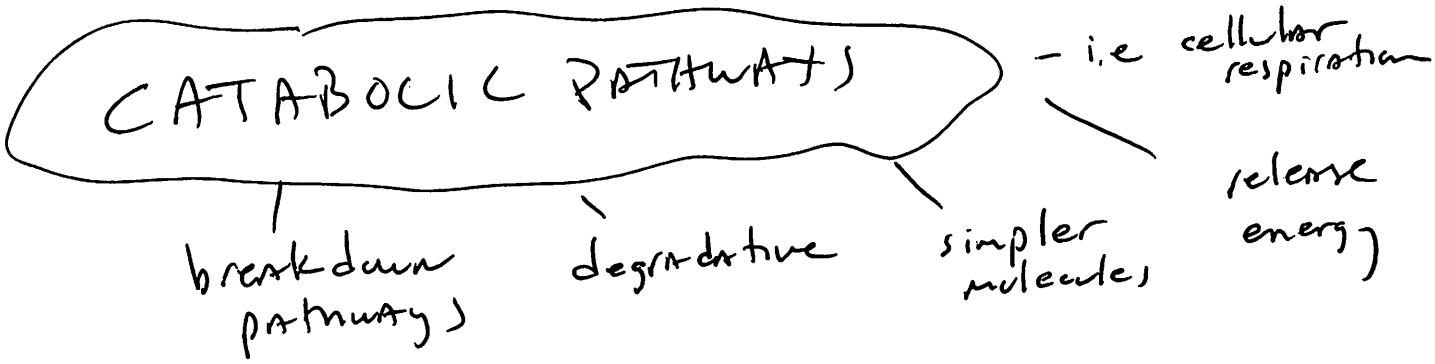
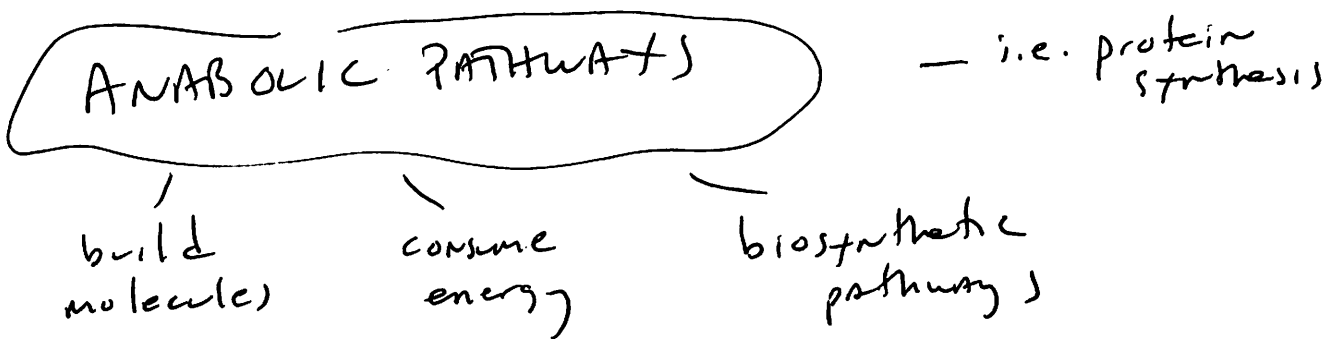
6.1.

Metabolism – sum total of an organism's chemical reactions
– emergent property

Metabolic "Pathway"
– series of defined steps (modifications) resulting in a product
– catalyzed by specific **ENZYMES**





BIG IDEA

ENERGY released from the "downhill" reactions of CATABOLIC PATHWAYS can be **STORED** and **USED** to drive uphill reactions of ANABOLIC PATHWAYS.

BIO-ENERGICS – energy flowing through living organisms

Forms of Energy

Kinetic Energy (KE)

- energy of motion

Thermal Energy

- kinetic energy associated with the random motion of atoms or molecules.

Heat – thermal energy being transferred from one object to another.

Potential Energy

- energy that matter possesses because of its location ⇒ positional

Chemical Energy

- refers to the potential energy available for release in a chemical reaction.

✡ Living Organisms are Energy Transformers

Thermodynamics

- study of energy transformations.

"System" – the matter under study

"Surroundings" – the rest of the universe

OPEN SYSTEM

- energy and matter can be transferred between the system and surroundings.

i.e. living organisms.

