Respiration & ATP

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Stage 1 Biology

Cell Chemistry

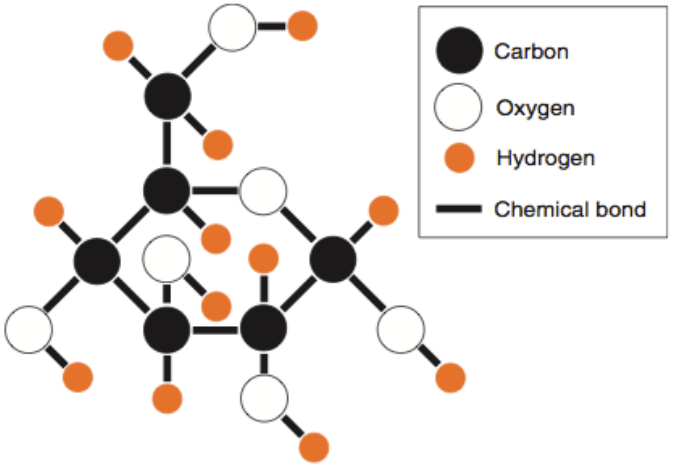
cell metabolism =

All metabolic reactions involve changes in energy (form or storage):

a) Anabolic Reactions (synthesis):

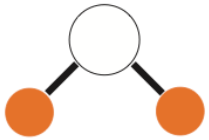
b) Catabolic Reactions (break down):

Energy in Bonds



Glucose ($C_6H_{12}O_6$)

Carbon dioxide (CO_2)



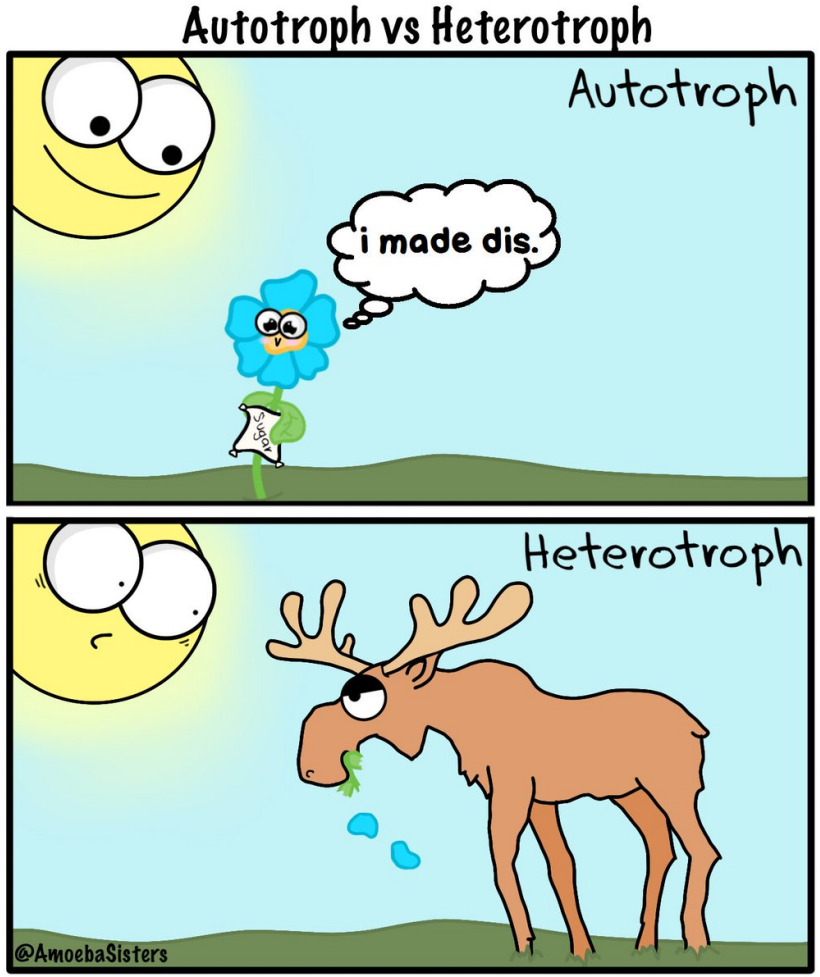
Water (H_2O)

energy rich
reactants/substrates

energy poor
products

Autotrophs vs Heterotrophs

Distinguish between autotrophs and heterotrophs.



