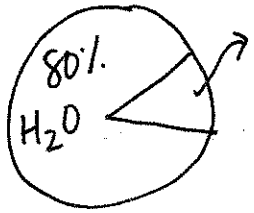
Biochemistry

Organization/Scale: atom → molecules → macromolecule → cell → tissue → organ → ...

What is your atomic composition?

H: 63%.
O: 24%.
C: 10%.
N: 1.4%.
P: 0.2%.
S: <0.1%.

What is your molecular composition?



Dry Weight: 20%.

50% protein
15% carb
10% lipid
15% nucleic acids

Covalent Bonds

→ shared e^- bonds

→ relatively stable (80 kilocal/mol to break)

atom	H	C	O	N	P
Max # Bonds	1	4	2	3 (4)	5

Electronegativity & Polarity

→ How tightly an atom holds onto the e^-

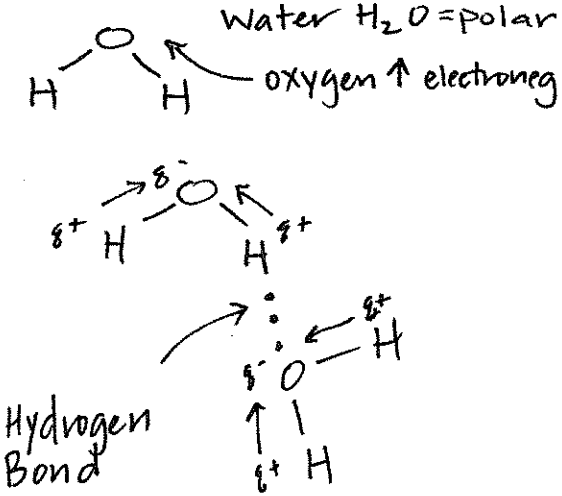
C–C = non-polar, same pull.

O–H = polar, oxygen $\delta^- \leftarrow \delta^+$ pulls @ e^- stronger

N–H = polar, N pulls e^- $\delta^- \leftarrow \delta^+$ stronger

Hydrogen Bonds

Water H_2O = polar

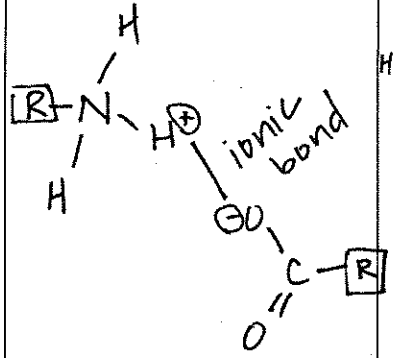


(5 kilocal/mol to break)

→ COHESION: surface tension
- Water – water

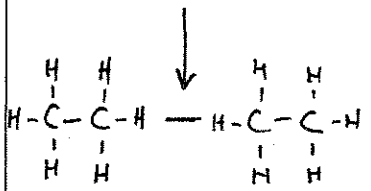
→ ADHESION: plants + towels
- water – other stuff

Ionic Bonds



- stable bonds

Van Der Waals Interactions



slight interactions

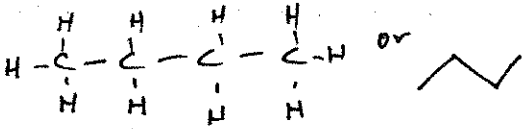
(1 kilocal/mol to break)

If you have a large macromolecule (say a protein), the sum of all these interactions and bonds can results in very stable molecules.

Hydrophobic Interactions

Water · fear/hate

Hydrocarbons –
- oil
- nonpolar



or

oil + water don't mix because nonpolar molecules cannot bond w/ polar molecules.

