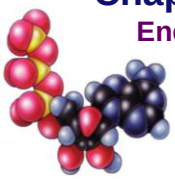
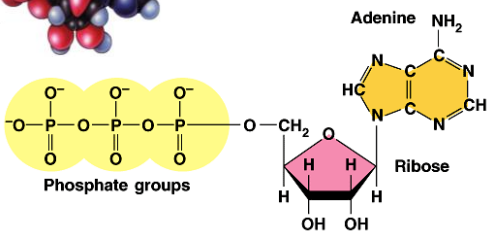
Chapter 8.1 – 8.2

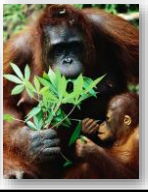
Energy and ATP!





Energy needs of life

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

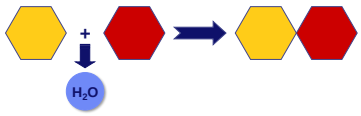


Chemical reactions of life

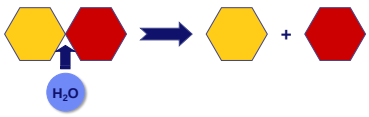
- Metabolism
  - forming bonds between molecules
    - dehydration synthesis
    - anabolic reactions
  - breaking bonds between molecules
    - hydrolysis
    - catabolic reactions

Examples

- dehydration synthesis

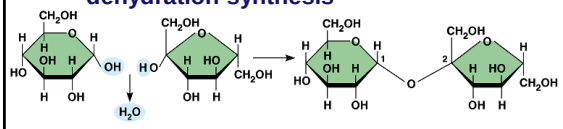


- hydrolysis

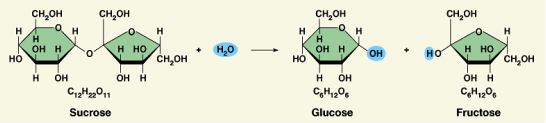


Examples

- dehydration synthesis



- hydrolysis

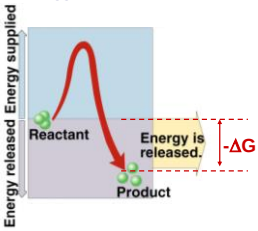


Chemical reactions & energy

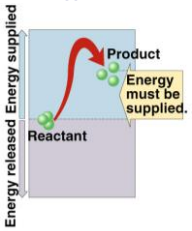
- Some chemical reactions release energy
  - exergonic
  - digesting polymers
  - hydrolysis = catabolism
- Some chemical reactions require input of energy
  - endergonic
  - building polymers
  - dehydration synthesis = anabolism

Endergonic vs. Exergonic rxn profiles

exergonic
energy released



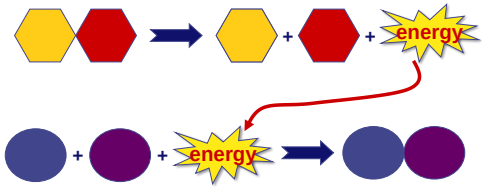
endergonic
energy invested



-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 exergonic reactions (releasing energy) with endergonic reactions (needing energy)



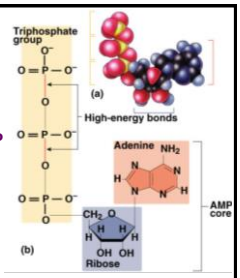
Living economy

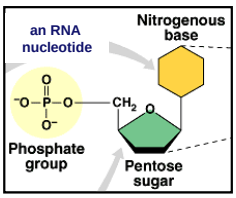
- Fueling the economy
  - eat high energy organic molecules (food)
  - break them down = catabolism (digest)
  - capture energy in form cell can use
- Need an energy currency
  - a way to pass energy around

You'd have to run about 14 miles to burn the calories from a pepperoni pizza.

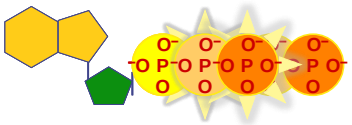
ATP

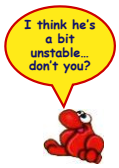
- Adenosine Triphosphate
  - modified nucleotide
    - adenine + ribose + P_i → AMP
    - AMP + P_i → ADP
    - ADP + P_i → ATP



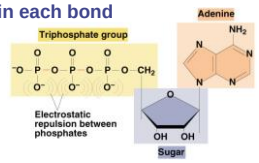


Why does ATP store energy?



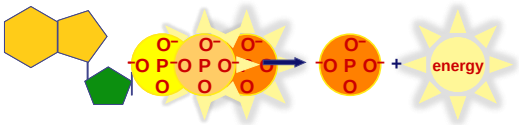


- Each P_i group more difficult to add
  - a lot of stored energy in each bond
    - most stored in 3rd P_i
    - ΔG = -7.3 kcal/mole
- Close packing of negative P_i groups
  - *spring-loaded*



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

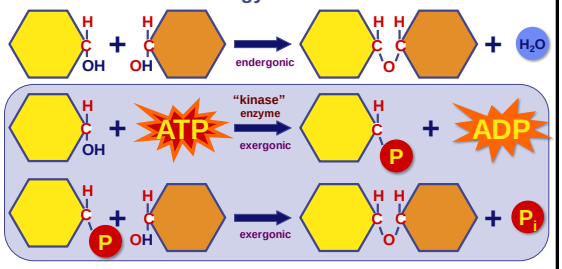
How does ATP transfer energy?



- 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)
  - **phosphates destabilize other molecules!**

An example of Phosphorylation…

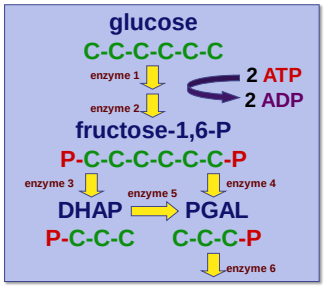
- Building polymers from monomers
  - need ATP for energy & to take the water out



Kinases are enzymes involved with moving phosphate groups!

Another example of Phosphorylation…

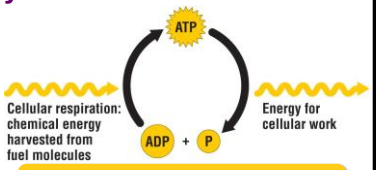
- The first steps of cellular respiration
  - beginning the breakdown of glucose → ATP



ATP / ADP cycle

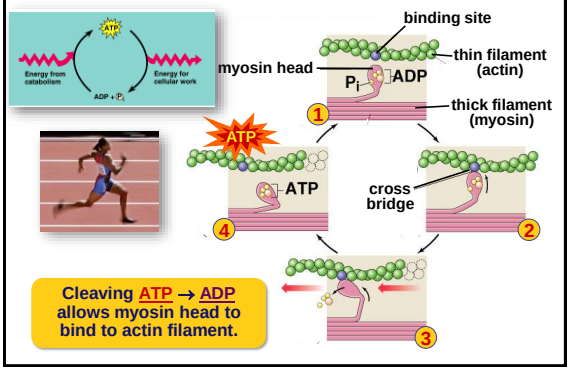
Can't store ATP for long periods

- 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.