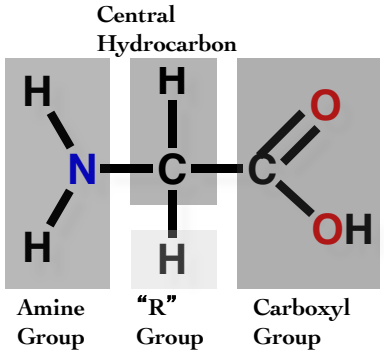
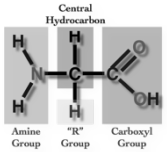
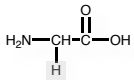
Proteins are composed of monomers called **amino acids**

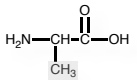


• ALL amino acids have the exact same structure *except* for the "R" Group

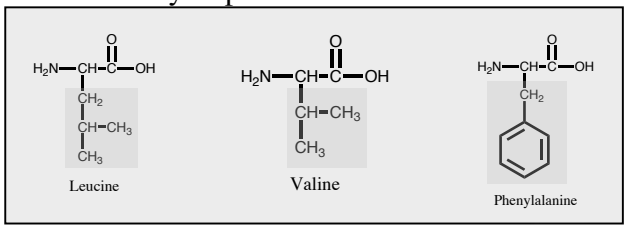
There are **20** different amino acids



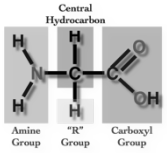

Glycine

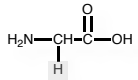

Alanine

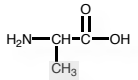
Hydrophobic Amino Acids



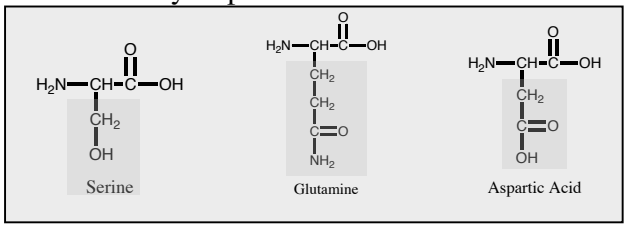
There are **20** different amino acids



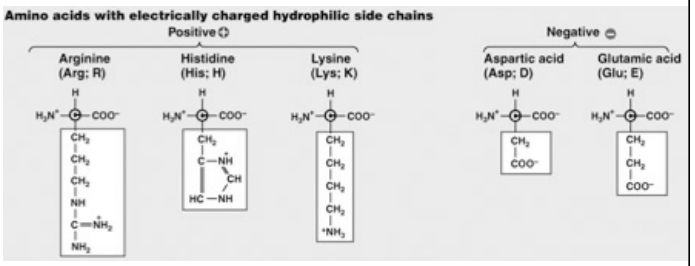

Glycine


Alanine

Hydrophillic Amino Acids

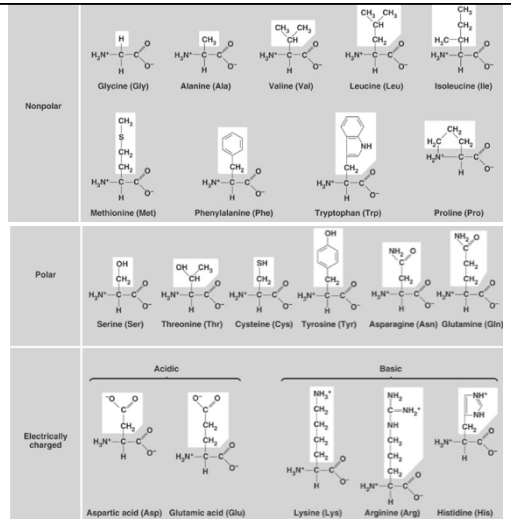


Charged amino acids (side-chains)

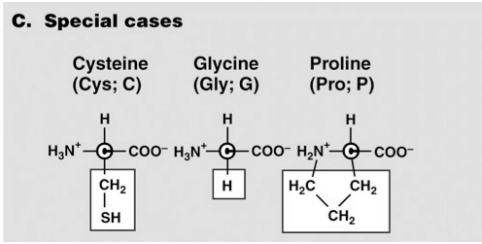


Are these polar or nonpolar side chains??

20 Amino Acids



Special amino acids



Cysteine has –SH that can react with another to form disulfide bridge. Controls peptide folding.

