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NORTH CENTRAL HIGH SCHOOL NOTE & STUDY GUIDE

X Biology I

Unit 1-4: Cellular Energy

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*REQUIRED READING FROM BIOLOGY: CONCEPTS & CONNECTION (CAMPBELL, ET. AL.):
CHAPTER 6, HOW CELLS HARVEST CHEMICAL ENERGY (pg. 88-105)
CHAPTER 7, PHOTOSYNTHESIS: USING LIGHT TO MAKE FOOD (pg. 106-122)*

Grade Chart: (For Teacher Use Only)

Section	Assignment	Score (✓ or ☒)	Points (Out of)
1	NOTES: ATP & Photosynthesis		10
2	Study Guide Part I, ATP & Photosynthesis		10
3	ACTIVITY: Photosynthesis Concept Map		20
4	NOTES: Cellular Respiration		10
5	Study Guide Part II, Cellular Respiration		10
6	ACTIVITY: Cellular Respiration Concept Map		20
TOTAL			80



Objectives

- * _____
- * _____
- * _____
- * _____
- * _____



Energy

- * Energy is the ability to do work and is required for life.
- * _____ are organisms that can create their own food by converting energy from the sun.
- * _____ can not create their on food and must consume other organisms for their energy.

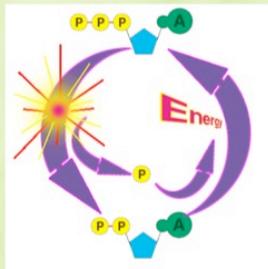


Forms of Energy

- * _____ (**Adenosine triphosphate**) is the functional unit of energy for all living things.
- * ATP stores energy so that an organism can access that energy when it is needed. This is _____.
- * When energy is released it can be converted in to _____ (movement) or **thermal energy** (heat.)

ATP

- * ATP consists of adenosine and three (3) _____
- * When one phosphate group detaches, energy is _____
- * The result is a free phosphate group and ADP (Adenosine diphosphate.)



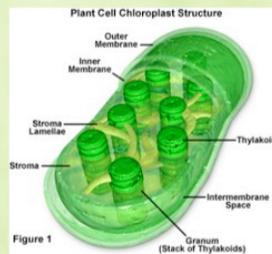
Photosynthesis

- * In **Photosynthesis**, energy from the sun is stored in the phosphate bond of ATP in an organelle called a _____.
- * Chloroplasts contain a pigment called _____ which absorbs certain wavelengths of light energy and reflects others (green).
- * The general chemical equation for photosynthesis is:



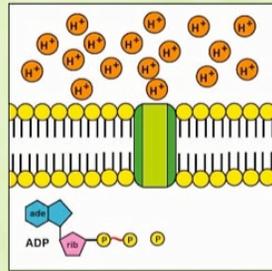
Inside the Chloroplasts

- * The chloroplasts consists of small _____ which are stacked into **grana**.
- * The thylakoids contain stacks of chlorophyll called **photosystems**.
- * The area outside the thylakoid is called the _____
- * The light absorbed by the chloroplast charges electrons that will create the bond in ATP.



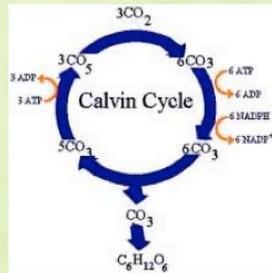
Photosynthesis (Cont...)

- * Light enters the chloroplast and breaks apart the water molecule.
- * The energy released is used to bond the _____ group to an ADP molecule.



Calvin Cycle

- * ATP is volatile so plants are able to take the energy and store in a more secure way.
- * The ATP produced in the thylakoid enters the _____ along with carbon dioxide (CO_2) to store the energy into a complex molecule called _____.
- * This process can occur without light energy because is a conversion of previously stored energy.



The Importance of Photosynthesis

- * Since animals (heterotrophs) can not produce their own food they depend on other organisms.
- * Accordingly, all of the energy in the "_____ " originates from plants (autotrophs.)
- * This means that all of the energy we need comes indirectly from the _____.

The Importance of Photosynthesis (Cont...)

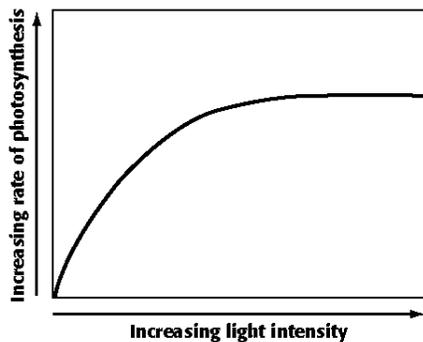
- * Photosynthesis also has the benefit of producing _____, which we need for survival.
- * More than 90% of the earth's oxygen is a result of photosynthesis.
- * Photosynthesis can be affected by the lack of _____, the lack of light, the lack of water, or extreme temperatures (range: 0-35°C.)