Sunlight for Photosynthesis

sunlight energy

photosynthesis
*in **chloroplasts** (plants and some protists)*
**some bacteria do a simplified version with pigments in cytoplasm*

stored chemical energy (in bonds)

respiration
*in cytoplasm and **mitochondria***

useful chemical energy in the form of ATP

Photosynthesis

Photosynthesis

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6O_2$$

carbon dioxide + water $\xrightarrow[\text{chlorophyll}]{\text{light}}$ glucose + oxygen

Aerobic Respiration

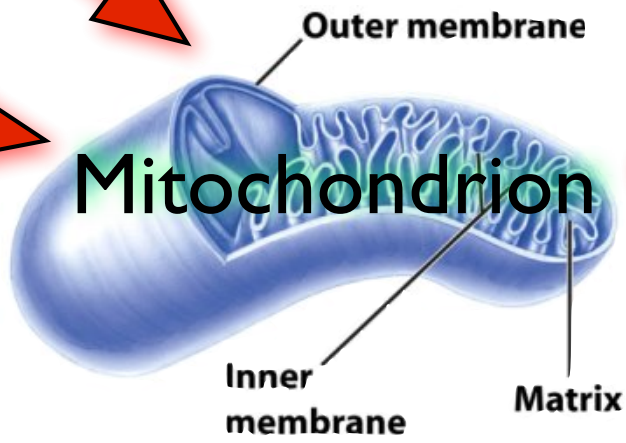
Glucose + Oxygen ⟶ Carbon Dioxide + Water + Energy

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$ + Energy

Respiration!

O_2

$C_6H_{12}O_6$



H_2O

CO_2

ENERGY...

38 ATP molecules

Anaerobic Respiration
(fermentation)

In plants and yeast:

alcohol fermentation

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$$

glucose ⟶ ethanol + carbon dioxide

In animals (and some bacteria):

$$C_6H_{12}O_6 \longrightarrow 2C_3H_6O_3$$

glucose ⟶ lactic acid

lactic acid fermentation

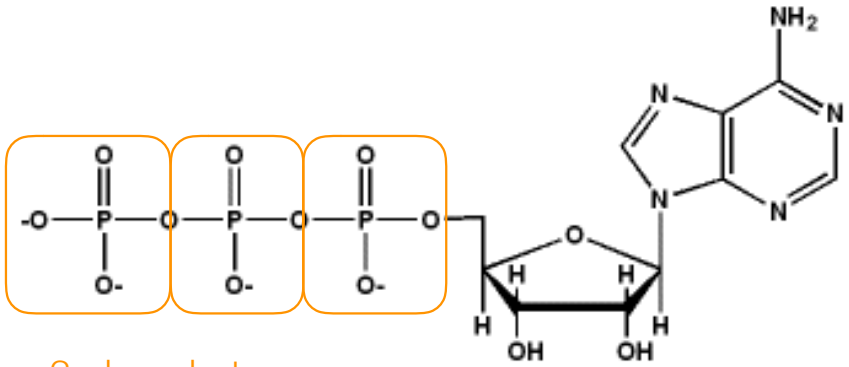
Energy Release Efficiency
(aerobic respiration vs fermentation)

Respiration produces energy in the usable form of ATP molecules.

Aerobic Respiration	**= 36-38 net ATP**
Alcohol Fermentation	**= 2 net ATP**
Lactic acid Fermentation	**= 2 net ATP**

