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The Unit 5 Organizer

BIG PICTURE: **Photosynthesis and Cellular Respiration (ch.8 & 9)**

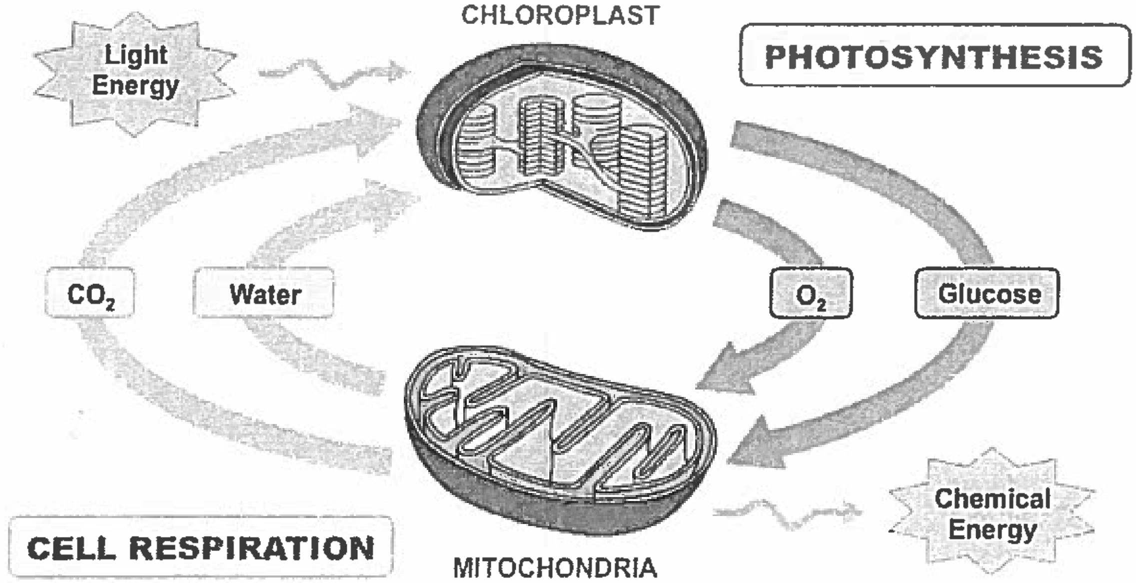
LAST UNIT
Cells

CURRENT UNIT
Photosynthesis & Respiration

NEXT UNIT
DNA, RNA, Protein Synth.

UNIT SCHEDULE

DATE	What's on the Agenda (Assignments)
11/21 (A) & 11/27 (B)	Notes on Photosynthesis, Lab
11/28 (A) & 11/29 (B)	Notes on Photosynthesis
11/30 (A) & 12/1 (B)	Soil Testing Lab
12/4 (A) & 12/5 (B)	Quiz on Photosynthesis, Notes
12/6 (A) & 12/7 (B)	Notes on Respiration
12/8 (A) & 12/11 (B)	Bromothymol Blue Lab
12/12 (A) & 12/13 (B)	Review
12/14 (A) & 12/15 (B)	Test



SOL OBJECTIVES

BIO.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations which:

a) Observations of living organisms are recorded in the lab and in the field;
i) appropriate technology including computers, graphing calculators, and probe ware, is used for gathering and analyzing data, communicating results, modeling concepts, and simulating experimental conditions;
j) research utilizes scientific literature;
k) differentiation is made between a scientific hypothesis, theory, and law;
l) alternative scientific explanations and models are recognized and analyzed;
m) current applications of biological concepts are used.

BIO.2 The student will investigate and understand the biochemical principles essential for life.

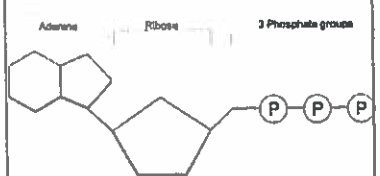
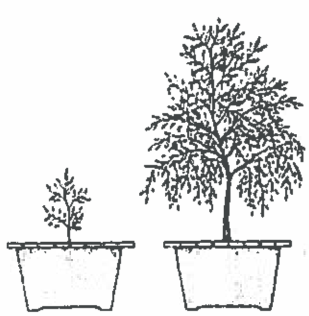
d) the capture, storage, transformation, and flow of energy through the processes of photosynthesis and respiration

LEARNING TARGETS

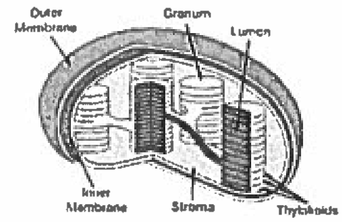
Your goal for the end of this unit is to be able to say, "I can..."

-describe the composition and function of ATP
-know that ATP is an energy molecule & can describe how it's used
-list several cell activities that require ATP
-describe the structure of a chloroplast & explain how it functions
-describe the light & dark reactions in detail
-explain how environmental factors influence photosynthesis
-describe the event of glycolysis and its products
-compare and contrast lactic acid & alcoholic fermentation
-summarize the events of aerobic cell respiration
-determine how many ATP are created by cell respiration
-write the overall balance equations for photosynthesis & respiration

UNIT 5 – PHOTOSYNTHESIS

Chapters: 8	Name: Date: Block:
People/Vocabulary/Pics	Objectives/Notes/ Definitions/Examples/Sketches
Section 8-1 & 8-2	**Objectives** Living Things Need Energy ATP and ADP Cells Use Energy Scientists Who Discovered Photosynthesis Photosynthesis Products & Reactants
	Living Things Need Energy Autotrophs: plants and some prokaryotes are able to use the energy from the sun to produce food. Heterotrophs: animals, some prokaryotes, and most multicellular organisms cannot use the sun's energy directly, therefore they need to consume autotrophs as a food source.
	**ATP** ATP stands for Adenosine Tri-phosphate ATP is the biochemical molecule which plants and animals use for energy: 3 Phosphates can be released for energy. ADP (adenosine di-phosphate) has only 2 phosphates. ATP and ADP are like battery strength. 3 phosphates = more power, and 2 phosphates = less power.
	Cells Use Energy Active Transport: Ions across cell membrane thru protein pump. Sodium-Potassium Pump : Ion movement: Na+ out & K+ in. Synthesis of Nucleic Acids: DNA & RNA Movement: work and exercise. ATP needed for cell movement and division. ATP is actually only good for short term use, its poor at long-term storage of large amounts of energy. Glucose is much better at long-term storage of energy. Glucose stores 90x more energy than ATP. Cells keep a small supply of ATP; they generate more from ADP when needed, by breaking down carbs like glucose (from digesting food).
	**Scientists Who Discovered Photosynthesis** Van Helmont (1643): Discovered that most of the mass of a plant comes from water. He weighed the plant and the soil. Joseph Priestley (1771): Discovered a mint plant produced a substance that kept a candle burning. Plants release oxygen. Jan Ingenhousz (1779): Discovered that plants only produce oxygen in the presence of light. Melvin Calvin (1948): Determined the details of the Calvin Cycle.

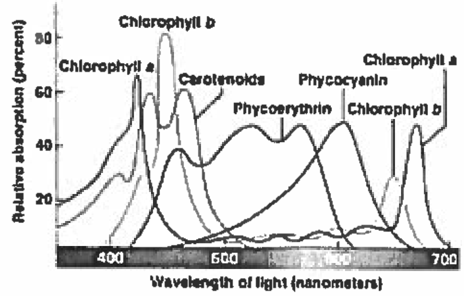
Chloroplast



Photosynthesis

Photosynthesis: is the process of converting light energy into biochemical energy.

Chloroplast: Organelle in plant cells only. Chlorophyll: Pigment that absorbs light. Appears green because it absorbs blue and red light. Chlorophyll is just one pigment in plants, there are others colors: Anthocyanin makes plants red. Carotenoids make plants look yellow or orange. As chlorophyll breaks down in the fall/autumn, we see these colors.



Products & Reactants

Reactants: $CO_2 + H_2O$ (carbon dioxide + water) along with light energy (for activation).

Products: $C_6H_{12}O_6 + O_2$ (glucose + oxygen).