Part I: Energy Transfer in Cells (ATP) & Photosynthesis

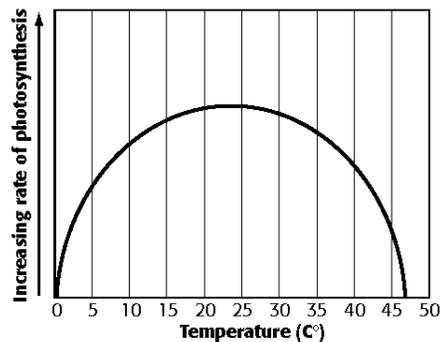
1. What is the general equation for photosynthesis?

- _____ 2. Energy is required for a variety of life processes including
- a. growth and reproduction.
 - b. movement.
 - c. transport of certain materials across cell membranes.
 - d. All of the above
- _____ 3. Heterotrophs are organisms that can
- a. produce food from inorganic molecules and sunlight.
 - b. survive without energy.
 - c. consume other organisms for energy.
 - d. carry out either photosynthesis or chemosynthesis.
- _____ 4. Based on the cycle of photosynthesis and cellular respiration, one can say that the ultimate original source of energy for all living things on Earth is
- a. glucose.
 - b. water.
 - c. the sun.
 - d. carbon dioxide.
- _____ 5. The process whereby plants capture energy and make complex molecules is known as
- a. homeostasis.
 - b. evolution.
 - c. photosynthesis.
 - d. development.
- _____ 6. All organic molecules contain carbon atoms that ultimately can be traced back in the food chain to
- a. the bodies of heterotrophs.
 - b. carbon dioxide from the atmosphere.
 - c. water absorbed by plants.
 - d. the carbon that comes from the sun.
- _____ 7. Suspended in the fluid stroma of chloroplasts are
- a. organelles called eukaryotes.
 - b. numerous mitochondrial membranes.
 - c. small coins that provide energy.
 - d. stacks of thylakoids called grana.
- _____ 8. photosynthesis : oxygen ::
- a. respiration : darkness
 - b. light reactions : dark reactions
 - c. respiration : carbon dioxide
 - d. oxygen : carbon dioxide

9. light reactions : thylakoids ::
- grana : thylakoids
 - grana : ATP
 - Calvin cycle : stroma
 - stroma : grana of chloroplast
10. The sun is considered the ultimate source of energy for life on Earth because
- all organisms carry out photosynthesis.
 - all organisms carry out cellular respiration.
 - either photosynthetic organisms or organisms that have eaten them provide energy for all other organisms on Earth.
 - the sun heats Earth's atmosphere.
11. The role of chlorophyll in photosynthesis is to
- absorb light energy.
 - pass electrons to carotenoids.
 - split water molecules.
 - All of the above
12. When electrons of a chlorophyll molecule are raised to a higher energy level,
- they become a particle of light.
 - they form a glucose bond.
 - they enter an electron transport chain.
 - they enter the Calvin cycle.
13. The source of oxygen produced during photosynthesis is
- carbon dioxide.
 - water.
 - chlorophyll.
 - glucose.
14. The major atmospheric byproduct of photosynthesis is
- nitrogen.
 - carbon dioxide.
 - water.
 - oxygen.
15. During the Calvin cycle, carbon-containing molecules are produced from
- carbon atoms from ATP.
 - carbon atoms, hydrogen atoms, and oxygen atoms from glucose.
 - carbon atoms from carbon dioxide in the air and hydrogen atoms from water.
 - carbon atoms from carbon dioxide in the air and hydrogen atoms from NADPH.