Hydrophilic Interactions

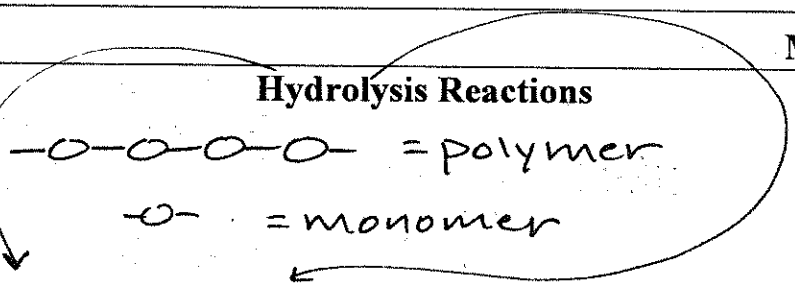
water love

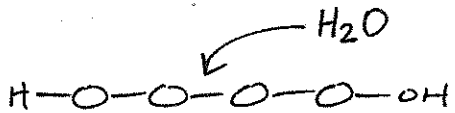
- polar molecules

Amphipatic: molecule with hydrophobic + hydrophilic regions.

Macromolecules

Hydrolysis Reactions



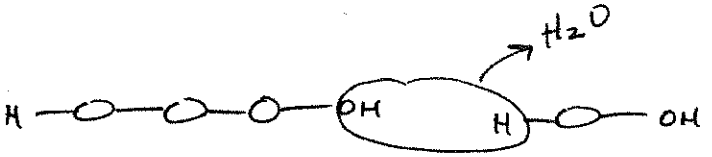


water splits the polymer into smaller pieces.

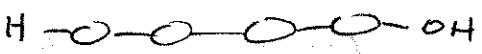
breakdown

Dehydration Reactions

remove Water



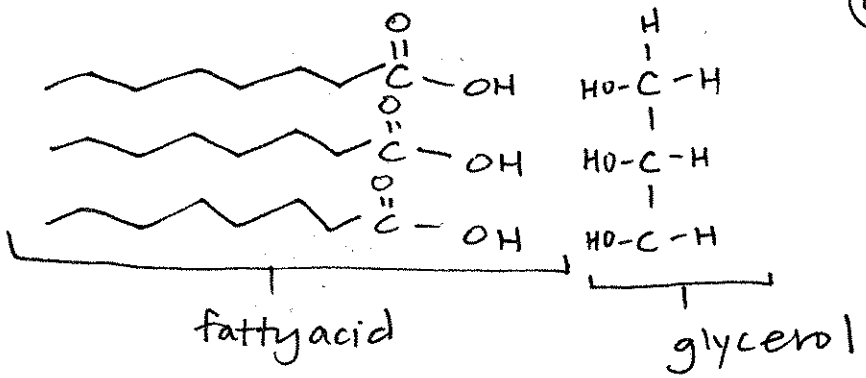
remove water to link together



build / link

Lipids

- oils, waxes, fats
- fat is stored in adipose tissue
- makes membranes, insulates, stores energy

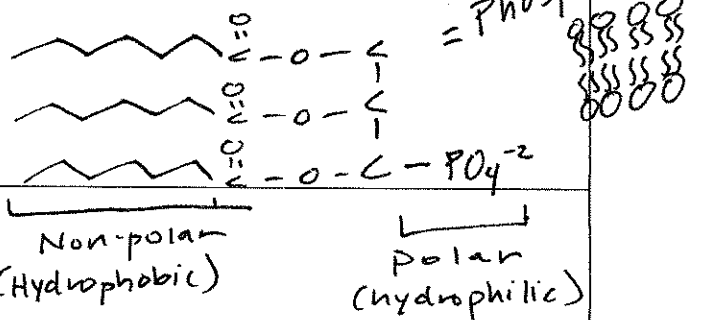


Q: How do we link these?
- Dehydration Rxns

→ Forms a triglyceride

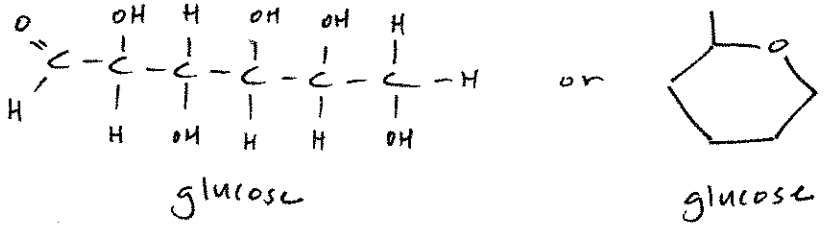
↓

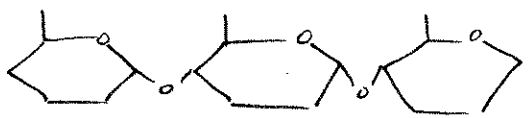
"fat in the blood"



