Name (s):

Date completed:

Class period:

Follow the links/directions for each section. Answers need NOT be in complete sentences.

Site 1: ATP: THE ENERGY OF LIFE

Go to: "Biology in Motion" website. Read & complete the activity. Answer the questions below. http://www.biologyinmotion.com/atp/index.html

1. What does the acronym "ATP" stand for?

2. What is the role of ATP in living things?

3. When ATP is used, a phosphate group is **removed/added** (circle one), and the energy from the broken bond can be used by the cell.

4. After a phosphate is broken off, ATP is converted into _____.

5. Can ADP be converted back into ATP? How? (briefly explain).

6. In *frame 2*, use your mouse to break apart (digest) the food (ice cream cone). What happens?

Now, take a phosphate off the ATP. Describe what happens

7. **THINK**: ATP provides the body with energy. List 3 *specific* examples of how ATP is used in organisms.

Site 2: How Cells Extract Energy From Complex Molecules
http://community.tncc.edu/faculty/zahn/mypage/cell_respiration.htm
Read through the information provided to answer the questions below.

1. Write the *chemical equation* for aerobic cellular respiration.

2. What are the *three steps* of cellular respiration?

3. In the *absence* of sufficient oxygen, an alternative to the usual cellular respiration steps is used. *What is this process called*?

4. What is the *energy yield* (in terms of numbers of ATP molecules made) in the above process (question 3), and *how does is compare* to the normal, aerobic respiration energy yield?

Sites 3&4: Anaerobic respiration (Fermentaion)
Read about how and why anaerobic respiration (also called "fermentation") takes place in cells. http://www.bbc.co.uk/education/guides/zm6rd2p/revision/2

Also:

http://pinkmonkey.com/studyguides/subjects/biology-edited/chap5/b0505601.asp

Summary: When cells become oxygen-starved, they may be forced to break down their glucose only partially, with very little energy payoff. When this happens, the by-products differ.

1. In which types of cells is lactate (lactic acid) produced as a result of anaerobic respiration? *Circle all that apply*:

animal cells human muscle cells bacteria yeast plant cells

2. In which types of cells is ethanol (ethyl alcohol) and CO_2 produced as a result of anaerobic respiration? *Circle all that apply*:

animal cells human muscle cells bacteria yeast plant cells

3. **Commercial application of fermentation:** List **5** industrial products of the microbial fermentation activities.

Site 5: Using Fermentation to make Biofuels
Go to
http://www.eia.gov/energyexplained/index.cfm/data/index.cfm?page=biofuel_home

1. Using biofuels can reduce our reliance on traditional fossil fuels. What is another advantage of using biofuels over gasoline in automobile engines?

2. List 5 items that can be fermented to make ethanol biofuel.

3. What crop is currently used to make the majority of biofuel ethanol in the U.S.?

4. Nearly all of the gasoline currently sold in the U.S. is about _____ % ethanol by volume.

5. What is "biodiesel"?

Site 6: CELL RESPIRATION: A SUMMARY
a) Go to About.com: Biology: Cellular Respiration. Read about ATP yields.
http://biology.about.com/library/weekly/aa090601a.htm

1. How many ATPs are produced (total) in cellular respiration?

Site 7:
http://www.sumanasinc.com/webcontent/animations/content/cellularrespiration.html

Put in your earbuds to listen to the audio while you watch the animations on the next website. If you don't have your earbuds, you can turn on the "subtitles" feature to read along. *Answer the questions below as you view and listen*.

Part I: The Big Picture

1. Name the specific internal chemical process (pathway) our bodies (and other organisms) use to break down food molecules and extract their energy?

2. In the animation example, what are the *inputs* and *outputs* of cellular respiration as the bison eats the grass?

3. Cells capture and store the energy released from food in the bonds of *what* "plentiful, readily available" *stored energy molecule*?

4. Cellular respiration is basically like which *other process*, in reverse?

5. What are *the three basic steps* of cellular respiration?

Part II: Glycolysis

6. Specifically where, inside the cell, does glycolysis occur?

7. TWO main things happen during glycolysis: _____ is split in half and a small amount of energy is released and captured in _____.

8. To get glycolysis going ("uphill" phase), how many ATP molecules must be used?

Summarize the processes in the "payoff" phase of glycolysis:

9. First, the two glucose halves both attach to a high-energy phosphate group. The glucose then donates high-energy _____ and _____ ions (protons) to electron carries called **NAD^+**.

