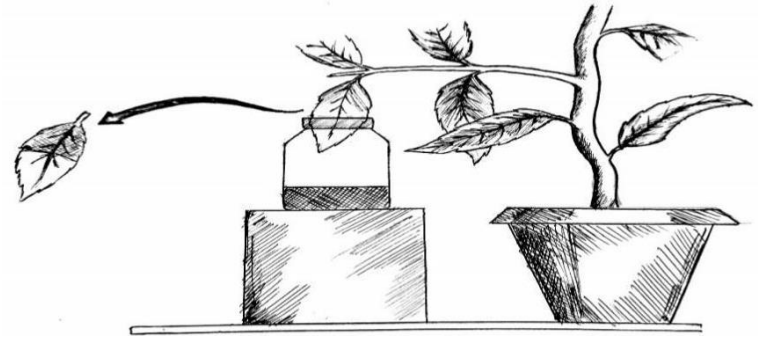


water plant

5. Which is the correct observation from the experimental set-up below?
   A. The plant is slowly increasing in length.
   B. The plant is slowly wilting in the absence of its roots.
   C. From the cut ends of the plant, new leaves are growing.
   D. From the cut ends of the plant, some bubbles are coming out

6. Which is being proven in this experiment?
   A. Gases are produced during fermentation.
   B. Oxygen is produced during photosynthesis.
   C. Glucose is converted to energy during glycolysis.
   D. Light can cause water to become warm and produce gases.

For nos. 7-10 refer to the Moll's half leaf experiment shown in the figure below.



In this experiment, the plant is de-starched by putting it in darkness for two days. A wide-mouthed bottle is filled partly with a strong solution of caustic potash and a split cork is fitted into its mouth. Half of the portion of the leaf of the de-starched plant is inserted into the bottle through the split cork. The whole set-up is placed under sunlight after applying grease on the upper portion of the split cork. The leaf is tested for the presence of starch after 10 hours.

7. What is the purpose of putting the plant in darkness for two days?
   A. To test if it will die.
   B. To remove excess water in it.
   C. To remove starch on its leaves.
   D. To test if the leaves will change in color.

8. What is the purpose of inserting half of the leaf of the plant inside the bottle?
   A. So that only half of the leaf will receive oxygen.
   B. So that only half of the leaf will receive carbon dioxide.
   C. So that only half of the leaf will be exposed to sunlight.
   D. To protect the other half of the leaf from harmful chemicals in the air.

9. Which hypothesis is being tested in this experiment?
   A. Plants will die without roots.
   B. Carbon dioxide is needed for plants to make food.
   C. Oxygen is important for photosynthesis to take place.
   D. Plants cannot undergo respiration in the absence of oxygen.

10. Which of the following statements are TRUE about cellular respiration?
    I. Cellular respiration is the process by which food molecules are broken down to release energy.
    II. Most of the reactions of cellular respiration take place in the mitochondria of the cell.
    III. The reactants of cellular respiration are water, carbon dioxide and energy.
    IV. The products of cellular respiration are oxygen and glucose.

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

11. Which of the following is the first step of both anaerobic and aerobic respiration?

    A. Glycolysis
    B. Krebs cycle
    C. Electron transport chain
    D. none of these

12. When cells break food into chemical energy, it undergoes three major processes: glycolysis, Krebs cycle and electron transport. Which of these processes of aerobic respiration produces the most ATP?

    A. Glycolysis
    B. Krebs cycle
    C. Electron transport chain
    D. none of these

13. Which of the following are the reactants of cellular respiration?

    A. Oxygen and glucose
    B. Carbon dioxide and water
    C. Water, oxygen, and ATP
    D. Water, Carbon dioxide, and ATP

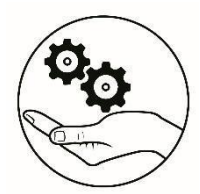
14. Which of the following processes release energy?