Remember, CHO always makes carbohydrates in 1:2:1 ratio ☺

Section 8-3

Objectives

Photosynthesis is 2 Reactions
Light Dependent
Converting Energy from Electrons
ATP Formation
Light Independent Reactions
Reaction Formulas
Factors that Effect Photosynthesis

Photosynthesis Occurs in 2 Reactions

Both reactions occur in the Chloroplast

Light Reactions: (Light dependent) AKA- Photophosphorylation Takes place in two photosystems.

Dark Reactions: (Light independent) AKA- Calvin Cycle. Dark means without light needed, doesn't happen only at night.

Light Dependent

AKA- Photophosphorylation

(Photo= light, phospho= phosperous, lation= process)

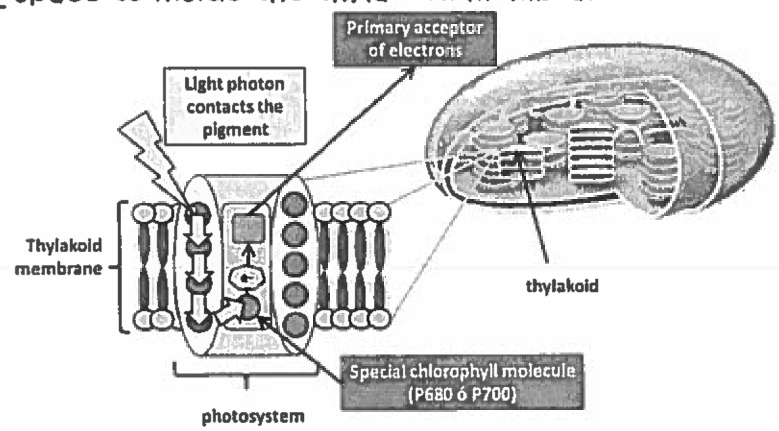
Uses light and water to make the energy storing molecules NADPH and ATP (which will be used in the dark reaction), and releases oxygen as waste. Takes place in the thylakoid membrane (stacks within the chloroplast).

Photosystem II: Light is absorbed by chlorophyll, the energy from the light photons are transferred to electrons, which then perform hydrolysis to break water into ions (H+ & O-).

Photosystem I: Electrons and H+ are picked up by NADP+ to combine and form NADPH.

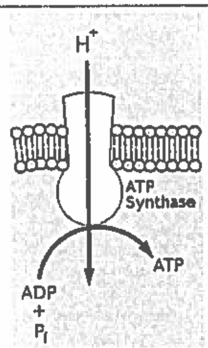
Hydrogen Ion Movement: The inside of the thylakoid membrane fills up with H+ ions, this makes the inside slightly positive, and the outside of the membrane slightly negative.

Electron Transport Chain: Electrons from photosystem II move to photosystem I, using their energy to transport H+ from the Stroma space to inside the thylakoid membrane.



Converting Energy from Electrons

The starting point for photosynthesis: Take the energy from an excited election (photon of light) and use it to break H2O to form NADPH. Occurs by passing the election from one thylakoid to another. Stacks of thylakoids = granum. Chlorophyll pigments are found inside the thylakoid membranes (green).



ATP Formation

The final phase of light reactions.

ATP Synthase: a specialized protein channel in the thylakoid membrane, at the end of the ETC. Converts ADP to ATP as H+ ions pump through to the outside of the membrane. ATP synthase turns/spins like a turbine as ions pass through.

Chemiosmosis: occurs as H+ ions move across a membrane to make ATP. (like osmosis, but with chemical ions instead of water)

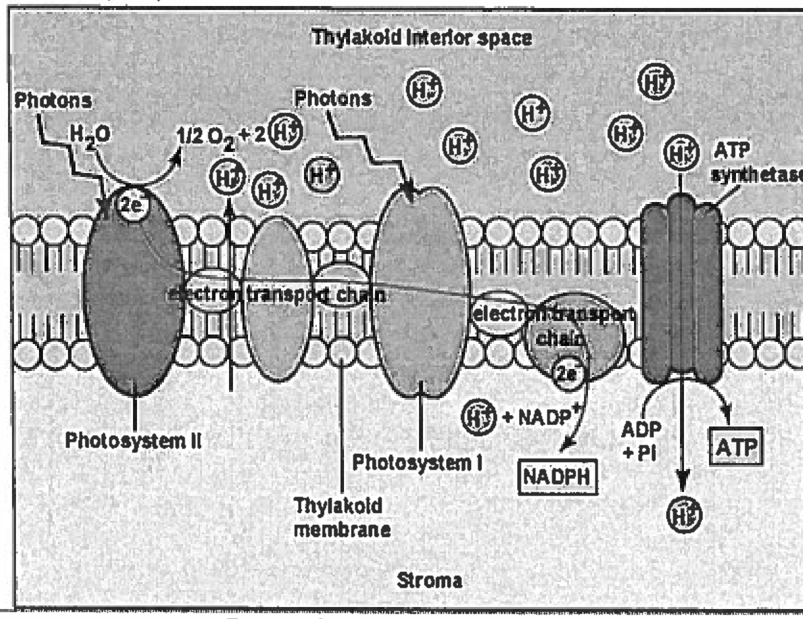
Light Independent

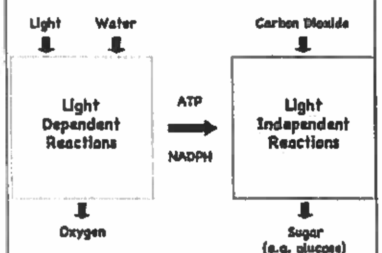
AKA- Calvin Cycle. Uses products of light reaction (NADPH and ATP) to convert CO2 into C6H12O6 = glucose (sugar). Takes place in the stroma (spaces).

- 6 molecules of CO2 enter the cycle from the atmosphere (air). They combine with 6 molecules containing 5 carbons each, forming into 12 molecules with 3 carbons each.
- ATP and NADPH are used to convert the 3-carbon molecules into higher-energy forms.
- 2 of the 3-carbon molecules are used to make 6-carbon sugars such as glucose.

- 10 of the 3-carbon molecules remaining are converted into 5-carbon molecules, to be used at the beginning again.

The Calvin Cycle uses 6 molecules of CO_2 to make 1 molecule of 6-carbon glucose at the end.





Reaction Formulas

Light Dependent Reactions in the thylakoid

- NADP + H → excited e- → NADPH + O2
- ADP + P → ATP Synthase → ATP

Light Independent Reaction in the stroma:

- ATP + NADPH + CO2 → $C_6H_{12}O_6$

Oxidation-Reduction Reactions always take place together:

- Oxidation: lose e- and H+, gain O2, release energy.
- Reduction: lose O2, gain e- and H+, takes in energy.

Photosynthesis Formula

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

Reactants: 6 carbon dioxides + 6 water molecules, light photons

Products: 1 glucose + 6 oxygen molecules

Factors That Effect Photosynthesis

These can either slow down or speed up the process:

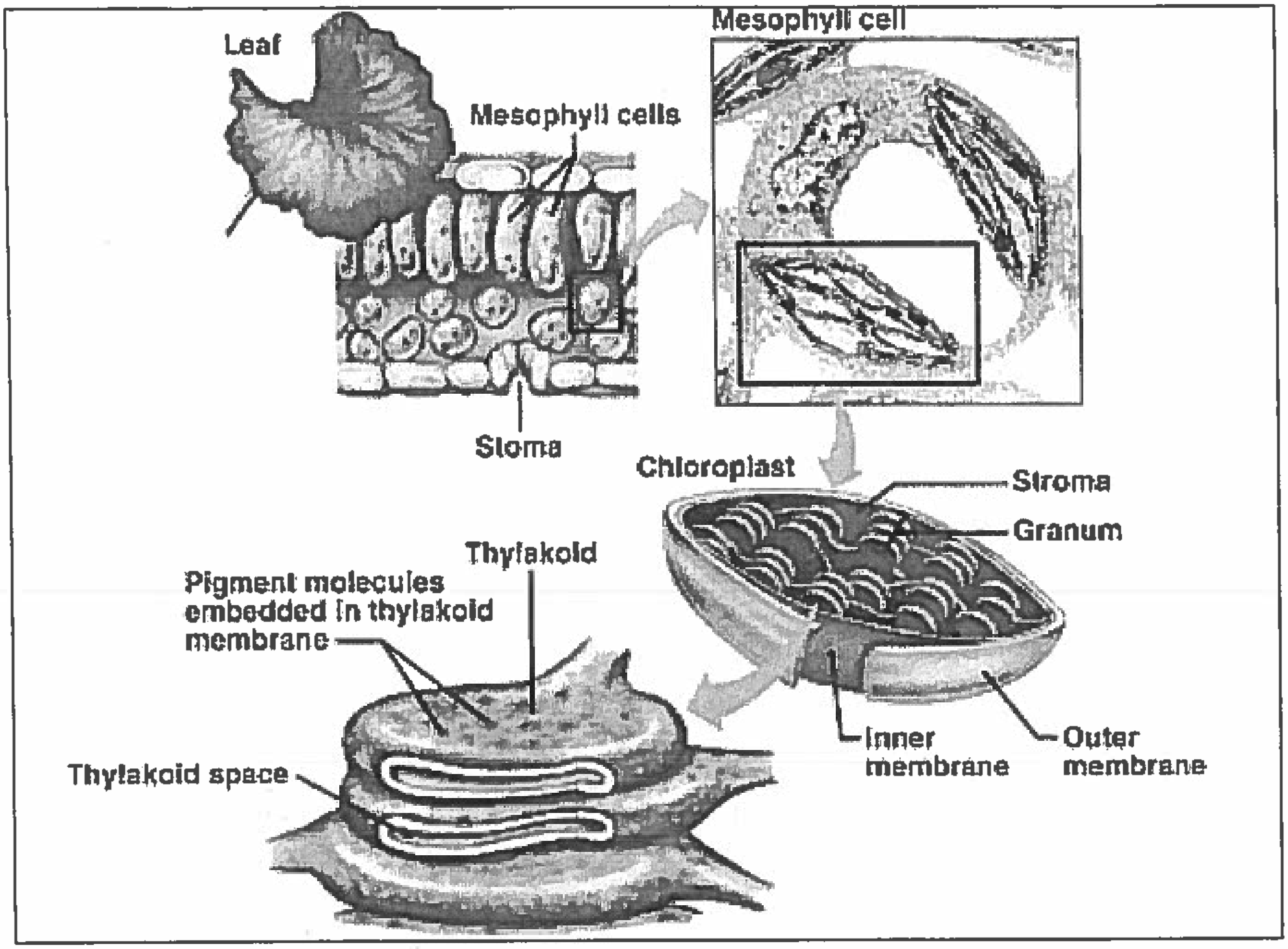
Light Intensity: More = more photosynthesis

Carbon Dioxide amount: More = more photosynthesis

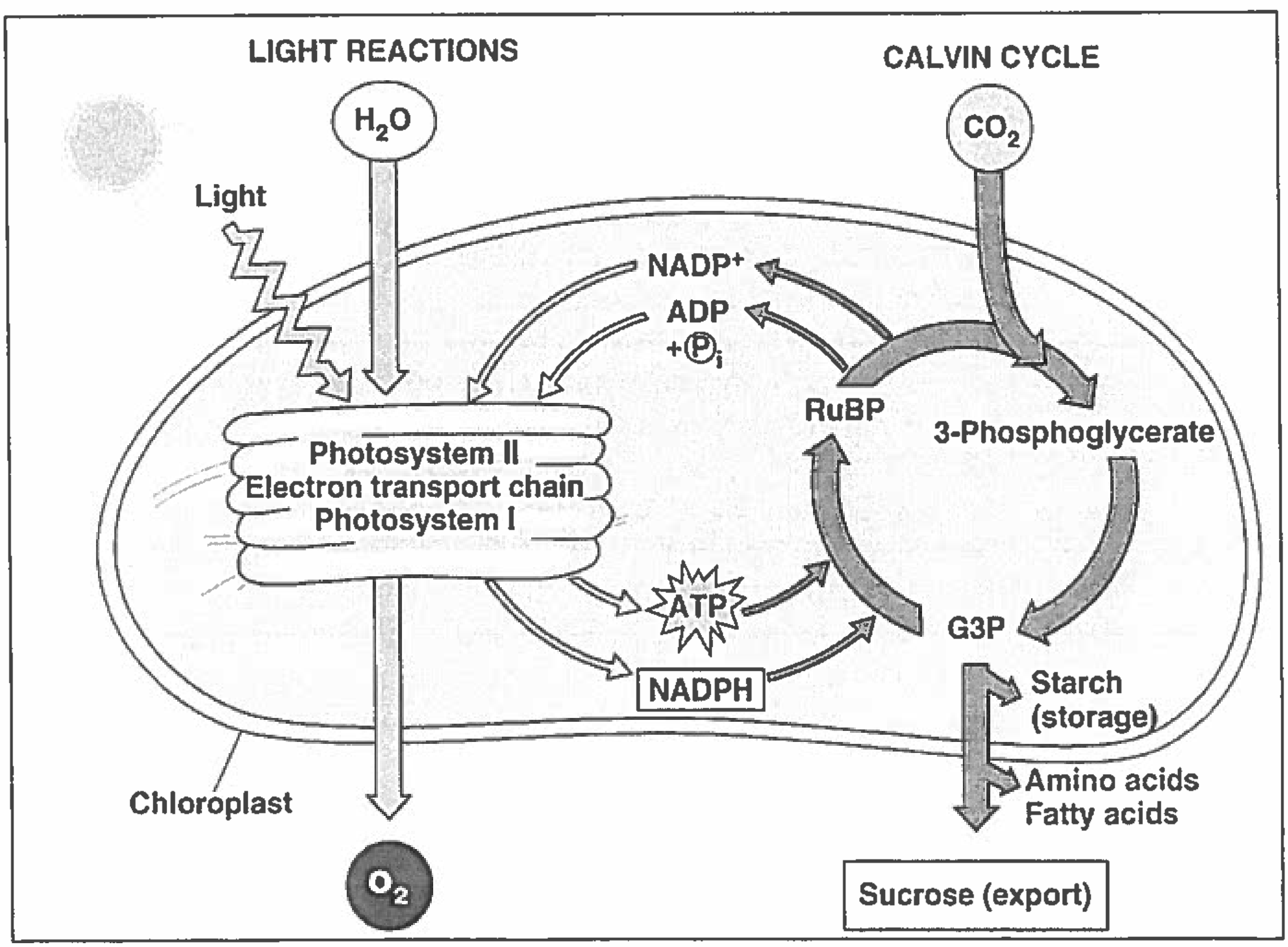
Temperature: Too high or too low = less photosynthesis

High Heat: plants close their stoma (pores in leaves) to conserve water. Different plants have an ideal temperature range. Trees that lose their leaves in fall don't do photosynthesis in winter.

Type of plant: C4 plants perform photosynthesis in different layers of their leaves. CAM plants (desert) perform photosynthesis at night (so they don't dry out).

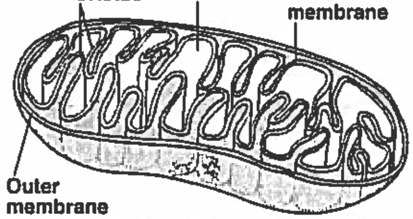


Leaf
Mesophyll cell
Mesophyll cells
Stoma
Chloroplast
Stroma
Granum
Thylakoid
Pigment molecules embedded in thylakoid membrane
Thylakoid space
Inner membrane
Outer membrane



LIGHT REACTIONS
CALVIN CYCLE
H_2O
CO_2
Light
$NADP^+$
ADP
$+ P_i$
RuBP
3-Phosphoglycerate
Photosystem II
Electron transport chain
Photosystem I
ATP
NADPH
G3P
Starch (storage)
Amino acids
Fatty acids
Chloroplast
O_2
Sucrose (export)

UNIT 5 – RESPIRATION

Chapter: 9	Name: Date: Block:
People/Vocabulary	Objectives/Notes/Definitions/Examples/Sketches
Section 9-1	**Objectives** Chemical Energy Mitochondria Respiration Formula Cycle Overview
	Chemical Energy Why do we eat? We need to consume food so we can break it down into usable energy, like glucose. The amount of energy we can get from food is calculated by the amount of Calories it contains. • Calorie = amount of energy needed to raise the temperature of 1g of H_2O by 1 degree Celsius. You don't "burn" through the glucose in food; your cells slowly release the energy it contains over time. This is measured by your Metabolism
	Mitochondria The site of cellular respiration: Organelle: AKA- powerhouse of the cell. Structure: made of 2 membranes (inner and outer). 
	Respiration Formula Cellular Respiration means to release energy by breaking down food molecules in the presence of oxygen. Formula: $C_6H_{12}O_6 + 6O_2 = 6H_2O$ + energy (heat and ATP) + $6CO_2$
	Overview of the Respiration Cycle Glucose + oxygen → carbon dioxide + water + energy Mitochondria perform respiration so we get energy, we breathe out carbon dioxide and water.
Section 9-2	**Objectives** Chemical Pathways Glycolysis Krebs Cycle Electron Transport Chain Fermentation
	Chemical Pathways Just like photosynthesis, there are several steps to respiration: 1.) Glycolysis 2.) Krebs Cycle (Citric Acid Cycle) 3.) Electron Transport Chain (ETC)

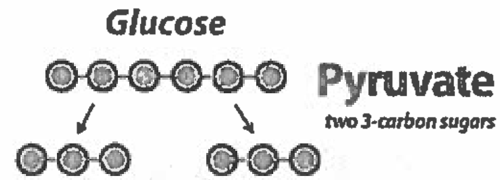
Glycolysis

Occurs in the cytoplasm outside of the mitochondria.

