General Biology 1
BIO1101
Syllabus & Textbook: http://goo.gl/rvgdrH

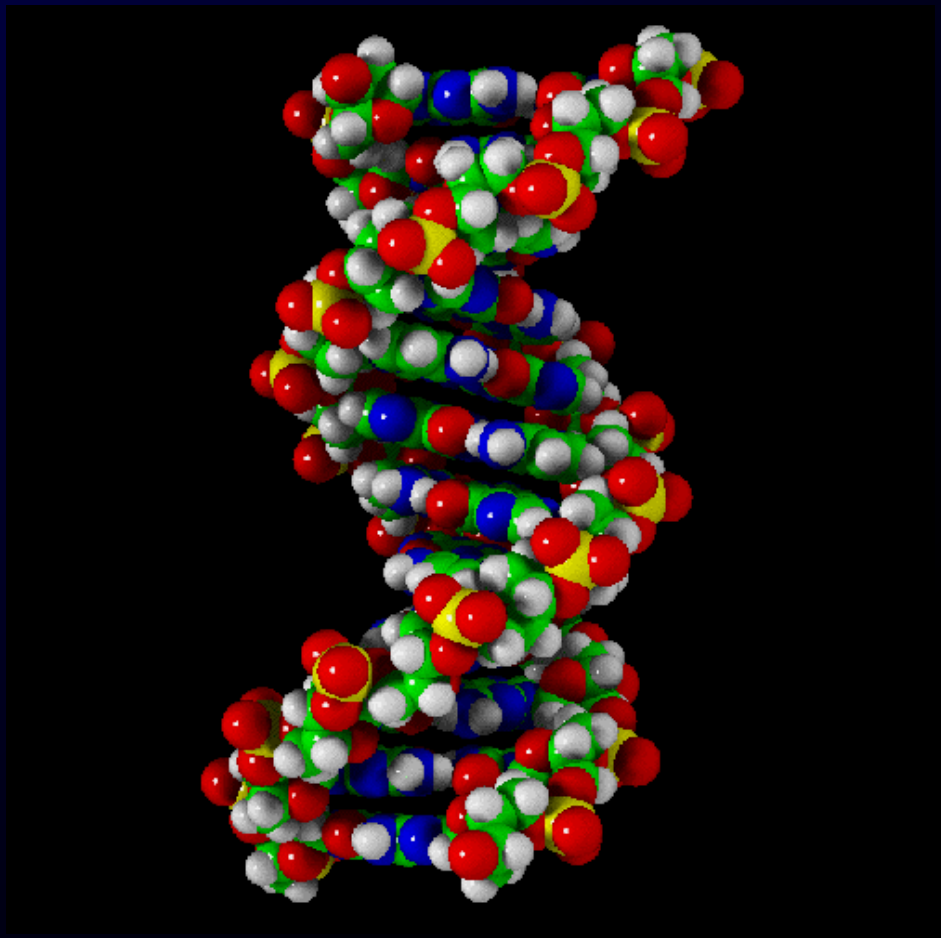
Lecturer: Michael Gotesman, PhD
Email: mgotesman@citytech.cuny.edu

Letter Grade	Numerical Ranges
A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	70-76.9
D	60-69.9
F	59.9 and below

OER
Lecture:https://openlab.citytech.cuny.edu/bio-oer/page/2/
Lab: https://openlab.citytech.cuny.edu/bio-oer/

Grade Breakdown:
Exams (4): 20% Each
Quizzes: 20% Average

Macromolecules



Macromolecules

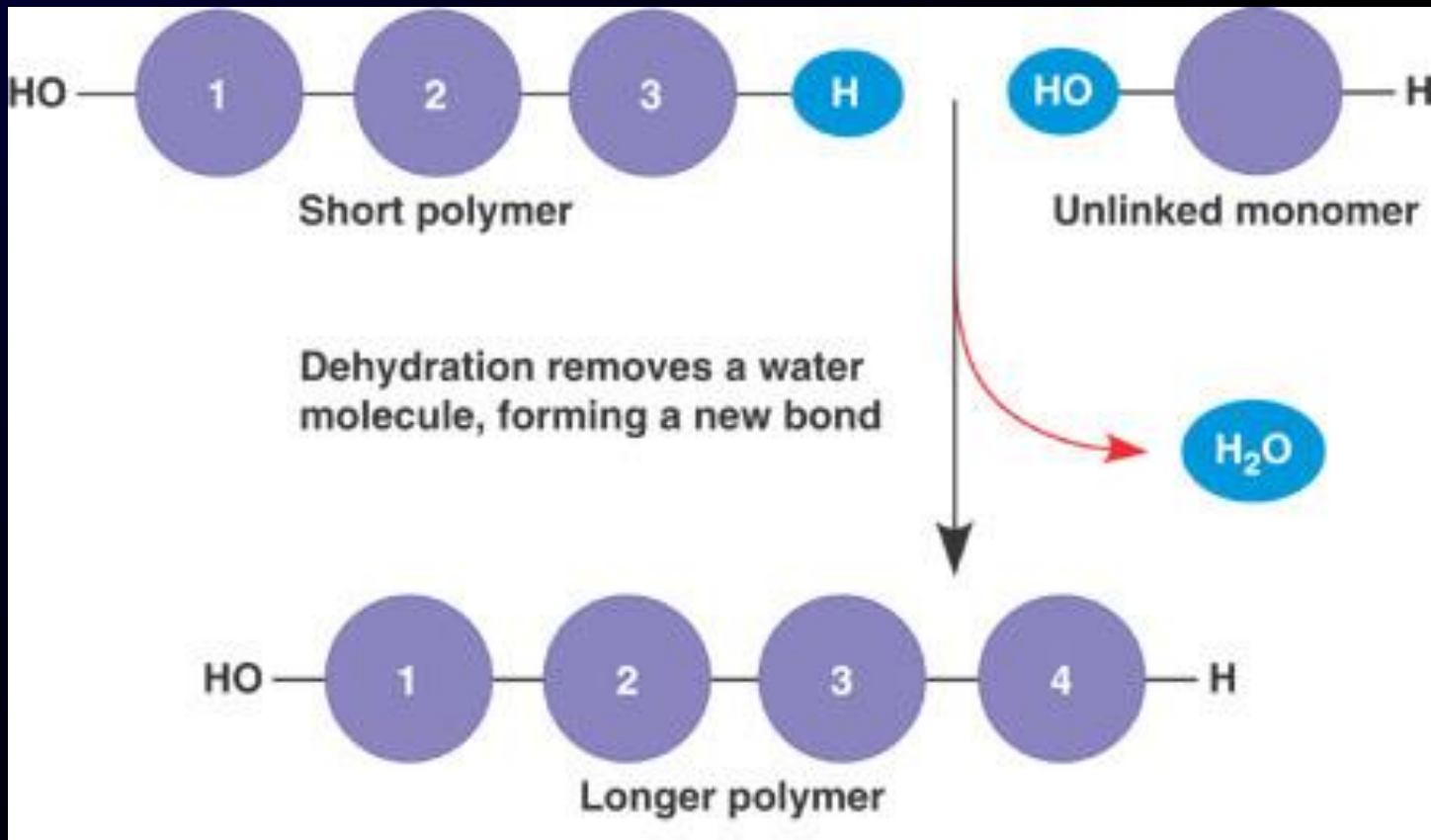
- Life's Large molecules
- Four types of Biological macromolecules:
  - Carbohydrates
  - Lipids
  - Proteins
  - Nucleic Acids
- Most are **Polymers** – long molecules that are repeating units of smaller building blocks (monomers)

