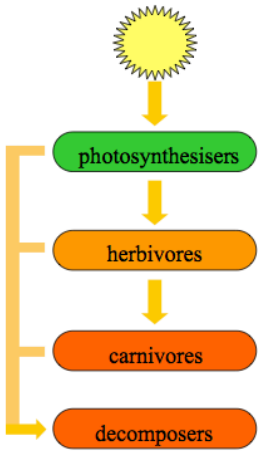
Metabolism

Energy

Living things require energy to grow and reproduce
Most energy used originates from the sun
Plants capture 2% of solar energy
Some captured energy is lost as metabolic heat
All energy is eventually returned as heat



Plants capture light energy and use it to synthesise carbon compounds

Herbivores gain energy by eating plant products

Carnivores gain energy by eating other animals

Decomposers gain energy by breaking down remains

Some ecosystems (e.g. sea floor or in solid rock) that gain their energy from oxidation of inorganic compounds and are independent of solar energy

Metabolism

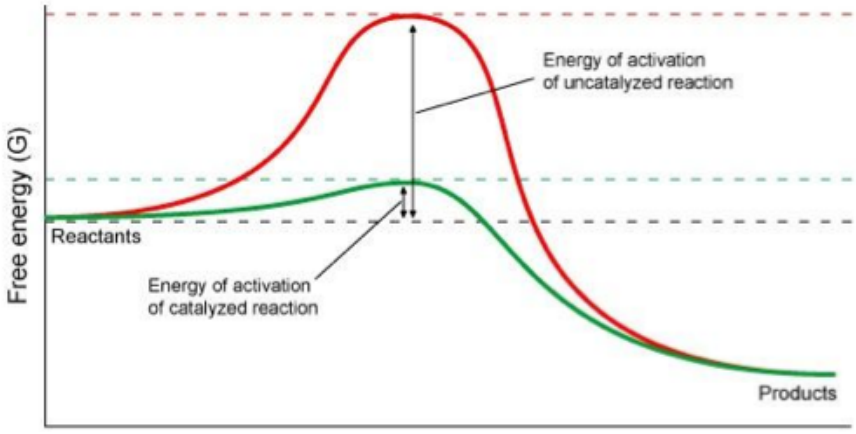
The sum total of all the chemical reactions that take place in a cell
Each reaction consists of substrates (reactants) and products

A + B → C + D
Substrates products

A reaction will only proceed spontaneously if it liberates energy (**exergonic reaction**)
Some reactions reactions require an imput of energy to proceed (**endergonic reaction**)

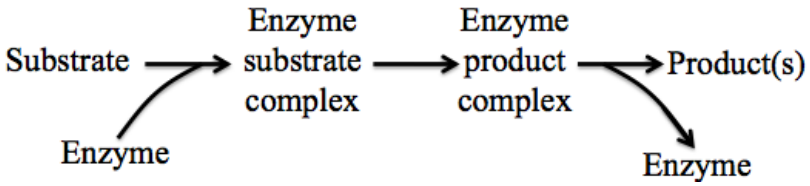
Energy of activation

Substrates often need to be activated before a reaction will take place
E.g. a match is needed to start a fire
Reactions in living things are catalyzed by enzymes
Enzymes lower the energy required for the activation of a reaction



Enzymes

Are proteins that bind reactants at an active site
Reaction occurs while bound to the enzyme then products are released



Metabolic pathway;
When a series of enzymes catalyse sequential steps in a set of linked reactions
Each enzyme works on a particular substrate

Substrate	**Enzyme**
Protein	Protease
Lipid	Lipase
Cellulose	Cellulose
Alcohol	Alcohol dehydrogenase
Lactose	Lactase
Urea	Urease
Sucrose	Sucrose

Factors affecting enzyme activity;

- Temperature
  - Enzymes have optimum temperatures
- pH
  - Enzymes have optimum pH levels
- Substrate conc
  - Generation of product increases with increasing substrate conc
- Enzyme conc
  - Increase in active enzyme increases generation of product
- Cofactors
  - Many enzymes require vitamin based coenzymes or metal ions to function
- Inhibitors
  - Molecules that bind to the enzyme

Photosynthesis and respiration

Both matter and energy are cycled through chloroplasts and mitochondria in the complementary processes of photosyn and resp.

