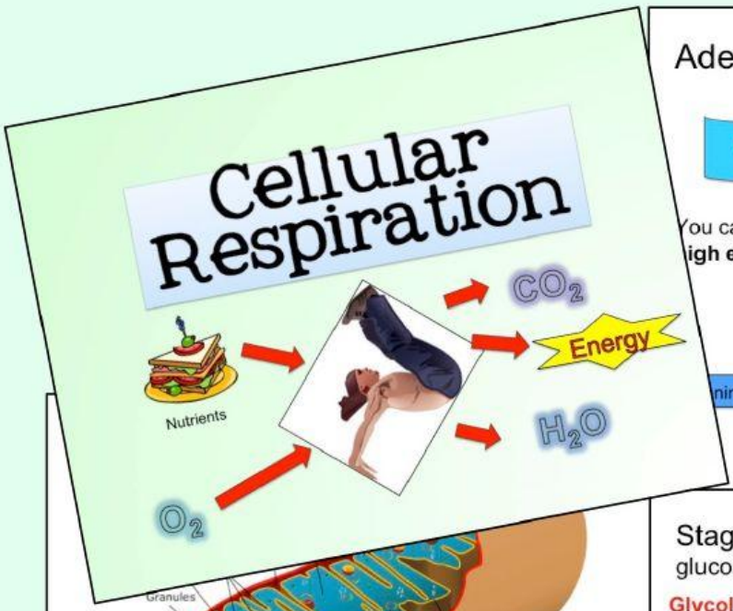
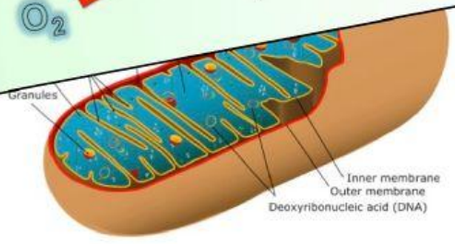
cell respiration
Complete Unit

CELLULAR RESPIRATION POWERPOINT



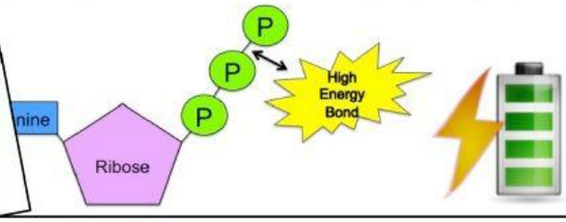


Mitochondria has a smooth outer membrane; a folded inner membrane. These folds are called crista The space inside the cristae is called the matrix.

Adenosine Triphosphate (ATP)

Remember! Chemical energy is stored in BONDS.

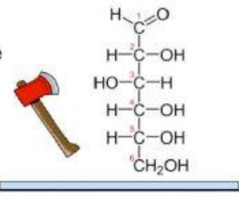
You can think of ATP as a fully charged battery because a **high energy bond** is found between the phosphate groups.



Stage One- Glycolysis splitting of a 6-carbon glucose into two pyruvates, each having 3 carbons.

Glycolysis

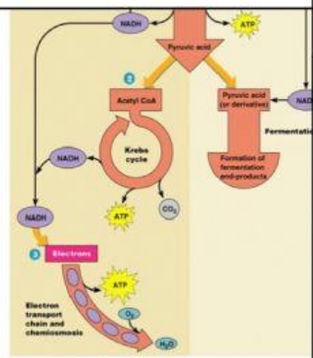
- occurs in the **cytoplasm** of the cell
- **anaerobic** process (no oxygen required)
- **breaks down glucose** into 2 **pyruvate molecules** (aka pyruvic acid)
- carbon dioxide is released.
- net of **2 ATP** molecules are made



the Krebs cycle cannot occur.

Aerobic respiration ceases; fermentation proceeds and ATP is produced in **minimal** amounts.

There are two types of fermentation depending on the organism: alcoholic and lactic acid.

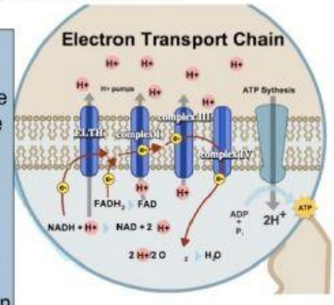


Each turn of the Krebs Cycle produces 3 NADH, 1 $FADH_2$, and 2 CO_2
Therefore, For each Glucose molecule, the Krebs Cycle produces 6NADH, $2FADH_2$, $4CO_2$, and 2ATP

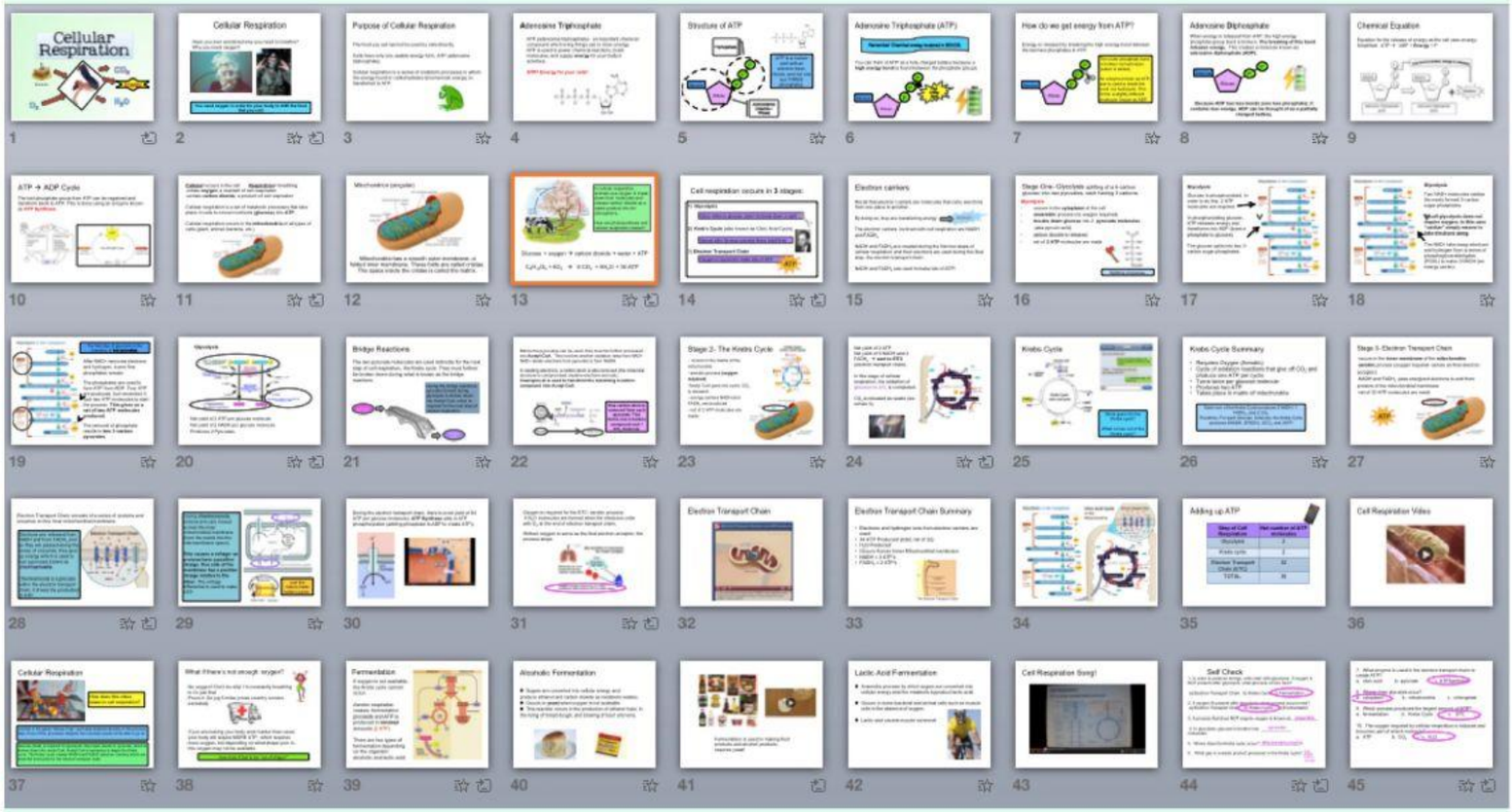
Electron Transport Chain consists of a series of proteins and enzymes on the inner mitochondrial membrane.