Polymerization

- **Polymer** – a long molecule made of many small, similar, repeating units connected in a chain by covalent bonds
- **Monomer** – the small building blocks of a polymer
- **Polymerization** - the process of linking monomers to form a polymer.
- Polymerization is a chemical reaction catalyzed by enzymes

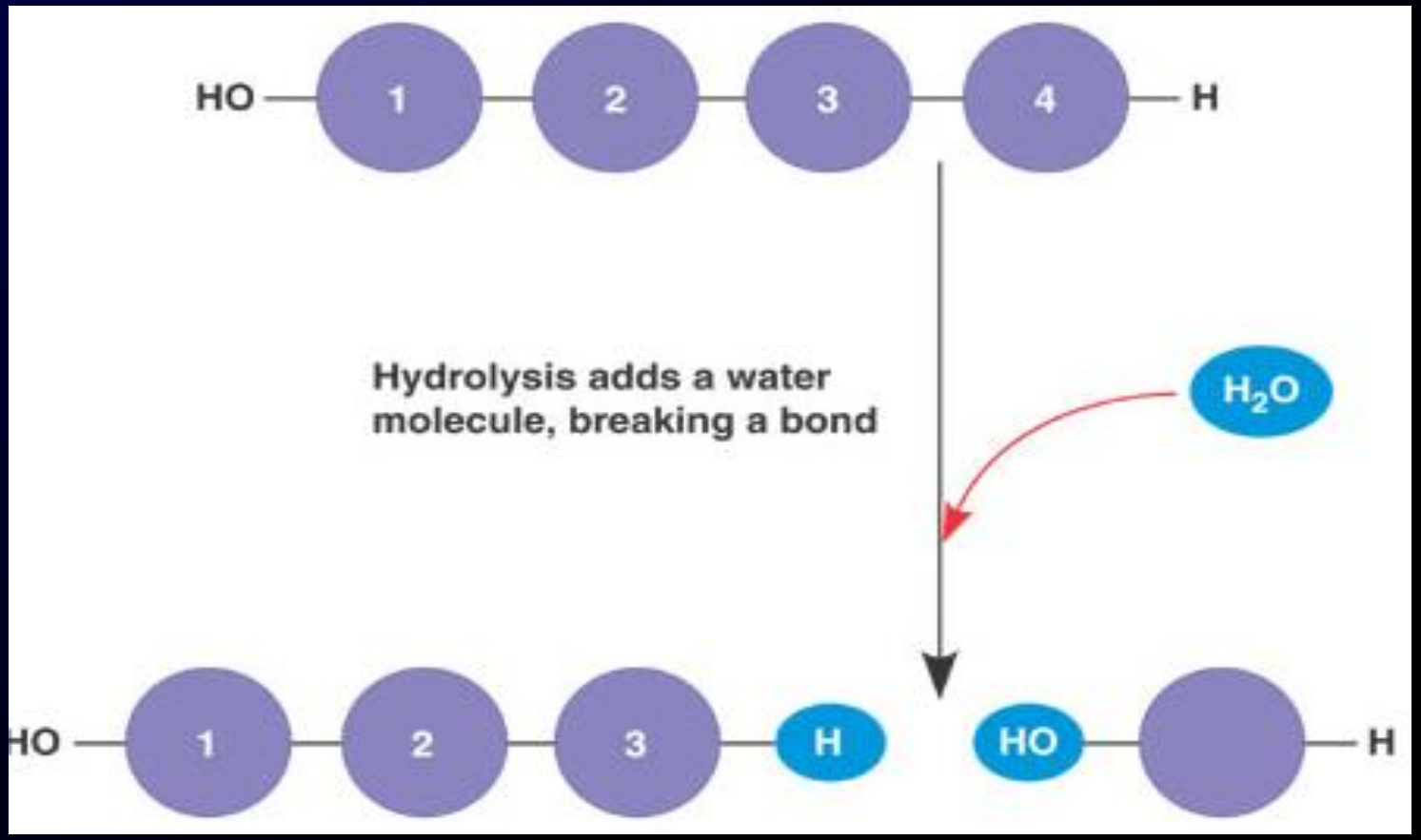
Role of water in polymerization

- The linkage of monomers involves a water molecule!
- When a polymer is built by linking monomers together:
  - a new water molecule is CREATED!
  - called a **Dehydration synthesis**, or **condensation reaction**



