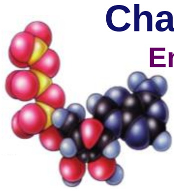
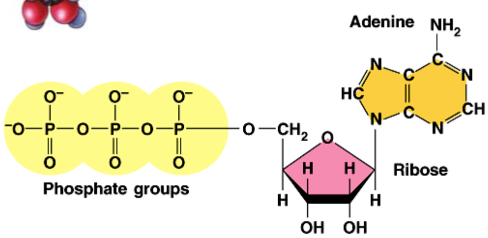
Chapter 8.1 – 8.2

Energy and ATP!



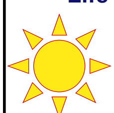


Energy needs of life

- Organisms are <u>endergonic</u> systems
  - What do we need energy for?
    - synthesis (biomolecules)
    - reproduction
    - active transport
    - movement
    - temperature regulation

Flow of energy through life

- Life is built on chemical reactions

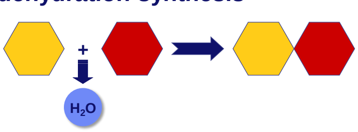


Chemical reactions of life

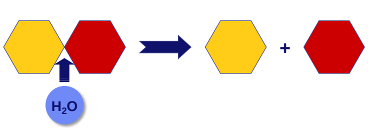
- Metabolism
  - <u>forming bonds</u> between molecules
    - dehydration synthesis
    - anabolic reactions
  - <u>breaking bonds</u> between molecules
    - hydrolysis
    - catabolic reactions

Examples

- dehydration synthesis

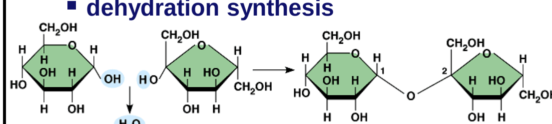


- hydrolysis

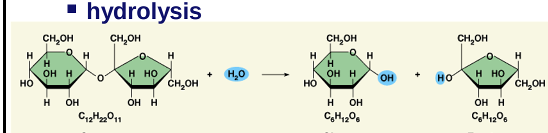


Examples

- dehydration synthesis



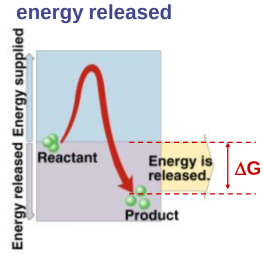
- hydrolysis



Chemical reactions & energy

- Some chemical reactions <u>release energy</u>
  - exergonic
  - digesting polymers
  - hydrolysis = catabolism
- Some chemical reactions require <u>input of energy</u>
  - endergonic
  - building polymers
  - dehydration synthesis = anabolism

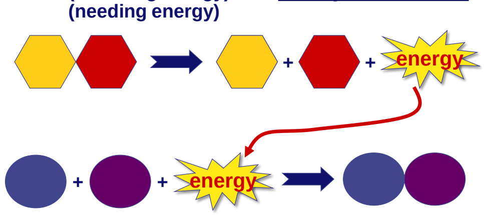
Endergonic vs. Exergonic reactions



-ΔG = change in free energy = ability to do work

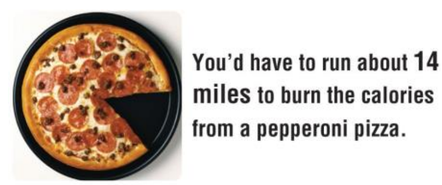
Energy & life

- Organisms require energy to live
  - where does that energy come from?
    - often via coupling <u>exergonic reactions</u> (releasing energy) with <u>endergonic reactions</u> (needing energy)



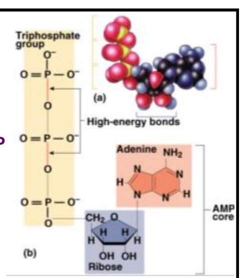
Living economy

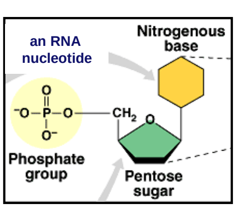
- Fueling the economy
  - eat high energy organic molecules (food)
  - break them down = <u>catabolism</u> (digest)
  - capture energy in form cell can use
- Need an <u>energy</u> currency
  - a way to pass energy around



