Chapter 6
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

Flow of energy through life
- Life is built on chemical reactions

**Chemical reactions of life**
- Metabolism
  - **forming bonds** between molecules
    - dehydration synthesis
    - anabolic reactions
  - **breaking bonds** between molecules
    - hydrolysis
    - catabolic reactions

Examples
- dehydration synthesis
  ![Dehydration synthesis example](image)
- hydrolysis
  ![Hydrolysis example](image)

Can you please pass the salt?
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 reactions
- exergonic
  - energy released
- endergonic
  - energy invested

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

ATP
- Adenosine Triphosphate
  - modified nucleotide
    - adenine + ribose + P\textsubscript{i} → AMP
    - AMP + P\textsubscript{i} → ADP
    - ADP + P\textsubscript{i} → ATP

Why does ATP store energy?
- Each P\textsubscript{i} group more difficult to add
  - a lot of stored energy in each bond
    - most stored in 3rd P\textsubscript{i}
      - ΔG = -7.3 kcal/mole
- Close packing of negative P\textsubscript{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 $\rightarrow$ ADP
    - releases energy
    - $\Delta G = -7.3 \text{ kcal/mole (-30kJ/mol)}$
    - it destabilizes the other molecule

**An example of Phosphorylation...**

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

**Another example of Phosphorylation...**

- **The first steps of cellular respiration**
  - beginning the breakdown of glucose $\rightarrow$ 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

**Where is ATP needed?**

- Cleaving ATP $\rightarrow$ ADP allows myosin head to bind to actin filament.