Role of water in polymerization

- When a polymer is BROKEN DOWN, releasing monomers:
  - A water molecule is consumed (**hydrolysis**)



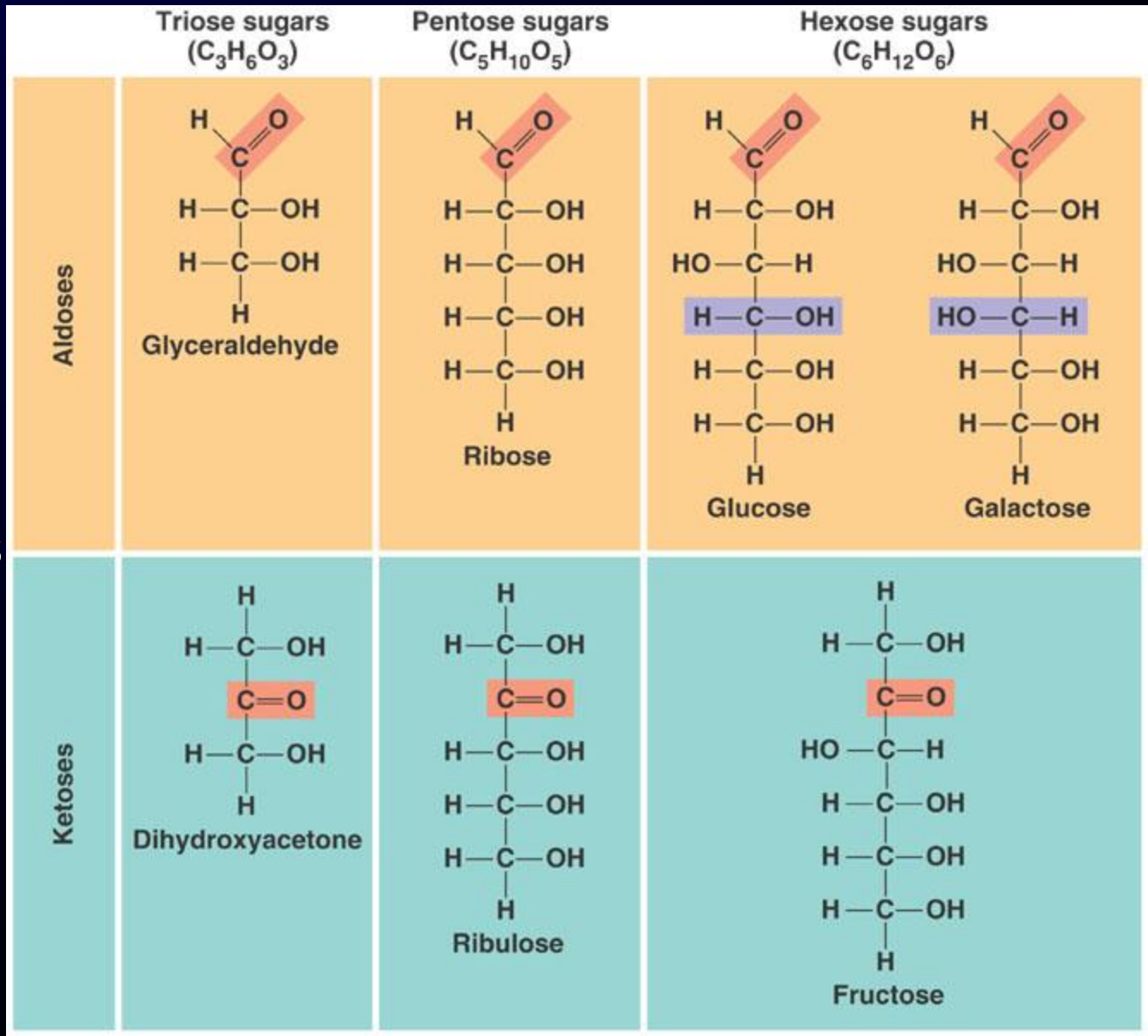
Carbohydrates

- Carbohydrates serve as fuel and building material
- Carbohydrates include sugars and the polymers of sugars
- The simplest carbohydrates are **monosaccharides =** single sugars
- Carbohydrate macromolecules are **polysaccharides** = polymers composed of many sugar building blocks