This results in two molecules of _____ that are high-energy electron carriers. These energy-carrying molecules are used later steps in cellular respiration.

10. Then, glycolysis continues and more bonds between the glucose molecules are broken. Energy is recaptured by attaching phosphate groups to 2 molecules of _____, which creates energy-rich ATP. In addition, _____ (how many) molecules of water are produced.

11. Finally, two more ADP molecules take the last two phosphate groups and make two more _____ molecules.
The glucose has now been broken down into two molecules of _____.

12. Do the math: What is the "net" gain of ATP in glycolysis alone? _____

Part III: The Krebs Cycle

13. Where, inside the cell, does the Krebs cycle take place?

14. To prepare for the Krebs cycle, the original two pyruvate molecules must be modified into three new products. The products are two _____ _____molecules (which are exhaled), two molecules of _____ (which carry more high-energy electrons, and protons), and two _____-CoA molecules which will enter the Krebs cycle, one at a time.

15. In the first step of the Krebs cycle, acetyl-CoA combines with _____ and _____ to form a six-carbon compound (citric acid).

16. During the next stage of the Krebs cycle, the six-carbon compound is modified by the removal and addition of water, as well as the removal of two more CO_2 molecules. More electrons and protons are stripped off and added to two _____ molecules to form more energy-rich NADH molecules.

17. In the third phase of the Krebs cycle, how many of each of the following are made?
___ ATP molecule(s) ___ NADH molecule(s) ___ $FADH_2$ molecule(s)

18. The final outcome of the Krebs cycle is the re-formation of the cycle's starting molecule, called _____, and then the cycle repeats one more time.

19. **SUMMARY** – after *both* acetyl-CoA molecules (made from the original glucose molecule) have been run through the Krebs cycle, what is the TOTAL number of molecules produced by the Krebs cycle?

___ ATP molecule(s) ___ NADH molecule(s) ___ $FADH_2$ molecule(s)

20. Look at your answer to #9, above. How many NADH molecules were made in glycolysis? _____.

21. Look at your answer to #14, above. How many NADH molecules were made in the production of acetyl-CoA? _____.

All of these high-energy, electron-carrying molecules will now bring their stored energy into the final phase of respiration.

Part IV: The Electron Transport Chain

22. Where, inside the cell, is the electron transport chain located?

23. NADH and $FADH_2$ enter the electron transport chain after being created during glycolysis and the Krebs cycle. Their role is to donate their extra _____ to the electron transport chain and go back to their original state, NAD^+ and FAD. Then, they go back to participate in the Krebs cycle again.

24. The potential energy from the electrons that are sent down the transport chain is used to pump protons (H^+ ions) across the inner mitochondrial membrane, creating a _____ (concentration difference),

25. What gas is required for the electron transport chain (ETC) to operate?

26. When oxygen picks up the electrons that have reached the end of the transport chain, and combines with protons, it forms what substance?

27. Once a proton gradient is set up on one side of the mitochondrial membrane, protons will then be allowed to diffuse ("chemiosmose") through special embedded passageways to the other side. This outward flow of protons provides the power to make lots of _____.

28. What will happen to Krebs and ETC if oxygen is not available?

Extra credit: "Why is cyanide such a deadly poison?"

Site 8: CELLULAR RESPIRATION: A CLOSER LOOK

Go to "BioCoach Activity: Cell Respiration". Click on each concepts and answer the following questions.
http://phschool.com/science/biology_place/biocoach/cellresp/intro.html

1. Click through *Concepts 1 & 2*. The function of the glycolysis stage is to split glucose into two molecules of _____.

2. Note how two molecules of ATP *are used* to drive glycolysis, yet the actual splitting of glucose *produces* four ATPs. Do the math!
What is the net gain of ATP? _____

Now, Click on *Concept 3*. Read through the information on the Krebs (Citric Acid) Cycle. Click through the "Review" in the top right corner.

3. Why is the Krebs cycle sometimes referred to as the "Citric acid cycle"? (Hint: look at the first product made in the cycle!)

4. Explain why this process is called a "cycle"? (Hint: what is the starting *and* ending molecule?)

5. Click on *Concept 4*. **Click through the "Review" in the top right corner.**
Briefly summarize the *purpose* of the Electron Transport Chain (in your own words).

additional notes :
pyruvate = pyruvic acid
citrate = citric acid
oxaloacetate = oxaloacetic acid