**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

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)
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
  - Reactant → Product
  - \( \Delta G \) = change in free energy = ability to do work

- **Endergonic**
  - Energy invested
  - Reactant → Product
  - Energy must be supplied.

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\(_i\) → 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\(_i\)
    - \( \Delta G = -7.3 \) 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
    - \( \text{ATP} \rightarrow \text{ADP} \)
    - releases energy
      - \( \Delta G = -7.3 \text{ kcal/mol (-30kJ/mol)} \)
      - 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? One example...

- Cleaving \( \text{ATP} \rightarrow \text{ADP} \) allows myosin head to bind to actin filament.

Cellular respiration chemical energy harvested from food molecules

A working muscle recycles over 10 million ATPs per second