Monosaccharides

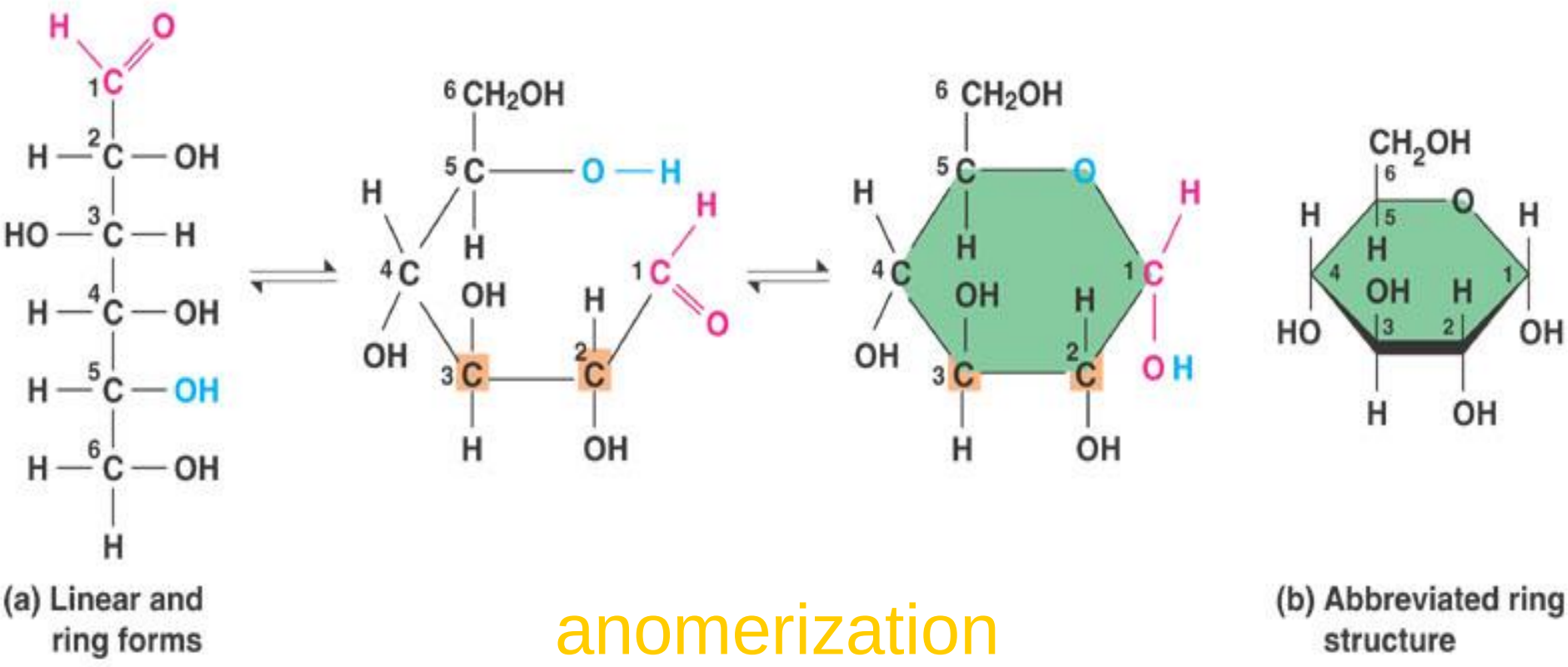
- **Monosaccharide**

  = simple sugar.
  - Ribose*,
  - Glucose,
  - Galactose,
  - Fructose
- Triose = 3 C's
- *Pentose = 5 C's
- Hexose = 6 C's
- Ketose (ketone)
- Aldose (aldehyde)



Linear form vs. ring form

- The linear form is convenient for drawing, but in aqueous solutions, sugars exist in a ring form.



Disaccharides

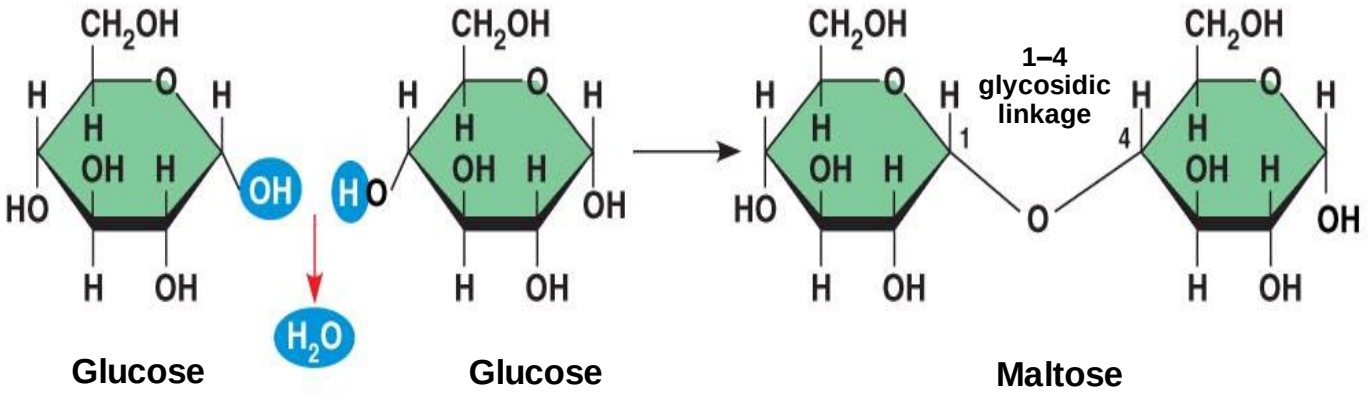
- A disaccharide is formed when a dehydration reaction joins two monosaccharides
- This covalent bond is called a **glycosidic linkage**

- Some Important disaccharides:
  - Maltose: 1 glucose + 1 glucose
  - Sucrose: 1 glucose + 1 fructose
  - Lactose: 1 glucose + 1 galactose

