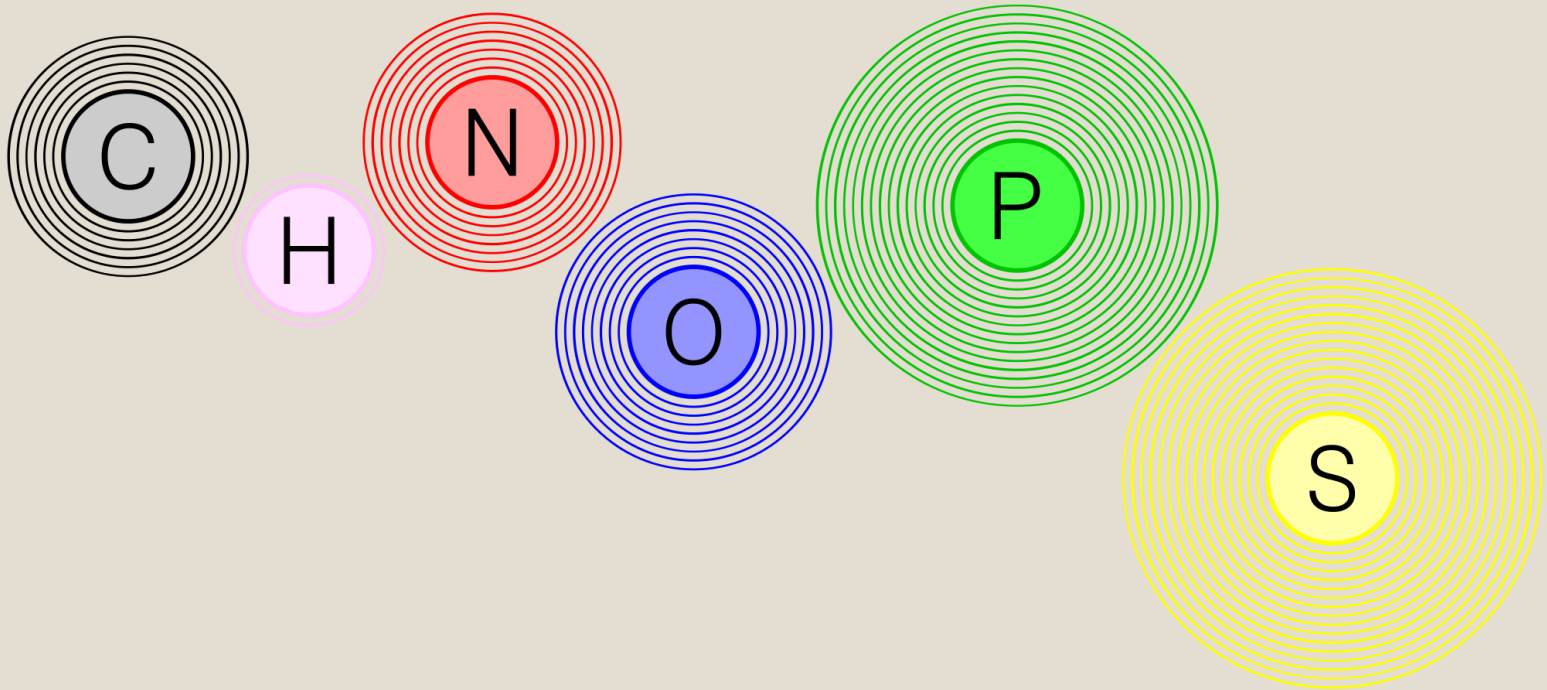
Unit 2 Topic 3: Macromolecules

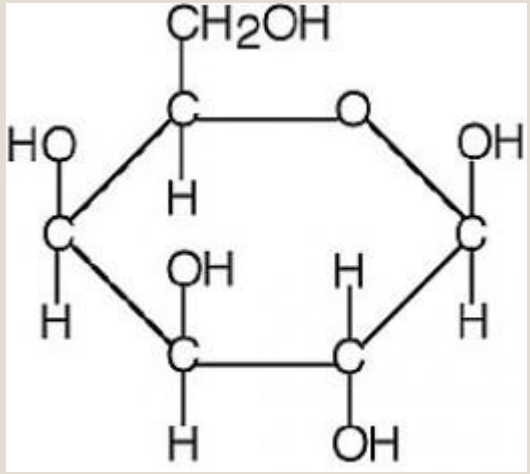
- By the end of this topic, you will be able to…
  1. Explain what the term “organic” means
  2. Define monomer and polymer and explain how polymers are made/broken
  3. Explain what happens to molecules during the processes of hydrolysis and dehydration synthesis
  4. Identify the monomer for each class of organic compounds
  5. Identify which class of organic compounds a compound falls into when given an image or function or elements used
  6. Explain the function of each of the four classes of organic compounds

Elements in Living Things

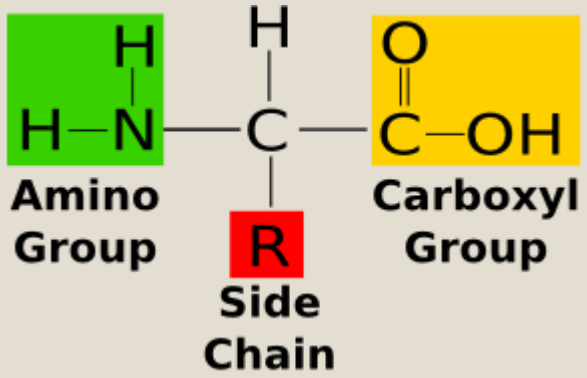
- Recap: what are the six main elements in living things?



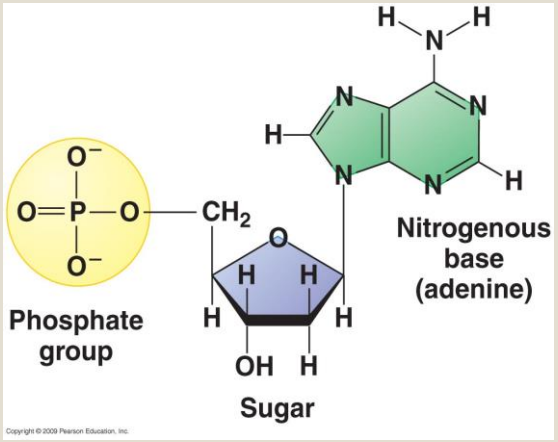
Macromolecules- Notice the Elements!



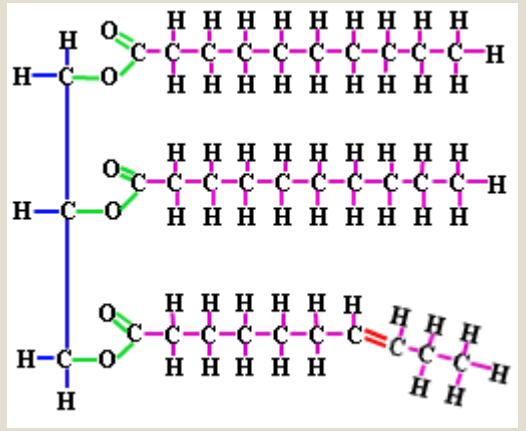
Carbohydrates



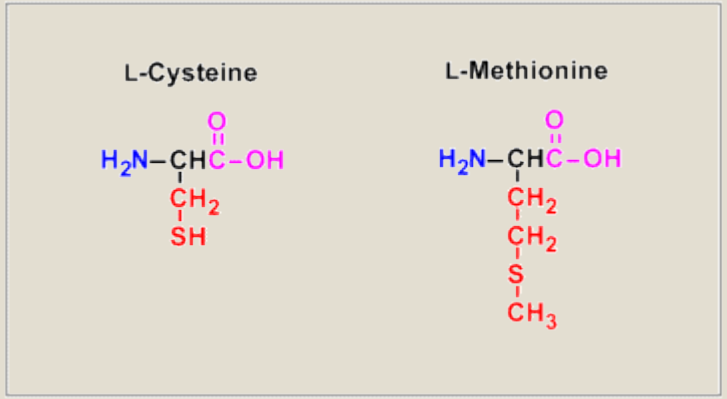
Proteins



Nucleic Acids



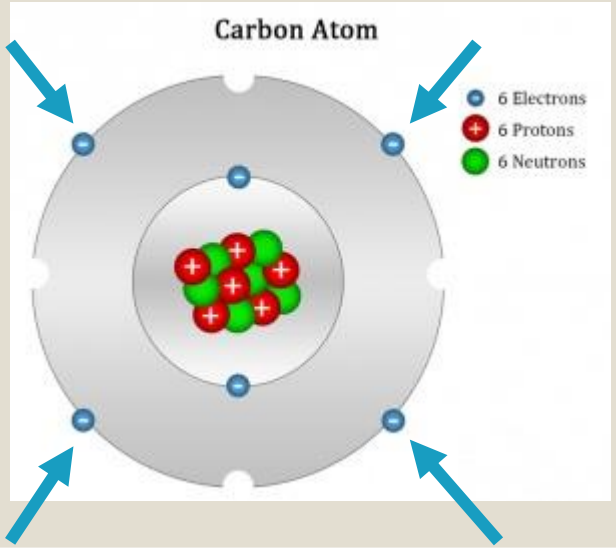
Lipids



Some of the amino acids (building blocks of proteins) contain sulfur, as shown in the image to the left