Glycolysis: the process of breaking 1 molecule of glucose into 2 molecules of pyruvic acid (3-carbon molecule). Glycolysis is a fast process; it produces thousands of ATP molecules in milliseconds!

This step of respiration does not require oxygen (anaerobic).

Because glycolysis is so fast, the cell uses up its available NAD+ quickly, and then ATP production will stop unless more is made.



Krebs Cycle

AKA – The Citric Acid Cycle

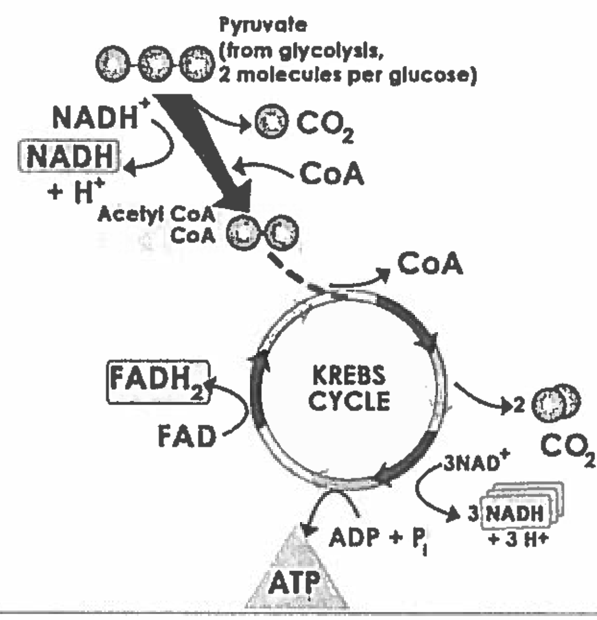
The pyruvic acid made during glycolysis is used to make CO2, NADH, ATP, and FADH2 inside the mitochondria.

The NAD+ molecule accepts/hold onto electrons as NADH until they are needed for making other molecules.

- Just like the NADP+ used in photosynthesis.

In the mitochondria matrix, the 3-carbon pyruvic acid releases 3 molecules of CO2 and become Acetyl-CoA (citric acid).

- Products made: NADH, FADH2, 2 ATP



Electron Transport Chain

Remember the ETC in photosynthesis: The ETC uses the high-energy electrons from the Krebs Cycle to convert ADP to ATP.

High energy electrons come from NADH and FADH2.

- For prokaryotes the ETC is in the cell membrane.

Fermentation

When oxygen is not present, glycolysis is followed by fermentation, an anaerobic process.

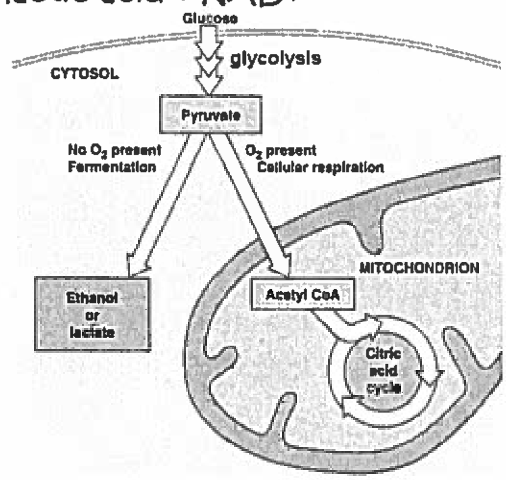
Alcoholic Fermentation: done by yeast in bread.

- Pyruvic acid + NADH = ethyl alcohol + CO_2 + NAD^+

Lactic Acid Fermentation: occurs when you're exercising rapidly and cannot supply your muscles with enough oxygen.

- Pyruvic acid + NADH = lactic acid + NAD^+

Results in muscle soreness.



One Man's Trash is Another Man's Treasure

The products of photosynthesis are the reactants of respiration.
The products of respiration are the reactants of photosynthesis.

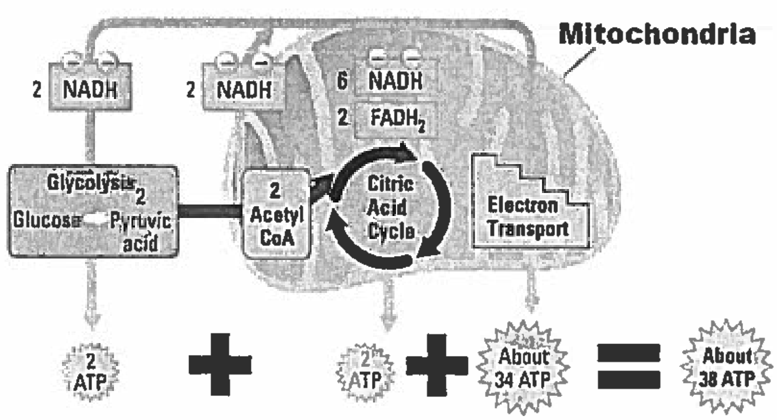
Net Results

Photosynthesis (Chloroplast) = Makes Glucose - total: 1

- Like "depositing" money into a bank

Respiration (Mitochondria) = Makes ATP - total: 36 to 38

- Like "withdrawing" money from a bank



Summary ch.9:

Unit 5 Vocabulary Key

Vocab Word	Definition
Acetyl-CoA (citric acid)	Pyruvate (or pyruvic acid) is converted into Acetyl-CoA when it enters the mitochondria matrix to be used in the Krebs Cycle.
ATP Synthase	A protein channel in the cristae membrane of the mitochondria, H+ moves through it to convert ADP into ATP.
Alcoholic Fermentation	Occurs in plants and some prokaryotes, does not require oxygen, product made is ethyl alcohol. Alcoholic Fermentation IS anaerobic respiration.
Anaerobic	Means WITHOUT oxygen.
Aerobic	Means WITH oxygen.
ADP	Adenosine di-phosphate: low powered molecule with only 2 phosphates. ADP is the result of using a phosphate from ATP to create energy.
ATP	Adenosine tri-phosphate: high energy molecule for cells, the phosphates can be removed to release energy.
Autotroph	Organism that can make its own energy, usually refers to plants and prokaryotes that can perform photosynthesis.
calorie	A measure of how much energy/heat you can get from food. A calorie is calculated by the amount of energy needed to raise the temperature of 1 gram of water by 1°.
Calvin Cycle	Step 3 in photosynthesis: Dark Reactions of photosynthesis, takes place in the stroma fluid of the chloroplast. ATP and NADPH (from light reactions) and CO_2 (from the air) are used to make glucose. Byproducts left over are ADP and NADP+.
Cellular Respiration	Process used by mitochondria to create energy and CO_2 from glucose and oxygen.
Chlorophyll	Green pigment in the thylakoid membrane of the chloroplast organelle. Its job is to capture sunlight photons for photosynthesis.
Chloroplast	Organelle in plants (and some prokaryotes) that carries out the process of photosynthesis.
Cristae	Inner membrane of mitochondria, contains many folds. Location of Electron Transport Chain to create ATP during cellular respiration.
Dark Reactions	Calvin Cycle of photosynthesis, takes place in the stroma fluid of the chloroplast. ATP and NADPH (from light reactions) and CO_2 (from the air) are used to make glucose. Byproducts left over are ADP and NADP+.
Electron Transport Chain	H+ ions flow from the inside to the outside a membrane through the ATP synthase protein channel, to generate ATP. The ETC is found in both photosynthesis and cell respiration processes.
Ethyl Alcohol	Byproduct created after alcoholic fermentation occurs. Anaerobic Respiration.