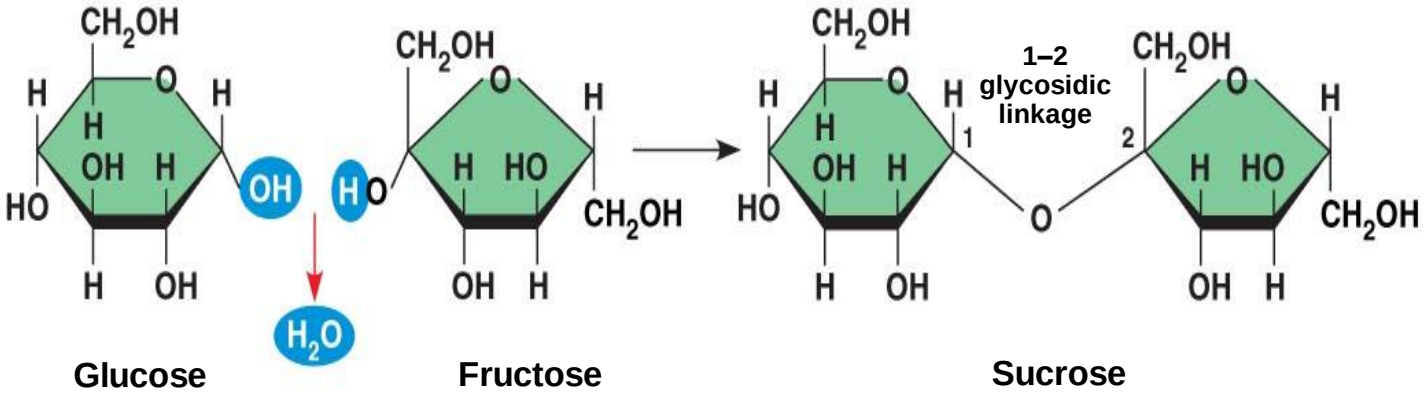
Disaccharides

Disaccharides are two monosaccharides joined by a **glycosidic linkage** (via dehydration)

(a) **Dehydration reaction in the synthesis of maltose**



(b) **Dehydration reaction in the synthesis of sucrose**



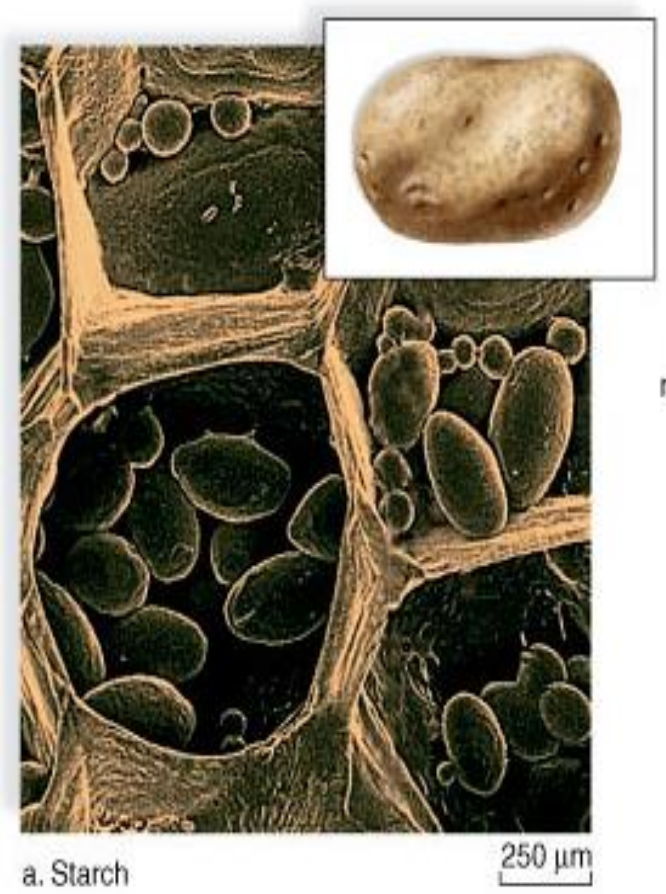
What is a tri-saccharide?