Carbohydrates

- store energy (starch / glycogen)
- structure (cellulose, chitin)





= polysaccharide
- many units of glucose

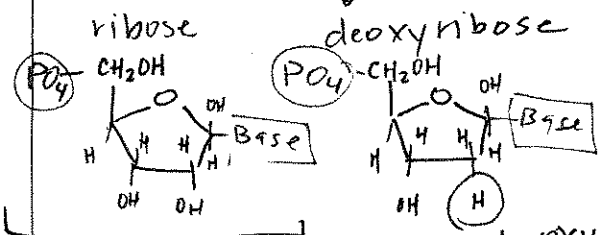
to break + use? = Hydrolysis

* named "-ose"

* length (mono / di / poly saccharides)

Nucleic Acids

- stores genetic infomation
- RNA + DNA



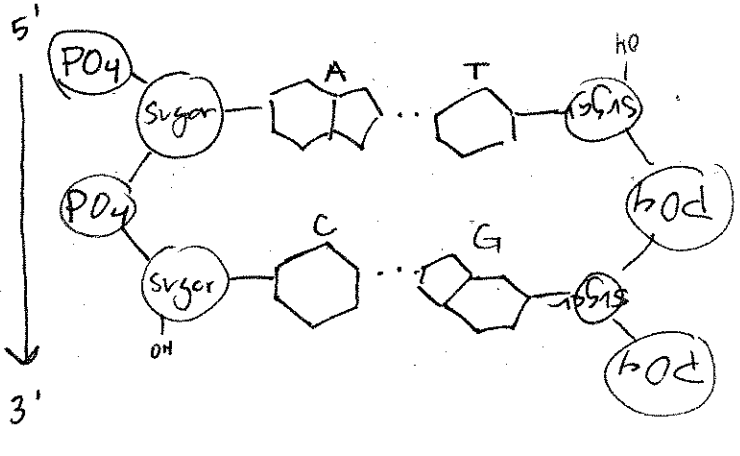
called a nucleotide

Bases: A T C G

Where does "U" go? (RNA)

Purines =  (A, G)

Pyrimidines =  (T, C)



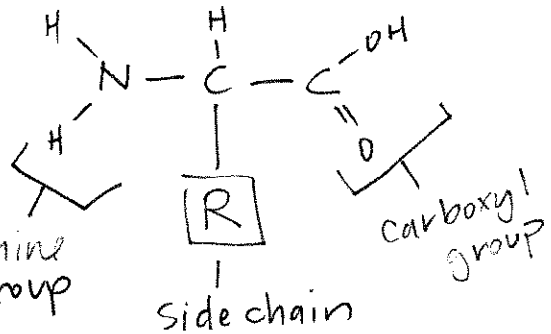
DNA

- antiparallel structure
- A-T
- C-G

Proteins

- Do everything!
- Very diverse + specific infunction

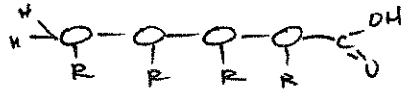
Amino Acids (peptide)



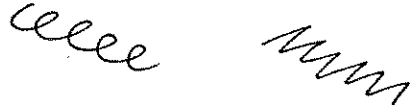
↳ 20 different amino acids

Structure:

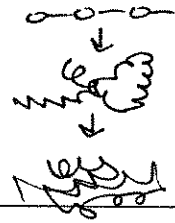
1° primary: a.a.'s linked by dehydration rxns