Glycine- small side chain allows it to pack tightly and fit in tight corners

Proline- ring structure limits its ability to rotate and form bonds. Stabilizes bends and loops.

There are **20** different amino acids

The type of R-Group will affect the 3-dimensional structure of the protein

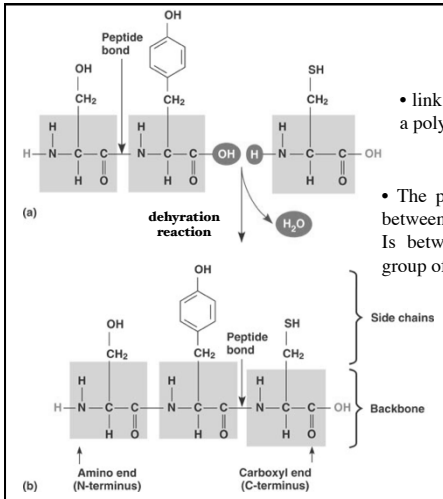
AMINO ACID			SIDE CHAIN
Aspartic acid	Asp	D	negative
Glutamic acid	Glu	E	negative
Arginine	Arg	R	positive
Lysine	Lys	K	positive
Histidine	His	H	positive
Asparagine	Asn	N	uncharged polar
Glutamine	Gln	Q	uncharged polar
Serine	Ser	S	uncharged polar
Threonine	Thr	T	uncharged polar
Tyrosine	Tyr	Y	uncharged polar

POLAR AMINO ACIDS

AMINO ACID			SIDE CHAIN
Alanine	Ala	A	nonpolar
Glycine	Gly	G	nonpolar
Valine	Val	V	nonpolar
Leucine	Leu	L	nonpolar
Isoleucine	Ile	I	nonpolar
Proline	Pro	P	nonpolar
Phenylalanine	Phe	F	nonpolar
Methionine	Met	M	nonpolar
Tryptophan	Trp	W	nonpolar
Cysteine	Cys	C	nonpolar

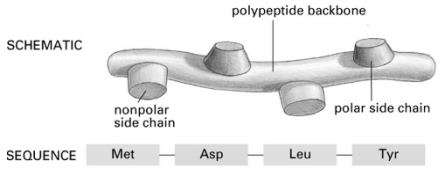
NONPOLAR AMINO ACIDS

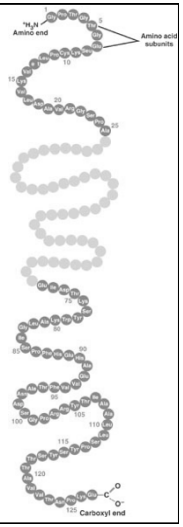
Peptide bonds



- link amino acids together to form a polypeptide chain
- The peptide bond does NOT occur between the "R" groups. Is between the amino and carboxyl group of the "backbone"

Peptide Bonds Form Chains (**Primary** Structure)

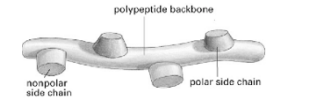


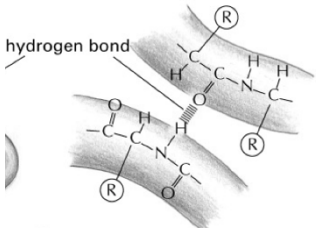


The **sequence** of amino acids constitutes the **primary structure** of a protein.

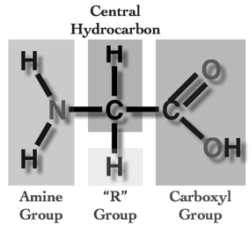
Held together by covalent peptide bonds.

Protein **Secondary** Structure



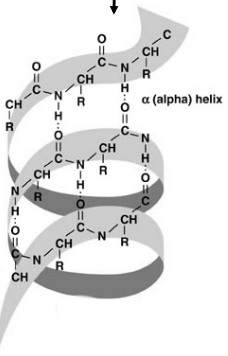


Secondary Structure Arises From the Hydrogen Bonds Between the ***Peptide Backbone***



Protein **Secondary** Structure

Amino acid sequence is **primary structure**



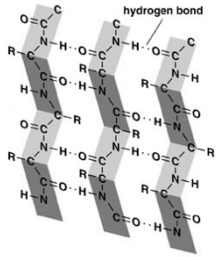
The **alpha helix** arises from hydrogen bonds within the amino acid chain itself.