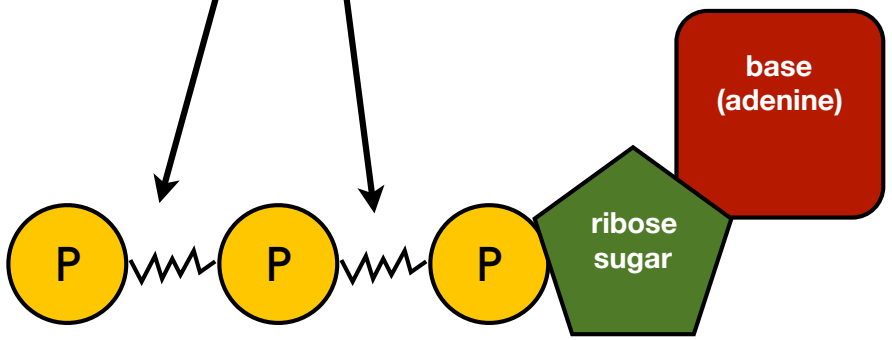
Formation of ATP

What is ATP?
adenosine triphosphate



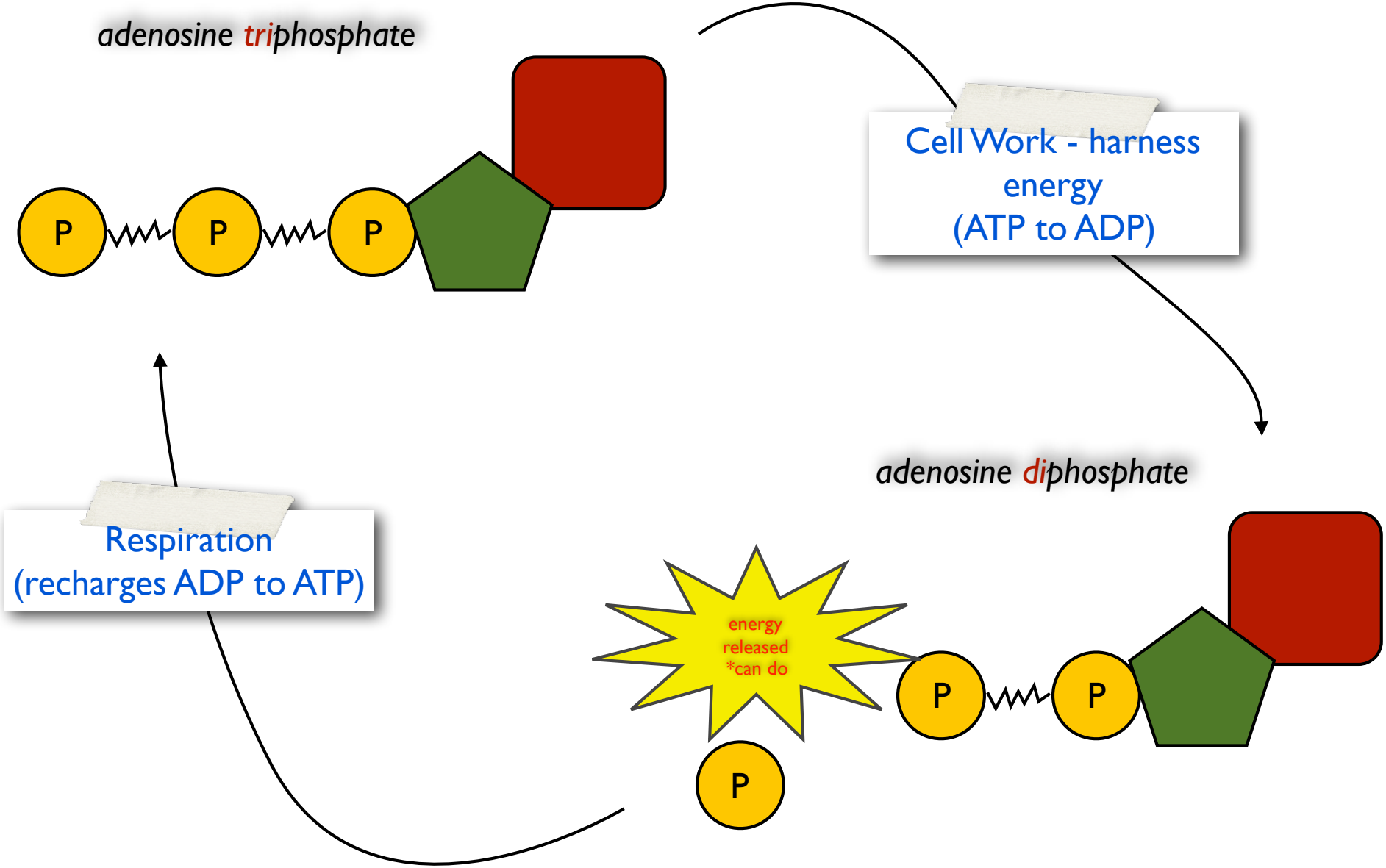
3 phosphate groups

Energy storing covalent bonds



used to store and transfer energy

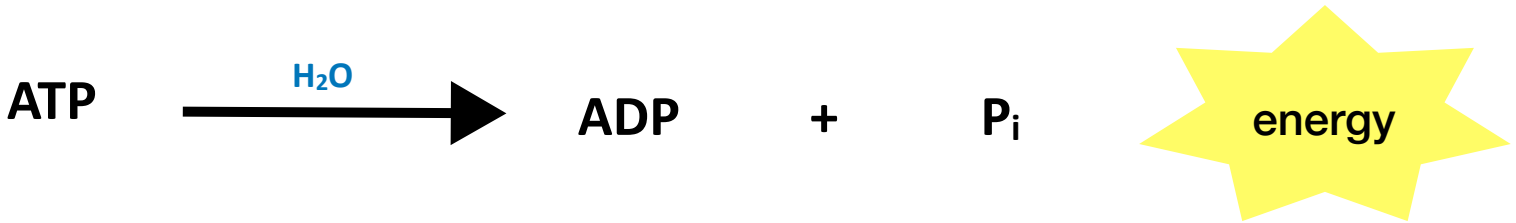
How does it work?



Releasing Energy from ATP

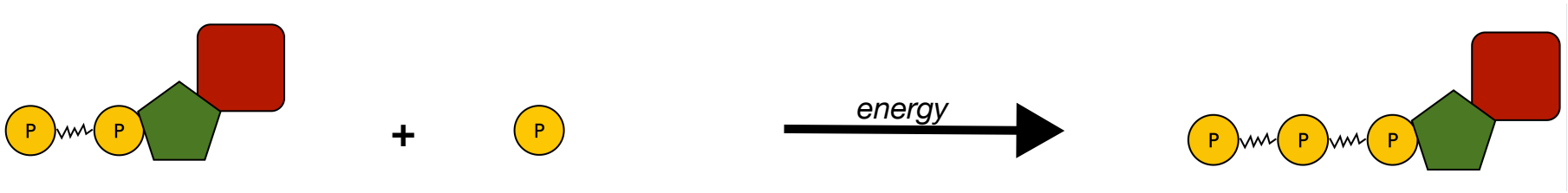
Hydrolysis

When a larger molecule (eg. ATP) is broken down into smaller molecules (eg. ADP and P_i) by reaction with water:



The energy released in the hydrolysis of ATP is used in key processes for life in cells…

Formation of ATP



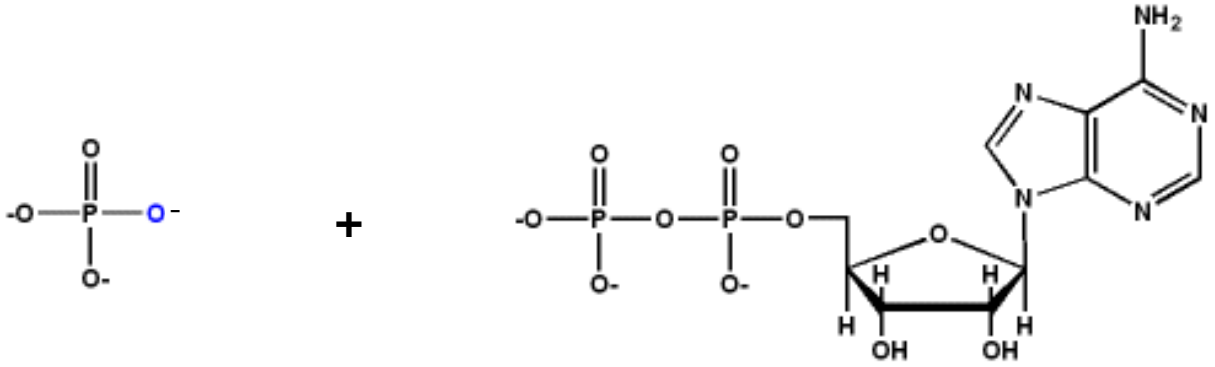
ADP + **P_i** —*energy*→ **ATP**

adenosine diphosphate + **inorganic phosphate** —*energy*→ **adenosine triphosphate**

ADP and Pi are both negatively charged ions in the cytoplasm.
Energy is required to overcome the repulsion to bond them.

