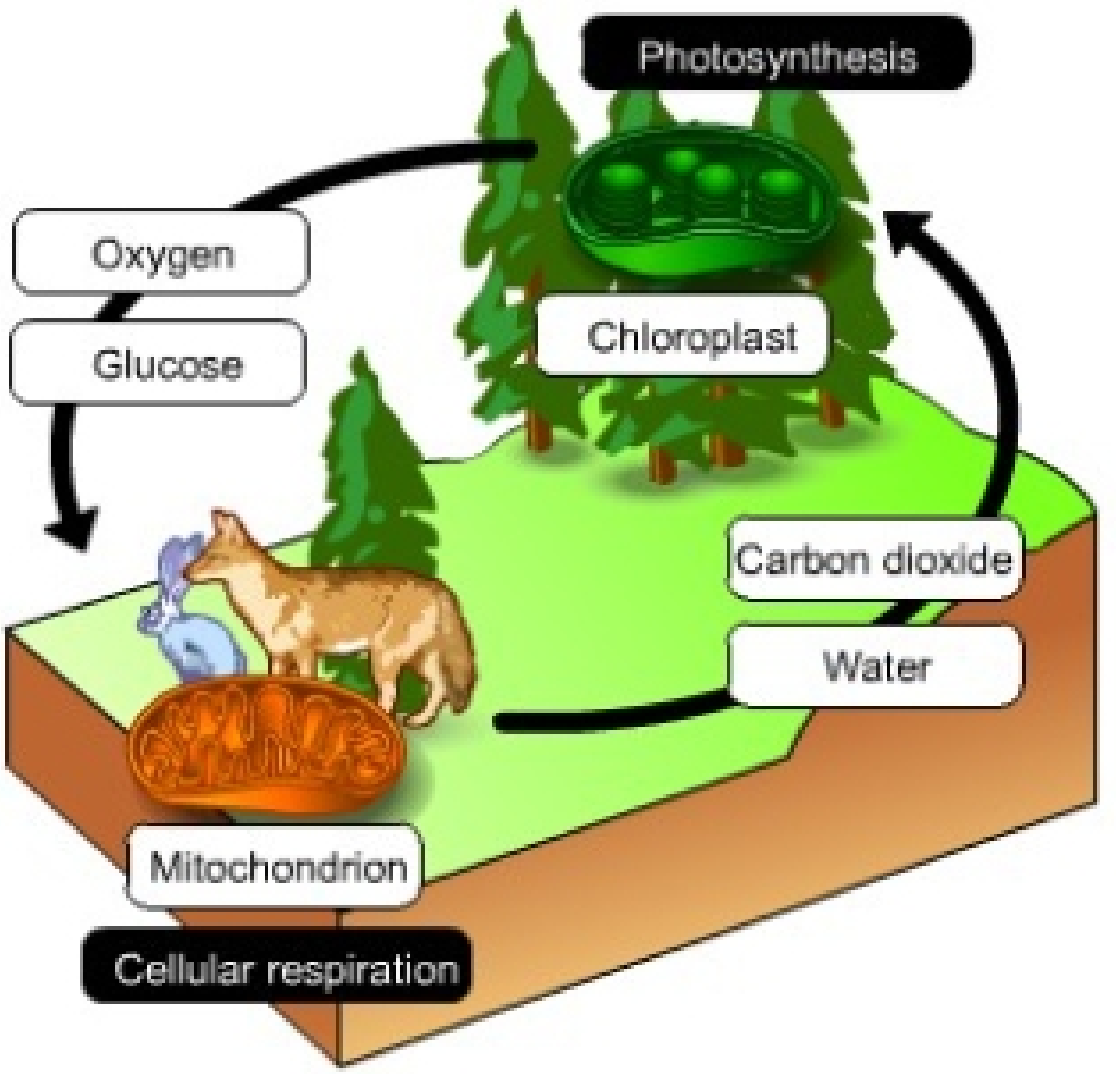
Ch. 2 Homework Study Guide

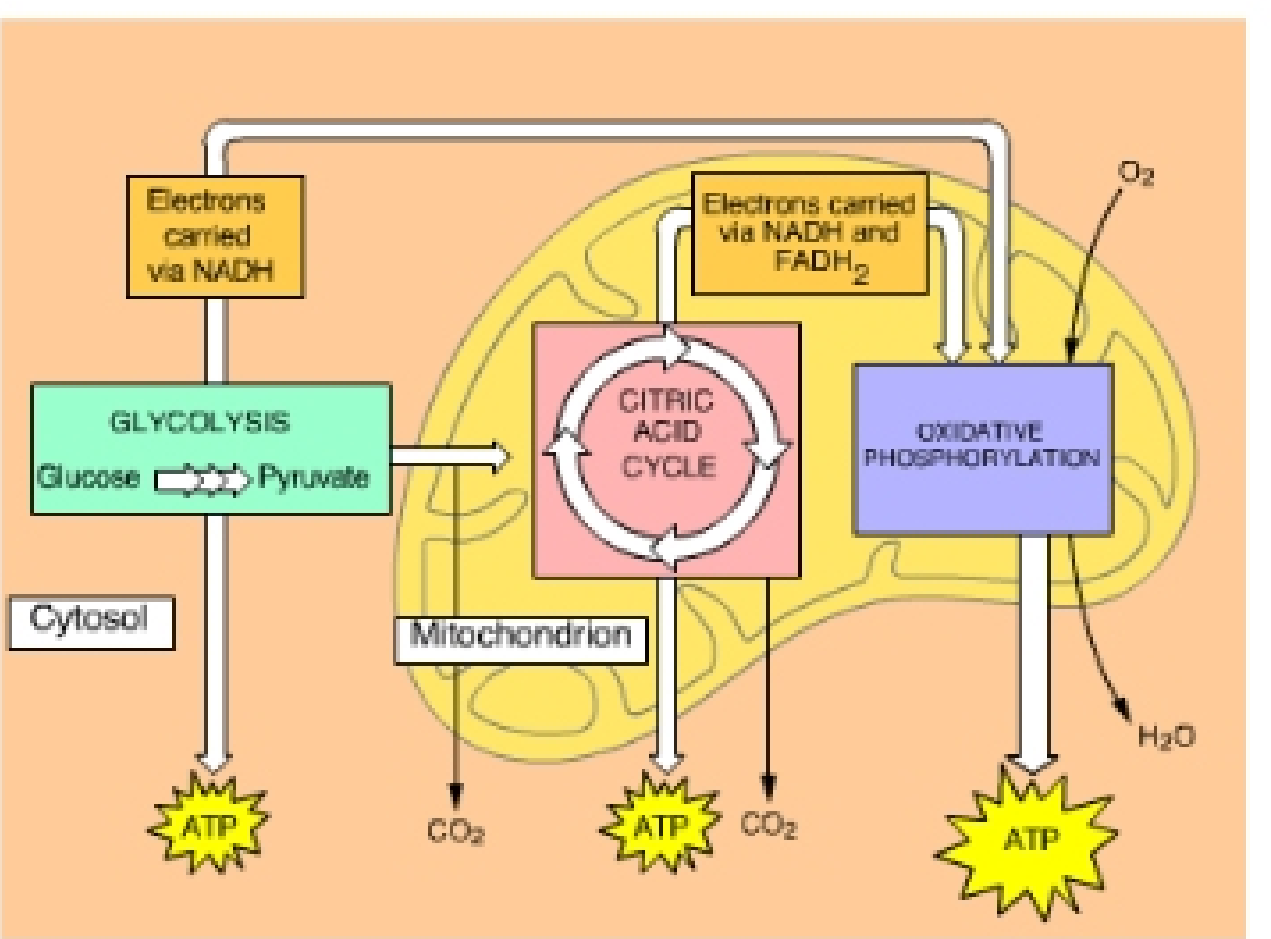
Aerobic Respiration

A. Chemical Cycling System



1. Chloroplast= site of photosynthesis
2. Photosynthesis produces glucose and releases oxygen into the atmosphere
3. Mitochondrion= site of cellular respiration
4. Cellular respiration makes CO_2 and H_2O as byproducts