The **R-groups** play only minor roles, if any, in stabilizing secondary structure

Protein **Secondary** Structure

Amino acid sequence is **primary structure**

β-pleated sheet

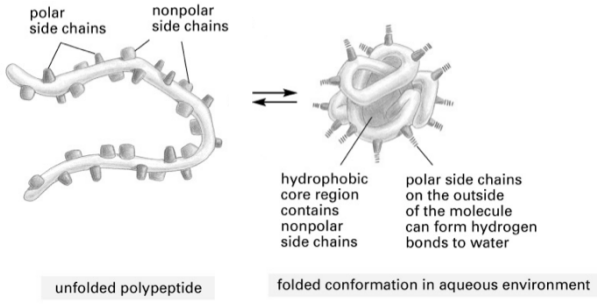


The **beta sheet** arises from hydrogen bonds within the amino acid chain itself.

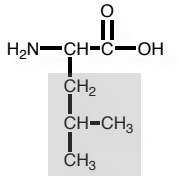
The **R-groups** play only minor roles, if any, in stabilizing secondary structure

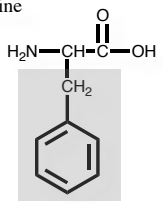
Protein **Tertiary** Structure

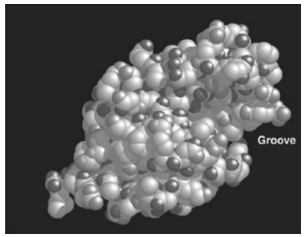
Tertiary Structure Arises From Folding of the
Amino Acid Sidechains (R groups)



The Hydrophobic Effect

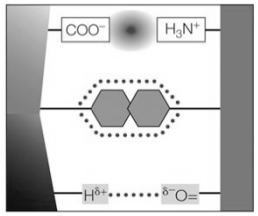






Hydrophobic side-chains will be near the center, *stabilized by van der Waals forces.*

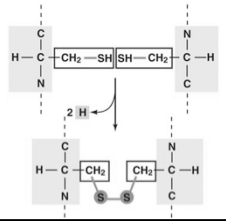
Protein **Tertiary** Structure, continued:



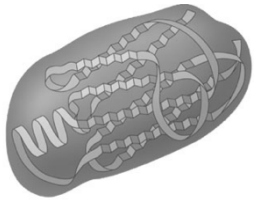
Ionic interactions occur between charged R groups.

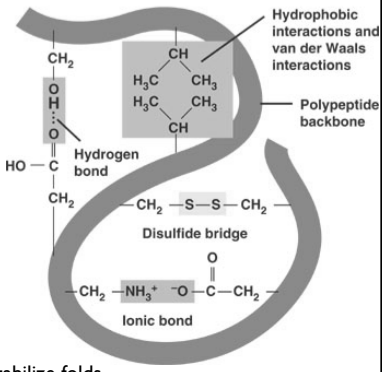
Two nonpolar groups interact **hydrophobically.**

Hydrogen bonds form between two polar groups.



Cysteine R group contains –SH. Can react with second –SH to form a **disulfide bridge**





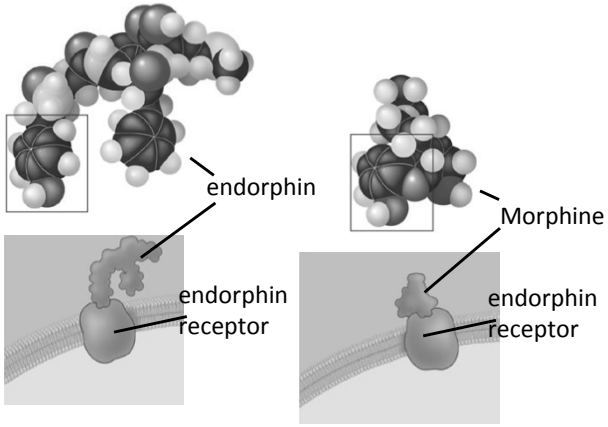
H-bonds between side chains stabilize folds

Ionic interactions form salt bridges

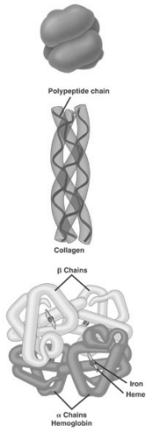
Hyrdrophobic side chains aggregate in interior

