Cellular Respiration Cheat Sheet - Just the highlights of Cellular Respiration

General formula: $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O + 32\ ATP$

Overall Point: Cellular respiration uses Oxygen to break down sugar and make ATP (cell energy)

Note : Very few cells actually produce 32ATP, most produces some number less than that.

There are four major steps to Cellular Respiration

Step 1. Glycolysis

$C_6H_{12}O_6$ is broken in half using 2 ATP → 2 Pyruvate + 2 NADH + 4 ATP

Where does this step occur?: In the cell's cytoplasm

Overall Point of this step: To break sugar and produce a small amount of ATP (cell energy)

Step 2. Oxidation of pyruvate to produce Acetyl-CoA

For each Pyruvate created in step 1 (so 2 times per glucose)

Pyruvate +NAD + CoEnzyme A (CoA) → Acetyl-CoA + NADH + CO_2

Where does this step occur?: Crossing from the cells cytoplasm into the Mitochondria

Overall Point of this step: To take the Pyruvate created in Glycolysis and make it smaller, and shaped correctly to enter the Mitochondria.

Step 3. Krebs Citric Acid Cycle :

For each Acetyl-CoA from step 2 (so 2 times per glucose)

Acetyl -CoA + 3 NAD+ 1 FAD+ → 1 ATP + 3 NADH + 1 $FADH_2$

Where does this step occur?: In the **Stroma** (fluid part) of the mitochondria

Overall Point of this step: To break up the remainder of the original glucose (the Acetyl-CoA) to create NADH and $FADH_2$ (the electron carriers)

Before you go on, we need to figure out what we have created so far:

6 CO2 (this actually accounts for all of the Carbon in glucose that we started with!)

10 NADH (electron carrier)

2 FADH2 (also an electron carrier)

4 ATP (cellular energy)

Step 4. The Electron Transport Chain and Chemiosmosis

Where does this step occur?: On the Cristae of the Mitochondria (the mitochondrial inner membranes)

Overall Point of this step: This step takes the H+ off of all of the NADH and $FADH_2$ that the previous steps have created and uses it along with Oxygen to power the production of ATP.

The protein **NADH Dehydrogenase** (which really just means NADH enzyme that pulls the hydrogen off) in the cristae pull the H+ off of NADH creating NAD+. This also happens to $FADH_2$ creating FAD+.

The H ions that have been pulled off of the electron carriers are put into the inner membrane space of the mitochondria. This makes one side of the membrane acidic (lots of H+) and one side less acidic. Membranes HATE to have one side higher in acid than the other! (remember when we looked at osmosis and water passes through a membrane to try and even out salt solutions on both side of the membrane?)

This difference in acidity (H+) is used to slowly pass some H+ to an Oxygen molecule. As the H+ passes from one side of the membrane to the other, it spins ATP syntheses.

ATP synthase is a protein complex that makes ATP when it spins.

The Oxygen that you breathe is used in this very last step to force the H+ across the membrane. If there is no oxygen here to pull the H+, there will be very little ATP created. **This** is why you breathe Oxygen. If I take away your O_2 you stop producing large numbers of ATP, your brain runs out of **ENERGY** and you die.