    I. Glycolysis
    II. Calvin Cycle
    III. Krebs cycle
    IV. Electron transport chain

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

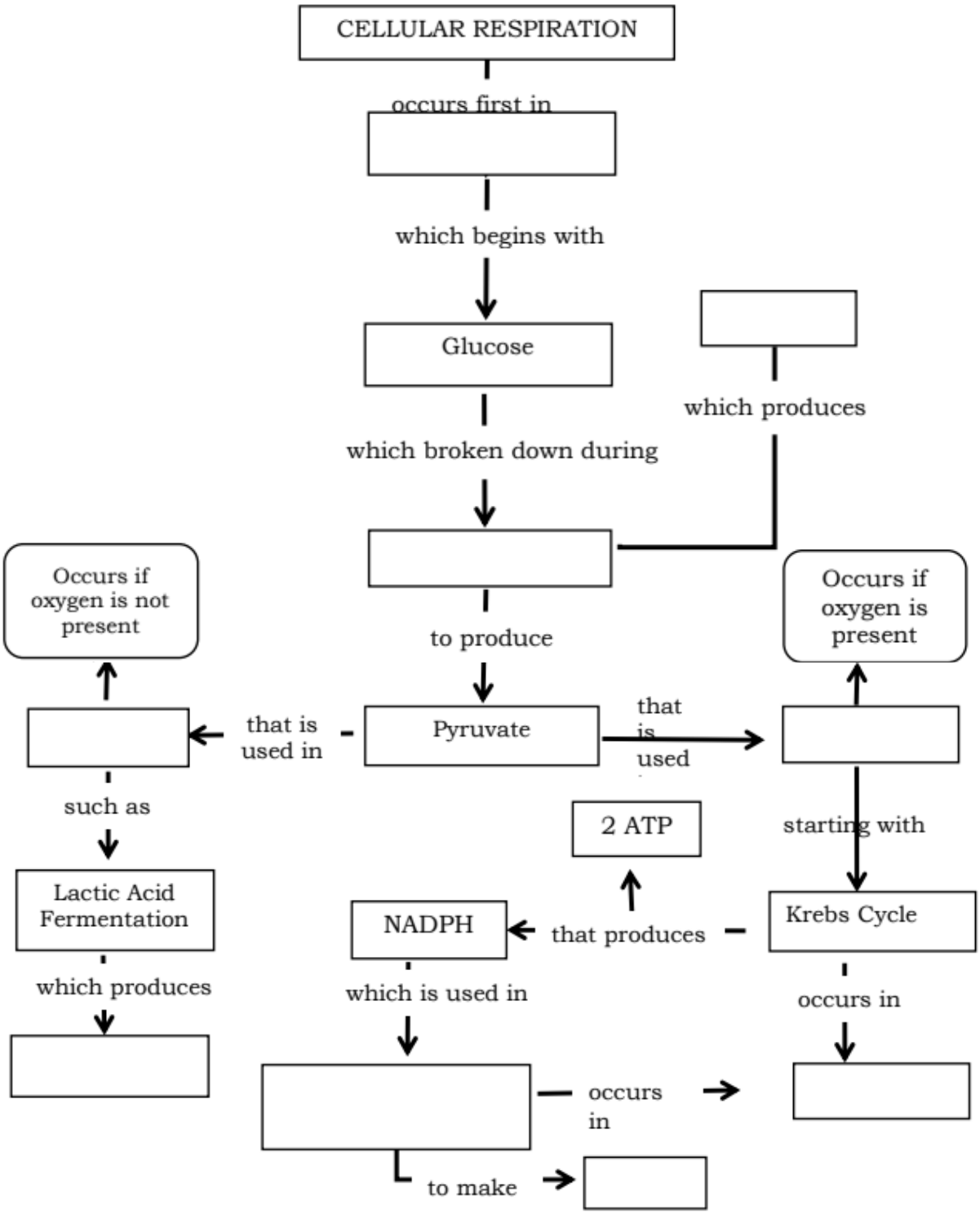
15. Which of the following statements correctly describes the difference between cellular respiration and photosynthesis?

