Unit 5: Cellular Respiration and Photosynthesis

How do cells obtain energy from food molecules?

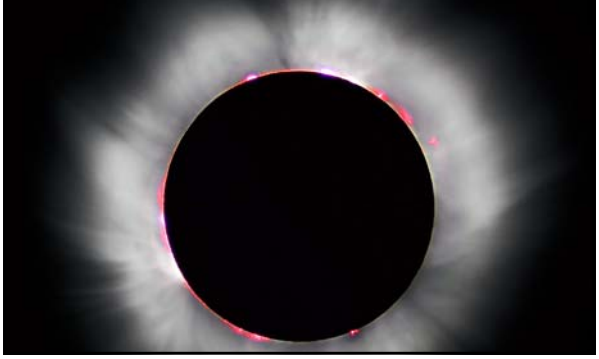
1. Cellular respiration release energy from food molecules
2. Glycolysis begins the production of cell energy
3. The Krebs Cycle completes the breakdown of glucose
4. The Electron Transport System packages energy from glucose to ATP
5. Anaerobic respiration works in the absence of oxygen

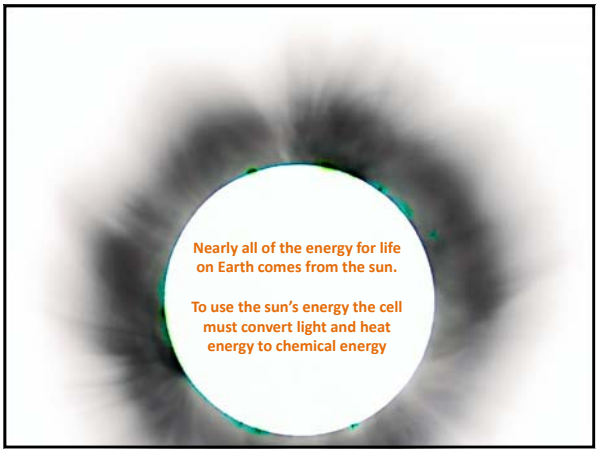
How do plants use photosynthesis to convert solar energy to chemical energy?

1. Photosynthesis harnesses light energy
2. The Calvin Cycle combines hydrogen with Carbon Dioxide to produce sugars.
3. Environmental factors affect the rate of photosynthesis

Energy is the ability to do work

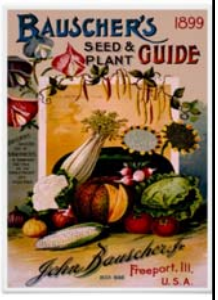
- **Energy cannot be created or destroyed but it can change form.**
- **Cells need energy to actively transport molecules across their membranes, to make and break molecules, to grow and to maintain homeostasis.**





Some organisms can make their own food from the inorganic raw materials of the Earth.

Autotrophs like **green plants**, algae and some prokaryotes **can use** the energy in **sunlight** to convert carbon dioxide and water into **sugar**.

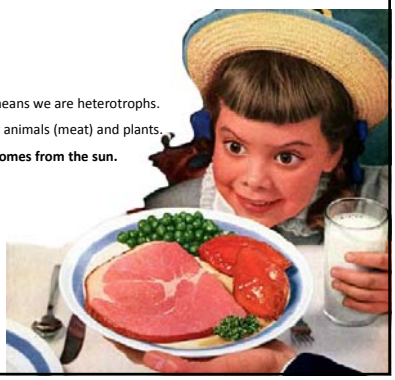


Heterotrophs get their energy from eating food.

Humans are animals which means we are heterotrophs.

Our food is made up of other animals (meat) and plants.

The energy in our food still comes from the sun.



Cells release energy from food molecules through the process of cellular respiration. **Cellular respiration** is a series of reactions that break down organic molecules into carbon dioxide, water and ATP (energy).

$$6O_2 + C_6H_{12}O_6 \rightarrow 6CO_2 + 6H_2O + ATP + HEAT$$

When something is burned a large amount of its energy is released quickly in the form of heat and light. Cells have figured out how to release the same amount of energy gradually in a series of chemical reactions controlled by enzymes.

The steps of cellular respiration can be divided into three stages

1. **Glycolysis** - Glucose is split into two 3-carbon pyruvate molecules in the cytoplasm

2. **Krebs Cycle** – The two pyruvate molecules are disassembled inside the mitochondria releasing 6 CO_2 molecules and Hydrogen atoms.

3. **Electron Transport System** – Each hydrogen atom is separated into its proton and electron and eventually is bonded with an oxygen to form water.