This energy used to bond them is stored in the chemical bond between the two reactants.

Formation of ATP



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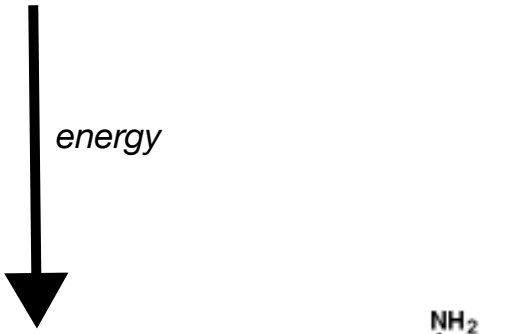
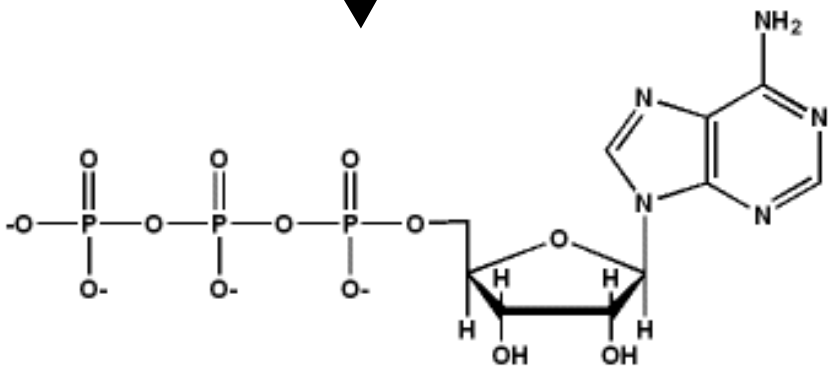
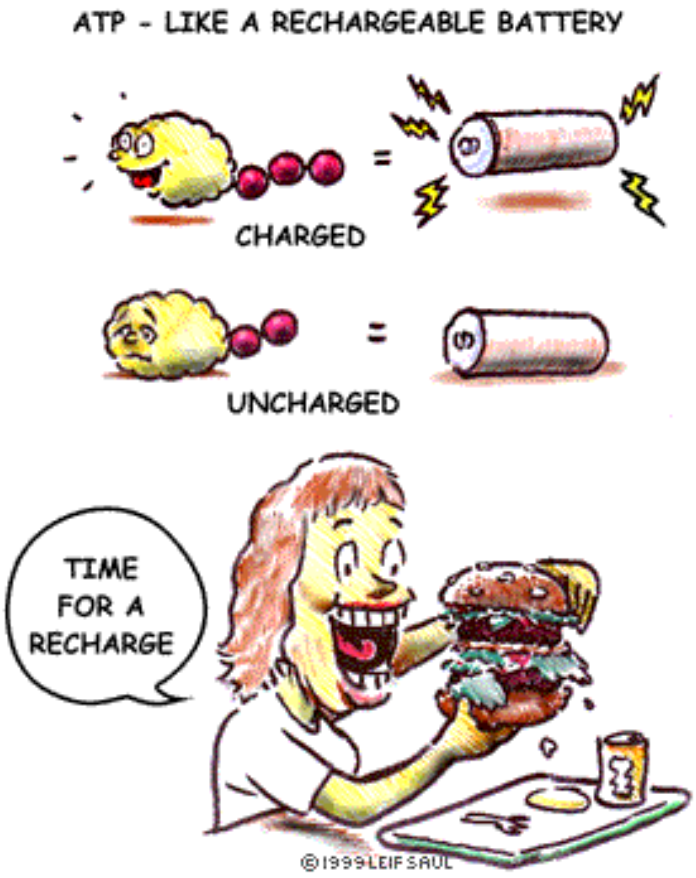




Key:
Cells break down large molecules into smaller ones, and the energy released by doing this is transferred into molecules of ATP.

Formation of ATP



The energy used by human cells requires the hydrolysis of **100** to **150** moles of ATP daily, which is around 50 to 75 kg.

A human will typically use up his or her body weight of ATP over the course of the day. Each equivalent of ATP is recycled **500**-750 times during a single day (100 / 0.2 = **500**).

Active Transport