    A. Cellular respiration occurs in cytoplasm only, while photosynthesis occurs in chloroplast.
    B. Cellular respiration reactants are carbon dioxide, water and light, while photosynthesis reactants are water sugar and oxygen
    C. Cellular respiration products include carbon dioxide, water and ATP, while photosynthesis products are glucose and oxygen.
    D. None of these.



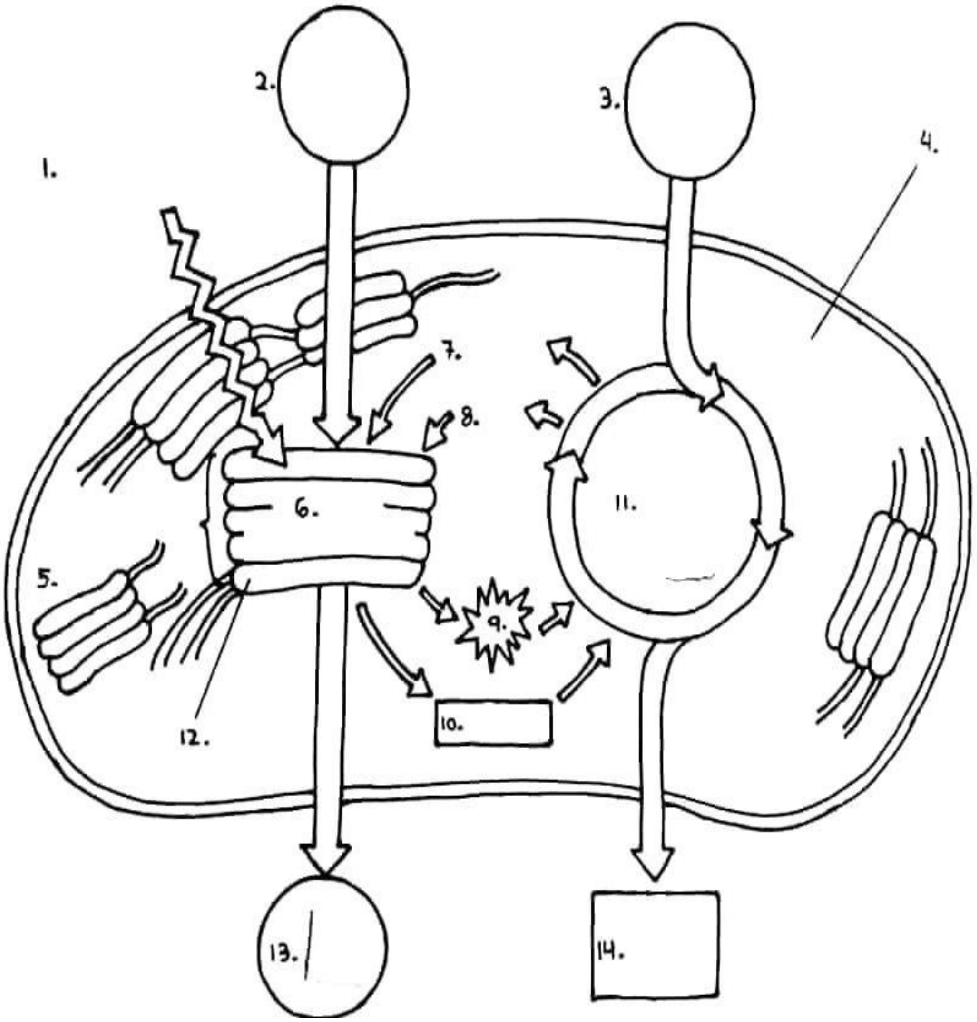
Additional Activities

I. Complete the concept below by filling in the correct term/s involved in the process of cellular respiration. Copy and answer the concept map on a separate sheet of paper.



II. Label the numbered parts of the diagram below to summarize the process involved in photosynthesis. Choose your answer from the word pool below. Write your answer on a separate sheet of paper.