FAD+	Accepts H+ ions in the mitochondria to make FADH, an energy storing molecule for use in the Krebs Cycle of cell respiration.
FADH	Used to give energy to the Krebs Cycle of cell respiration in mitochondria where Acetyl-CoA is converted into CO_2 and ATP.
Fermentation	Process that occurs if a cell attempts to do respiration, but no oxygen is present. Fermentation will happen in the cytoplasm of a cell following glycolysis in an anaerobic environment.
Glucose	Sugar made from photosynthesis reaction. Glucose = $C_6H_{12}O_6$.
Glycolysis	First step in cell respiration where glucose is broken in half into two molecules of pyruvate (or pyruvic acid). Glucose has 6 carbons; each pyruvate has 3 carbons.
Granum	A stack of thylakoids in chloroplast.
Heterotroph	Organisms that consume/eat food or other organisms as a food/energy source.
Krebs Cycle	The second step in cell respiration, takes place in the mitochondria matrix. Used Acetyl-CoA, O_2, and FADH to create ATP and CO_2.
Lactic Acid	Byproduct created after fermentation occurs in an animal/eukaryotic cell. Lactic acid causes muscle soreness.
Metabolism	A measure of how fast or slow an organism utilizes the calories from food/glucose.
Mitochondria	Organelle found in both animals and plants that performs Cellular Respiration to provide ATP energy to the cell/organism.
NADP+	Accepts an H+ ion from the inner thylakoid membrane of a chloroplast to become NADPH during Photosystem I, and then be used as a source of power to aid in the Calvin Cycle reactions of photosynthesis in the stroma fluid.
NADPH	Used as a source of power to generate glucose during the Calvin Cycle of photosynthesis which occurs in the stroma fluid.
Photosynthesis	Process of converting light energy into biochemical energy. Occurs in the chloroplast of plants and some prokaryotes. • Formula: $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
Photosystem I	Step 2 in Photosynthesis: high energy electrons from photosystem II are used to add H+ to NADP+ to make NADPH (an energy carrying molecule). Also, H+ ions travel through the ATP Synthase protein channel to turn ADP into ATP (an energy carrying molecule).
Photosystem II	Start of Photosynthesis: sunlight enters a chloroplast and is captured by green chlorophyll pigments. The light photons are converted into high energy electrons and used to power the reaction of hydrolysis (breaking water into O_2 and H+). O_2 is then released out of the leaf through the stomata pores, and H+ stays in the thylakoid membrane where it will be used in Photosystem I.
Photon	Light from the sun, to be converted into electrons/energy during photosynthesis.

Pyruvic Acid (Pyruvate)	Molecules made after glycolysis occurs in the cytoplasm of a cell. Glycolysis is the first step in cell respiration where glucose is broken in half to create 2 pyruvates. Glucose has 6 carbons, each pyruvate has 3 carbons.
Stomata	Pore/small holes on the bottom of a leaf where gas exchange occurs. Plants bring in CO_2 and release out O_2 through their stomata.
Stroma	Fluid surrounding the thylakoids inside of a chloroplast. The stroma fluid is the place where the Calvin Cycle of photosynthesis occurs = where glucose is made.
Thylakoid	Membranes inside a chloroplast, contain green chlorophyll to capture sunlight and convert it into energy molecules. Thylakoids are where the light reactions occur.

Name: Block: Date:

LEAF CHROMATOGRAPHY LAB

Question

- Do leaves contain other pigments besides green chlorophyll?

Hypothesis

____

____

____

____

Materials

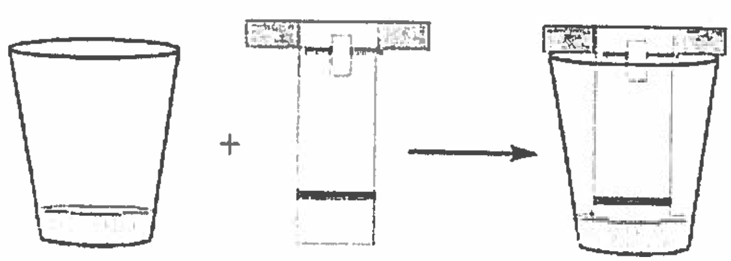
Isopropyl alcohol
Fresh leaves
Chromatography Paper
Penny

50mL beaker
Ruler
Scissors
Pencil

Tape
Colored pencils

Introduction

**Paper chromatography is a process that uses special filter paper to separate and identify the different substances in a mixture. Chromatography means "to write with color." The substances in the mixture dissolve in the alcohol and move up the paper. The heavier substances move up the paper more slowly. The lighter substances move up the paper more quickly. So the heavy and light substances will get separated from one another on the paper. Plants contain chlorophyll, a green pigment, as well as carotenoid, a pigment that ranges in color from red to orange to yellow.*



Name: Block: Date:

Procedure

1. Cut a strip of chromatography paper to the height of your beaker.
2. Use a ruler to measure 2 cm above the bottom of the paper strip, draw a pencil line here.
3. Wrap a leaf around a coin with the waxy side of the leaf facing outward. Now rub the leaf along the light pencil line on the paper strip until you make a dark colored line. **DON'T RUB THE LEAF ABOVE/BELOW THE LINE. RUB ONLY ON THE PENCIL LINE!**
4. Tape the top of the paper strip to a pencil so that the end of the strip with the green line hangs down. The pencil should be able to sit across the top of the beaker with the bottom of the paper strip just touching the bottom of the beaker. Cut off any excess paper from the top of the strip if it is too long. **DO NOT CUT THE BOTTOM OF THE STRIP WITH THE GREEN LINE.**
5. **Remove the pencil/paper strip from the beaker for now.**
6. Add isopropyl alcohol to the beaker until it reaches 10mL.
7. Now lay the pencil across the top of the beaker with the paper strip extending into the alcohol. MAKE SURE THAT THE LEVEL OF THE ALCOHOL IS BELOW THE GREEN LINE ON YOUR PAPER STRIP!
8. Observe as the alcohol gets absorbed and travels up the paper. This may take up to 20 minutes. Do not touch your experiment during this time!
9. Below, using colored pencils, draw your lab set-up before and after this experiment.

Results

FILTER PAPER	LEAVES TESTED	
	Green	Brown/Orange
Before chromatography		
After chromatography		

Name: Block: Date:

Post-Lab: Conclusions

1. Why is paper chromatography an appropriate technique to use to determine if different pigments are present in a leaf?

2. How does paper chromatography work?

3. Did the leaves you tested contain different pigments? Use your results to support your answer.

4. Based on what you have learned, explain why leaves tend to change color in the fall.

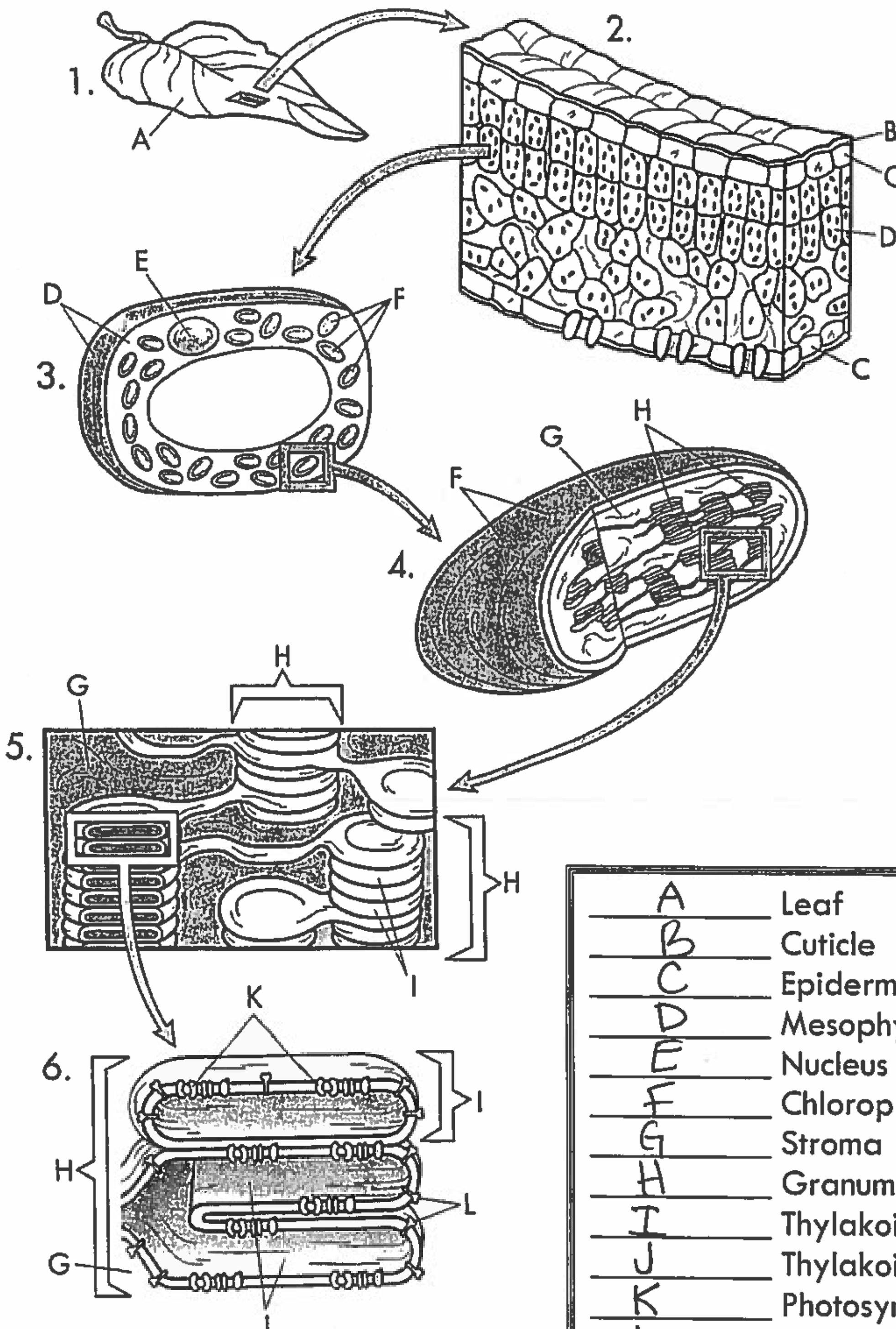
5. Leaves in Virginia change color in the fall. However, leaves in Florida do not change color in the fall. Why is this so? (Hint: Think of a difference between the two locations that might act as a trigger for leaves to change color in the fall.)

6. Was your hypothesis correct? If not, rewrite your hypothesis here so that it is correct.

Name:______________________________ Date:____________ Period:________

Photosynthesis Diagrams Worksheet

Part I: In the diagram below, label parts A-L next to the words in the structures of photosynthesis box below.



Structures of Photosynthesis

A	Leaf
B	Cuticle
C	Epidermis
D	Mesophyll Cells
E	Nucleus
F	Chloroplasts
G	Stroma
H	Granum
I	Thylakoid
J	Thylakoid Space
K	Photosynthetic Pigments
L	ATP Synthetase

Part II: Use Diagram A to help you label Diagram B. Write labels on the lines in Diagram B.

Diagram A

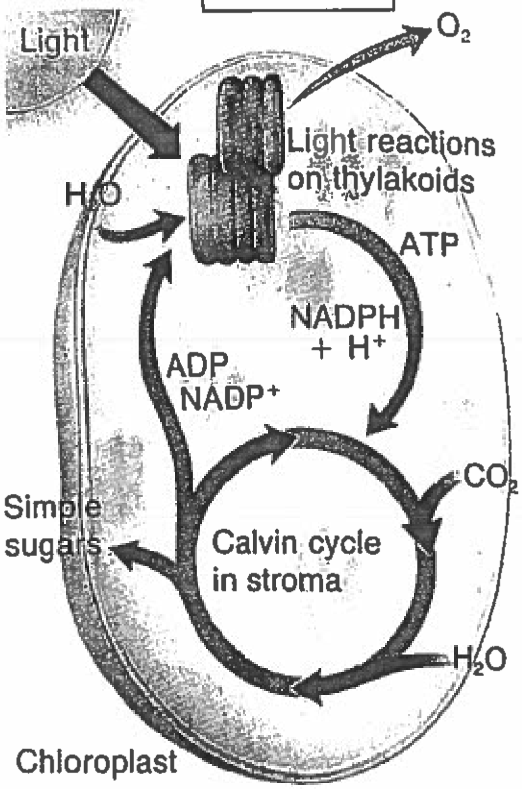
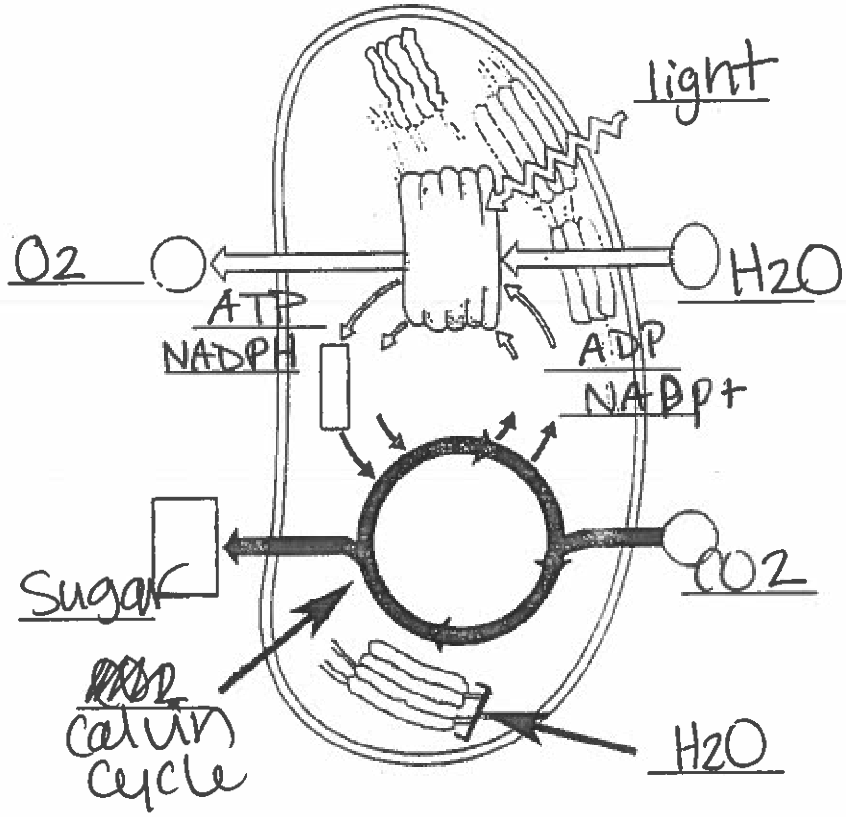
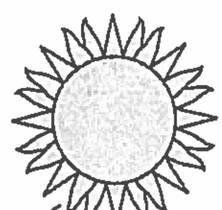


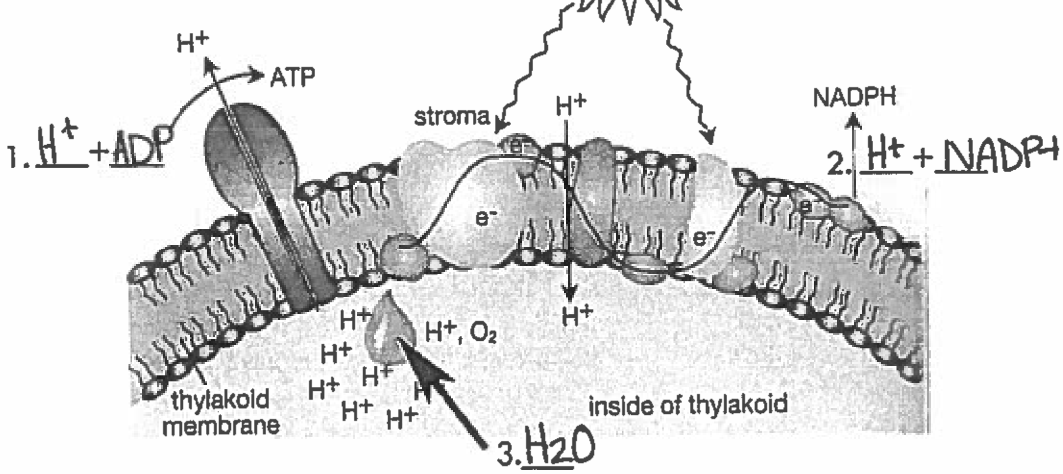
Diagram B



Part III: Label numbers 1, 2, and 3 in the diagram below.