Electrons are released from NADH and from $FADH_2$ and as they are passed along the series of enzymes, they give up energy which is used to fuel a process known as **chemiosmosis.**

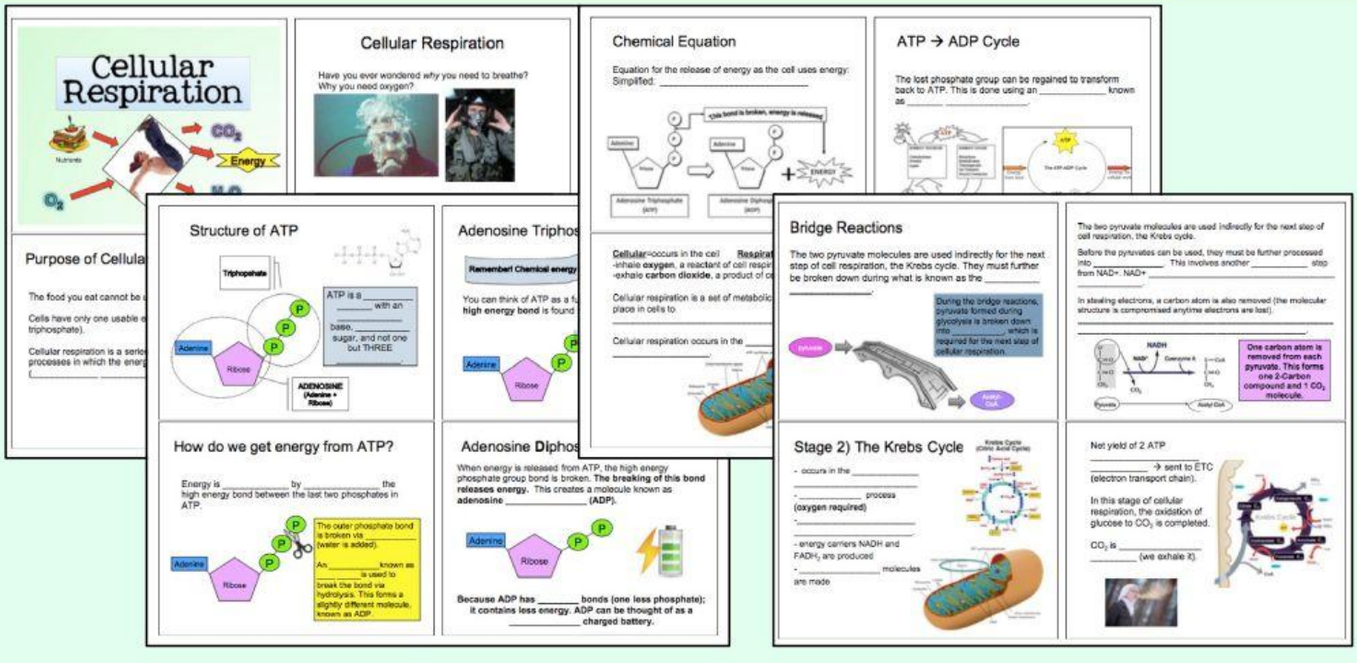
Chemiosmosis is a process within the electron transport chain; it drives the production of ATP.



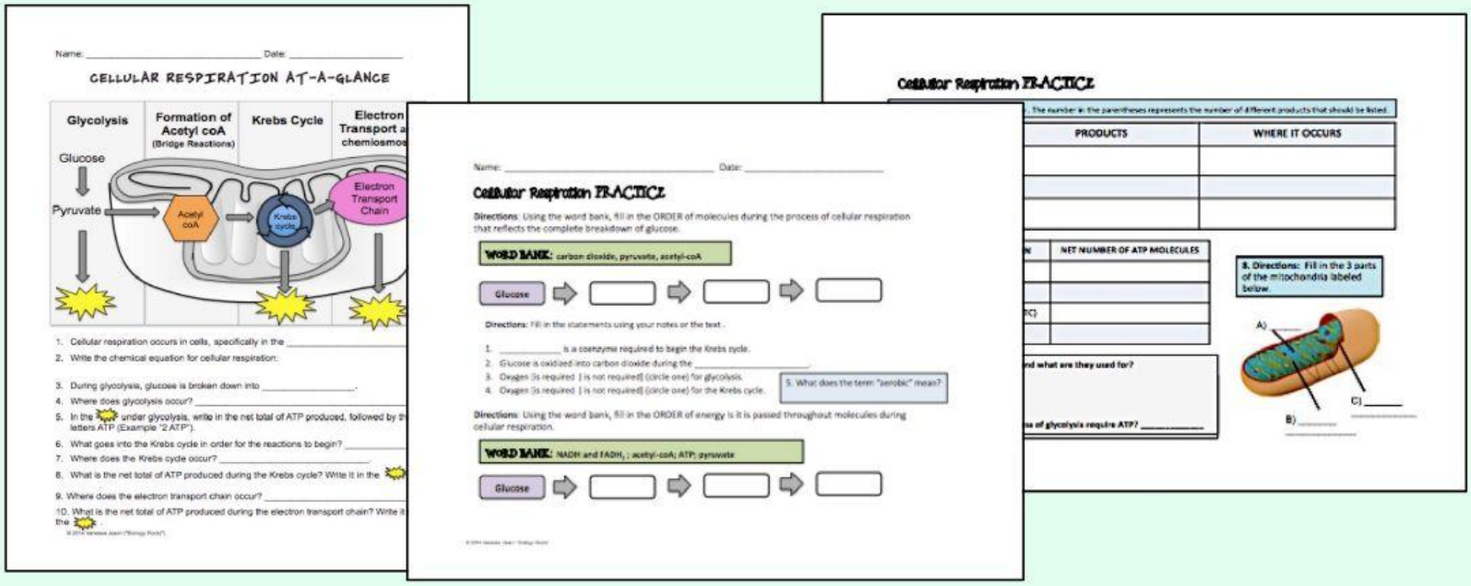
POWERPOINT PRESENTATION- 45 SLIDES- COMPLETELY EDITABLE