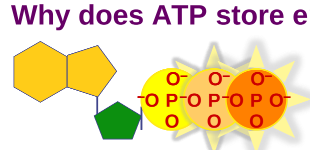
ATP

- Adenosine Tri<u>phosphate</u>
  - modified nucleotide
    - adenine + ribose + $P_i \rightarrow$ AMP
    - AMP + $P_i \rightarrow$ ADP
    - ADP + $P_i \rightarrow$ ATP

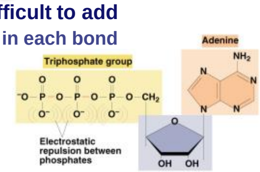




Why does ATP store energy?

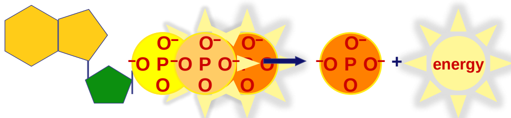


- Each P_i group more difficult to add
  - a lot of stored energy in each bond
    - most stored in 3rd P_i
    - ΔG = -7.3 kcal/mole
- Close packing of negative P_i groups
  - *spring-loaded*



The instability of its P bonds makes ATP an excellent energy donor

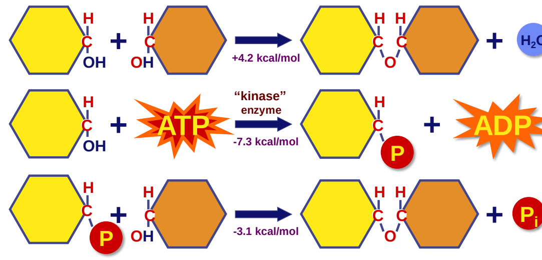
How does ATP transfer energy?



- **Phosphorylation**
  - when ATP does work, it transfers its 3rd P_i to other molecules
    - ATP → ADP
    - releases energy
      - ΔG = -7.3 kcal/mole (-30kJ/mol)
    - it destabilizes the other molecule

An example of Phosphorylation…

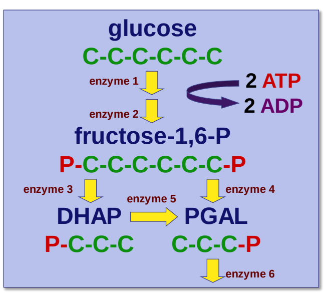
- **Building polymers from monomers**
  - need ATP for energy & to take the water out



Kinases are enzymes involved with moving phosphate groups!

Another example of Phosphorylation…

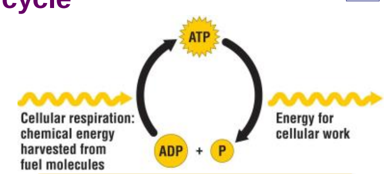
- **The first steps of cellular respiration**
  - beginning the breakdown of glucose → ATP



ATP / ADP cycle

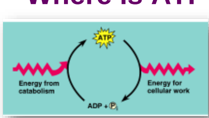
Can't store ATP for long periods

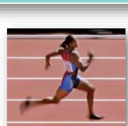
- too reactive
- transfers P_i too easily
- only short term energy storage
  - carbs & fats are long term energy storage

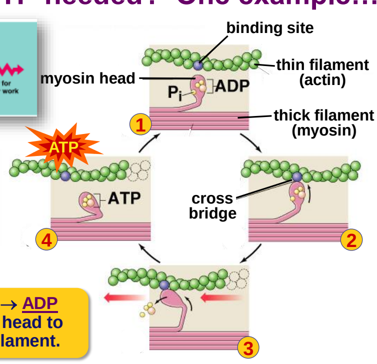


A working muscle recycles over 10 million ATPs per second

Where is ATP needed? One example…







Cleaving ATP → ADP allows myosin head to bind to actin filament.