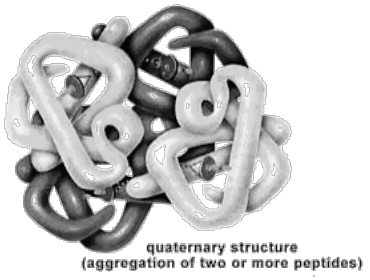
van der Waals stabilize hydrophobic side chains

Proteins Have 3D Shape



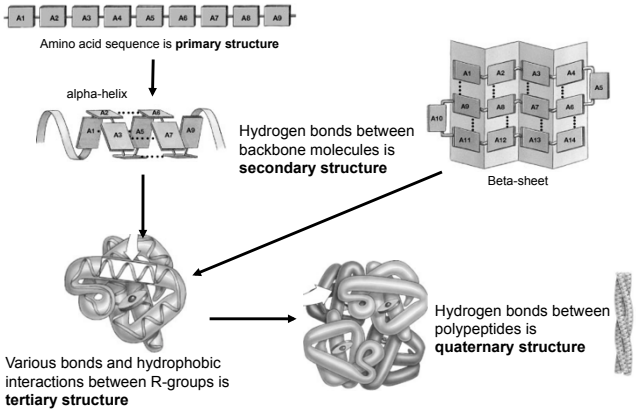
Quaternary structure



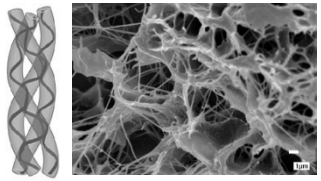


Results from the way different protein subunits bind and interact

Protein Structure–Review

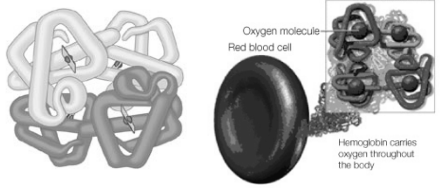


The Results of Protein Folding

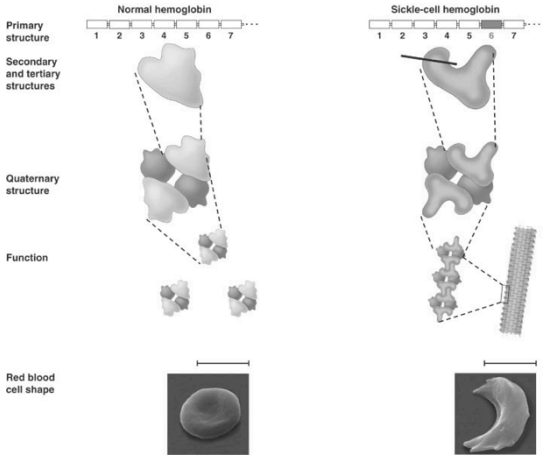


Collagen

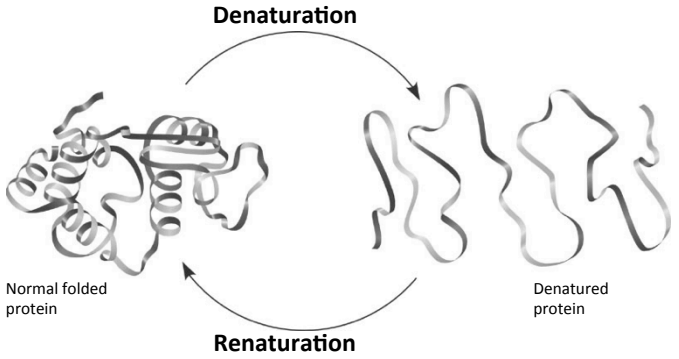
Hemoglobin



Sickle Cell Anemia



Proteins Can "Unfold"



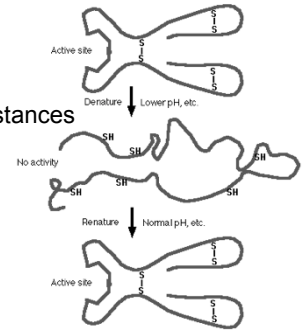
What external stimuli affect protein structure?