The 3 stages of Cellular respiration allow for the controlled release of food energy into the chemical ATP

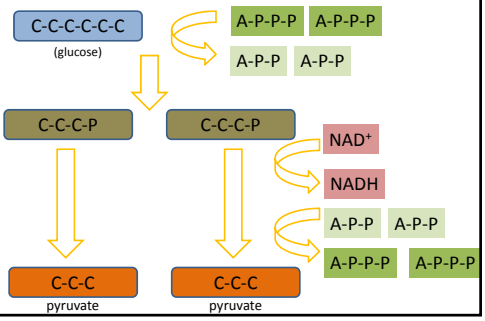
Glycolysis

Glucose is split into two 3-carbon pyruvate molecules in the cytoplasm

1

Glycolysis

1. Using 2 ATP molecules a single glucose is broken in half into two 3-carbon molecules.
2. 2 Hydrogen atoms are released and bonded to 2 NAD^+ molecules forming 2 NADH.
3. As the molecules are rearranged 4 ATP molecules are formed.
4. Two pyruvate molecules are now ready to go to the next stage.



Glycolysis

Glucose is split into two 3-carbon pyruvate molecules in the cytoplasm

The end products are: 2 molecules of pyruvate, 2 ATP, 2 NADH

Before the next step of cellular respiration can take place the pyruvate molecules must enter the mitochondria.

Once the pyruvate enters the cell it is converted by enzymes into a 2 carbon molecule called **Acetyl CoA**

This process releases CO_2 and makes more NADH

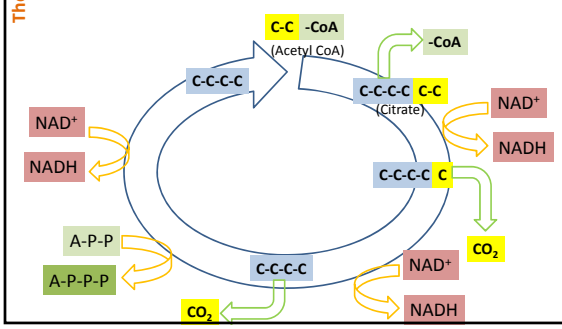
The Krebs Cycle

Acetyl CoA is broken down into Carbon Dioxide in the mitochondria

2

The Krebs Cycle

1. Acetyl CoA enters the cycle where it combines with a 4 carbon molecule
2. CoA is releases the 6 carbon molecule which is now called Citrate
3. Citrate is acted on by many enzymes and rearranged
4. This releases CO2 and makes NADH and ATP



The Krebs Cycle

Acetyl CoA is broken down into Carbon Dioxide in the mitochondria

2 ATP are made along with NADH

Electron Transport System

Hydrogen atoms are separated from their electrons using oxygen

3

The Electron transport system is a series of electron carrying molecules and enzymes located in the highly folded inner membrane of the mitochondria.

As the electron carriers interact with the enzymes they release energy.

This energy is used to make ATP, LOTS of ATP

32 ATP

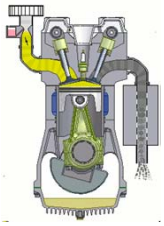
Totals for Cellular Respiration

1. **Glycolysis** - Glucose is split into two 3-carbon pyruvate molecules in the cytoplasm
   2 ATP
2. **Krebs Cycle** – The two pyruvate molecules are disassembled inside the mitochondria releasing 6 CO_2 molecules and Hydrogen atoms.
   2 ATP
3. **Electron Transport System** – Each hydrogen atom is separated into its proton and electron and eventually is bonded with an oxygen to from water.
   32 ATP

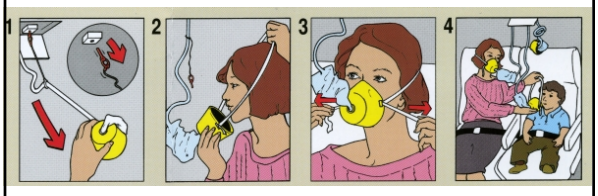
36 ATP Total

Cellular respiration is able to convert 44% of the energy in a glucose molecule.

A car's engine only converts 25% of the energy in the gas.



Without Oxygen Cellular Respiration Stops Because Electron Transport is Unable to Transfer Electrons



Anaerobic Respiration takes place when there is not enough oxygen. Sprint athletes in particular have to deal with not enough O_2 reaching their muscles.

When you still need to run but you can't breathe fast enough your cells will use **FERMENTATION** instead.

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Fermentation only produces 2 ATP along with the chemical lactate. Lactate builds up in the muscle tissue and eventually reduces their ability to contract.

Fermentation does not require an anaerobic environment.

Even in the presence of oxygen yeast prefer fermentation as long as sugars are available.

Yeast are used in the production of ethanol in beers, wines and other alcoholic drinks, along with the production of large quantities of carbon dioxide.

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