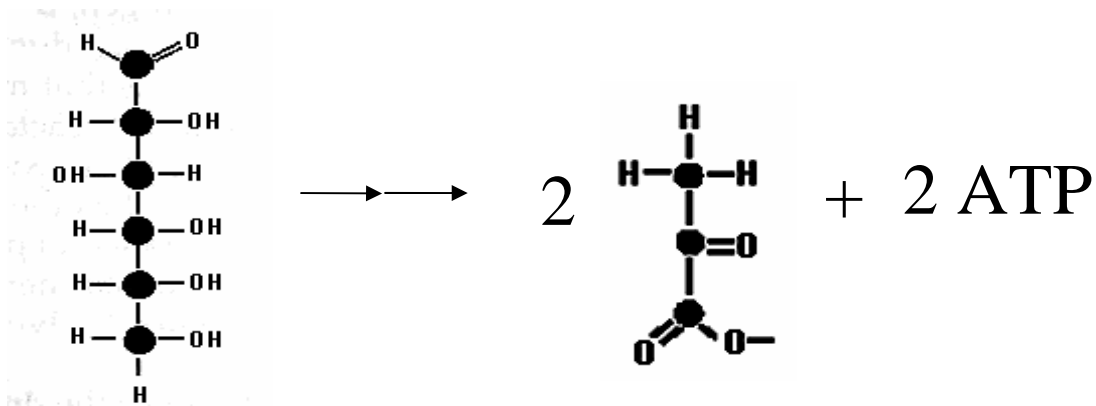


## Lab #9 Cellular Respiration and Fermentation.

1. Cellular Respiration
  - A. One broad term for a whole set of chemical reactions that are all designed to extract energy from glucose and store it in another compound (ATP) for later use.
  - B. These reactions are catabolic reactions: ones that involve the breakdown of larger molecules into smaller ones, with an accompanying release of energy.
  
2. Virtually every living cell starts with glycolysis. (The one metabolic pathway common in all living organisms)
  - A. Lots of energy is held inside the chemical bonds holding glucose together.
  - B. 11 enzymes and 11 chemical reactions are designed to rearrange and breakdown one glucose (6-carbon molecule) into 2 pyruvate molecules. (3-carbons).
  - C. In the process, 2 ADP molecules are turned into 2 ATP using some of that liberated energy.



3. The path divides as pyruvate moves on.
  - A. Higher forms of cells and animals have evolved a way to suck more of the energy out of glucose than just 2 measly ATP – THE KREBS CYCLE AND THE ETC
    - 1.) With oxygen and inside the mitochondria, pyruvate is converted into CO<sub>2</sub> and water, liberating enough energy in the process to build at least 34 more ATP.

2.) 36 ATPs (2 from glycolysis added to the 34 from the Krebs Cycle & ETC) sounds like a lot of energy, but it is still only about 40-45% of what was originally contained in the glucose.

B. But, some bacteria, yeasts, and muscle cells follow another route that takes them right back to glycolysis – **FERMENTATION**

- 1.) No oxygen is needed for these reactions occurring in the cytosol.
- 2.) There is NO payoff in terms of ATP in fermentation.
- 3.) The payoff is in the oxidation of NADH to NAD, which is needed for the glycolysis process.
- 4.) There are two common kinds of fermentation, named for the products they produce as “waste.”
  - a.) Lactic Acid Fermentation
  - b.) Alcohol Fermentation

What is yeast?

1. Yeasts are a tiny form of fungi. Fungi live in the soil and on your body, in your house and on plants and animals, in freshwater and seawater. A single teaspoon of topsoil contains about 120,000 fungi.
2. Yeasts grow typically in moist environments where there is a plentiful supply of simple, soluble nutrients such as sugars and amino acids. For this reason they are common on leaf and fruit surfaces, on roots and in various types of food.
3. Yeasts are egg-shaped cells that can only be seen with a microscope.
4. It takes 20,000,000,000 (twenty billion) yeast to weigh one gram or 1/28 of an ounce.
5. Yeasts will consume sucrose (cane or beet sugar), fructose (fruit sugar), glucose (honey, molasses, maple syrup, and some fruits) and maltose (derived from the starch in flour).
6. Most yeasts can't handle lactose. (The point of the second part of the lab today.)
7. There are basically two major kinds of yeast used in brewing beer.
  - A. Ale yeast works at about room temperature, ferments quickly, and produces the pleasant "fruitiness" characteristic of most ales.
  - B. Lager yeast works at cold temperatures (30 to 40 degrees Fahrenheit), ferments more slowly, and produces the clean taste of a lager beer.
8. Sourdough bread is not produced with baker's yeast, but rather a combination of wild yeast (often *Candida milleri*) and an acid-generating bacteria (*Lactobacillus sanfrancisco*, for example).

9. One yeast cell can ferment approximately its own weight of glucose per hour. Under optimal conditions *S. cerevisiae* can produce up to 18 percent, by volume, ethanol with 15 to 16 percent being the norm. Yeast reach a threshold of alcohol concentration (by volume), after which they die off. The level of alcohol that each type of yeast can tolerate is unique to that yeast strain.
10. In the process of extracting 2 ATP (Glycolysis) and recycling the NADH into NAD, yeast excretes ethanol and carbon dioxide. This process is energetically wasteful because so much of the free energy of glucose (some 95%) remains in the alcohol (a good fuel!).



#### WHAT YOU WILL DO IN LAB TODAY:

1. Alcohol fermentation experiment
  - a. 4 test tubes filled with the following solutions:
    - i. 4ml water, 0ml yeast, 3ml glucose
    - ii. 6ml water, 1ml yeast, 0ml glucose
    - iii. 3ml water, 1ml yeast, 3ml glucose
    - iv. 1ml water, 3ml yeast, 3ml glucose
  - b. Tubes will be incubated at 30°C for 20 minutes
  - c. The amount of CO<sub>2</sub> produced will be measured, this indicates the amount of fermentation taking place
2. Discuss what will need to be written as lab report #3