Chpt 8: An Introduction to Metabolism

we will use this chapter to look at energy and enzymes

Energy: the capacity to do work

Why do cells need E?

-to make larger more complex molecules

monosacc------> disacc---->polysacc

AA + AA+ AA---------->polypeptides

-to break down worn out cell parts

-to move things in & out of cells: active transport

-to move cells: sperm, WBC -

-to reproduce, make more cells

Why do organisms need E?

-to grow

by increasing number of cells in body

-to develop

by making more complex structures

cells---->tissues---->organs---->org sys

-to move in response to environment

-to reproduce

First Law of Thermodynamics or Law of Conservation of E

E of the universe is constant, E cannot be created nor destroyed, instead it can be transferred or transformed

How does this law apply to living organisms?

where do we get our E from?

is E exchange totally efficient?

Second Law of Thermodynamics

as E is transferred, some E is always lost, so systems tend to change in a way that increases entropy or disorder

world becomes increasingly disordered as free E is released

non biological example: my attic

But...life is organized! you started as a single fertilized egg, you gained cells, tissues, organs, organ systems

at birth you were much more organized than that single fertilized egg and that has continued, you have gotten more complex

how are you defying the 2nd Law?

when do organisms finally obey the 2nd Law?

Cellular Metabolism: the sum total of all the chemical reactions that take place in body
there are 2 kinds of rx: synthesis and decomposition reactions

-synthesis rx: make larger molecules
what process fits here?
in synthesis rx, we put E in and store that E in chemical bonds
ex: make carbs fr glucose, prot fr AA

-decomposition rx: breaks down molecules
what process fits here?
in decomposition rx, we release free E
ex: break down proteins into AA

what is our food E molecule? glucose

but there is too much E in glucose, so we convert it to a chemical E molecule

ATP is our chemical E molecule

it is a nucleotide: made of adenine, ribose & 3 PO4 groups

ATP: adenosine triphosphate

ADP: adenosine diphosphate

AMP: adenosine monophosphate

A-P~P~P the P to P bonds are high E bonds

when we break these, we release E into the cell to do work

A-P~P~P---------->A-P~P + P + E

ATP---------->ADP + P + E releases E

ATP <----------ADP + P + E stores E

In living organims, E transfers involve Oxidation/ Reduction Reactions

oxidation: the removal of e- from molecule
those electrons are then given to another

reduction: the addition of e- to a molecule
these are paired reactions

when you remove e- from a molecule, it is lower in E
when you add e- to molecule, it is higher in E
it is called reduction b/c you are lowering the charge, thus, making it more negative

OIL RIG: oxidation is less, reduction is more

Catalysts: anything that speeds up chemical rx
anything that lowers the activation E
what is activation E?
E required to start a rx
what did you use in chemistry? heat

living things are constantly undergoing chemical reactions (metabolism)
every rx needs activation E, why can't we use heat?

Enzymes are biological catalysts
enzymes are proteins
every chem rx in body is catalyzed by a specific enzyme
names of enzymes end in -ase
ex. lactase

Enzymes are specific

1-each enzyme works on specific chem rx

- lactase is enzyme to break down lactose
- sucrase breaks down sucrose

2-each enzyme works best in narrow temperature range

- too high temp or too low temp denatures enzyme
- enzyme work best at normal body temp
  - high fever--enzymes don't work well

3-each enzyme works best in narrow pH range

- usually near neutral
- high acid denatures enzyme
- exception is in the stomach
  - stomach has pH 2, enzymes here work best at this pH

denaturing an enzyme: this means the 3D structure of the enzyme is destroyed

remember back to proteins

primary structure: sequence of AA

secondary structure: due to polar R groups, the polypeptide chain begins bending or folding

tertiary structure: due to secondary bending, now other polar parts are attracted and more folding occurs, giving the protein its 3D shape

proteins are not functional until they achieve a 3D shape

too high heat, acid can denature enzymes or destroy the 3D shape, then they no longer function

How do enzymes work?

enzymes have active site: part of enzyme that matches the starting molecules

starting molecules called substrate

there are 2 models of how enzymes work

1-lock & key

active site of enzyme perfectly fits the substrates like a key in a lock

2-induced fit

substrates are attracted to active site & then enzyme changes shape to bring substrates close together

enzymes do not directly enter rx, they bring substrates together, then release them, then enzyme is used again