Hint: In number one, you are labeling the reactants for ATP. In number 2, you are labeling the reactants for NADPH. In number 3, you are labeling the source of H and O.





Soil Analysis Lab

Background:

Nutrient rich soil is needed to grow healthy plants and crops to provide food for humans and animals. Nutrient rich soils contain phosphate and other nutrients such as nitrogen and potassium. Unfortunately, not all soils are naturally nutrient rich. In the early 1800s, it was learned that phosphorus promotes growth in plants and animals. Today, phosphate rock provides the phosphorus element of the nitrogen-phosphorus-potassium mix that commercial fertilizer provides for plants.

Soils need phosphate and other nutrients. When farmers apply fertilizers, either in organic or mineral form, it is to add nutrients to the soil for the plants. The key to growing crops that are plentiful, and that contain the nutrients we need, is to assure that the soil has the adequate nutrients it needs.

Mineral fertilizers are needed to maintain the level of soil fertility needed to meet the nutritional needs of the world's population. There is an ongoing discussion on the matter worldwide in the agricultural community, and soil experts agree that the use of fertilizers, both inorganic and organic, needs to be tailored to the local soil needs. Soil testing and other diagnostic tools should be used. If the nutrients in the soil are already sufficient, adding fertilizers is more likely to be damaging environmentally, as well as economically wasteful.

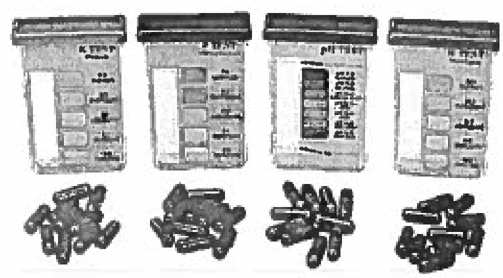
Having sufficient amounts of phosphate and other nutrients will improve agricultural production in order to provide enough food for the world's population. Phosphate is a vital nutrient for plant growth, development, and reproduction.

Objectives: **The student will be able to...**

-Identify the components of fertile soil, including the major elements needed for growth
-Explain how modern farming practices aid in soil fertility

Materials:

Gloves	Goggles	Trowel or spoon
Clean dry cup	2 liter container	500mL Beaker
Soil sample (1 cup)	Pipette	Distilled water
Rapitest Soil Test Kit	Glass Stir Rod	



Preparation (prior to class/the day before this lab)

1. Using the trowel take a soil sample from 2-4" below the ground surface.
2. Take several samples from the same area.
3. Place the samples in a clean container, <u>you need 2 cup worth of soil.</u>
4. Break the sample up with the trowel or spoon and allow it to dry out naturally (not necessary but makes working with the sample easier).
5. Remove small stones and organic matter such as grass, weeds, or roots.

➔ In the classroom

1. Fill a clean 500mL beaker with 1 cup soil and 5 cups of distilled water.
   a. Save ¼ cup of soil in your original container (don't mix with water)
2. Thoroughly stir the 1 cup of soil and distilled water together for at least 1 minute then allow to stand undisturbed until it settles.

pH Test (green)

1. Remove the cap from the green container
2. Fill test chamber to soil fill line with your saved dry soil sample
3. Carefully separate the two halves of the green pH capsule and pour powder into the test chamber – **wear gloves and goggles!**
4. Using the pipette, add plain-fresh distilled water to the fill line
5. Replace the cap on the container making sure the cap is on tightly and shake thoroughly
6. Allow soil to settle and color to develop for **1 minute**
7. Compare the color of the solution against the pH chart and record in the data table

Nitrogen Test (purple)

1. Select the purple nitrogen container. Remove the cap
2. Using the pipette fill the test and reference chambers with the soil/water mix (liquid part only)
3. Carefully separate the two halves of the purple nitrogen capsule and pour powder into the test chamber – **wear gloves and goggles!**
4. Replace the cap on the container making sure the cap is on tightly and shake thoroughly
5. Allow the color to develop in the test chamber for **10 minutes**
6. Compare the color of the solution in the test chamber to the color chart and record in the data table.

Phosphorus Test (blue)

1. Select the blue phosphorus container. Remove the cap
2. Using the pipette fill the test and reference chambers to the fill mark with the liquid soil mix
3. Carefully separate the two halves of the blue phosphorus capsule and pour powder into the test chamber – **wear gloves and goggles!**
4. Replace the cap on the container making sure the cap is on tightly and shake thoroughly
5. Allow the color to develop in the test chamber for **10 minutes**
6. Compare the color of the solution in the test chamber to the color chart and record in data table

Potassium Test (orange)

7. Select the orange potassium container. Remove the cap
8. Using the pipette fill the test and reference chambers to the fill mark with the liquid soil mix
9. Carefully separate the two halves of the orange potassium capsule and pour powder into the test chamber – **wear gloves and goggles!**
10. Replace the cap on the container making sure the cap is on tightly and shake thoroughly
11. Allow the color to develop in the test chamber for **10 minutes**
12. Compare the color of the solution in the test chamber to the color chart and record in data table

Data/Observations:

SAMPLE LOCATION	pH	Nitrogen (N)	Phosphorus(P)	Potassium (K)
Location: ______________				

Observations:

Original soil color: ____________________

Did the soil contain any organic particles? (i.e: leaves, hairs, plants, etc.)

What was currently growing where you collected your sample?

Analysis/Conclusion:

1. What are the nutrient components of fertile/rich soil?

2. What causes soil degradation (soil becomes unfertile)?

3. What would happen to crops if they were grown in unfertile soil? What would happen to the organisms that consume them?

4. Did your soil sample contain adequate nutrients?

5. What was your soil sample lacking?

6. How could you improve your soil quality?

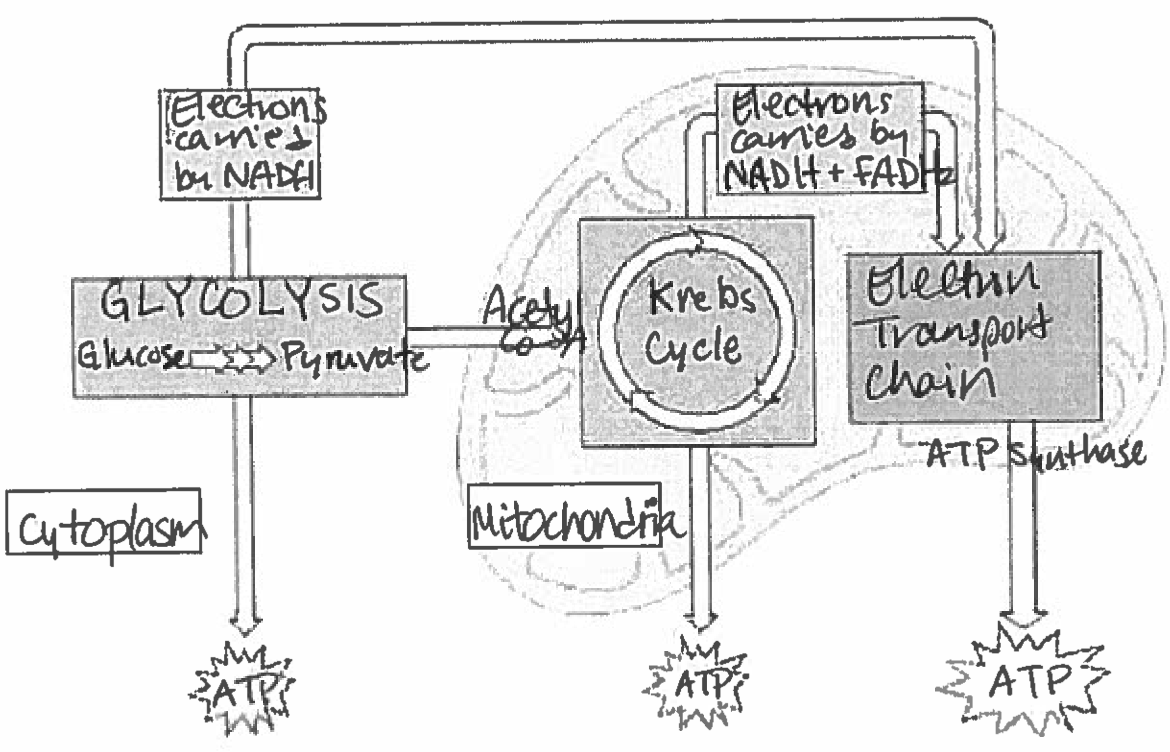
Cellular Respiration Worksheet

Directions: Use your notes, textbook, or phone to fil in the following information:

Cellular Respiration Basics

1. Define Cellular Respiration Mitochondria use glucose and oxygen to create 36 ATP for energy, and release CO_2 + H_2O.
2. What organisms perform cellular respiration? Plants + Animals
3. Where in the cell does cellular respiration occur? (which organelle) Mitochondria
4. What is the chemical equation for cellular respiration? $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + Energy
5. What is the equation in words for cellular respiration? glucose + oxygen create carbon dioxide + water + energy
6. What are the reactants for cellular respiration? glucose + oxygen
7. What is the ultimate function of cellular respiration? To create energy!