-Increase in temperature

-Alterations in H+ concentrations

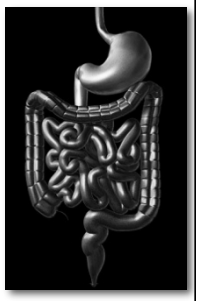
-high concentrations of polar substances

-nonpolar substances



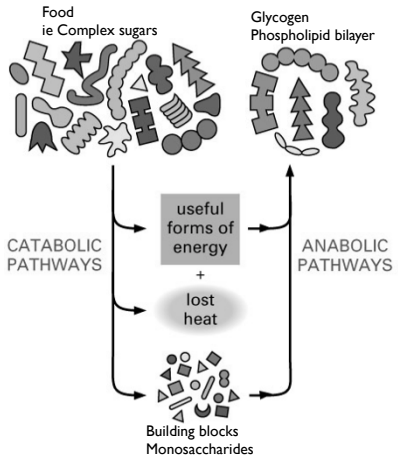
Metabolism

Catabolism is the process of breaking down large molecules to smaller components



Anabolism is the synthesis of new molecules from smaller components

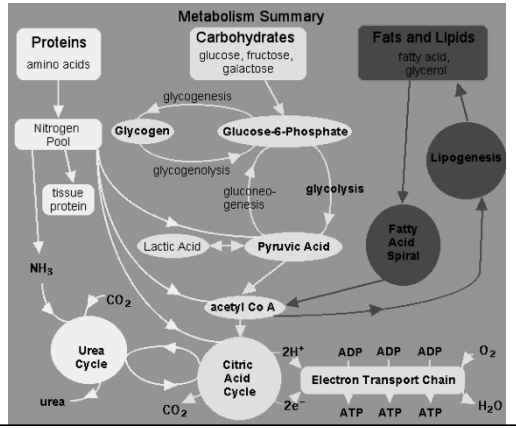
Metabolism



Metabolism- Sum of all chemical reactions in a cell

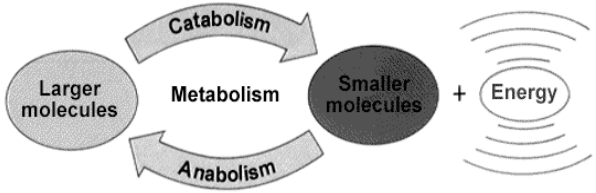
Sucrose + H2O ➔ fructose + glucose

Reactants products



Breakdown

Proteins to Amino Acids, Glycogen to Monosaccharides

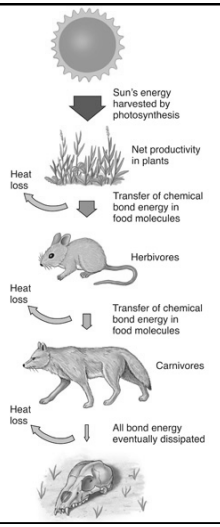


Synthesis

Amino Acids to Proteins, Nucleotides to Nucleic acids

Energy

- Energy is the capacity of a physical system to perform work.
- The ultimate source of energy for most living things is the sun.



Energy

Energy - The capacity to do work (to move matter against an opposing force).

Potential Energy - The energy stored by matter as a result of its location or spatial arrangement.

Potential Energy (gravitational)

Kinetic Energy

Kinetic Energy - The energy of motion, which is directly related to the speed of that motion. Moving matter does work by imparting motion to other matter.

Thermodynamics I

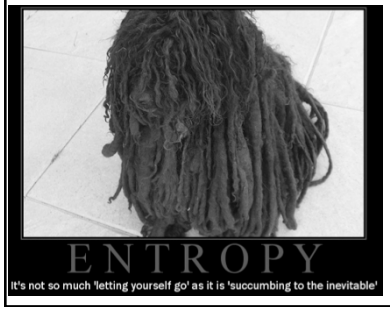
A. Energy cannot be created or destroyed

B. Energy can only be transformed into another form

Thermodynamics II

A *closed* system moves toward entropy, increasing disorder.

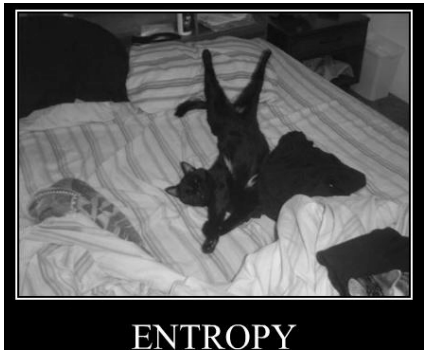
Living systems are open systems that maintain organization and increase it during development



Life increases **order**...
but increases overall **disorder** (entropy) in the process

Chaos will reign

Entropy is a measure of disorder in the system



Eg. Anabolic reactions required to make 1kg of your body requires 10kg of food. Rest is "waste:.