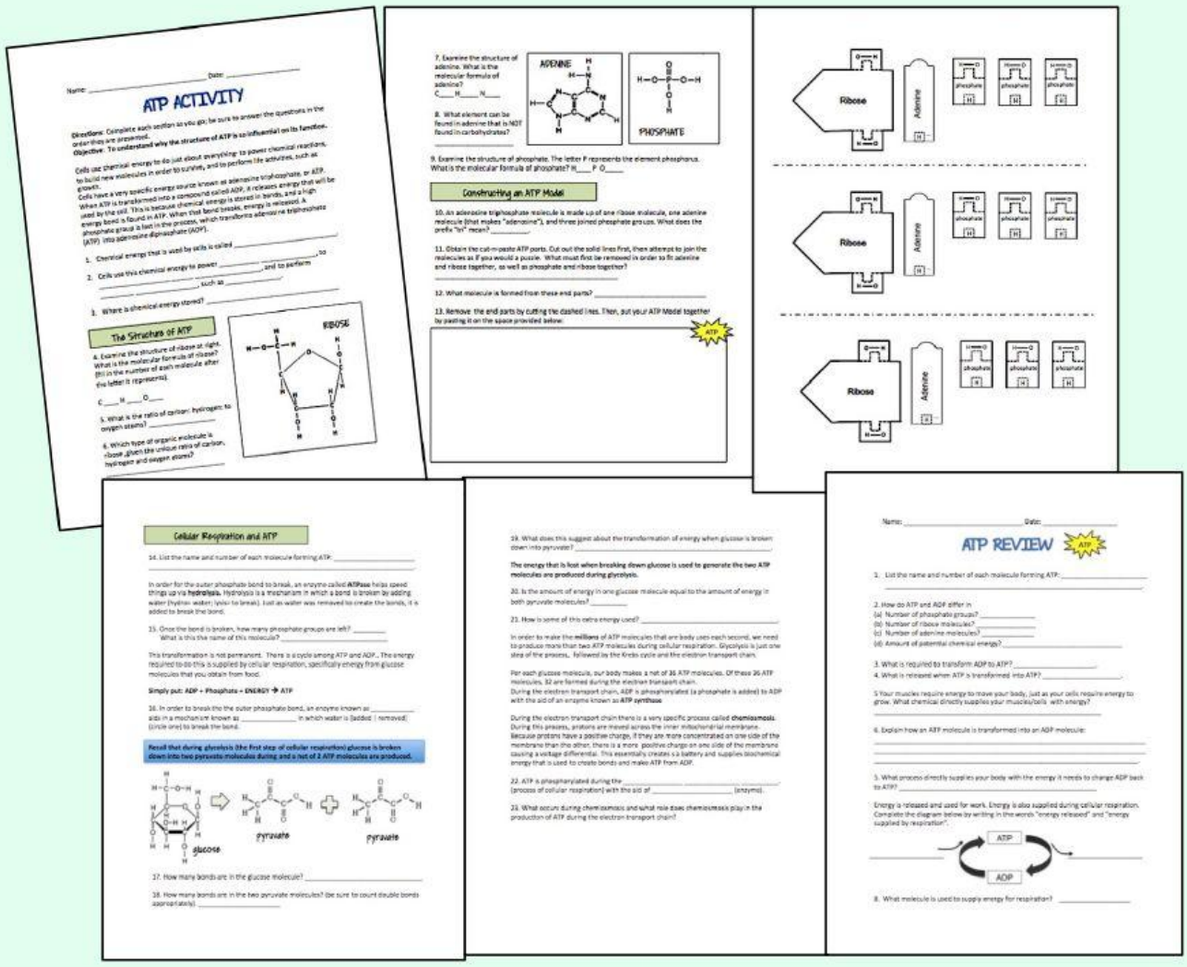
STUDENT SHEET FOR RECORDING NOTES INCLUDED