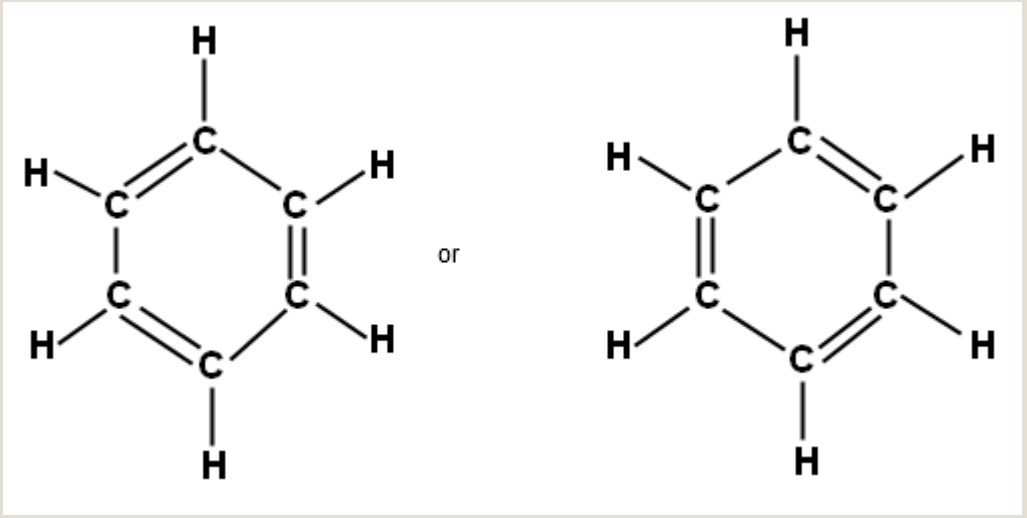
Carbon

- Carbon is the backbone of organic compounds (macromolecules)
  - The term organic means contains carbon
  - Organic chemistry is an entire field dedicated to studying compounds containing bonds between carbon atoms
- An atom of carbon contains FOUR valence electrons
  - So, it is able to make up to four covalent bonds with other atoms!



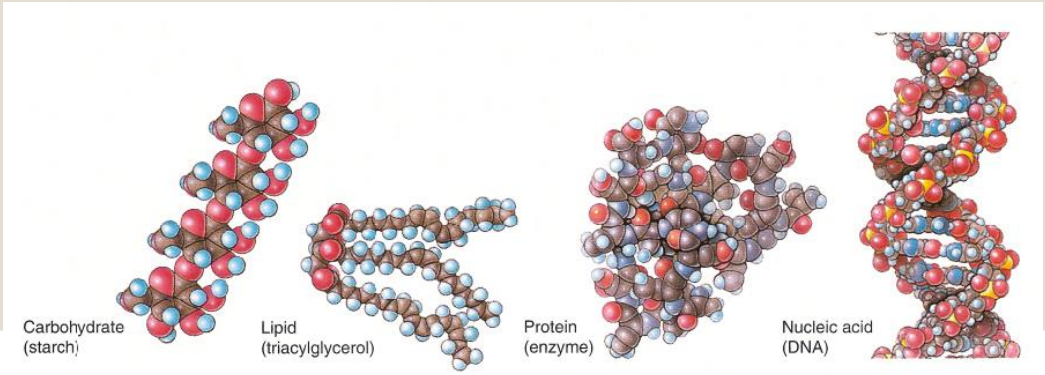
Organic Compounds

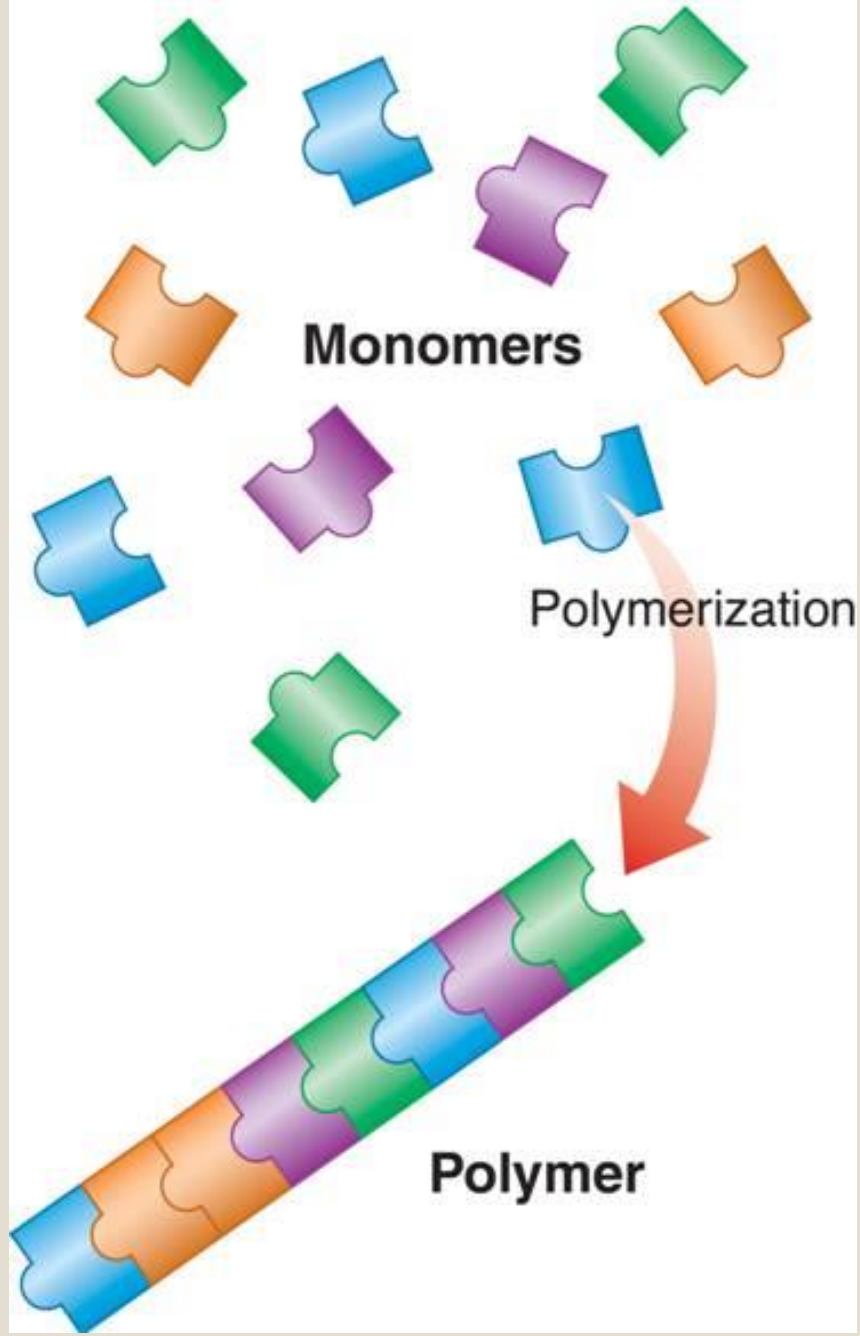
- Look at the compounds to the right. Notice how the carbon are responsible for essentially holding the molecules together.



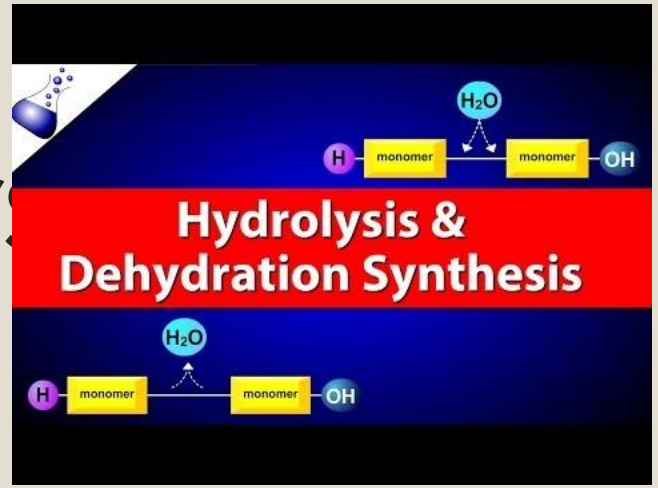
Macromolecules

- Macro- large
  - Macromolecules are large molecules with a backbone made of carbon
  - Macromolecules are so large because they are made up of smaller units
    - Monomer: the building block of a polymer (repeating unit)
    - Polymer: long chain of repeating units (monomers)
    - Polymerization: process of linking monomers together to produce polymers