Graph 1



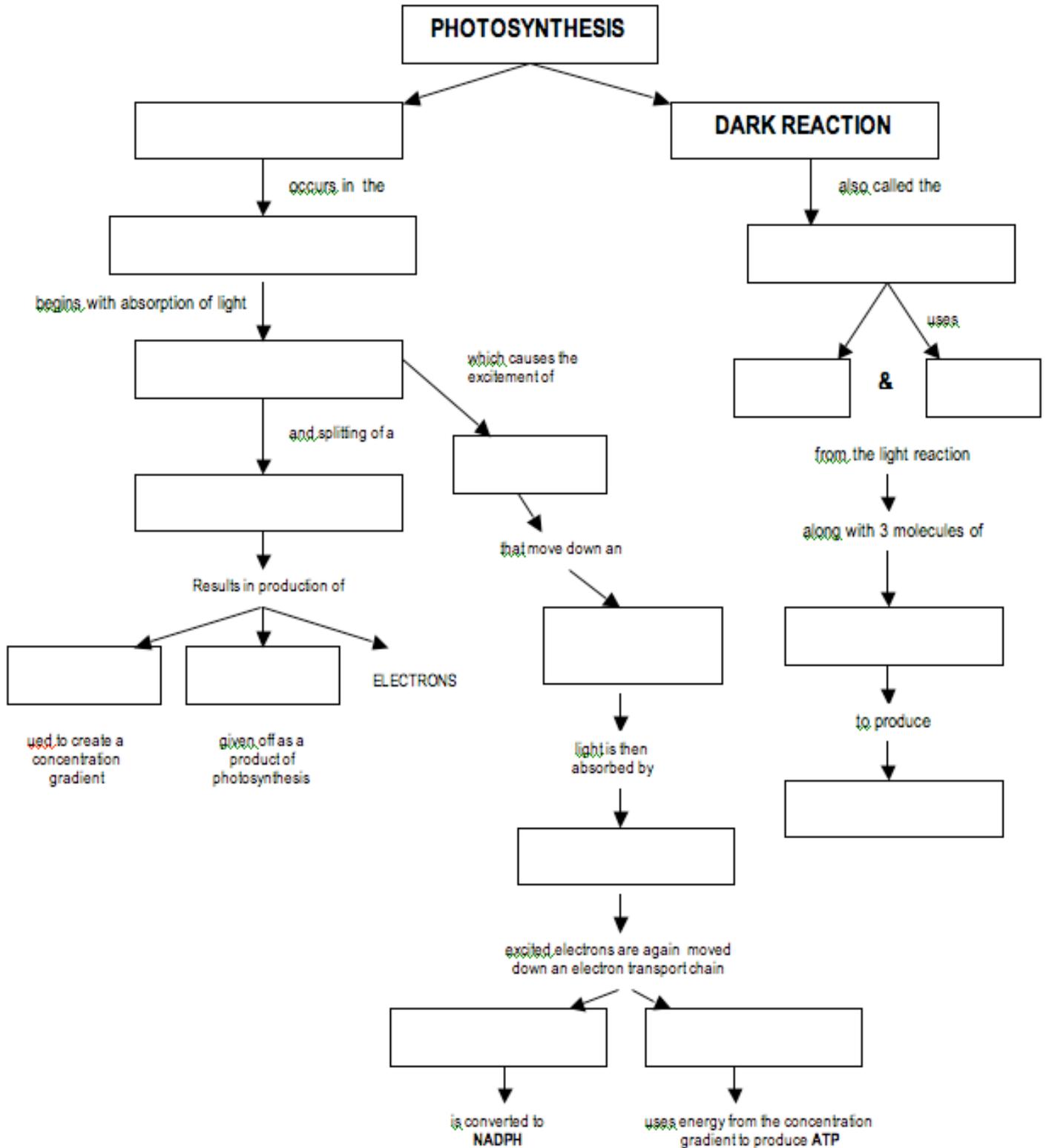
Graph 2

16. Refer to the illustration above. Graph 1 demonstrates that the rate of photosynthesis
- decreases in response to increasing light intensity.
 - increases indefinitely in response to increasing light intensity.
 - increases in response to increasing light intensity, but only to a certain point.
 - is unaffected by changes in light intensity.
17. Which of the following processes occurs in the thylakoid membrane and converts captured light energy into chemical energy?
- the Calvin cycle
 - ATP synthase
 - light absorption
 - chemiosmosis
18. The energy used in the Calvin cycle for the production of carbohydrate molecules comes from
- ATP made during cellular respiration.
 - the Krebs cycle.
 - ATP made in the light reactions of photosynthesis.
 - CO₂ absorbed during the last stage of photosynthesis.