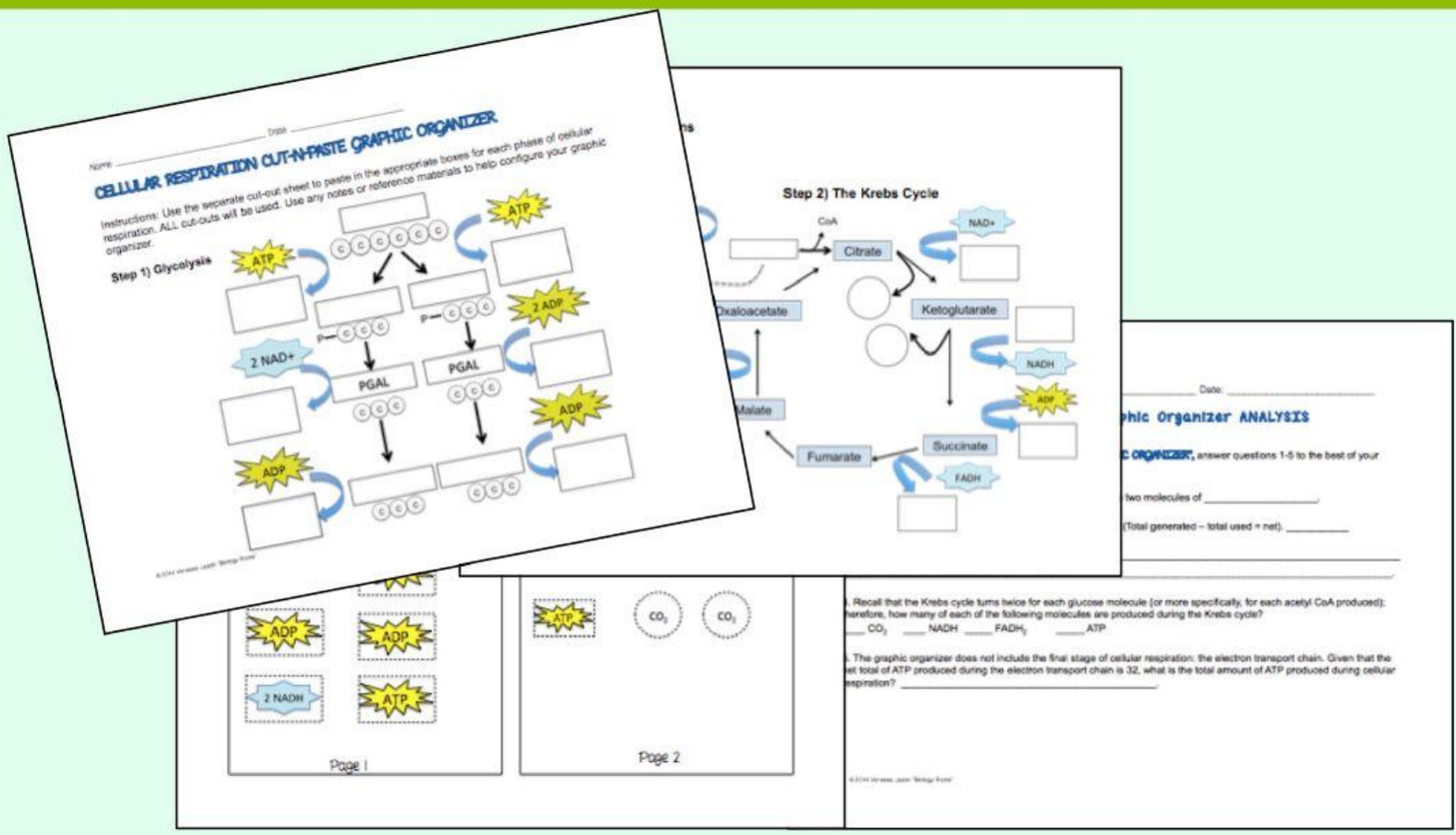
BELL RINGER & HOMEWORK



ATP ACTIVITY CUT & PASTE

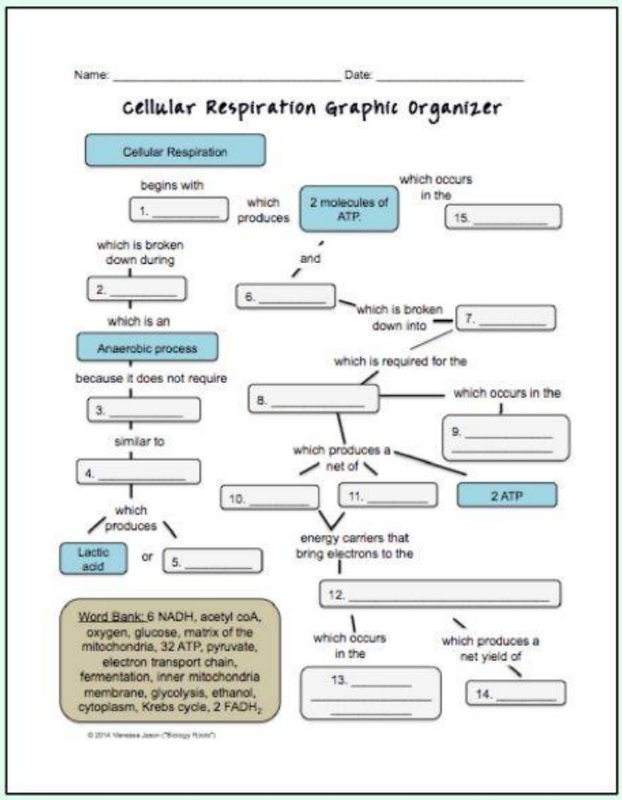


CUT N PASTE GRAPHIC ORGANIZER



GRAPHIC ORGANIZER & CROSSWORD





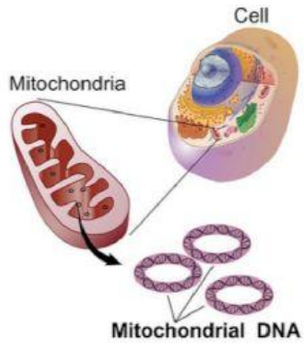
TASK CARDS PLUS STUDENT RECORDING SHEET (28 TASK CARDS TOTAL)

Station 1

True or false?
Both animals *and* plants perform cellular respiration. Explain.



Station 2



Hypothesize what would happen if mitochondria were removed from cells.

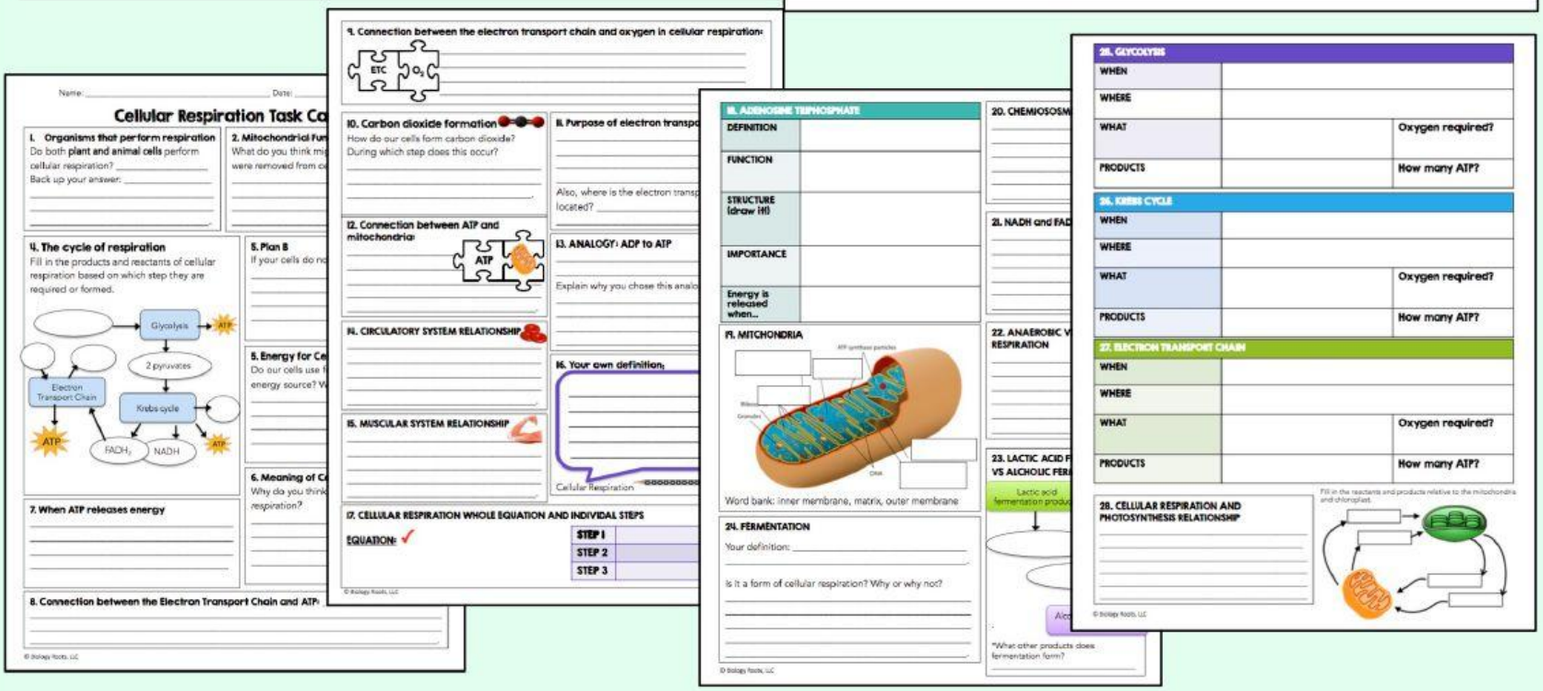
Station 3

What are the reactants (ingredients) required for cellular respiration?
What are the products?
(word bank: water, CO2, glucose, O2)

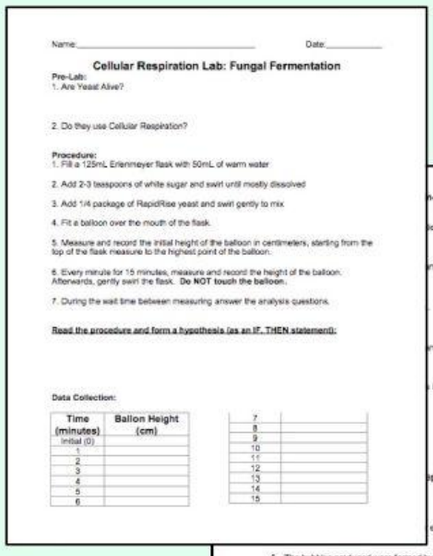
Station 4

What happens if our cells do not get enough oxygen?