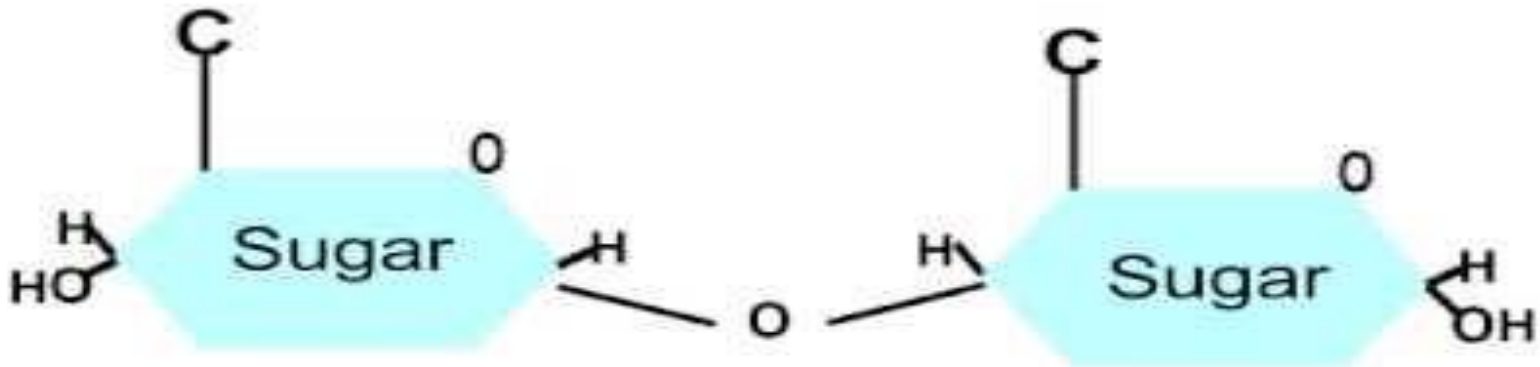

Monomers
Polymerization
Polymer

Making & Breaking Polymers



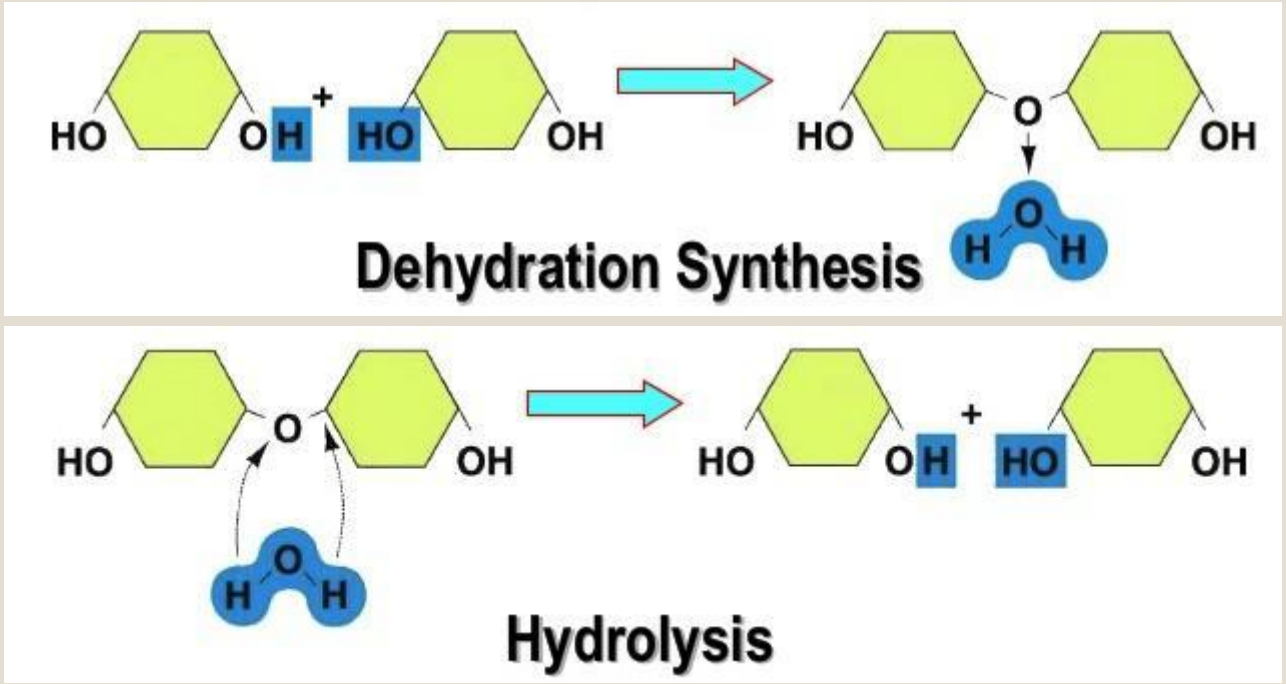
- Dehydration Synthesis
  - Dehydrate – loss of water
  - Synthesis – to produce/make/combine
    - All together: this is the process by which monomers join together to make a polymer. In the process, water is lost. One water molecule is lost for every monomer joined to another.
- Hydrolysis
  - Hydro – water
  - Lysis – to break or to burst
    - All together: this is the process where water is added to break the bonds holding monomers together.

. . . creating a disaccharide

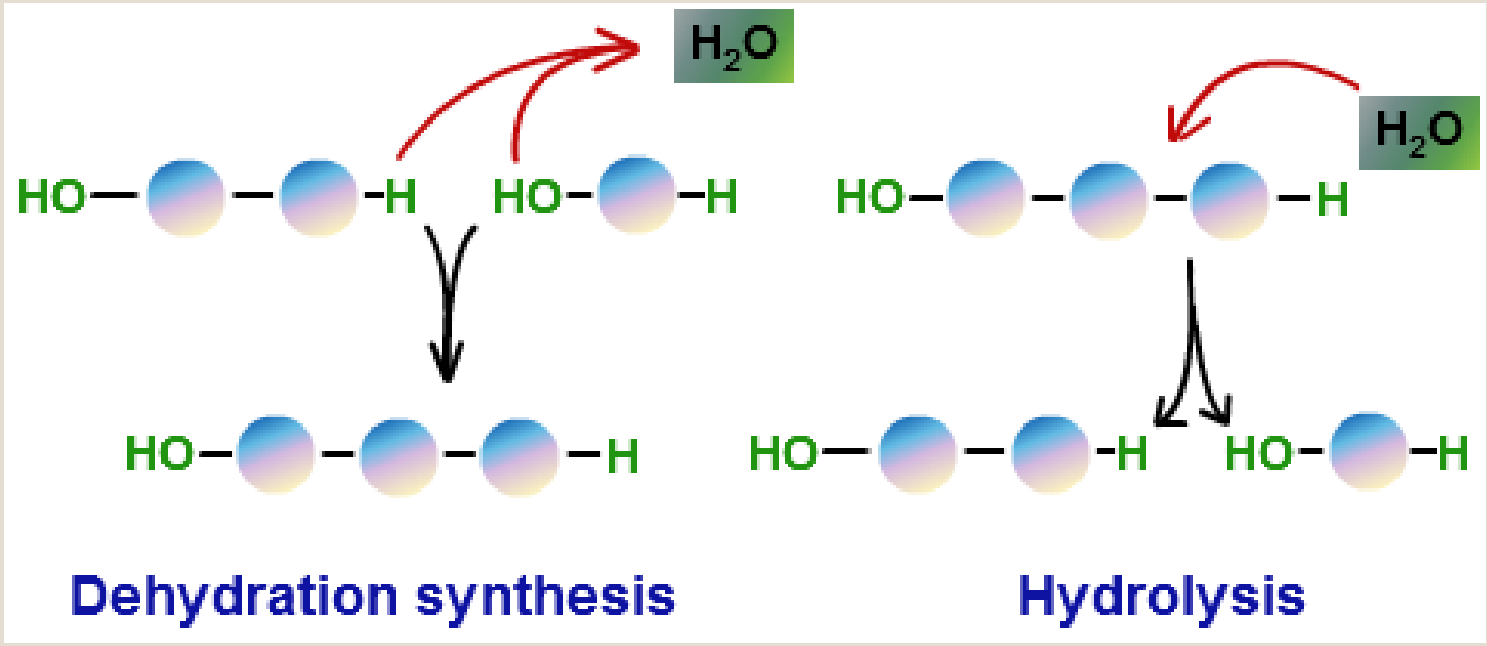


HOH Water is formed.

Comparing the two:



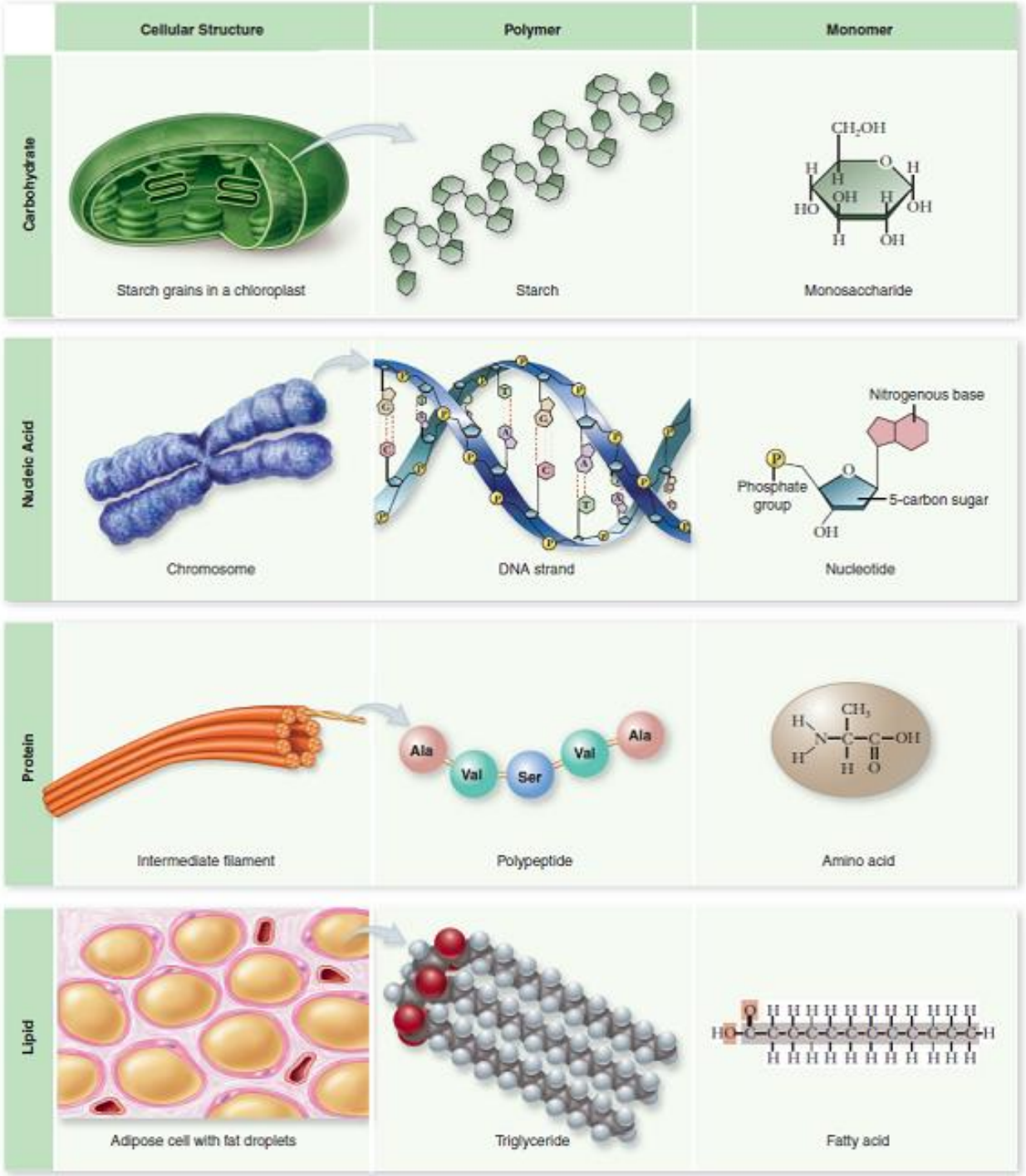
One more time…



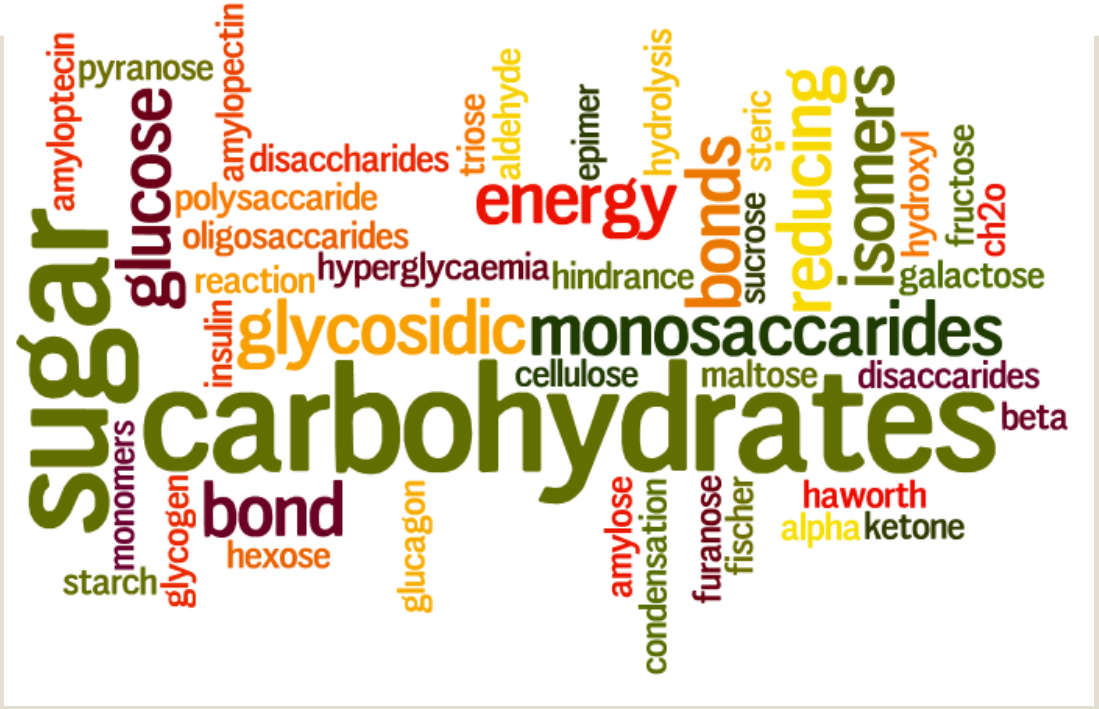
What are we building through dehydration synthesis?

Our macromolecules!

- Four classes:
  - Carbohydrates
  - Lipids
  - Nucleic acids
  - Proteins



Carbohydrates



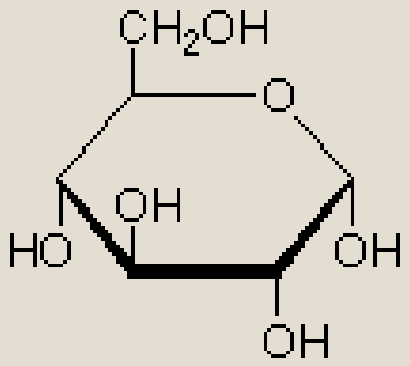
- Carbohydrates are sugars
  - Carbo – carbon
  - Hydrate – water
    - So, carbohydrates are made of : carbon, hydrogen, and oxygen (1:2:1 ratio)
- Function: **short term** energy storage; maintain plant structure (cellulose)

*General rule: anything that ends in –ose is a sugar

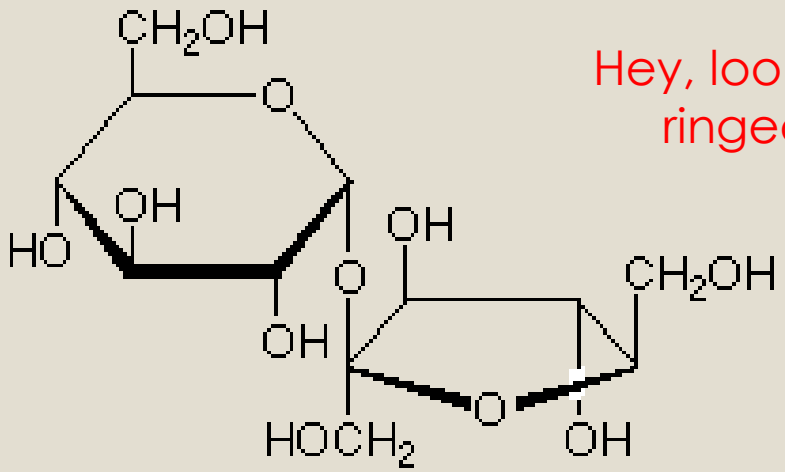
glucose… sucrose… galactose… lactose

Carbohydrates, cont.

- Monosaccharide: **monomer** of carbohydrates; simple sugars (ie glucose)
  - Mono – 1
  - Saccharide - sugar
- Disaccharide: two monosaccharides bonded together (ie sucrose)
  - Di – 2
- Polysaccharide: carbohydrate polymer (many sugars joined together in a chain)

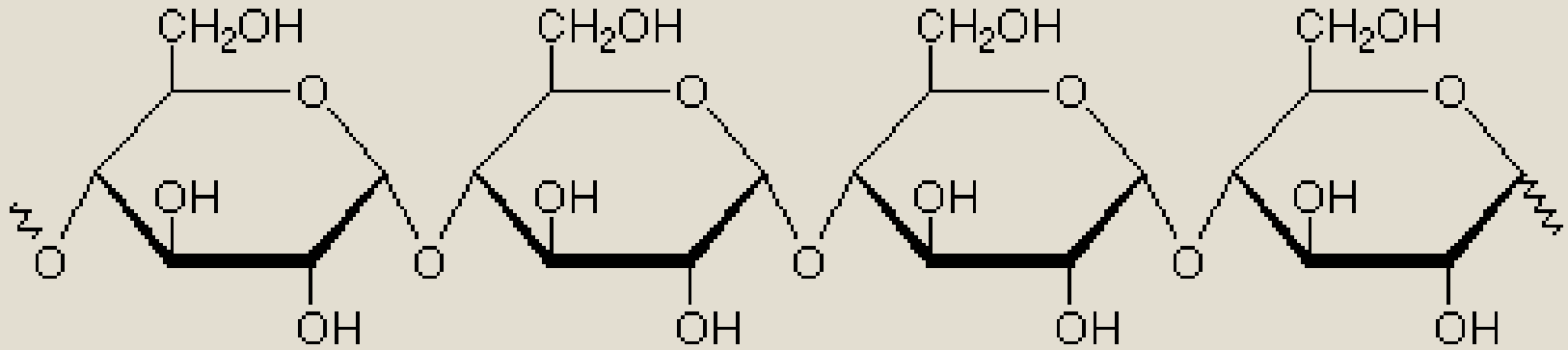


monosaccharide (glucose)



disaccharide (sucrose)

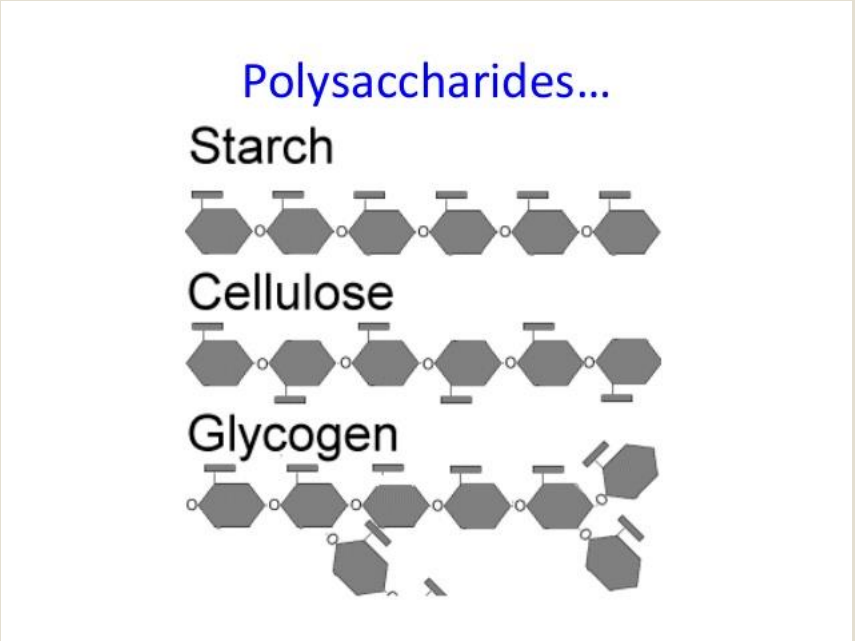
Hey, look! Sugars have a ringed structure! ☺



polysaccharide (amylose starch)

Importance of Polysaccharides

- Store energy (short term)
- Examples:
  - Starch: food storage in plants (think potatoes!)
  - Glycogen: food storage in animals (us!)
  - Cellulose: cell walls in plants



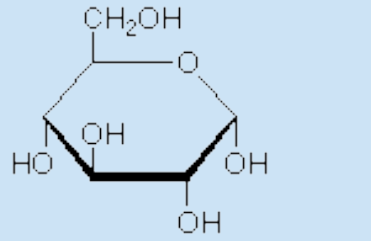
Language target!