2° secondary: basic folding α helix + β sheet



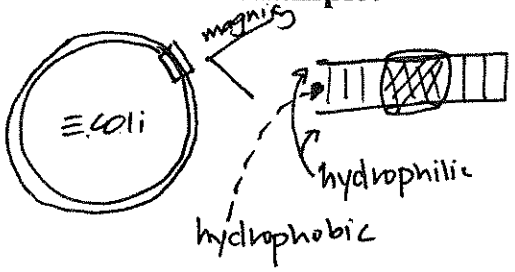
3°/4° structure: more complex folding



* if it's not folded correctly, it will not work ↓

Chaperonin (helps fold correctly)

E.Coli OMPF Example:

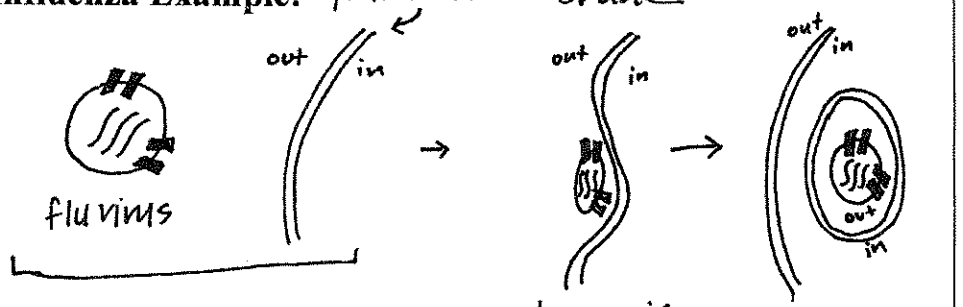


* create a protein that allows molecules through
→ nothing big, nothing charged or hydrophobic
→ allow small polar molecules in.

→ "beta barrel": need hydrophobic sidechains on the outside to keep it between the bilayer.

→ inside the hole: need charged side chains to keep charged ions out.

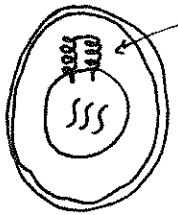
Influenza Example: your cell membrane



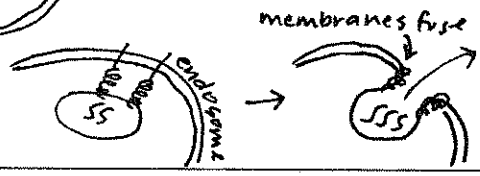
endocytosis occurs

"endosome"

* when the body recognizes an endosome, "push into" it lowers the pH (more acidic) and destroys the endosome. But....



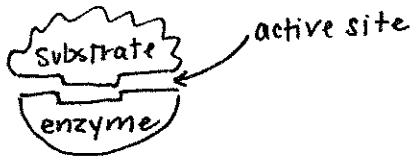
flu virus has long α helix chains, as pH ↓ the endosome collapses, but the virus coils spring open + fuse with the membrane of the endosome.

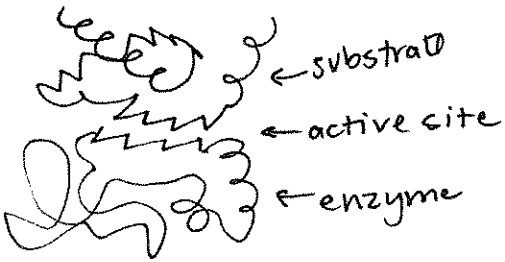


flu virus is now officially in your cell and starts reproducing.

Enzymes

→ speed up chemical reactions by ↓ the activation energy



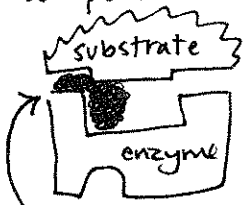


→ examples:
- catalase (liver) + H_2O_2
- amylase (spit) + starch
- lactase + lactose
- polymerase + DNA

→ Reactions:
- catabolic → break apart (▱ → △△)
- anabolic → build up (△△ → ▱)

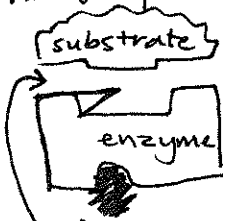
→ Turn enzyme off? Inhibitors

competitive



inhibitor directly blocks the active site. No rxn.

non-competitive



inhibitor binds to a different part of the enzyme, which causes the active site to Δ shape.