LABS- LACTIC ACID (MUSCLE FATIGUE) AND ALCOHOLIC FERMENTATION (YEAST)



Name:_____ Date:_____

Cellular Respiration Lab: Fungal Fermentation

Pre-Lab:
1. Are Yeast Alive?

2. Do they use Cellular Respiration?

Procedure:
1. Fill a 125mL Erlenmeyer flask with 50mL of warm water

2. Add 2-3 teaspoons of white sugar and swirl until mostly dissolved

3. Add 1/4 package of RapidRise yeast and swirl gently to mix

4. Fit a balloon over the mouth of the flask.

5. Measure and record the initial height of the balloon in centimeters, starting from the top of the flask measure to the highest point of the balloon.

6. Every minute for 15 minutes, measure and record the height of the balloon. Afterwards, gently swirl the flask. **Do NOT touch the balloon.**

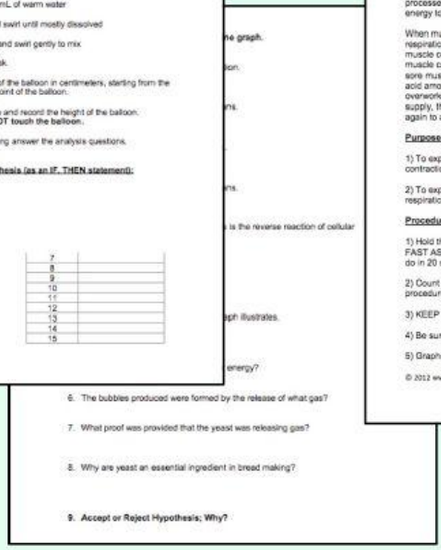
7. During the wait time between measuring answer the analysis questions.

Read the procedure and form a hypothesis (as an IF, THEN statement):

Data Collection:

Time (minutes)	Ballon Height (cm)
Initial (0)	
1	
2	
3	
4	
5	
6	

7	
8	
9	
10	
11	
12	
13	
14	
15	



...he graph.

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...ns.

...is the reverse reaction of cellular

...aph illustrates.

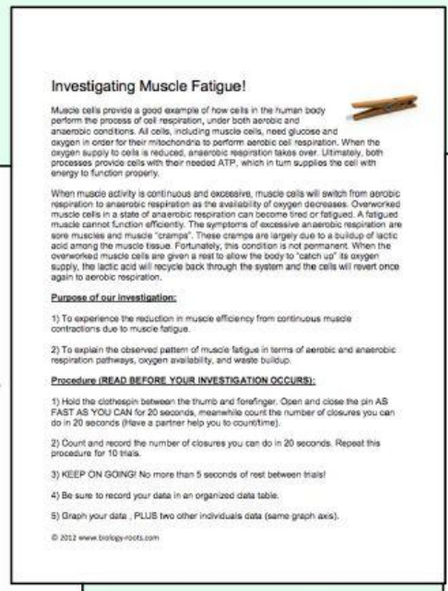
...energy?

6. The bubbles produced were formed by the release of what gas?

7. What proof was provided that the yeast was releasing gas?

8. Why are yeast an essential ingredient in bread making?

9. Accept or Reject Hypothesis; Why?



Investigating Muscle Fatigue!

Muscle cells provide a good example of how cells in the human body perform the process of cell respiration, under both aerobic and anaerobic conditions. All cells, including muscle cells, need glucose and oxygen in order for their mitochondria to perform aerobic cell respiration. When the oxygen supply to cells is reduced, anaerobic respiration takes over. Ultimately, both processes provide cells with their needed ATP, which in turn supplies the cell with energy to function properly.

When muscle activity is continuous and excessive, muscle cells will switch from aerobic respiration to anaerobic respiration as the availability of oxygen decreases. Overworked muscle cells in a state of anaerobic respiration can become tired or fatigued. A fatigued muscle cannot function efficiently. The symptoms of excessive anaerobic respiration are sore muscles and muscle "cramps". These cramps are largely due to a buildup of lactic acid among the muscle tissue. Fortunately, this condition is not permanent. When the overworked muscle cells are given a rest to allow the body to "catch up" its oxygen supply, the lactic acid will recycle back through the system and the cells will revert once again to aerobic respiration.

Purpose of our investigation:

1) To experience the reduction in muscle efficiency from continuous muscle contractions due to muscle fatigue.

2) To explain the observed pattern of muscle fatigue in terms of aerobic and anaerobic respiration pathways, oxygen availability, and waste buildup.

Procedure (READ BEFORE YOUR INVESTIGATION OCCURS):

1) Hold the clothespin between the thumb and forefinger. Open and close the pin AS FAST AS YOU CAN for 20 seconds, meanwhile count the number of closures you can do in 20 seconds (Have a partner help you to count/time).

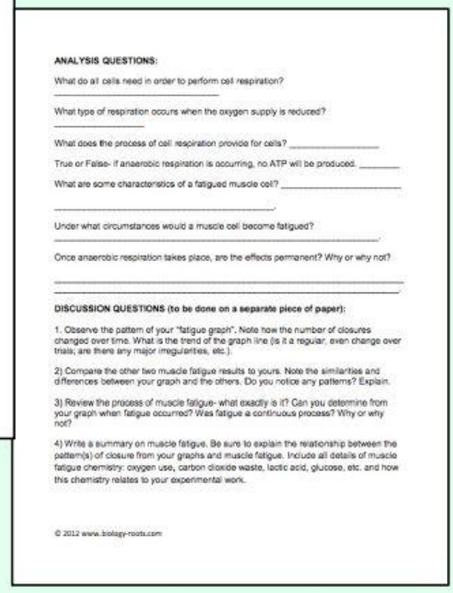
2) Count and record the number of closures you can do in 20 seconds. Repeat this procedure for 10 trials.

3) KEEP ON GOING! No more than 5 seconds of rest between trials!

4) Be sure to record your data in an organized data table.

5) Graph your data , PLUS two other individuals data (same graph axis).

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ANALYSIS QUESTIONS:

What do all cells need in order to perform cell respiration?
_____

What type of respiration occurs when the oxygen supply is reduced?
_____

What does the process of cell respiration provide for cells? _____

True or False- if anaerobic respiration is occurring, no ATP will be produced. _____

What are some characteristics of a fatigued muscle cell? _____
_____.

Under what circumstances would a muscle cell become fatigued?
_____.

Once anaerobic respiration takes place, are the effects permanent? Why or why not?
_____
_____.

DISCUSSION QUESTIONS (to be done on a separate piece of paper):

1. Observe the pattern of your "fatigue graph". Note how the number of closures changed over time. What is the trend of the graph line (is it a regular, even change over trials; are there any major irregularities, etc.).