ATP

All living things use adenosine triphosphate (ATP) as energy currency
It's a carrier for energy required in many diff kinds of processes

Aerobic cellular respiration

All animals and plants carry out aerobic cellular respiration
Oxidation of glucose into CO2 and water with the consequent generation of ATP
Some bacteria, fungi and protozoa are anaerobic. May be killed by exposure to O2

Glycolysis/Fermentation

Glycolysis;
Occurs in the cytoplasm
Does not require O2
A molecule of glucose breaks down to 2 molecules of pyruvate with a net production of 2 ATP molecules
In the absence of O2 an additional step reduces pyrivate to lactate, or to alcohol and CO2
Glycolysis with this additional step is called **fermentation**
Yeast ferments glucose to alcohol, and lactic acid bacteria ferments glucose to lactate

Mitochondrial function

A **transition reaction** (pyruvate bound to coenzyme A) occurs in the matrix of the mitochondrion
The Krebs cycle also occurs in the matrix
The electron transport chain is embedded in the cristae. It pumps hydrogen ions into the inter membrane space

After glycolysis

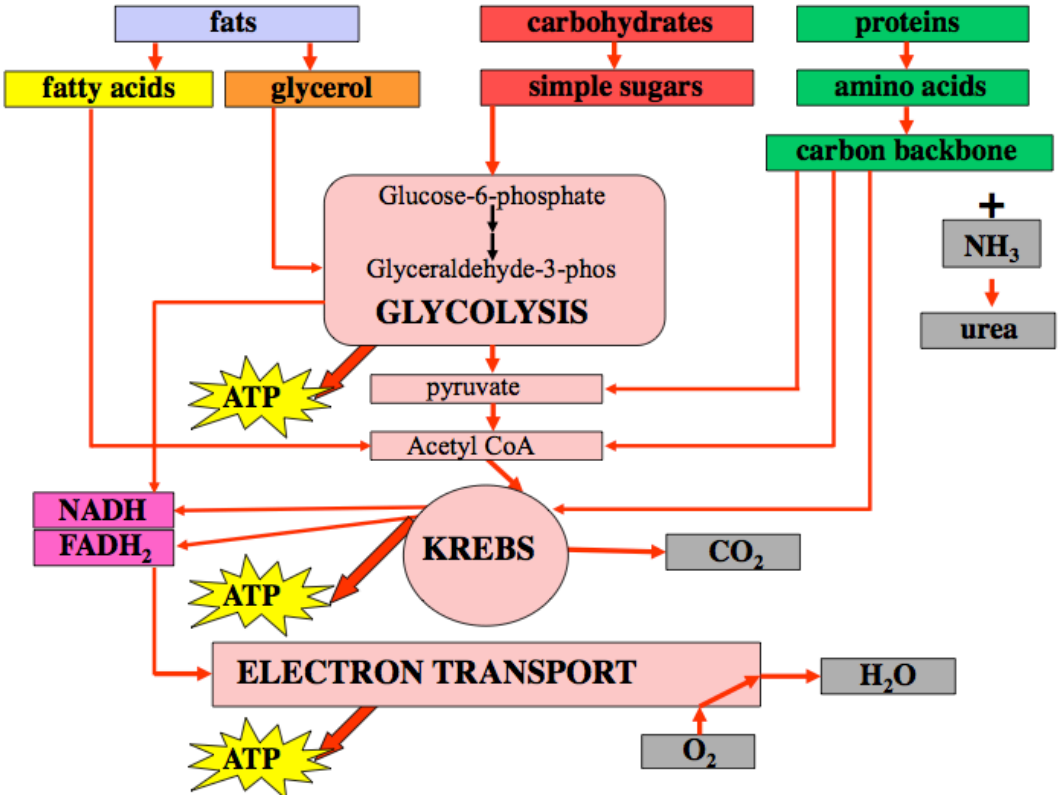
Glycolysis occurs in the cytoplasm. Further breakdown of pyruvate occurs in the mitochondria:

1. **Transition reaction:** Pyruvate enters mitochondria and is converted to an acetyl group with liberation of carbon dioxide
2. **Krebs cycle**: In the mitochondrial matrix CO2, ATP, NADH and FADH2 are generated
3. **Electron transport system:** On the mitochondrial cristae, more ATP is generated

Energy Balance sheet for the final yield of ATP from aerobic cellular respiration:

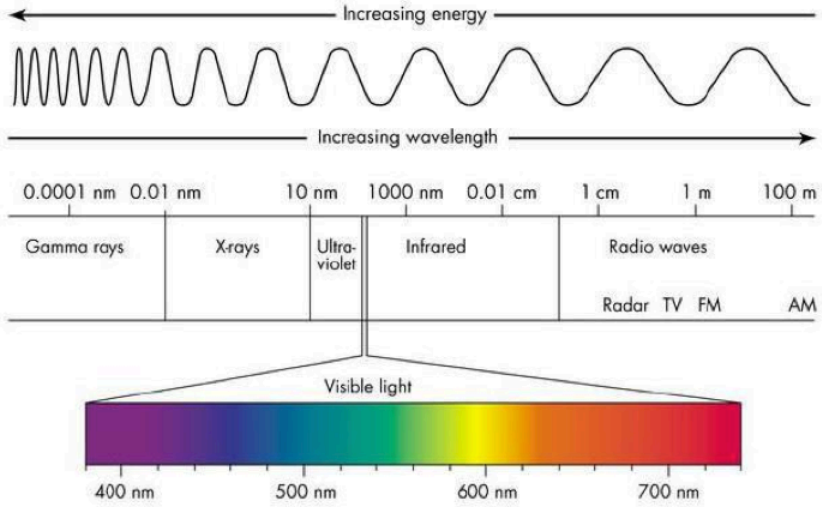
Complete oxidation of glucose to CO2 and H2O = 686 kcal
Energy in terminal phosphate bonds of 38 ATP = 278 kcal
Aerobic respiration recovers 40% of the available energy. The rest is lost as heat.

Where food goes



Electromagnetic spectrum

Describes the range of radiation types from gamma rays to radio waves



Plants can absorb particular wavelengths of light and use the energy in photosynthesis

Photosynthesis and light

Chlorophyll a and chlorophyll b absorb energy from blue-violet and red-orange wavelengths

They reflect green wavelengths ,', plants appear green

Carotenoid pigments absorb blue-violet and blue-green wavelengths and reflect red-orange

Mesophyll cells are in plant leaves. They contain chloroplasts

Photosynthesis occurs from light energy absorbed in the thylakoid membranes of chloroplasts
Raw materials (CO2 and H2O) come from leaf veins and stomates

The light dependent reactions

Photosynthesis II comes before photosynthesis I due to discovery dates

PSII

Light energy is harvested in thylakoid membranes
Light energy splits water
$H_2O \rightarrow \frac{1}{2} O_2 + 2H^+ + 2e^-$
Hydrogen ions pumped into thylakoid space by electron transport
Gradient in hydrogen ion conc allows ATP synthase to make ATP

PSI

PSI captures light energy
It passes 2 e- on to NADP+ which accepts a hydrogen ion to become NADPH
ATP and NADPH are used in the next stage of ps, the Calvin cycle

Light independent reactions

CO2 fixation

ATP and NADPH are generated by thylakoids and released into the stroma
Used to fix CO2
Products of Calvin Benson cycle are glucose and water