- Flip to the table in your notes at the end of topic 3 – complete the portion of the table dealing with carbohydrates

Language target

	Function	Structure	Polymer	Monomer
Carbohydrate				

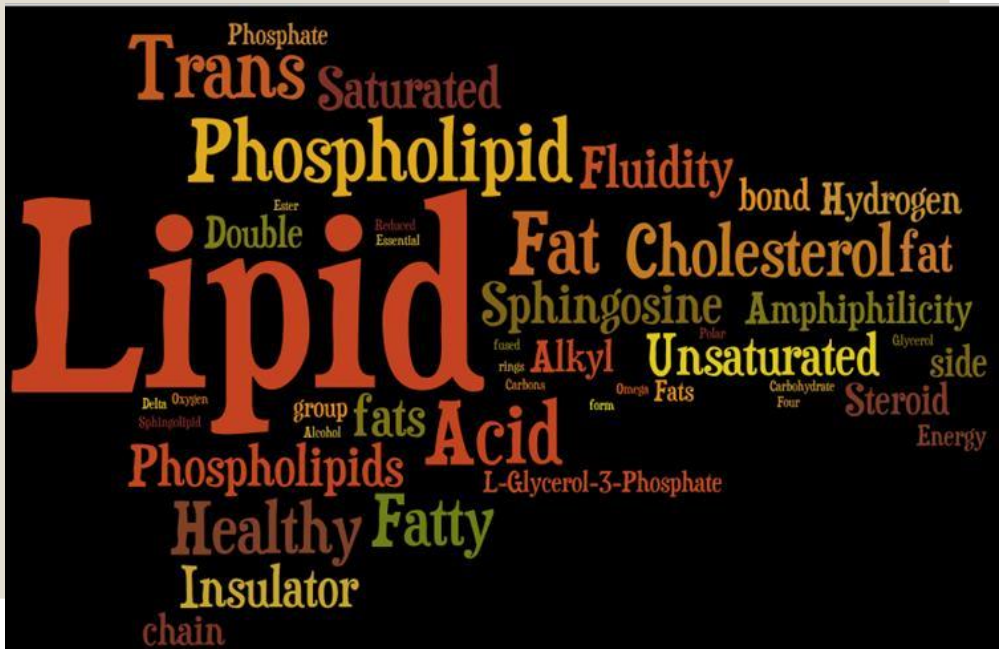
Language target

	Function	Structure	Polymer	Monomer
Carbohydrate	SHORT term energy storage; maintain structure (cellulose makes up cell walls in plants)	RINGED! CHO in a 1:2:1 ratio  monosaccharide (glucose)	poly-saccharide (like starch, glycogen, cellulose)	Mono-saccharide (glucose; single-ringed sugar)

Lipids

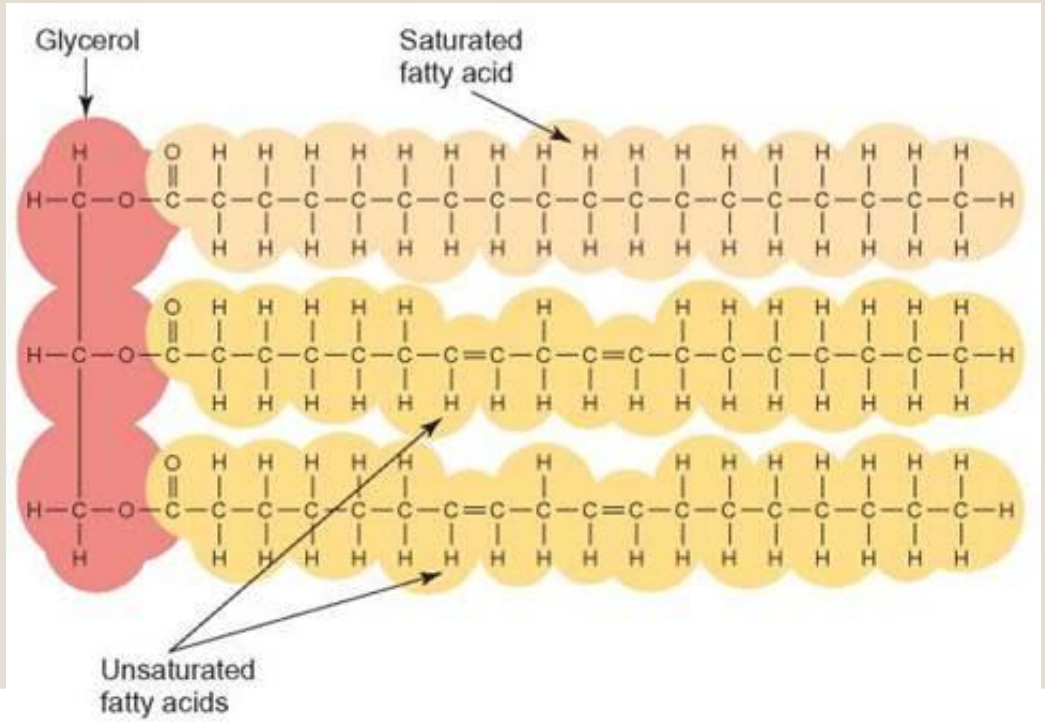
- Lipids include fats, oils, waxes, and steroids
  - Elements: like carbohydrates, these are composed of carbon, hydrogen, and oxygen
    - There are very few oxygen, and there is not a set ratio like in carbs
  - Functions: long-term energy storage, insulation, and protective coatings (think waxy layers of plants)
    - ***L***ipids: ***L***ong term energy storage

**Steroids often carry chemical messages*



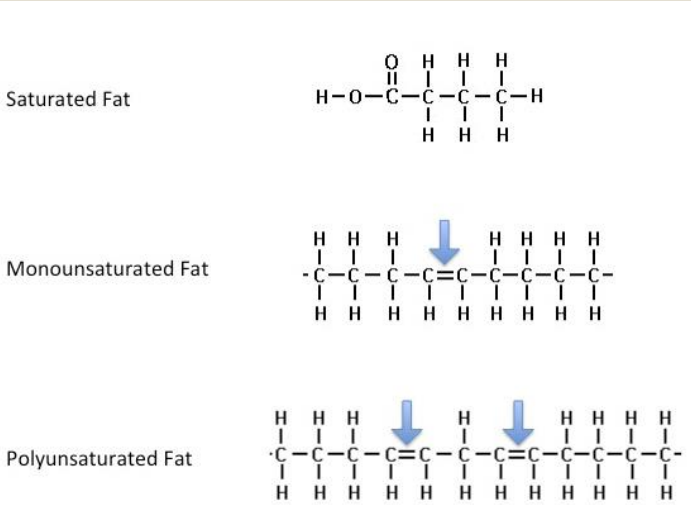
Lipids, cont.

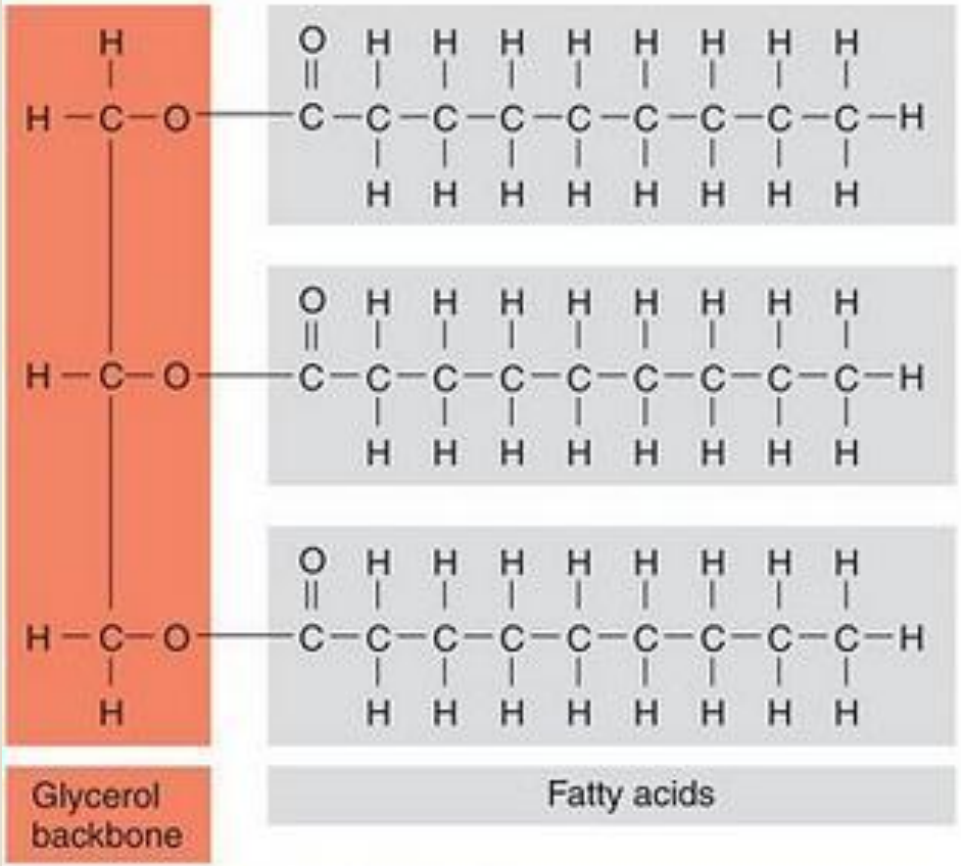
- Unlike the other classes of organic compounds, lipids do not have a "true" monomer. However, the structure between lipids is fairly consistent:
  - 3 fatty acids + 1 glycerol
  - TRIGLYCERIDE!
  - Saturated v unsaturated:
    Next slide!