Fill in the blanks in the diagram below, using the figures from your textbook as a reference. Page 222



An Overview of the Stages of Aerobic Cellular Respiration

Name of Stage	Location in Cell Where it Occurs	Reactants	Products
1. Glycolysis	cytoplasm	Glucose	pyruvate
2. Krebs Cycle	Mitochondria Matrix	Acetyl Co-A oxygen NAD+ FAD+	CO_2 H_2O NADH $FADH_2$
3. ETC	Mitochondria cristae	NADH $FADH_2$	NAD+ FAD+

ATP and Aerobic Cellular Respiration

Name of Stage	How many ATP does this stage "cost"?	How many ATP does this stage produce?	How many ATP does this stage "profit"?
1. Glycolysis	2	4	2
2. Krebs Cycle	0	2	2
3. ETC	0	0	34

Anaerobic Cellular Respiration Basics

1. Anaerobic respiration is also called...	fermentation
2. The fermentation process includes which stage that is also present in aerobic respiration?	Glycolysis
3. What is the by-product of fermentation in humans?	Lactic Acid
4. What are the products of fermentation in yeast?	Ethyl Alcohol
5. The absence of which substance will determine if a cell will undergo fermentation?	oxygen

ATP and Anaerobic Cellular Respiration

How many ATP does fermentation "cost"?	How many ATP does fermentation produce?	How many ATP does fermentation "profit"?
2	2	2

Name: Date: Block:

Exercise & Cellular Respiration Lab

Purpose:

The purpose of this lab activity is to analyze the effect of exercise on cellular respiration.

Background:

- To observe the effects of exercise on cellular respiration.
- To identify the role of carbon dioxide production, breathing rate, and heart rate in determining the rate of cellular respiration.

I. Background Information.

Cellular respiration (*see chemical reaction below*) is a chemical reaction that occurs in your cells to create energy; when you are exercising your muscle cells are creating ATP to contract. Cellular respiration requires oxygen (which is breathed in) and creates carbon dioxide (which is breathed out).

$$C_6H_{12}O_6 + 6\ O_2 \longrightarrow 6\ CO_2 + 6\ H_2O + 36\ \text{ATP (energy)}$$

This lab will address how exercise (increased muscle activity) affects the rate of cellular respiration. You will measure 3 different indicators of cellular respiration: breathing rate, heart rate, and carbon dioxide production. You will measure these indicators at rest (with no exercise) and after 1 and 2 minutes of exercise. Breathing rate is measured in breaths per minute, heart rate in beats per minute, and carbon dioxide in the time it takes bromthymol blue to change color.

Carbon dioxide production can be measured by breathing through a straw into a solution of bromthymol blue (BTB). BTB is an acid indicator; ***when it reacts with acid it turns from blue to yellow***. When carbon dioxide reacts with water, a weak acid (carbonic acid) is formed (*see chemical reaction below*). The more carbon dioxide you breathe into the BTB solution, the faster it will change color to yellow.

$$6CO_2 + 6\ H_2O \longrightarrow 6\ H + 6HCO_3\ \text{(Carbonic acid)}$$

Materials:

Beaker/Test tube/cup
bromthymol blue solution (BTB)
straw
stop watch

Pre-Lab: *Use your Cellular Respiration notes to answer the following pre-lab questions.*

1. What is the equation for cellular respiration? Label the reactants and the products.

2. In what part of the cell does **cellular respiration** occur? ____________________ (organelle)
3. Write a prediction/hypothesis of how exercise will affect your body's production of carbon dioxide (i.e. do you think your body will produce *more* or *less* carbon dioxide as you exercise).

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Name: Date: Block:

Procedure:

PART A: Resting (no exercise)

Measuring Carbon Dioxide Production:

1. Use a graduated cylinder to measure out 20 mL of tap water and pour it into a small beaker.
2. Use a dropper to add 8 drops of bromthymol blue to make a BTB solution.
3. Using a straw, exhale into the BTB solution. (CAUTION: Do not inhale the solution!)
4. Time how long it takes for the blue solution to turn yellow. Record the time in **Table 1.**
5. Wash out the beaker repeat steps 1-4 twice more.
6. Average the results of the 3 trials. Record this in **Table 1.**

Measuring Breathing Rate:

1. Count breaths (1 breath = inhale + exhale) you take in 1 minute. Record in **Table 2.**
2. Repeat this 2 more times.
3. Average the 3 trials to get your average breathing rate. Record this in **Table 2.**

Measuring Heart Rate:

1. While you calculate your breathing rate, have your partner take your pulse.
2. Count the number of beats in 30 seconds and multiply that number by 2. Record this in **Table 3.**
3. Repeat this 2 more times.
4. Average the 3 trials to get your average heart rate. Record this in **Table 3.**

PART B: Increased Muscle Activity (Exercise)

1. Exercise for exactly 1 minute by doing jumping jacks, etc.
2. While you are exercising, your partner should get the BTB solution ready as in Part A.
3. After 1 minute of exercise, immediately exhale through the straw into the BTB solution. Time how long it takes for the BTB to turn yellow. Record this in **Table 1.**
4. Then quickly calculate your breathing and heart rates as you did before. You only need to do this once.
5. Record these values in **Tables 2 & 3.** *Remake your BTB solution.*
6. Exercise as you did before, but for 2 continuous minutes.
7. Immediately exhale through the straw into the BTB solution. Time how long it takes for the BTB to turn yellow. Record this in **Table 1.**
8. Then quickly calculate your breathing and heart rates as you did before. You only need to do this once.
9. Record these values in **Tables 2 & 3.**
10. If there is time, repeat the entire procedure for your lab partner.

Results:

Table 1. Carbon Dioxide Production (time it takes BTB to change color)

		Student 1	Student 2	Student 3	Student 4	Average
RESTING	Trial 1					
	Trial 2					
	Trial 3					
	Average					
EXERCISE	1 minute					
	2 minutes					

Table 2. Breathing Rate (breaths/minute)

		Student 1	Student 2	Student 3	Student 4	Average
RESTING	Trial 1					
	Trial 2					
	Trial 3					
	Average					
EXERCISE	1 minute					
	2 minutes					

Table 3. Heart Rate (beats/minute)

		Student 1	Student 2	Student 3	Student 4	Average
RESTING	Trial 1					
	Trial 2					
	Trial 3					
	Average					
EXERCISE	1 minute					
	2 minutes					

Name: Date: Block:

Analysis & Conclusions: *Answer the questions below using the info in this lab, as well as your lab data.*

1. How did exercise affect the time needed for the solution to change color? Explain why the color change occurred (How does BTB work?)

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2. What can you conclude about the effect of exercise on the amount of carbon dioxide that is present in your exhaled breath? Why is this so?

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3. What can you conclude about the effect of exercise on breathing rate? Why is this so?

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4. What can you conclude about the effect of exercise on heart rate? Why is this so? What do your muscles need during exercise that the blood brings?

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5. State whether your hypothesis was correct or incorrect and why. In doing so, discuss what you think is going on in the muscles of the body as muscle activity is increased. Address the need to get oxygen to the muscles and get rid of carbon dioxide, as well as how the muscles cells get the energy needed to continue contracting.

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