5 principles governing metabolism

•Complex chemical transformations occur through a series of separate intermediate reactions.

•These reactions are catalyzed by specific enzymes.

•These enzymes are activated/inactivated to control reaction rate.

•Most metabolic pathways are similar between organisms.

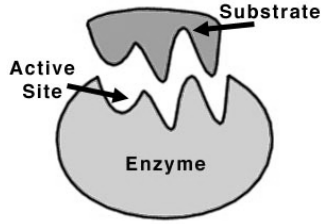
•In eukaryotes these metabolic pathways are compartmentalized in organelles.

Biological catalysts: Enzymes….

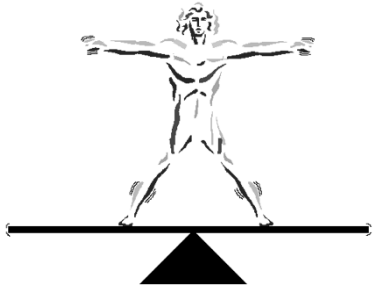
Catalysts: Proteins that speed up biochemical reactions
Increase reaction rates without themselves being altered

these reactions may occur without catalysts, but too slowly

Enzyme: most common type of catalyst



Enzymes catalyze metabolic reactions and maintain **homeostasis**



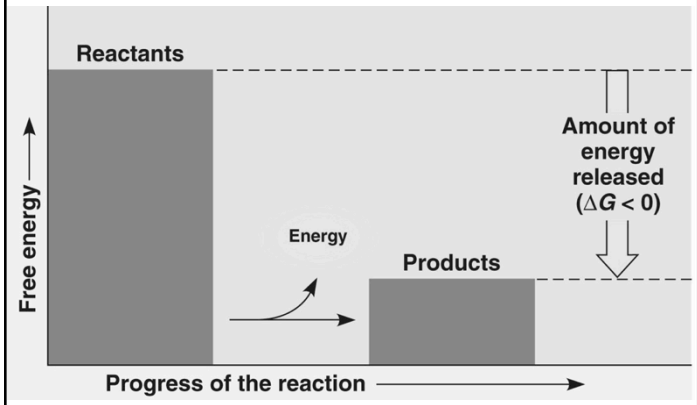
How do cells create this balance?

- regulation of enzyme expression levels
- regulation of enzyme activity

Free Energy (ΔG)

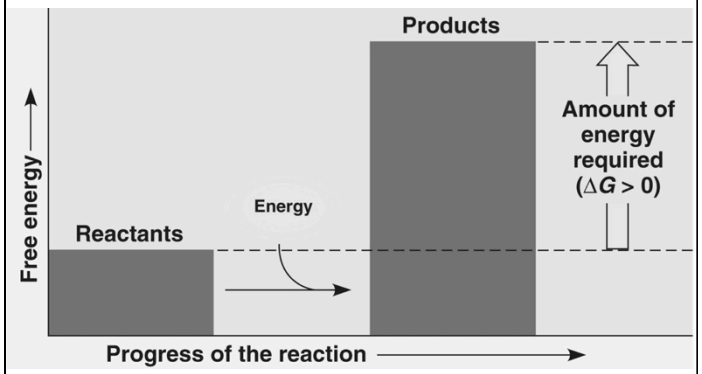
- **Free energy** – the energy available for doing work.
  - Most chemical reactions release free energy
    - they are **exergonic**.
      - Downhill
  - Some reactions require the input of free energy
    - they are **endergonic**.
      - Uphill

Exergonic Reaction



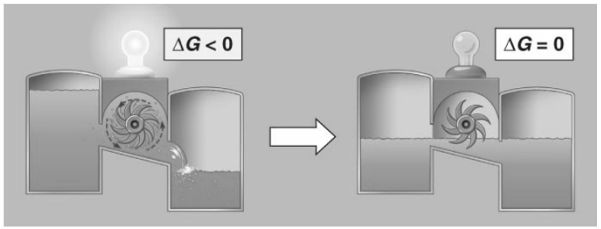
Notice the value of ΔG

Endergonic Reaction



Notice the value of ΔG

Exergonic Reactions can perform Work



A reaction that releases energy (-ΔG) can "change" a system

Equilibrium has ΔG of 0

Exergonic and endergonic reactions are often "coupled"