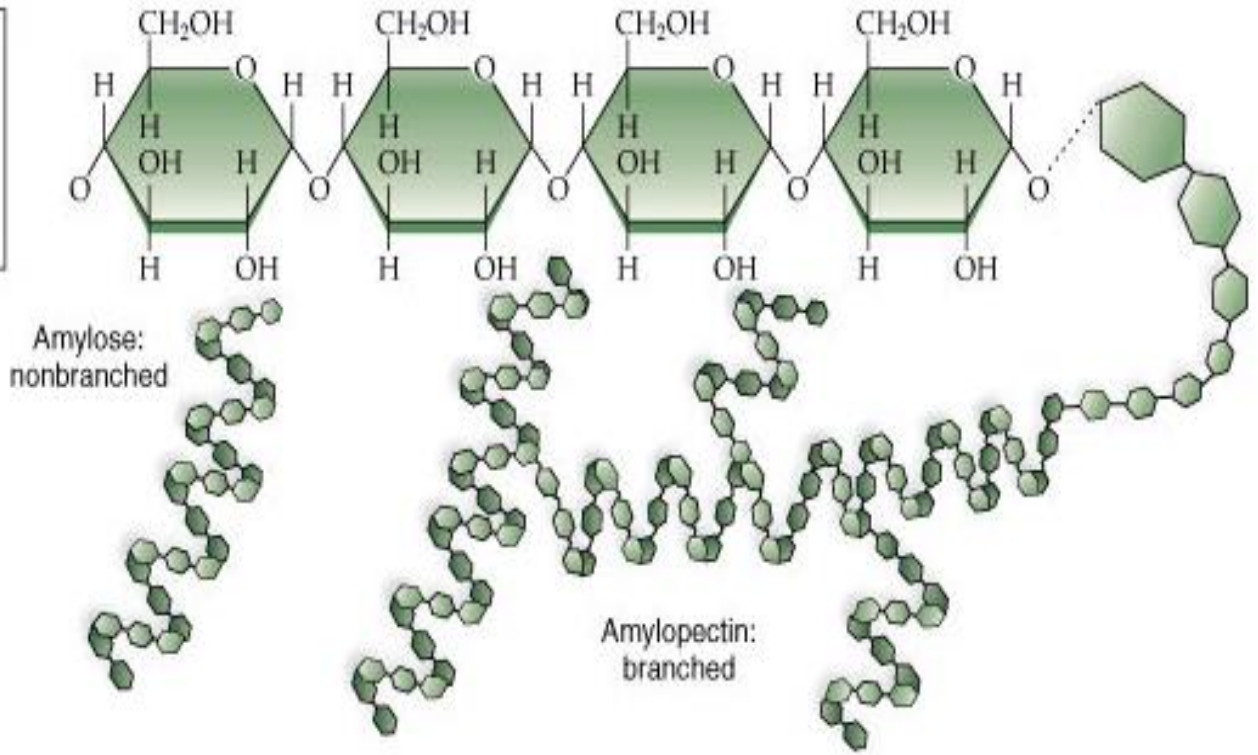
Polysaccharides

- Polysaccharides are long polymers of sugars
- Usually for one of two possible purposes:
  - Energy storage polysaccharides (starch, glycogen)
  - Structural polysaccharides (cellulose, peptidoglycan, chitin)
  - Cellulose – Plant structural polymer for cell wall
  - Peptidoglycan is a polymer that makes up the cell wall of all bacteria.
  - Chitin: fungal cell wall and the exoskeletons of arthropods such as insects and crustaceans (e.g. crabs, lobsters and shrimps).

Polysaccharides **to know**

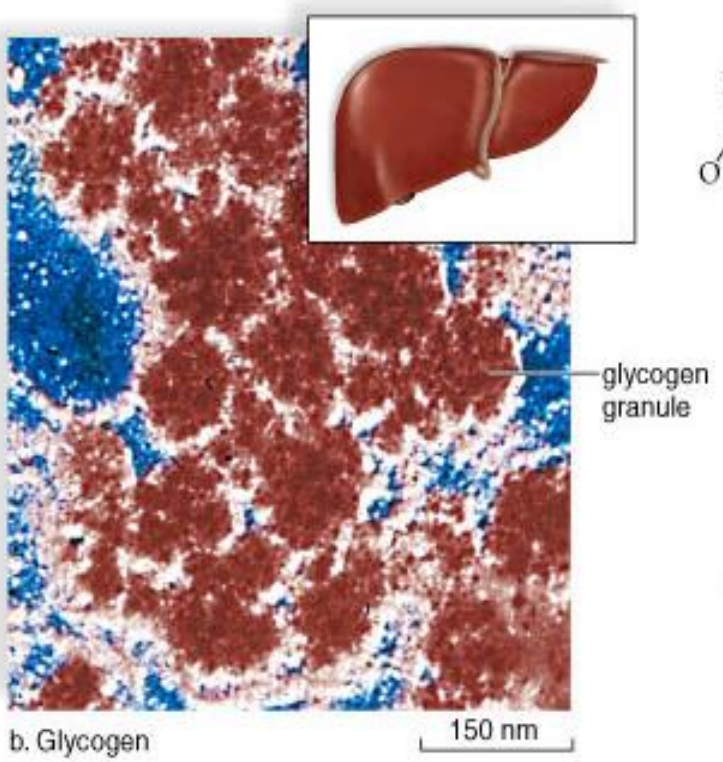
- **Starch** – plant storage of glucose
  - two forms: amylose and amylopectin
  - This is easily digested by all animals.