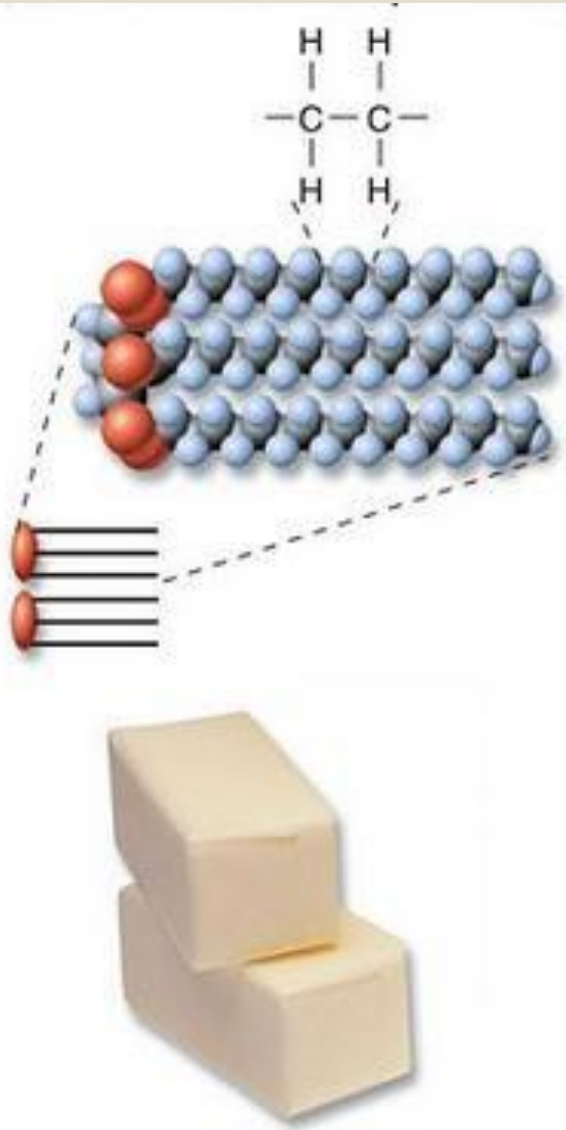
Saturated and Unsaturated Fats

- Saturated: solid at room temperature (butter or coconut oil)
  - Only single bonds between the carbons on the fatty acid tails
    - "saturated" with hydrogen atoms
- Unsaturated: liquid at room temperature (vegetable or canola oil)
  - At least one double bond in the fatty acid chain
    - Monounsaturated fat: only one double bond
    - Polyunsaturated fat: 2+ double bonds in structure

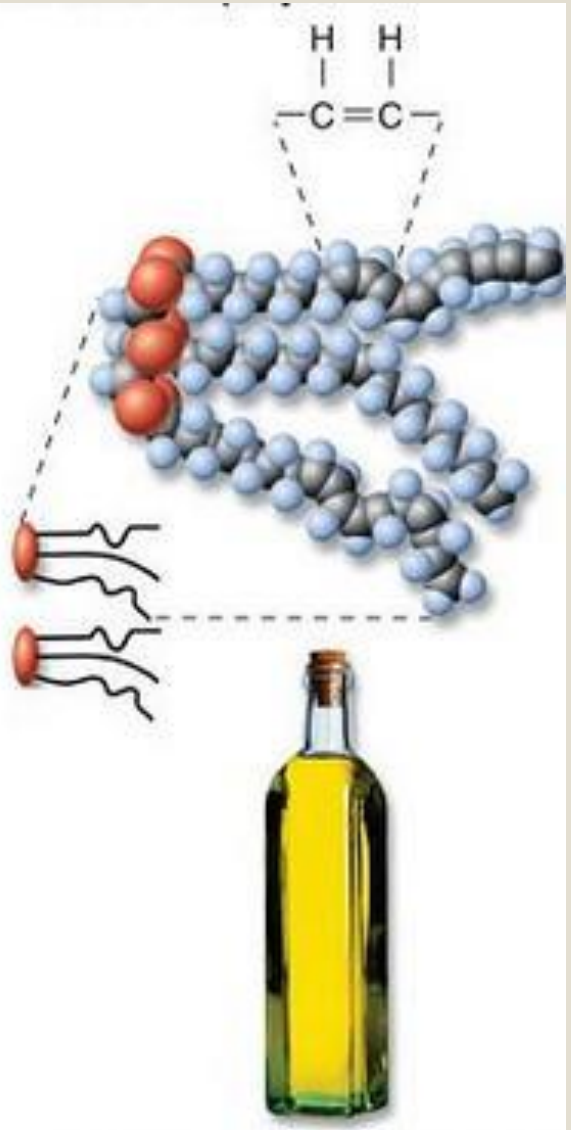




(a) Fat molecule (triacylglycerol)



(b) Hard fat (saturated): Fatty acids with single bonds between all carbon pairs



(c) Oil (unsaturated): Fatty acids that contain double bonds between one or more pairs of carbon atoms

Language target!

- Flip to the table in your notes at the end of topic 3 – complete the portion of the table dealing with lipids

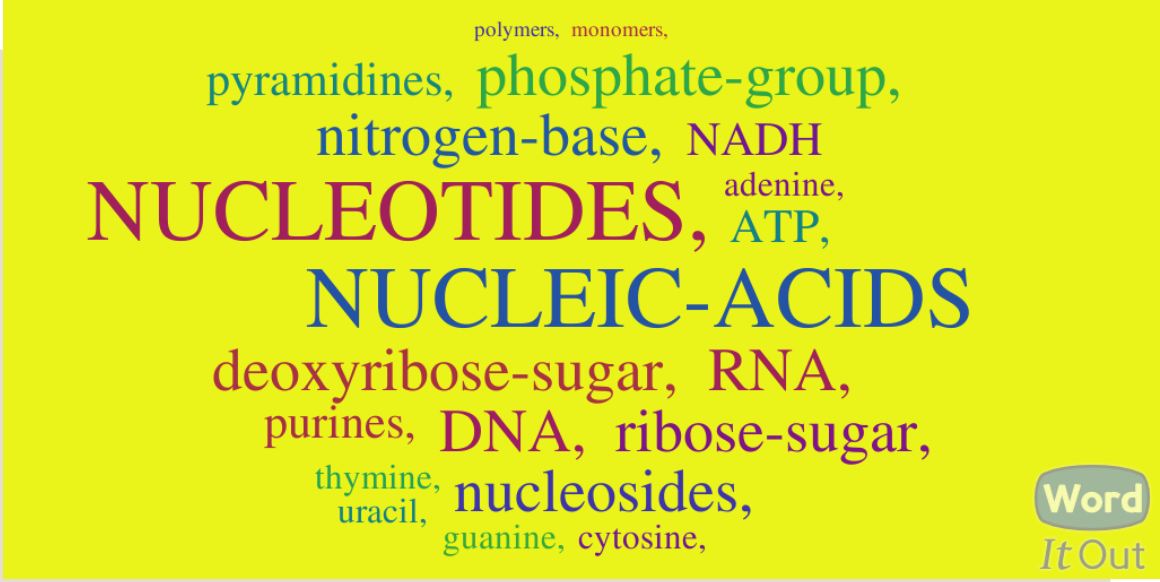
Language target

	Function	Structure	Polymer	Monomer
Lipid				

Language target

	Function	Structure	Polymer	Monomer
Lipid	LONG term energy storage; insulation; waxy (protective) coating (like cuticle)	Cap. Letter E; CHO (not in a specific ratio)	Fats, oils, waxes, steroids	Technically, not one in specific… for us, we are saying a triglyceride (1 glycerol + 3 fatty acids)

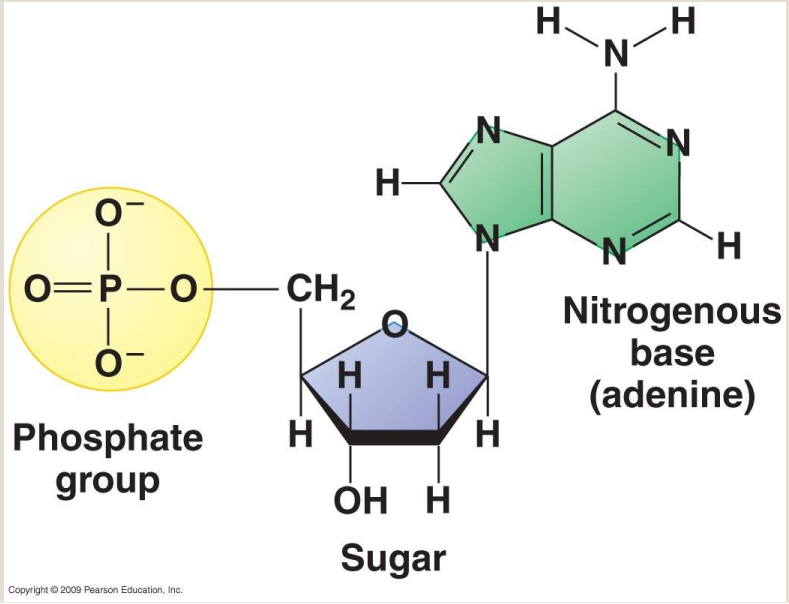
Nucleic Acid



- DNA and RNA are both types of nucleic acids
  - Elements: CHNOP
    - Each nucleotide, or monomer, has a 5-C sugar, phosphate group, and nitrogenous base
      - Remember, sugars contain CHO… add in the N base and P-group, and there you have the elements CHNOP!
  - Functions: store and transmit genetic information (DNA- master code; RNA- carries code)

Nucleic Acid, cont.

