# ***Chapter 6: Energy, Enzymes, & Metabolism***

I. **Metabolism** - *Sum of all chemical reactions in a cell/organism*
   A. Organisms need a source of energy & a source of carbon: ***Fig. 6.1***

II. **Energy** - *A system's capacity to do work*
   A. **Can be converted between forms (*ex.* potential→kinetic)**
      1. When energy changes forms, it's conserved but less is available for work because of loss to entropy (i.e. heat, usually)
   B. **Molecules contain potential energy**
      1. Electrons farther from the nucleus have more potential energy
      2. *Ex.* ATP contains potential energy because of clustering of 3 negative O charges

III. **Chemical Reactions** – processes in which molecules are transformed
   A. Reactions have **direction & rate**
      1. Energy & concentration of reactants drive direction & rate
   B. **H/G/T/S**
      1. **H = G + TS**
         a. *H = enthalpy = total energy*
         b. *G = free energy (FE) = usable energy for work*
         c. *T = Temperature*
         d. *S = entropy or unusable energy*
      2. **G = H – TS**
      3. **$\Delta G = \Delta H - T\Delta S$**
   C. **Exergonic vs. Endergonic Reactions**
      1. **$\Delta G = \Delta H - T\Delta S$**
      2. $\Delta G < 0$: **exergonic** reaction (spontaneous, free energy released)
         a. *Spontaneous* – reaction that occur without an input of free energy
            *i.* May occur very slowly at a given temperature
            *ii.* Reaction rate (kinetics) is in depended of reaction spontaneity
         b. ATP Hydrolysis (ATP → ADP + P) is exergonic
            *i.* $\Delta G$ = -7kcal/mol
      3. $\Delta G > 0$: **endergonic** reaction, NOT spontaneous, requires input of free energy
      4. Cells couple exergonic & endergonic reactions to "push" the endergonic reaction forward
         a. Energy from the exergonic reaction is used to drive the endergonic one
   D. **Catabolism/Anabolism**
      1. **Catabolic** reactions/pathways: break down molecules & store energy in molecules (*ex.* ATP synthesis)
      2. **Anabolic** reactions: use energy to build molecules

## IV. <u>Enzymes</u>

- **A.** Usually proteins
- **B.** Big (compared to reactant molecules)
- **C.** Catalyze reactions
- **D.** Specific to substrates
- **E.** Energy diagram: Reaction process vs. Free energy
  - **1.** Transition state: highest energy state (peak)
- **F.** How enzymes decrease activation energy
  - **1.** Reactants change shape when they bind with enzyme, which strains bond energy
    - **a.** Easier to remove molecules needed for reaction (*ex.* ATP → ADP + P)
  - **2.** Reactants are close together
    - **a.** Some enzymes bind to both reactants needed for a reaction, increasing the likelihood that the reactants will contact each other

## V. <u>Metabolic Pathway</u> – *a coordinated series of chemical reactions*

- **A.** Each step is typically catalyzed by a single enzyme