2) Compare the other two muscle fatigue results to yours. Note the similarities and differences between your graph and the others. Do you notice any patterns? Explain.

3) Review the process of muscle fatigue- what exactly is it? Can you determine from your graph when fatigue occurred? Was fatigue a continuous process? Why or why not?

4) Write a summary on muscle fatigue. Be sure to explain the relationship between the pattern(s) of closure from your graphs and muscle fatigue. Include all details of muscle fatigue chemistry: oxygen use, carbon dioxide waste, lactic acid, glucose, etc. and how this chemistry relates to your experimental work.

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QUIZZES- OPEN NOTE AND CLOSED NOTE



Name _____ Date: _____

Cellular Respiration Quiz #1

Words to use for Fill-In numbers 1-23. (Some will be used more than once).

Mitochondria	32 ATP	The Krebs cycle	water	oxygen
Carbon dioxide	glucose	Acetyl-CoA	pyruvate	aerobic
Anaerobic	glycolysis	Electron Transport Chain	matrix	fermentation
NADH	FADH	inner membrane	cell	cytoplasm

The first step of cellular respiration is a process called (1)_____, it occurs in the (2)_____ of the (3)_____. This is the only step of cellular respiration that does not require (4) _____, therefore it is an (5) _____ process. Step one is the break down of (6) _____ into two molecules of (7) _____. These molecules are then further broken down into separate compounds, one of which become a molecule known as (8)_____. This molecule is used to being (9) _____, which is the second stage of cellular respiration. Also during glycolysis, (10)= cauldron (takes electrons away) from sugar, forming the electron carrier (11)_____.

2) How many molecules of ATP are made during the **first step** of cellular respiration?

During the Krebs cycle, the electron carriers (12) _____ and (13) _____ are created through a series of molecular transformations. The Krebs cycle occurs in the (14) _____ of the (15) _____. During the Krebs cycle, the waste product (16) _____ is produced, and with the aid of our bloodstream brought to our lungs for exhalation. The electron carriers aforementioned are then used in the third step of cellular respiration, which is (17) _____.

3) How many molecules of ATP are made during the **second step** of cellular respiration?

The Electron transport chain occurs in the (17) _____ of the (18) _____. Electrons from (19) _____ and (20) _____ are used in a series of reactions to create a net of (21) _____ molecules. (22) _____ serves as the final electron acceptor, and unites with hydrogen protons and electrons to form (23) _____.

4) What is the net amount of ATP molecules created during **cellular respiration?**

24. If oxygen is not available during the electron transport chain, aerobic respiration stops and _____ occurs.

25. Describe the similarities and differences among lactic acid and alcoholic fermentation.



Name: _____

ANSWER SHEET- Cell Respiration Quiz #1

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____
23. _____

24. _____

25. _____



Name _____ Date _____

Cellular Respiration Quiz #2

For numbers 1-5, use the statements at right to match the terms.

___1. Aerobic respiration — A. The third step of cellular respiration.

___2. Anaerobic respiration — B. Rising bread dough.

___3. Krebs cycle — C. Cellular respiration involving oxygen.

___4. Electron Transport Chain — D. Fermentation.

___5. Alcoholic fermentation — E. Results in the formation of NADH and FADH$_2$.

___6. $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$
This equation above summarizes the overall process of:
a. The Krebs cycle. c. Cellular respiration.
b. Photosynthesis. d. The electron transport chain.

___7. Glucose is converted into pyruvate during:
a. Glycolysis. c. Fermentation.
b. The Krebs cycle. d. Carbon fixation.

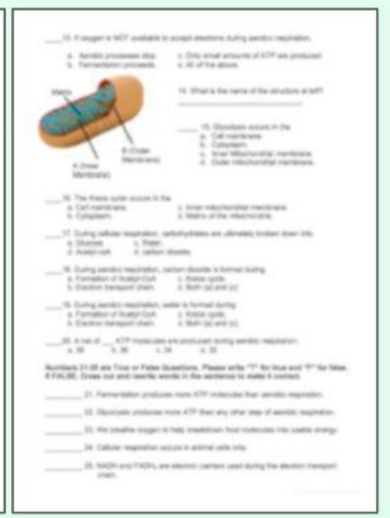
___8. Which of the following statements is FALSE?
a. Glycolysis does not require oxygen.
b. Glycolysis occurs in the mitochondria.
c. Glycolysis is the first step in both aerobic and anaerobic respiration.
d. Glycolysis produces 2 ATP, 2 NADH, and 2 pyruvates.

___9. This process uses NADH and FADH$_2$ to produce ATP.
a. The Electron Transport Chain. c. Glycolysis
b. Fermentation d. The Krebs cycle

___10. Acetyl-CoA is necessary to begin:
a. Fermentation c. Chemiosmosis
b. Glycolysis d. The Krebs cycle

___11. Cramps during exercise are caused by:
a. Alcohol fermentation. c. Lactic acid fermentation.
b. Glucose inhibition. d. Increased oxygen levels.

___12. The final electron acceptor during the electron transport chain is:
a. oxygen c. Carbon dioxide
b. Water d. ATP



___13. If oxygen is NOT available to accept electrons during aerobic respiration,
a. Aerobic processes stop. c. Only small amounts of ATP are produced.
b. Fermentation proceeds. d. All of the above.

14. What is the name of the structure at left?
_____

___15. Glycolysis occurs in the
a. Cell membrane. c. Cytoplasm.
b. Cytoplasm. d. Inner Mitochondrial membrane.
e. Matrix of the mitochondria.

___16. The Krebs cycle occurs in the
a. Cell membrane. c. Inner mitochondrial membrane.
b. Cytoplasm. d. Matrix of the mitochondria.

___17. During cellular respiration, carbohydrates are ultimately broken down into
a. Glucose c. Water
b. Acetyl-CoA d. carbon dioxide

___18. During aerobic respiration, carbon dioxide is formed during
a. Formation of Acetyl-CoA c. Krebs cycle.
b. Electron transport chain. d. Both (a) and (c)

___19. During aerobic respiration, water is formed during
a. Formation of Acetyl-CoA c. Krebs cycle.
b. Electron transport chain. d. Both (a) and (c)

___20. A net of _____ ATP molecules are produced during aerobic respiration.
a. 36 c. 34
b. 38 d. 32

Numbers 21-25 are True or False Questions. Please write "T" for true and "F" for false. If FALSE, Does not and rewrite words in the sentence to make it correct.