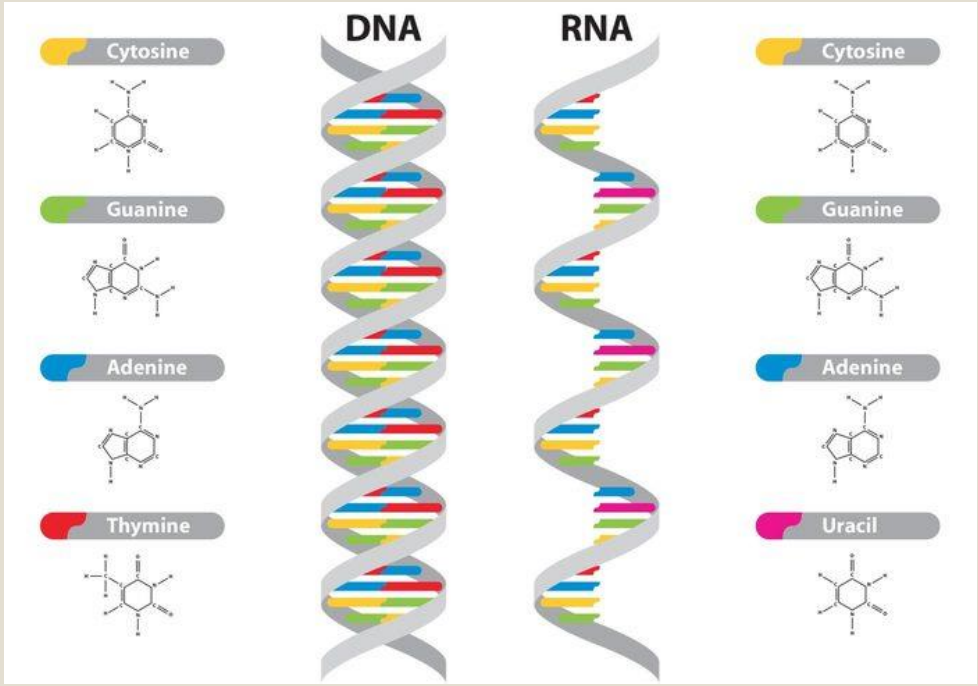
- Nucleotides are the building blocks, or monomers, of all nucleic acids
  - 3 parts:
    1. 5-carbon sugar (deoxyrib**ose** in DNA, rib**ose** in RNA)
    2. Phosphate group (almost always represented using a sphere/circle)
    3. Nitrogenous base (DNA – adenine, thymine, cytosine, guanine; RNA – uracil instead of thymine)



DNA & RNA

DNA

- Deoxyribonucleic acid
- Master copy of an organism's genetic code



RNA

- Ribonucleic acid
- Copy of DNA (able to leave nucleus)
- Plays major role in protein synthesis

Language target!

- Flip to the table in your notes at the end of topic 3 – complete the portion of the table dealing with nucleic acids

Language target

	Function	Structure	Polymer	Monomer
Nucleic Acid				

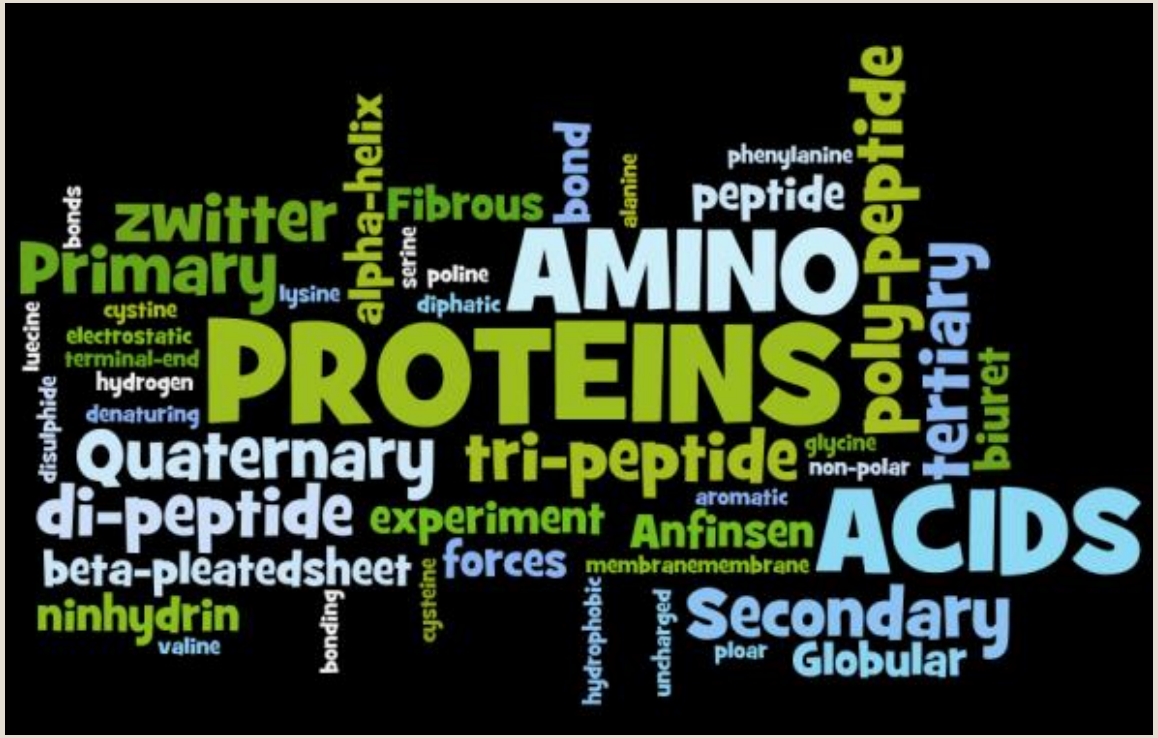
Language target

	Function	Structure	Polymer	Monomer
Nucleic Acid	Carry/transmit genetic code	DNA: double helix (held together by hydrogen bonds)	DNA or RNA	Nucleotide (5-C central sugar with a phosphate group on one end and nitrogenous

Protein

- Elements found in proteins include:
  - CHNO and sometimes S
- Functions:

1. Structure (hail, nails)
2. Transportation (hemoglobin in blood)
3. Movement (muscle fiber)
4. Defense (antibodies)
5. Regulation (hormones and enzymes)

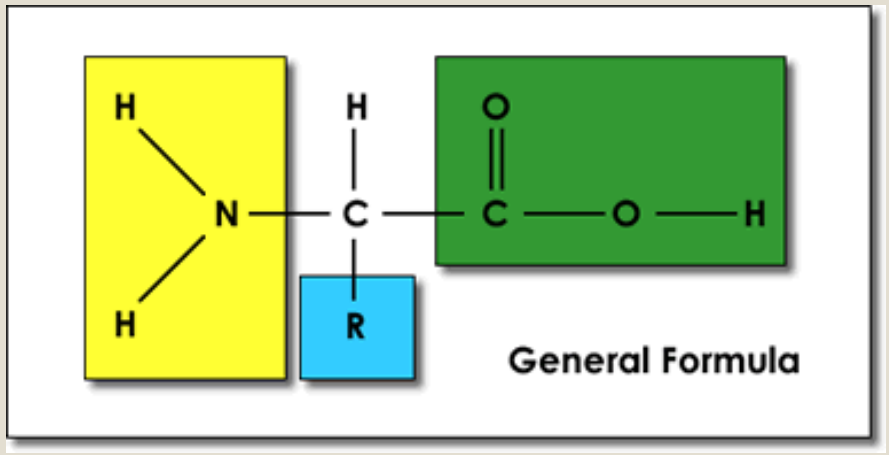


Protein, cont.

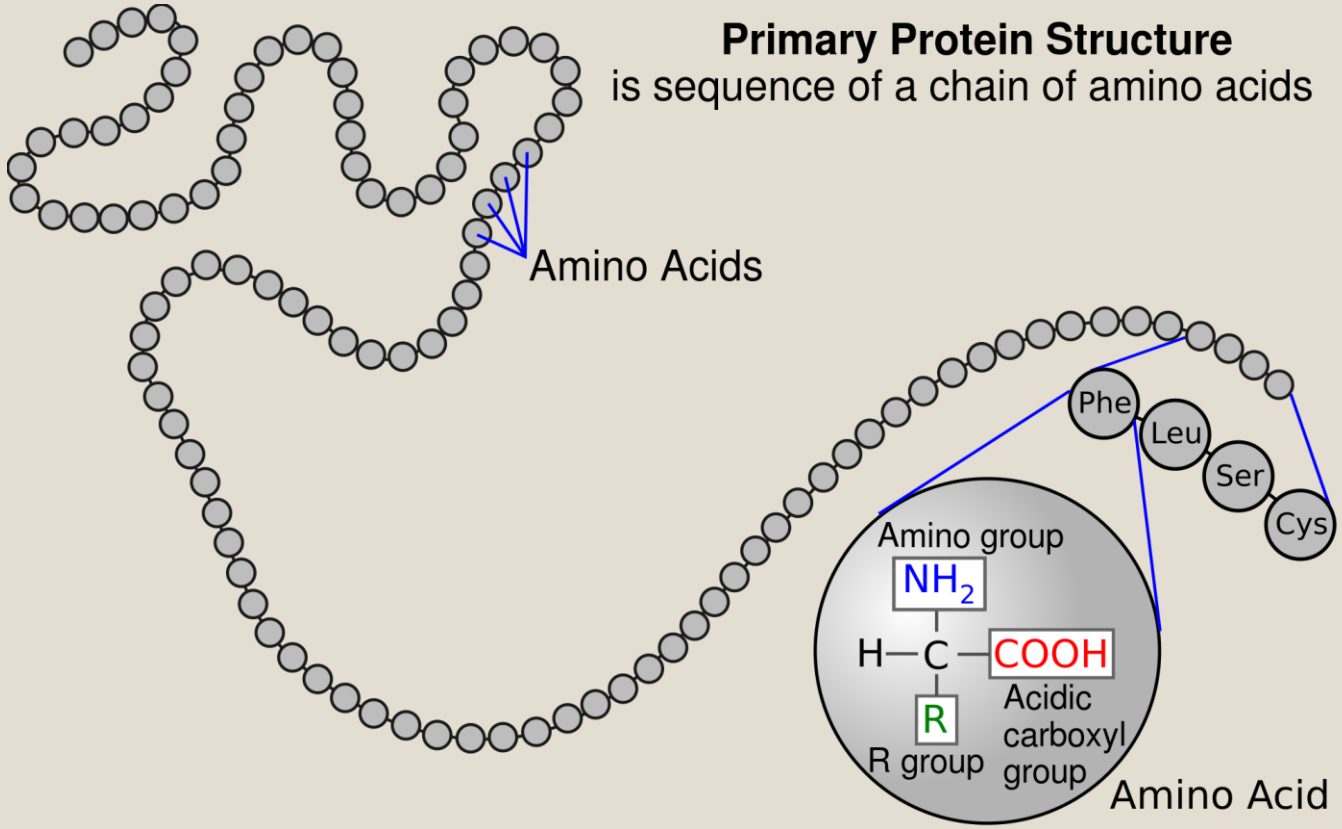
- Amino acids are the building blocks, or monomers, of proteins
  - There are 20 different amino acids that can be bonded together in many different ways to make all of our proteins!