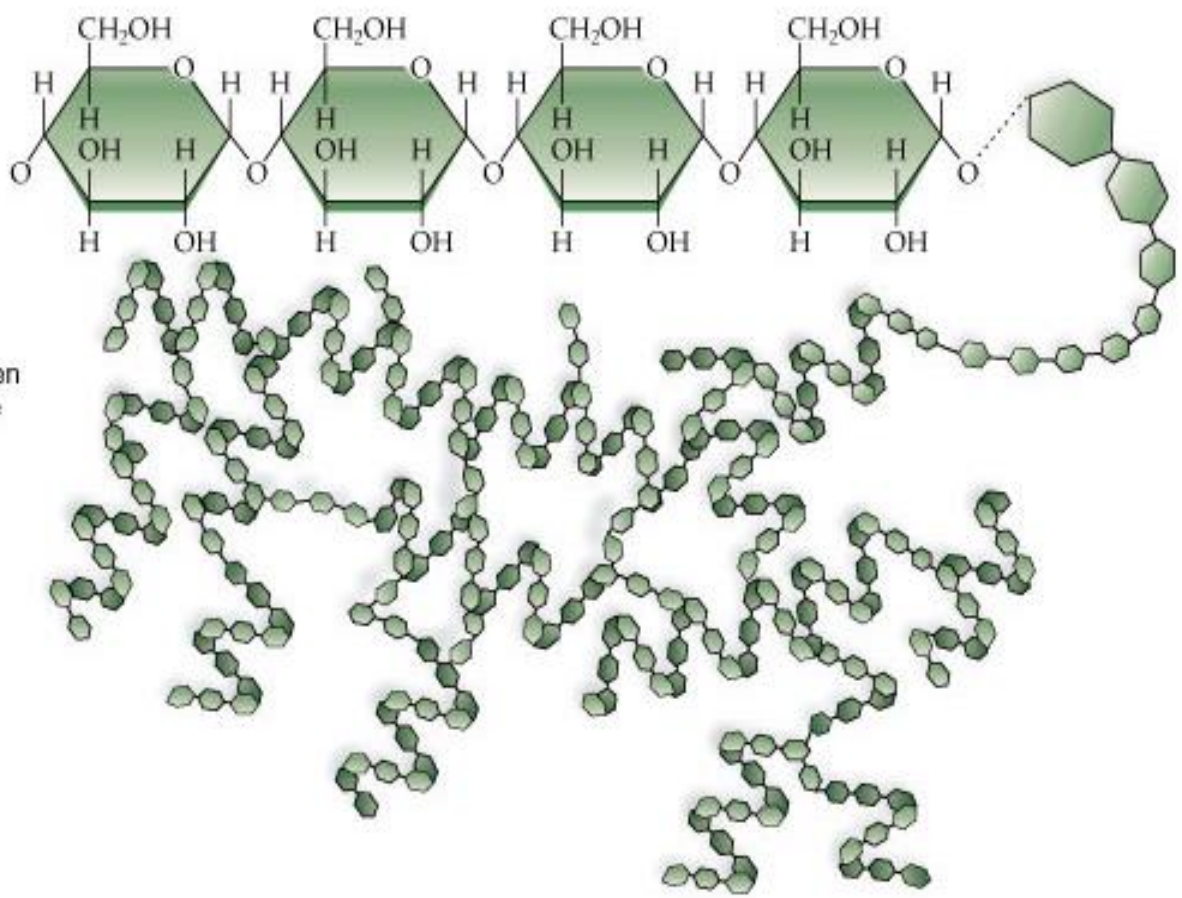




Polysaccharides **to know**

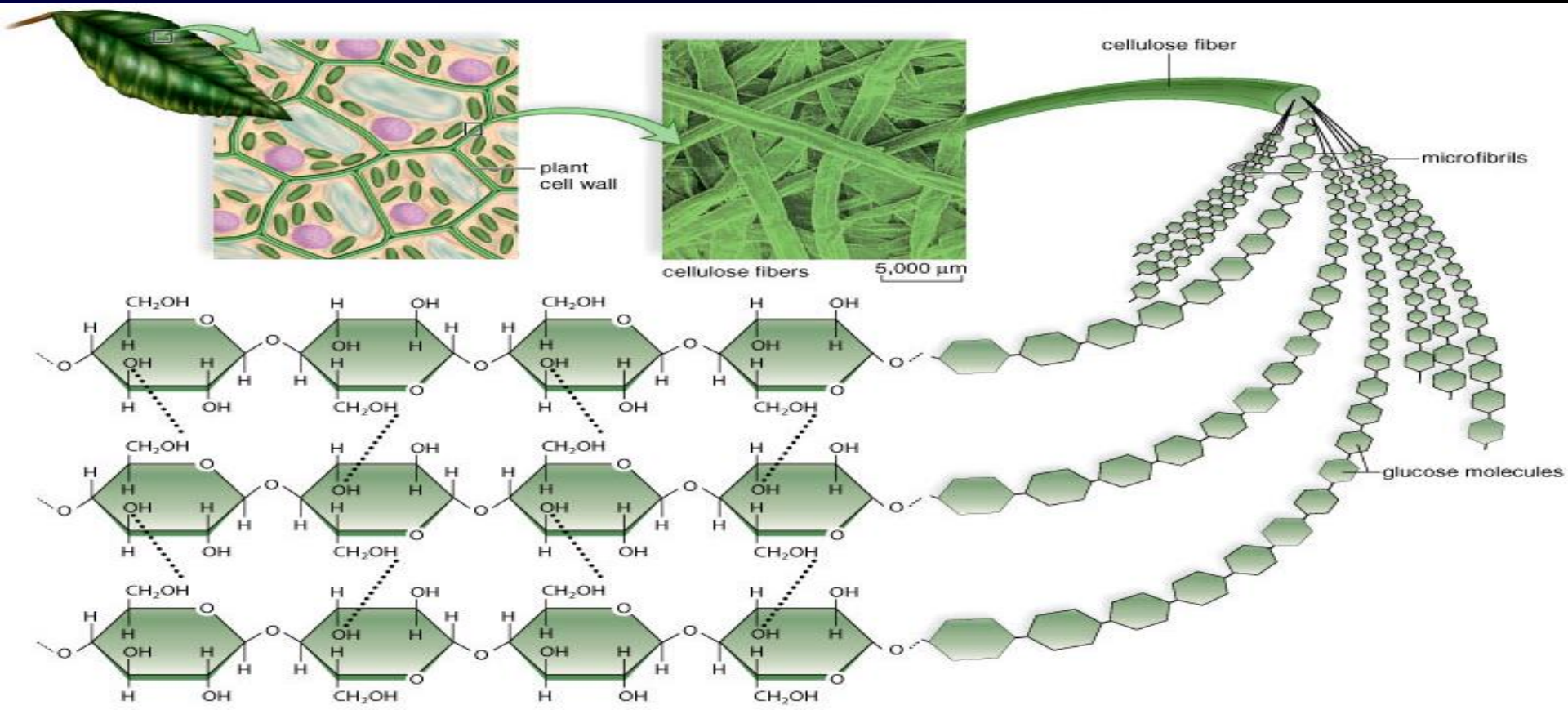
- **Glycogen** – animal storage of glucose (humans: liver and muscle)
- Also polymer of glucose, but much more branched





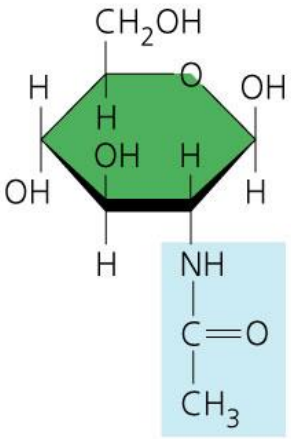
Polysaccharides to know, cont.