_____21. Fermentation produces more ATP molecules than aerobic respiration.

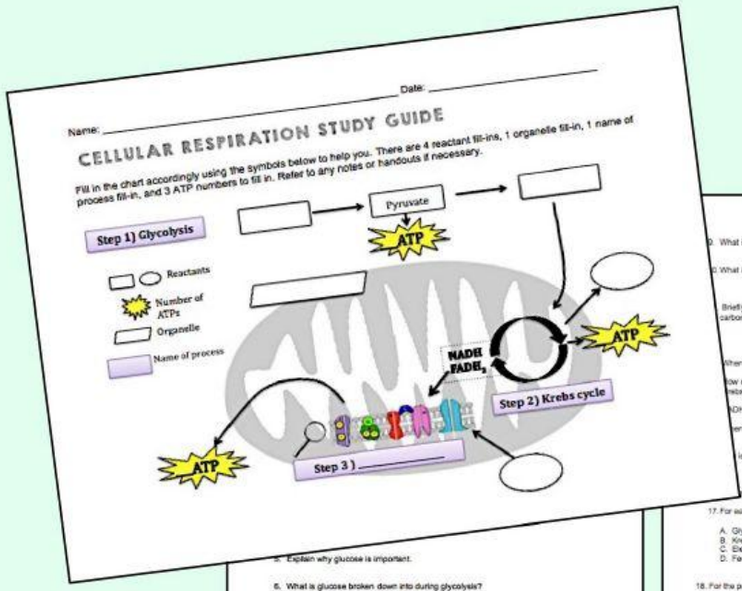
_____22. Glycolysis produces more ATP than any other step of aerobic respiration.

_____23. We breathe oxygen to help breakdown food molecules into usable energy.

_____24. Cellular respiration occurs in animal cells only.

_____25. NADH and FADH$_2$ are electron carriers used during the electron transport chain.

STUDY GUIDE & TEST



Name: _____ Date: _____

CELLULAR RESPIRATION STUDY GUIDE

Fill in the chart accordingly using the symbols below to help you. There are 4 reactant fill-ins, 1 organelle fill-in, 1 name of process fill-in, and 3 ATP numbers to fill in. Refer to any notes or handouts if necessary.

Step 1) Glycolysis

Pyruvate

ATP

Reactants

Number of ATPs

Organelle

Name of process

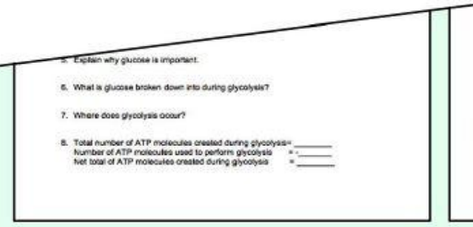
NADH
FADH2

ATP

Step 2) Krebs cycle

ATP

Step 3) _____



5. Explain why glucose is important.

6. What is glucose broken down into during glycolysis?

7. Where does glycolysis occur?

8. Total number of ATP molecules created during glycolysis= _____
Number of ATP molecules used to perform glycolysis = _____
Net total of ATP molecules created during glycolysis = _____

9. What is acetyl-Co A and why is it important?

10. What is the function of NADH and FADH2?

11. Briefly explain what occurs during the Krebs cycle using the terms acetyl-Co A; carbon dioxide; NADH and FADH2

12. Where does the Krebs cycle occur?

13. How many of the following molecules are produced per each glucose molecule (Krebs cycle= two cycles per glucose)

_____FADH2 _____NADH _____CO2 _____ATP

14. Where does the electron transport chain take place?

15. Why is oxygen important for the electron transport chain?

16. How many ATP molecules are created during the electron transport chain?

17. For each phase below, write whether it is aerobic (A) or anaerobic (AN).

A. Glycolysis _____
B. Krebs cycle _____
C. Electron Transport Chain _____
D. Fermentation _____

18. For the passage below, circle which term in the brackets best completes the phrase or sentence.

During cellular respiration, glucose (food molecules) is [built up | broken down] into cellular energy, known as [glucose | ATP]. This occurs in three distinct steps: glycolysis, the Krebs cycle, and the electron transport chain. During this process, carbon dioxide is [released | taken in] and oxygen is [released | taken in]. Cellular respiration occurs in the cell, specifically in the cytoplasm and the [chloroplast | mitochondria]. Cellular respiration occurs in [all cells | muscle cells].

19. What is fermentation?

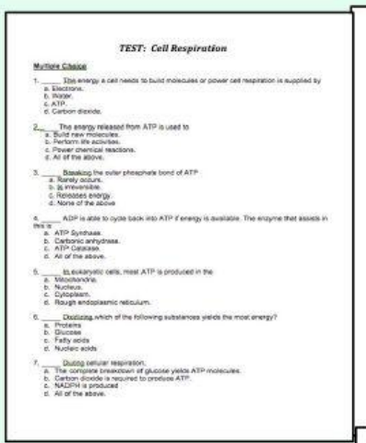
20. What is the difference between lactic acid fermentation and alcoholic fermentation?

21. Imagine yourself doing a wall sit for gym class. After about 30 seconds, your quadriceps begin to burn. Explain why you are feeling this burning sensation.

22. During science class, a student mixes some sugar, warm water and yeast into an Erlenmeyer flask. Then, the flask is gently stirred. There seems to be some bubbling. The student covers the mouth of the flask with a balloon. The balloon begins to rise.
What is causing the balloon to expand?

23. Write the equation for cellular respiration:

24. What is the total number of ATP molecules produced during cellular respiration?



TEST: Cell Respiration

Multiple Choice

1. _____ The energy a cell needs to build molecules or power cell respiration is supplied by
a. Electrons.
b. Water.
c. ATP.
d. Carbon dioxide.

2. _____ The energy released from ATP is used to
a. Build new molecules.
b. Perform life activities.
c. Power chemical reactions.
d. All of the above.

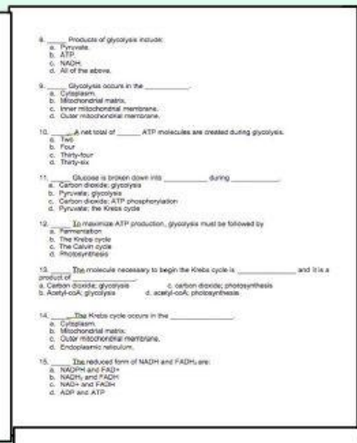
3. _____ Breaking the outer phosphate bond of ATP
a. Rarely occurs.
b. Is irreversible.
c. Releases energy.
d. None of the above

4. _____ ADP is able to cycle back into ATP if energy is available. The enzyme that assists in this is _____
a. ATP Synthase.
b. Carbonic anhydrase.
c. ATP Catalase.
d. All of the above.

5. _____ In eukaryotic cells, most ATP is produced in the
a. Mitochondria.
b. Nucleus.
c. Cytoplasm.
d. Rough endoplasmic reticulum.

6. _____ Oxidizing which of the following substances yields the most energy?
a. Proteins
b. Glucose
c. Fatty acids
d. Nucleic acids

7. _____ During cellular respiration,
a. The complete breakdown of glucose yields ATP molecules.
b. Carbon dioxide is required to produce ATP.
c. NADPH is produced.
d. All of the above.



8. _____ Products of glycolysis include:
a. Pyruvate.
b. ATP.
c. NADH.
d. All of the above.

9. _____ Glycolysis occurs in the _____.
a. Cytoplasm.
b. Mitochondrial matrix.
c. Inner mitochondrial membrane.
d. Outer mitochondrial membrane.