1st Law of Thermodynamics

✱ Principle of the conservation of energy.

→ Energy can be transferred or transformed, but it cannot be CREATED or DESTROYED

2nd Law of Thermodynamics

✱ ENTROPY is a measure of disorder or randomness

→ Every energy transfer or transformation INCREASES the ENTROPY of the universe.

Spontaneous Process (ENERGETICALLY FAVORABLE)

- A process that can occur without an input of ENERGY
- for a process to occur on its own it must increase the entropy of the universe.
- A NON-SPONTANEOUS process will only occur with energy added

→ "For a process to occur spontaneously, it must increase the entropy of the universe."

6.2

$$\Delta G = \Delta H - T\Delta S$$

$\Delta G = -686$ kcal/mol

Respiration

Exergonic Reaction
- net release of free energy
- ΔG is NEGATIVE
- spontaneous (not necessarily quick)

Endergonic Reaction
- Absorbs free energy from surroundings
- ΔG is POSITIVE
- non-spontaneous

photosynthesis

$\Delta G = +686$ kcal/mol

6.3 Three Types of Cellular Work

1) Chemical
2) Transport
3) Mechanical

ENERGY COUPLING ★
- the use of an exergonic process to drive an endergonic one

↳ ATP MEDIATES

ATP Hydrolysis

$$ATP + H_2O \Rightarrow ADP + P_i$$
$$\Delta G = -7.3 \text{ kcal/mol}$$

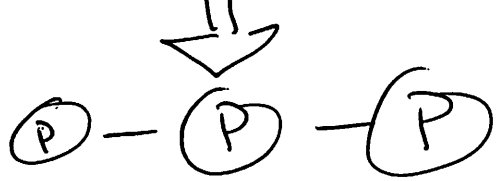
ATP interesting stuff

→ "high-energy" phosphate bonds ?

↓

NOT really !! ⇒ the release of energy during the hydrolysis of ATP comes from the chemical change to a state of lower free energy, not from the phosphate bonds themselves

⇒ ATP hydrolizes so easily because the 3 phosphate groups are negatively charged, crowded, and repulsive



is like a compressed spring !!

KEY to coupling is:

Phosphorylated Intermediates

See FIG 6.9.

↳ enables an otherwise endergonic reaction to become overall exergonic and therefore spontaneous.

6.4 Enzymes

- Enzyme is a biological catalyst
- catalysts lower ACTIVATION ENERGY (E_A)

See Fig 6.12

Substrate

- the reactant an enzyme acts upon
- when the enzyme binds to it, the name is ENZYME-SUBSTRATE COMPLEX

ACTIVE SITE

- restricted area of the enzyme molecule that actually binds to the substrate

★ the specificity of an enzyme is attributed to a complementary fit between the shape of its ACTIVE SITE and the shape of the substrate

See Fig 6.15

1. Proper orientation
2. Distort toward transition state
3. conducive micro-environment - ph
4. Direct participation.

Effects of Temp and pH

- each enzyme has an optimal temp and pH due to 3-D structure of proteins

Cofactors

- non-protein "helpers"
- can be inorganic – i.e. Zn, Fe, Cu ions

or

organic (co-enzymes) ⇒ VITAMINS

Enzyme Inhibitors (reversible)

(1) Competitive Inhibitors

- mimic substrate molecules
- compete for admission into ACTIVE SITE
- block substrate from active site

↳ to overcome, increase concentration of substrate.

(2) Non-competitive Inhibitors

- bind to another part of enzyme (NOT ACTIVE site)

↓

conformational change

↓

substrate can't bind effectively !

- toxins, poisons, antibiotics can be irreversible inhibitors — bond to enzyme and permanently alter it.

Regulation of Gene Activity

Allosteric Regulation

- Molecules that naturally regulate enzyme activity by behaving like reversible non-competitive inhibitors

↳ function of protein at one site is affected by the binding of a regulatory molecule at a separate site

↓↓

may result in:

(1) Inhibition of Enzyme
or
(2) Stimulation of Enzyme.

Allosteric Activators
and
Allosteric Inhibitors

→ oscillates between "active" and "inactive" shape.

Feedback Inhibition

↓

A metabolic pathway is switched "off" by the inhibitory binding of its end product to an enzyme that acts early in the pathway.

See Fig 6.19

Super Cool!!