The Molecules of Life: *MacroMolecules*

Chapt. 3

- Most molecules are small!
- More molecules in a cup of water than there are stars in the sky!
- Water is small. At. Mass = ?
- But there ARE also many big (relatively) molecules

Macromolecules

- Large molecules made up of long chains of smaller molecules
- Macromolecules are the molecules of life!
- Because life is built largely of Carbon atoms, macromolecules are large carbon-carbon molecules

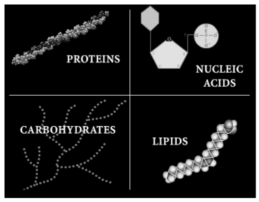
Carbon Chemistry

- In building large macromolecules carbon usually combines with other carbons…
- AND, with one or more "functional groups"
- See Text pg. 31 (Chapt. 2)
- Know these groups!

Carbon-Carbon Macromolecules

- Aka: Organic Molecules
- Fall into 4 groupings:

Carbohydrates
Lipids
Proteins
Nucleic Acids



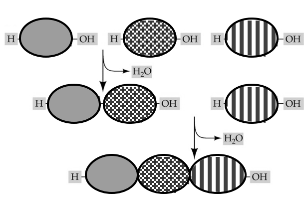
Macromolecules of Life

- Text pg. 35
- All 4 are put together in essentially the same way….
- Condensation Reaction:

Covalent bonds form
between pieces
by removing water

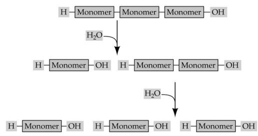
Condensation Synthesis

- Requires Energy input
- Text pg. 35

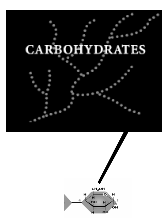


Hydrolysis

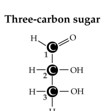
- The reverse reaction of dehydration synthesis- will break down molecules and liberate energy.
- What will it require as input?
- Text pg. 35



How to Make a Macromolecule: Carbohydrates



- Role: energy storage, structural role
- Not all carbos are macromolecules- some are small: Simple sugars



The macromolecular form is just a long chain of simple sugars

Simple Carbohydrates

- Aka: The Monosaccharides
- Text pg. 43
- Composed entirely of C, H and O in a (1:2:1) ratio
- General formula = $(CH_2O)_n$ Where n =5 or 6
- The many C-H bonds contain lots of E.
- Bonds release ~4 Kcal/gram

calorie

- Amount of heat needed to raise 1 gram of water 10 Celsius
- 1 Kilocalorie =
- 1 Kilocalorie also called 1 Calorie

A Simple Sugar: Glucose

- Of primary importance for E. storage
- A linear 6C molecule, usually assumes a ring-configuration in water
- Text pg. 43-44
- Very similar 6C sugars: fructose, galactose

Role of Glucose in Organisms

- Animals: ship it about in blood as glucose
- Plants: join two glucose units to make a *disaccharide* and ship it about.
- Ie. Maltose, Sucrose
- Text pg. 44-45

Another Disaccharide: Lactose

- Mothers milk
- Disaccharide of Glucose + Galactose
- Lactose (and other disaccharides) cannot be used until they're broken down to mono-units
- Specific *enzymes* required for this
- Lactase enzyme breaks down Lactose

Polysaccharides

- Long repeating chains of monosaccharides
- Often used for Energy storage
- **Animals** form Glycogen from glucose units
- Stored in Liver and muscles
- Text pg 45

Polysaccharides

- **Plants** also store glucose polysaccarides
- Starch
- Text pg. 45

Polysaccharides

- Structural role too:
- Glucose units can be assembled into structural material
- Plants make Cellulose Text pg. 45
- Some animals make Chitin
- Cellulose can NOT be broken down by enzymes that break down starch?

Quiz

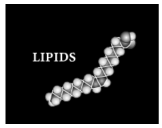
- Name the enzyme that breaks down Cellulose?

  Cellulase
- Cows lack cellulase…How do cows digest grass?

Carbohydrate Complexity

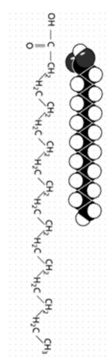
- Monosaccharides : useable Energy
- Disaccharides : transport form
- Polysaccharides : Storage and structural forms

Lipids: Fats & Oils



- Insoluble in water, but soluble in oil
- Examples include:
  - Oils (olive, corn…)
  - Waxes (bee's, ear)
  - Fats
- Text pg. 49-53

Fats

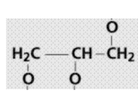


- Composed of 2 pieces:

1) a 3-carbon alcohol: termed glycerol This is the fat "backbone"
2) Fatty acids:
   Long chains of C-C-C ending with a
   -COOH group

Glycerol

—C-OH
—C-OH
—C-OH



Fatty Acid

-C-C-C-C-C-C-C-C-C-C-C-C-COOH

REMEMBER! Each -C- must have 4 covalent bonds with it!

Make a Fat!

- Add 3 fatty acids to the glycerol unit
- Text pg. 50

Triglyceride

- Correct name for a fat
- Attach different f.a. to glycerol and make a different fat (triglyceride)

Fatty Acids

-C-C-C-C-C-C-C-C-C-C-C-COOH

But, there is lots of room for variation:

- Different chain length: commonly 14-20 Carbons
- Different type of -C-C- bonding …

F.A. Degree of Saturation:

- If the f.a. has all C's with their 4 covalent bonds going to *4 different* atoms…it is termed *saturated*.
- Text pg. 50
- If all 3 f.a. are saturated-->Saturated fat
- Saturated fats are common in animal fats

Unsaturated Fats

- If double bonds exist in the -C=C- chain--> Unsaturated fat
- Text pg. 50

Polyunsaturated Fats

- Contain several double bonds in C chain
- -C=C-C-C=C-C-C-
- Double bonds result in lower melting points….liquid at room temp.
- Often called oils & more common in plants
- Easier to break down and digest

Crisco

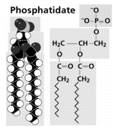
- Hydrogenated oils
- Convert plant oils into fat
- Chemically add H's to saturate the -C=C- bonds
- Is this any better than animal fat?

Fat Energy

- Because of the large number of C-H bonds, fats contain lots of E.
- E. released in breaking each C-H bond
- ~9 Kcal of E. per gram of fat
- Vs. ~4Kcal/gram in carbos

Other Lipids

- Phospholipids… important in cell membranes
  - Text pg. 51



- Steroids… testosterone, cholesterol, hormones
  - Text pg. 47