Amino acids…

- Central Carbon
- Hydrogen Atom
- Amino Group
- Carboxyl Group
- R Group



Another View



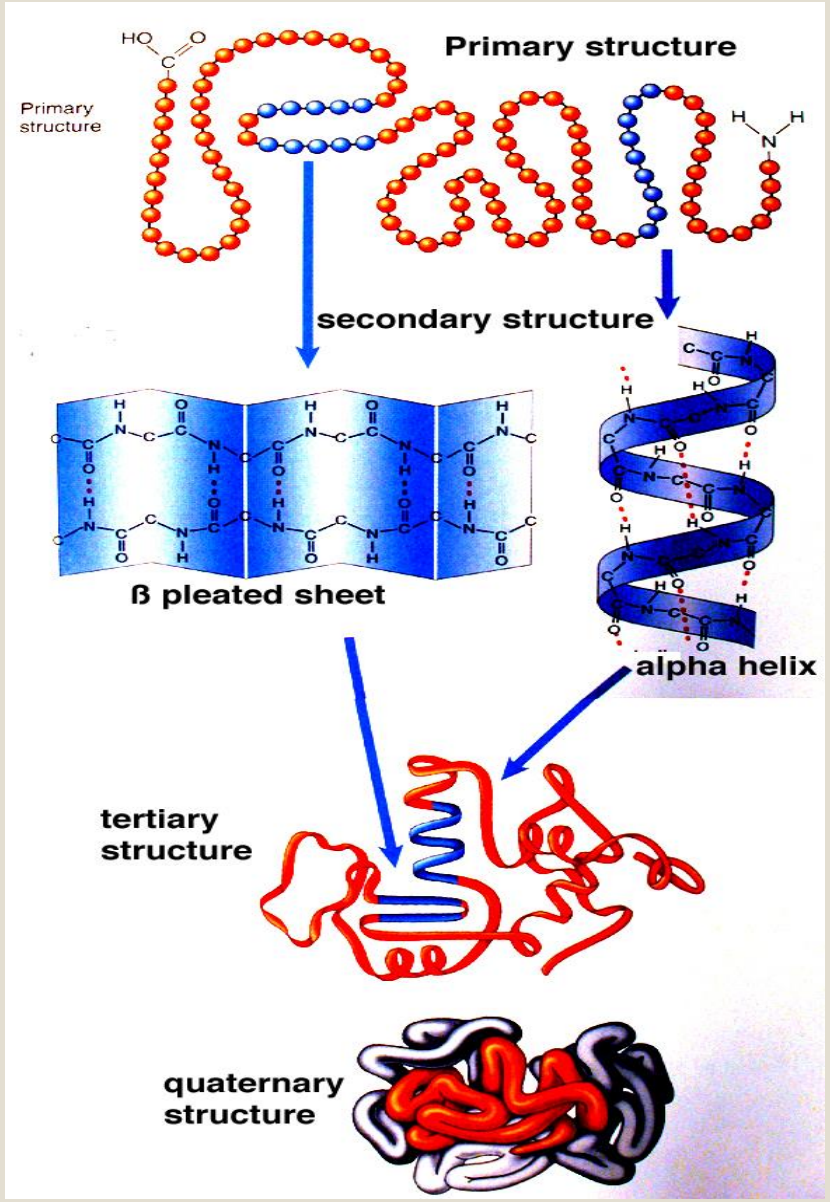
Protein

- Polypeptide: a chain of amino acids linked together (polymer)
  - Amino acids are connected through peptide bonds
- Proteins are made of polypeptides folded into complex structures

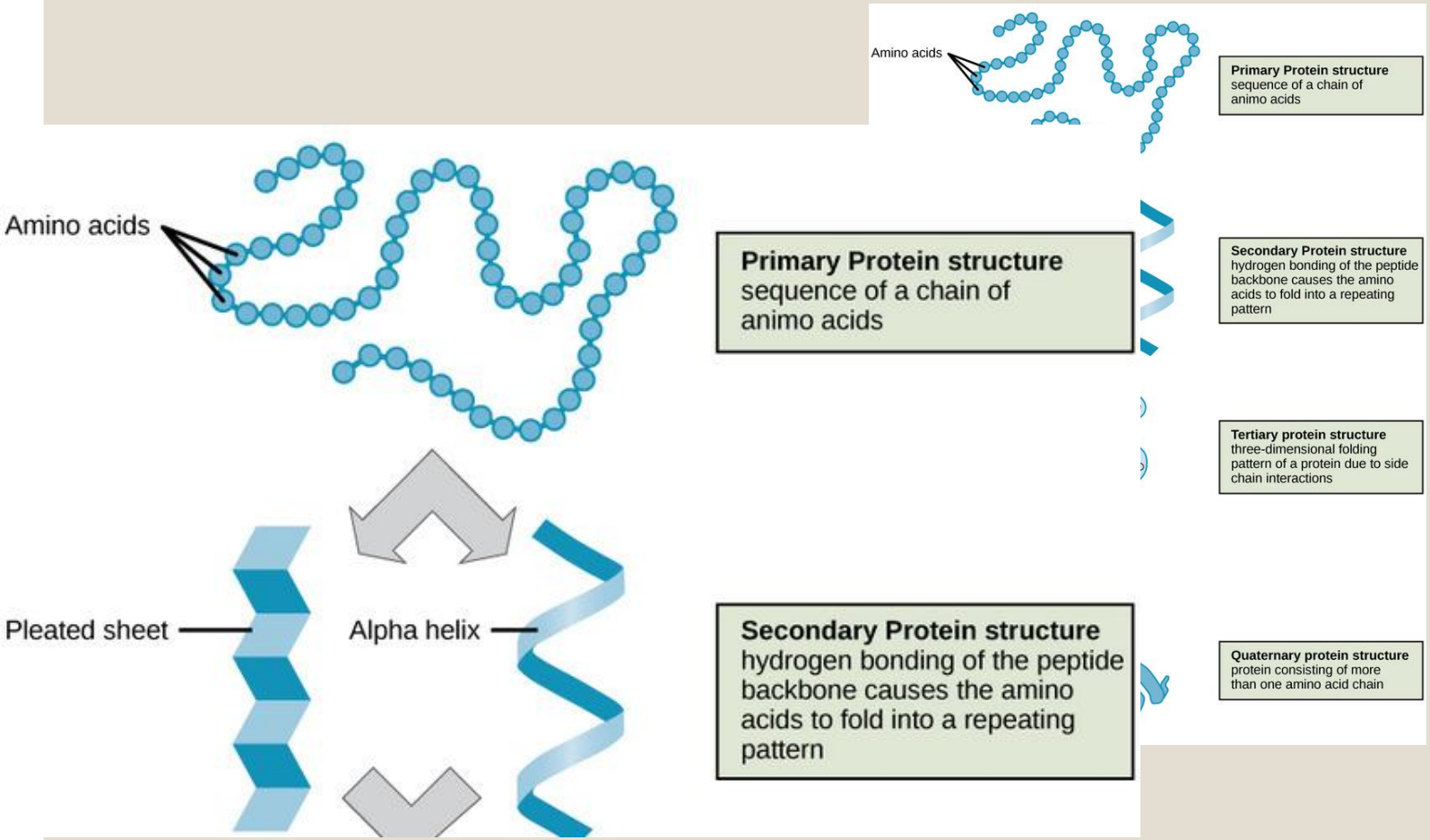
Protein Structure

Four levels of protein structure:

1. Primary
2. Secondary
3. Tertiary
4. Quaternary



Structures, cont



Language target!

- Flip to the table in your notes at the end of topic 3 – complete the portion of the table dealing with proteins

Language target

	Function	Structure	Polymer	Monomer
Protein				

AA structure: central carbon with hydrogen atom/ amino group/ carboxyl group/ R group

Language target

	Function	Structure	Polymer	Monomer
Protein	SO many things – structure, transportation, defense, movement, regulation… (DNA carries instructions)	4 different structural tiers: primary, secondary, tertiary, quaternary	Polypeptide (enzymes, hemoglobin, antibodies, keratin)	Amino Acids (the order of the amino acids determines function of protein)

AA structure: central carbon with hydrogen atom/ amino group/ carboxyl group/ R group