10. _____ A net total of _____ ATP molecules are created during glycolysis.
a. Two
b. Four
c. Thirty-four
d. Thirty-six

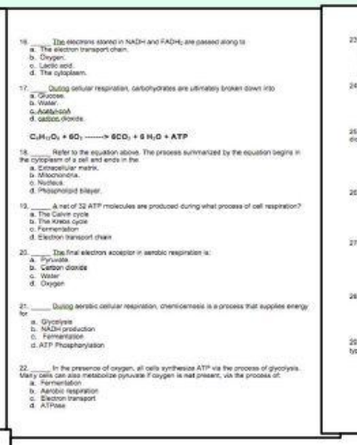
11. _____ Glucose is broken down into _____ during _____.
a. Carbon dioxide; glycolysis
b. Pyruvate; glycolysis
c. Carbon dioxide; ATP phosphorylation
d. Pyruvate; the Krebs cycle

12. _____ To maximize ATP production, glycolysis must be followed by
a. Fermentation
b. The Krebs cycle
c. The Calvin cycle
d. Photosynthesis

13. _____ The molecule necessary to begin the Krebs cycle is _____ and it is a product of _____.
a. Carbon dioxide; glycolysis
b. Acetyl-coA; glycolysis
c. carbon dioxide; photosynthesis
d. acetyl-coA; photosynthesis

14. _____ The Krebs cycle occurs in the _____.
a. Cytoplasm.
b. Mitochondrial matrix.
c. Outer mitochondrial membrane.
d. Endoplasmic reticulum.

15. _____ The reduced form of NADH and FADH2 are:
a. NADPH and FAD+
b. NAD+ and FADH
c. NAD+ and FADH
d. ADP and ATP



16. _____ The electrons stored in NADH and FADH2 are passed along to
a. The electron transport chain.
b. Oxygen.
c. Lactic acid.
d. The cytoplasm.

17. _____ During cellular respiration, carbohydrates are ultimately broken down into
a. Glucose.
b. Water.
c. Acetyl-coA
d. carbon dioxide.

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

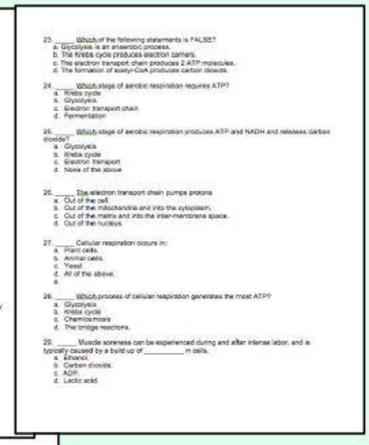
18. _____ Refer to the equation above. The process summarized by the equation begins in the cytoplasm of a cell and ends in the
a. Extracellular matrix.
b. Mitochondria.
c. Nucleus.
d. Phospholipid bilayer.

19. _____ A net of 32 ATP molecules are produced during what process of cell respiration?
a. The Calvin cycle
b. The Krebs cycle
c. Fermentation
d. Electron transport chain

20. _____ The final electron acceptor in aerobic respiration is:
a. Pyruvate
b. Carbon dioxide
c. Water
d. Oxygen

21. _____ During aerobic cellular respiration, chemiosmosis is a process that supplies energy for
a. Glycolysis
b. NADH production
c. Fermentation
d. ATP Phosphorylation

22. _____ In the presence of oxygen, all cells synthesize ATP via the process of glycolysis. Many cells can also metabolize pyruvate if oxygen is not present, via the process of:
a. Fermentation
b. Aerobic respiration
c. Electron transport
d. ATPase



23. _____ Which of the following statements is FALSE?
a. Glycolysis is an anaerobic process.
b. The Krebs cycle produces electron carriers.
c. The electron transport chain produces 2 ATP molecules.
d. The formation of acetyl-CoA produces carbon dioxide.

24. _____ Which stage of aerobic respiration requires ATP?
a. Krebs cycle
b. Glycolysis
c. Electron transport chain
d. Fermentation

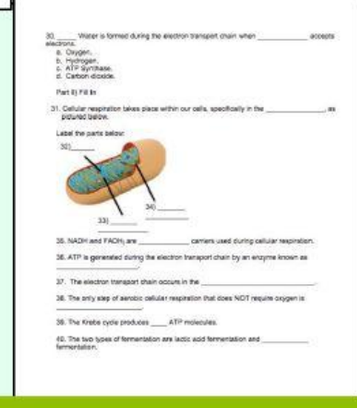
25. _____ Which stage of aerobic respiration produces ATP and NADH and releases carbon dioxide?
a. Glycolysis
b. Krebs cycle
c. Electron transport
d. None of the above

26. _____ The electron transport chain pumps protons
a. Out of the cell.
b. Out of the mitochondria and into the cytoplasm.
c. Out of the matrix and into the inter-membrane space.
d. Out of the nucleus

27. _____ Cellular respiration occurs in:
a. Plant cells.
b. Animal cells.
c. Yeast
d. All of the above.
e.

28. _____ Which process of cellular respiration generates the most ATP?
a. Glycolysis
b. Krebs cycle
c. Chemiosmosis
d. The bridge reactions.

29. _____ Muscle soreness can be experienced during and after intense labor, and is partially caused by a build up of _____ in cells.
a. Ethanol.
b. Carbon dioxide.
c. ADP.
d. Lactic acid.



30. _____ Water is formed during the electron transport chain when _____ accepts electrons.
a. Oxygen.
b. Hydrogen.
c. ATP synthase.
d. Carbon dioxide.

Part B) Fill In

31. Cellular respiration takes place within our cells, specifically in the _____ as pictured below.

Label the parts below:

32)_____

34) _____

33) _____

35. NADH and FADH2 are _____ carriers used during cellular respiration.

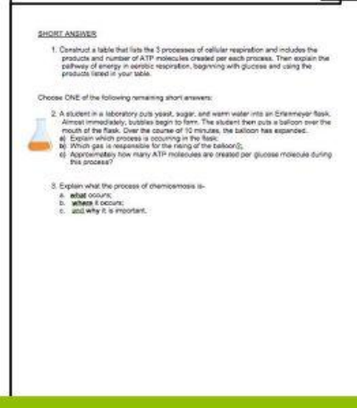
36. ATP is generated during the electron transport chain by an enzyme known as _____.

37. The electron transport chain occurs in the _____.

38. The only step of aerobic cellular respiration that does NOT require oxygen is _____.

39. The Krebs cycle produces _____ ATP molecules.

40. The two types of fermentation are lactic acid fermentation and _____ fermentation.



SHORT ANSWER

1. Construct a table that lists the 3 processes of cellular respiration and includes the products and number of ATP molecules created per each process. Then explain the pathway of energy in aerobic respiration, beginning with glucose and using the products listed in your table.

Choose ONE of the following remaining short answers:

2. A student in a laboratory puts yeast, sugar, and warm water into an Erlenmeyer flask. Almost immediately, bubbles begin to form. The student then puts a balloon over the mouth of the flask. Over the course of 10 minutes, the balloon has expanded.
a) Explain which process is occurring in the flask.
b) Which gas is responsible for the rising of the balloon?
c) Approximately how many ATP molecules are created per glucose molecule during this process?

3. Explain what the process of chemiosmosis is-
a. **what** occurs;
b. **where** it occurs;
c. **and** why it is important.

ALL ANSWER SHEETS INCLUDED
SUGGESTED PLANNING GUIDE ALSO INCLUDED