Carbon dioxide	NADP+	NADPH	O_2
Thylakoids	ADP+ P	ATP	CO_2
Calvin Cycle	Stroma	Light	H_2O
Light Reaction	Sugar	Granum	



Answer Key

What I Know

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

What's In

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

What's More
Activity No.1

1. Plant
2. Leaf
3. Stomata
4. Chloroplast
5. Chlorophyll

What's More
Activity No.2

1. OFF
2. ON
3. OFF
4. OFF
5. ON
6. ON
7. ON
8. ON
9. OFF
10. OFF

What's More
Activity No.3

1. Temperature
2. Carbon dioxide
3. Water
4. Light
5. pH

What's More
Activity No.4

1. Intermembrane
2. Inner membrane
3. Matrix
4. Cristae
5. Outer membrane

What's More
Activity No.6

A. 2
B. 5
C. 1
D. 6
E. 7
F. 4
G. 3

What's More
Activity No.5

Pyruvate Oxidation

Pyruvate enters the mitochondrion from the cytoplasm. One carbon atom is removed via decarboxylation and hydrogen is removed using NAD+. Coenzyme A becomes attached to the remaining carbon atoms, creating acetyl–CoA, which then enters the Krebs cycle.

Krebs Cycle

Acetyl-CoA enters the cycle and then combines with oxaloacetate to make the six-carbon compound citrate. During the eight steps of the Krebs cycle, citrate undergoes a number of reactions, releasing CO2 and ATP in a number of steps. Citrate is eventually converted into oxaloacetate so it can be used again during the Krebs cycle.

Products of the Krebs Cycle

1. CO_2 is released as waste.
2. NADH and $FADH_2$ move to the next stage of cellular respiration.
3. Energy is released in the form of ATP. A glucose molecule produces two molecules of ATP because two molecules of pyruvate are created from each molecule of glucose.

What I Can Do

Guide Questions (Answer varies)

1. Photosynthesis requires the products from cellular respiration. Without photosynthesis, there wouldn't be any glucose or oxygen which are needed for cellular respiration reaction to occur Without respiration, plants would use up all the CO_2 and starve to death

2. Photosynthesis and cellular respiration are important biological processes needed by organism, to carry out their life process.

What I Have I Learned

1. photosynthesis
2. carbon dioxide
3. chloroplast
4. light-dependent
5. glucose
6. Krebs cycle
7. aerobic
8. mitochondria
9. electron transport chain
10. oxygen
11. pyruvate
12. NADH
13. Acetyl CoA
14. 34 ATPs
15. glucose