- _____ 19. During photosynthesis, the series of reactions that create the complex carbohydrates needed for energy and growth is called
- the Calvin cycle.
 - the Krebs cycle.
 - the light reactions.
 - the electron transport chain.
- _____ 20. Which of the following can be produced from the products of the Calvin cycle?
- carbohydrates
 - lipids
 - proteins
 - All of the above
- _____ 21. Refer to the illustration above. Taken together, these graphs demonstrate that
- photosynthesis is independent of environmental influences.
 - increases in light intensity cause increases in temperature.
 - as the rate of photosynthesis increases, the temperature of the plant eventually decreases.
 - the rate of photosynthesis is affected by changes in the plant's environment.
22. Organisms that harvest energy from either sunlight or chemicals in order to make food molecules are called _____.
23. The main pigment associated with the two photosystems is _____.
24. The second stage of photosynthesis, in which glucose is manufactured, is called the _____.
25. Why do the cells of plant roots generally lack chloroplasts?
26. Define the terms *autotroph* and *heterotroph*. What types of organisms belong in each of these categories?
27. The relationship between photosynthesis and cellular respiration is usually described as a cycle. Briefly explain. Write your answer in the space below.

ACT: Photosynthesis Concept Map

WORD BANK			
Thylakoid membrane	Calvin Cycle	Photosystem II	Photosystem I
Water molecule	Electrons	ATP	NADPH
Electron transport chain	CO ₂	Protons	Oxygen
Glucose	NADP ⁺	ATP synthase	Light Reaction



NOTES: Cellular Respiration

Objectives

- * _____
- * _____
- * _____
- * _____
- * _____

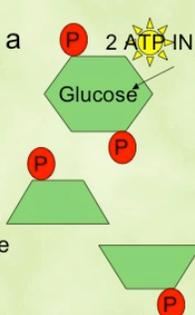
Cellular Respiration

- * _____ is the complex process in which cells make ATP by breaking down other organic compounds (like glucose.)
- * The summary equation for cellular respiration is:

$$\text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 \longrightarrow \text{CO}_2 + \text{H}_2\text{O}$$

Glycolysis

- * _____ is a chemical process that occurs in the cytoplasm of a cell, in which glucose is broken down into organic pyruvic acid.
- * **Step 1:** 2 Phosphate groups attach to a glucose molecule. (Uses _____.)
- * **Step 2:** The glucose/phosphate molecule splits in half.

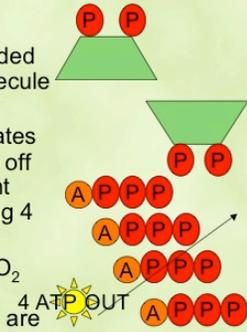


Glycolysis (Cont...)

• **Step 3:** An additional phosphate group is added to each half of the molecule from step 2.

• **Step 4:** The 4 phosphates (2 per molecule) break off and attach to 4 different ADP molecules creating 4 ATP molecules.

• **NOTE:** There was no O_2 used and only a net of _____ are produced.



Fermentation

• _____ is a process that replaces the molecules used in glycolysis .

• **Lactic Acid Fermentation** converts _____ into lactic acid.

• Leads to soreness in muscles.

• Breaks down in the presence of O_2 .

• **Alcohol Fermentation** converts pyruvic into _____.

• Yeast undergoes fermentation and is Responsible for beer, wine, and other alcoholic products.

Aerobic vs. Anaerobic

• Fermentation and glycolysis occur in the cytoplasm of a cell , and do not use oxygen, and are therefore _____ forms of respiration.

• Cellular respiration can continue in the mitochondrion and in the presence of oxygen to produce much more energy.

• Cellular respiration that uses oxygen is called _____.

Aerobic Respiration

- * The _____ is responsible for creating 2 ATP molecules, CO₂, and the energy required to produce more ATP.
- * _____ continue using oxygen to create ATP.
- * At the end of aerobic and anaerobic respiration a cell can produce _____ molecules from 1 molecule of glucose.
- * 2 ATP molecules are used to fuel this process (from glycolysis), which give a net production of _____.

Efficiency of Cellular Resp.

- * Cellular respiration is a fairly efficient process compared to other energy conversion processes.
- * The conditions such as temp., pH, % of food and existing energy effect efficiency, but here are some estimates:
 - Aerobic Respiration: Approx. _____
 - Anaerobic Resp. (Glycolysis): _____
 - Automobile: _____
 - NOTE: This means that for every dollar you pay for gas, you are only getting about a quarter's worth of energy, the rest is lost as heat.

Part II: Cellular Respiration

1. What is the general equation for cellular respiration?

- _____
2. When cells break down food molecules, energy
- a. is released all at once.
 - b. is released entirely as body heat into the environment.
 - c. is temporarily stored in ATP molecules.
 - d. causes excitation of electrons in chlorophyll molecules.
- _____
3. ATP
- a. contains five phosphate groups.
 - b. is essential for a cell to perform all the tasks necessary for life.
 - c. is found only in bacteria.
 - d. All of the above
- _____
4. The process of cellular respiration
- a. is performed only by organisms that are incapable of photosynthesis.
 - b. breaks down food molecules to release stored energy.
 - c. occurs before plants are able to carry out photosynthesis.
 - d. occurs only in animals.