B. **Overview of Cellular Respiration**



- Organic compounds like (glucose) store energy in their arrangements of atoms.
- These molecules = broken down and energy extracted in cellular respiration
- Location of stages of cellular respiration:
    1. First stage = cytosol
    2. Second sate= mitochondria
    3. Third stage= mitochondria
- Process summary:
    1. Electrons transferred form glucose → coenzymes → oxygen
    2. Energy that is released by relocation of electrons→ used to make ATP
    3. Carbon dioxide and water are given off as byproducts
- Coenzymes- (like NAD+) organic molecules serving as a cofactor. Most vitamins function as coenzymes in important metabolic reactions.
- Process in detail:
    1. Glycolysis-series of steps where glucose is broken down to 2 or more molecule of pyruvate
        a. (Glucose→ pyruvate)
        b. Occurs in cytosol
        c. As the chemical bonds are broken on the glucose→ electrons (and hydrogen ions) are picked up by NADH+→ forming NADH
        d. Glucose = oxidized and NAD+ = reduced
        e. 2 ATP molecules are produced as the net output for every 1 glucose that is processed
            i. (2:1 ratio ATP made for glucose broken down)
        f. BUT most of the energy released by the breakdown of glucose is carried by electrons attached to NADH
        g. All of the reactions of glycolysis are catalyzed by soluble enzymes located in the cytosol of the cell. None of the enzymes is associated with membranes.
- Pyruvate molecules→ are modified entering mitochondrion→ release CO_2→ altered molecules enter citric acid cycle
    2. Citric acid cycle- series of reactions with 8 steps, that completes the metabolic breakdown of glucose molecules to CO_2
        a. More CO_2 released as oxidation of glucose is completed
        b. 2 ATPs formed per glucose
        c. Most energy is released by oxidation of glucose → carried by NADH and $FADH_2$
        d. Occurs in mitochondrion
        e. 2nd major step in cellular respiration
        f. The citric acid cycle transfers electrons to NADH and $FADH_2$.

- NADH & FADH2 molecules produced→ donate the electron transport chain
    3. Oxidative phosphorylation- the production of ATP using energy derived from the redox reactions of an electron transport chain.
        a. End of chain, oxygen exerts strong pull on electrons→ combines with them & hydrogen ions (protons)→ forms H2O
        b. Transport chain converts chemical energy of moving electrons →to a form that can be used to drive oxidative phosphorylation→this produces about 34 ATP molecules for each glucose molecule consumed.
        c. In oxidative phosphorylation, the last stage of cellular respiration, energy released from the oxidation of NADH and FADH2 is used to produce ATP from ADP and free inorganic phosphate (Pi) ions.
    4. **Oxygen is the final electron acceptor of cellular respiration.**

C. Cellular Respiration (2 of 5): Glycolysis

- In glycolysis, the first stage of cellular respiration, one molecule of glucose is oxidized to two molecules of pyruvate, with the production of ATP and NADH.
- Reactions involved in the production of NADH= redox (oxidation-reduction) reactions
- Play a key role in cellular respiration
- Also pay attention to the mechanism by which ATP is synthesized. Think about how ATP synthesis at this stage differs from ATP synthesis during oxidative phosphorylation, where most of the ATP in cellular respiration is made.

A. In glycolysis, as in all the stages of cellular respiration, the transfer of electrons from electron donors to electron acceptors plays a critical role in the overall conversion of the energy in foods to energy in ATP. These reactions involving electron transfers are known as oxidation-reduction, or redox, reactions.
    a. When a compound donates (loses) electrons, that compound becomes oxidized. Such a compound is often referred to as an electron donor.
    b. When a compound accepts (gains) electrons, that compound becomes reduced. Such a compound is often referred to as an electron acceptor.
    c.

B. Among the products of glycolysis, which compounds contain energy that can be used by other biological reactions?

C. The ATP that is generated in glycolysis is produced by substrate-level phosphorylation, a very different mechanism than the one used to produce ATP during oxidative phosphorylation. Phosphorylation reactions involve the addition of a phosphate group to another molecule.