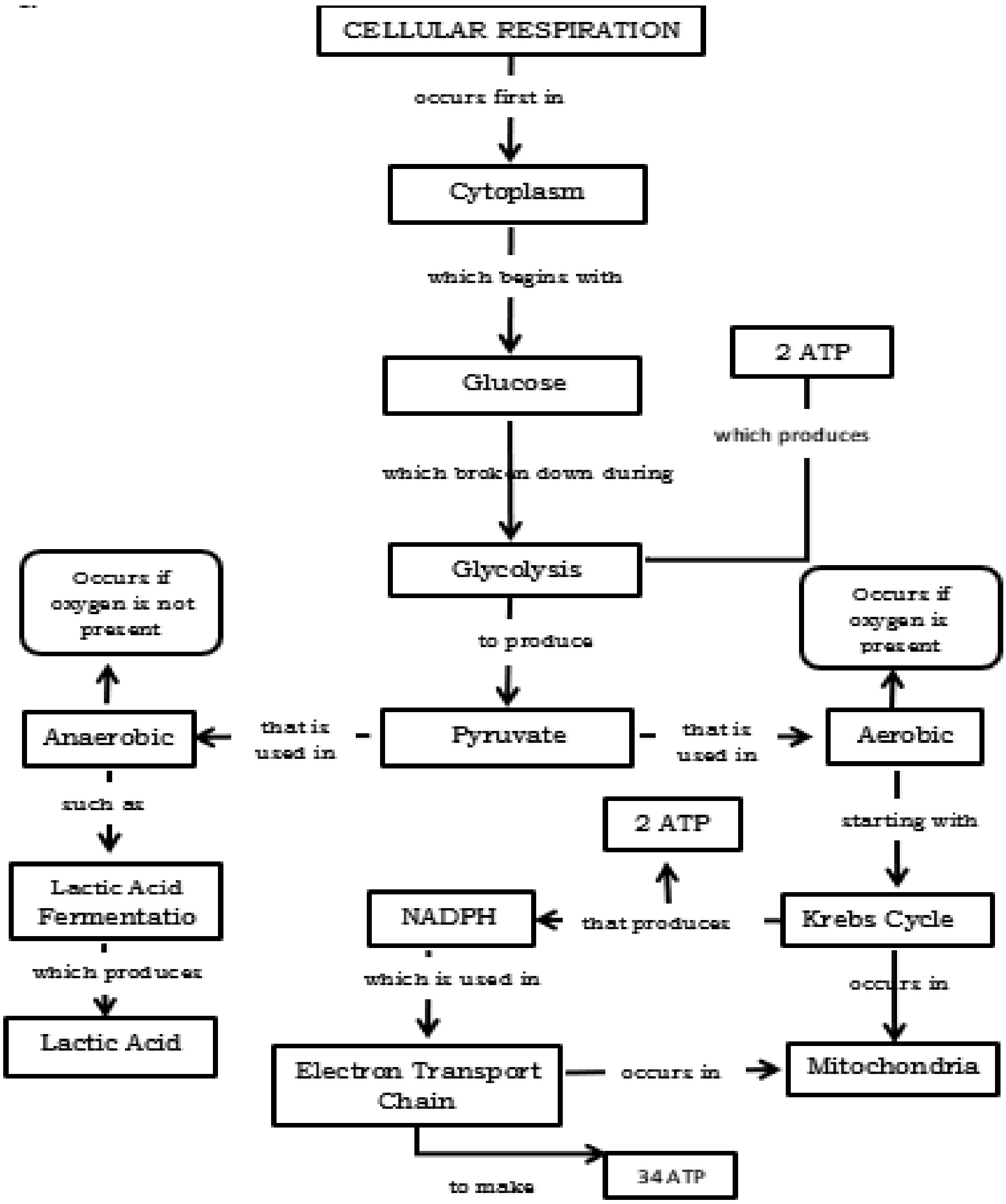
Assessment

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

What I Can Do

COMPARATIVE FEATURES	CHOICES	PHOTO-SYNTHESIS	CELLULAR RESPIRATION
Occurs in	Plants	/	
	All living things		/
	Algae	/	
	Photosynthetic bacteria	/	
Function/ Purpose	Release energy		/
	Capture, convert and store energy	/	
Reactants	Water	/	
	Glucose		/
	Oxygen		/
	Carbon dioxide	/	
	Light energy	/	
Metabolic Process	Catabolic		/
	Anabolic	/	
Location	Mitochondria		/
	Chloroplast	/	
	Cytoplasm		/
Source of Energy	Glucose		/
	Sunlight	/	
Stages	Light- dependent Reactions	/	
	Calvin Cycle,	/	
	Glycolysis		/
	Krebs cycle		/
	Electron Transport Chain		/
Products	Water		/
	Oxygen	/	
	Glucose	/	
	Carbon dioxide		/
Equation	$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$	/	
	$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$		/

I. Additional Activity



II. Additional Activity

Light
H_2O
CO_2
Stroma
Thylakoid
Light Reactions
$NADP^+$
ADP +P
ATP
NADPH
Calvin Cycle
Granum

References

Book

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Online Resources

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For inquiries or feedback, please write or call:

Department of Education - Bureau of Learning Resources (DepEd-BLR)

Ground Floor, Bonifacio Bldg., DepEd Complex
Meralco Avenue, Pasig City, Philippines 1600

Telefax: (632) 8634-1072; 8634-1054; 8631-4985

Email Address: blr.lrqad@deped.gov.ph * blr.lrpd@deped.gov.ph