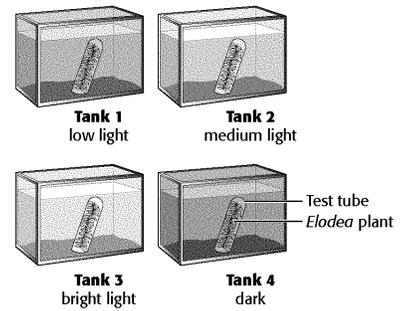
- _____ 5. cellular respiration : organic compounds ::
a. light bulb : glass c. automobile : gasoline
b. trunk : clothing d. country : nation
- _____ 6. When glycolysis occurs,
a. a molecule of glucose is split.
b. two molecules of pyruvic acid are made.
c. some ATP is produced.
d. All of the above
- _____ 7. The name of the process that takes place when organic compounds are broken down in the absence of oxygen is
a. respiration. c. fermentation.
b. oxidation. d. All of the above
- _____ 8. When muscles are exercised extensively in the absence of sufficient oxygen,
a. a large amount of ATP is formed.
b. NADH molecules split.
c. lactic acid is produced.
d. cellular respiration ceases.
- _____ 9. Cellular respiration takes place in two stages:
a. glycolysis and fermentation.
b. Stage 1 and Stage 2 of photosynthesis.
c. glycolysis, then aerobic respiration.
d. aerobic respiration, then glycolysis.
- _____ 10. In cellular respiration, a two-carbon molecule combines with a four-carbon molecule to form citric acid as part of
a. glycolysis.
b. carbon fixation.
c. the Krebs cycle.
d. the electron transport chain.
- _____ 11. Glycolysis and aerobic respiration are different in that
a. glycolysis occurs on the cell membrane, while aerobic respiration occurs in mitochondria.
b. glycolysis occurs only in photosynthesis, while aerobic respiration is part of cellular respiration.
c. glycolysis occurs in the absence of oxygen, while aerobic respiration requires oxygen.
d. There is no difference; these terms are different names for the same process.
- _____ 12. Which of the following is *not* part of cellular respiration?
a. electron transport c. the Krebs cycle
b. glycolysis d. the Calvin cycle
- _____ 13. With oxygen present, the Krebs cycle and the electron transport chain
a. provide organisms an alternative to glycolysis.
b. produce most of the ATP needed for life.
c. break down glucose to produce carbon dioxide, water, and ATP.
d. All of the above
- _____ 14. In cellular respiration, the most energy is transferred during
a. glycolysis.
b. lactic acid fermentation.
c. the Krebs cycle.
d. the electron transport chain
15. In the absence of oxygen, glycolysis is followed by _____ instead of aerobic respiration.
16. During fermentation, either ethyl alcohol and carbon dioxide or _____ is formed.
17. Of the maximum possible yield of 38 ATP molecules produced by the complete oxidation of one glucose molecule, _____ molecules of ATP are produced during glycolysis.

Practical Application

1. Amy wants to test the hypothesis that the rate of photosynthesis is directly related to the light level to which plants are exposed. She has chosen the aquatic plant *Elodea* as her study organism. In her experimental design, she has four different tanks in which she will place *Elodea* plants inside an inverted test tube. She plans to estimate the relative rate of photosynthesis by measuring the amount of oxygen produced by plants placed under different light levels.

Amy plans to place tank 3 next to a window in the classroom. She plans to place tank 2 ten feet away from the window. She plans to place tank 1 twenty feet away from the window. She plans to place tank 4 in the classroom's refrigerator, because it is the only place she can find that is dark.

a. What is wrong with the design of Amy's experiment?



b. What could Amy change in her experimental design to make it a better experiment?

ACT: Cellular Respiration Concept Map

WORD BANK			
Glucose	Electron Transport Chain	36 ATP	2 ATP
6 NADH ₂	Cytoplasm	Mitochondria	2 ATP
6 FADH ₂	Krebs Cycle	Mitochondrial Membrane	Alcohol
Lactic Acid	CO ₂	Fermentation	Hydrogen
Hydrogen Ions	Aerobic Respiration	Glycolysis	Oxygen
Pyruvic Acid	32 ATP	Water (H ₂ O)	Anaerobic Respiration