- **<u>Cellulose</u>** – Plant structural polymer for cell wall
  - Polymers of glucose but NOT helical, NOT branched
  - NOT digestible by animals!



Polysaccharides to know, cont.

- **Chitin** – Structure for Insect exoskeleton and fungal cell wall
  - Polymers of a Nitrogen-containing form of glucose



(a) The structure of chitin.

(b) Chitin forms the exoskeleton of arthropods. This cicada is molting, shedding its old exoskeleton and emerging in adult form.

(c) Chitin is used to make a strong and flexible surgical thread that decomposes after the wound or incision heals.

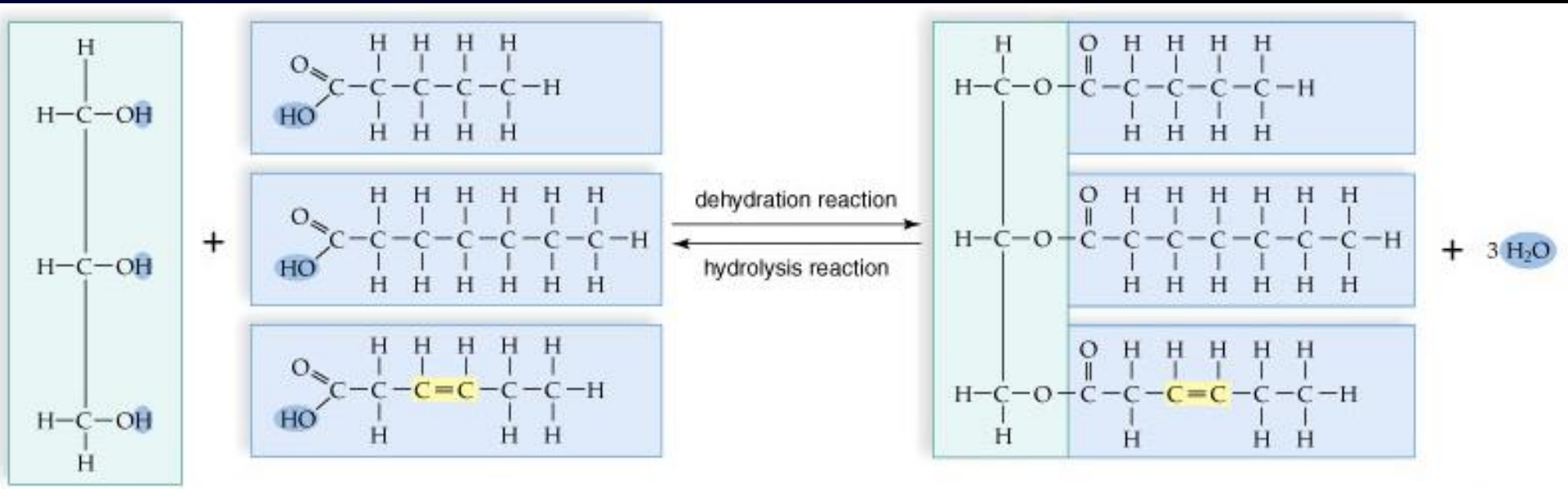
Lipids

- Not technically polymers, but still large molecules
- The unifying feature of lipids is having little or no solubility in water (hydrophobic)

  - consist mostly of hydrocarbons, which form nonpolar covalent bonds
- Three important types:
  - Fats, Phospholipids, Steroids (aka sterols)

Fats (triglycerides)

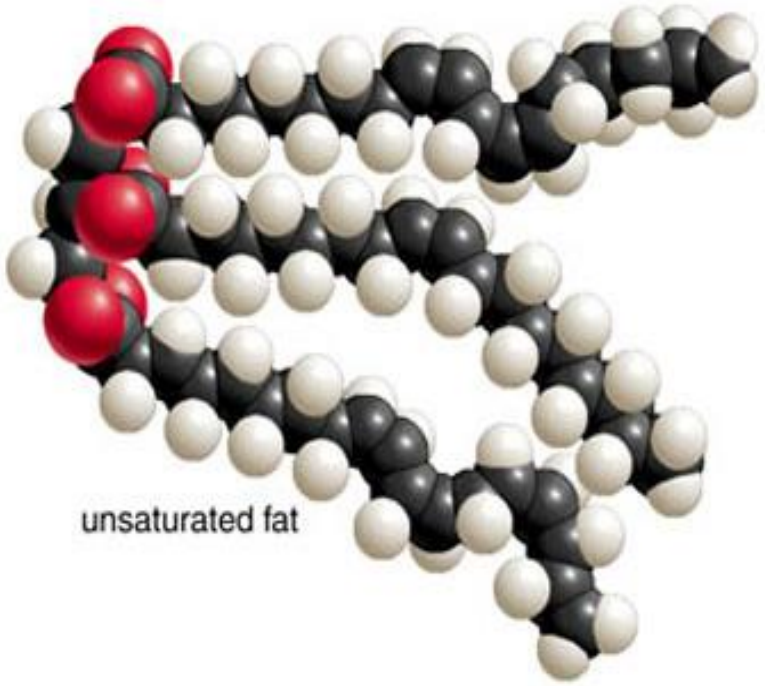
- Group also includes waxes and oils
- Made of 1 glycerol and 3 fatty acids (**triacylglycerol**)
  - Glycerol = 3-carbon alcohol (3-OH's) - Triol
  - Fatty Acid:
    - Long-chain carboxylic acid, usually 16 or 18 C's
    - mostly hydrocarbon units (high energy storage)

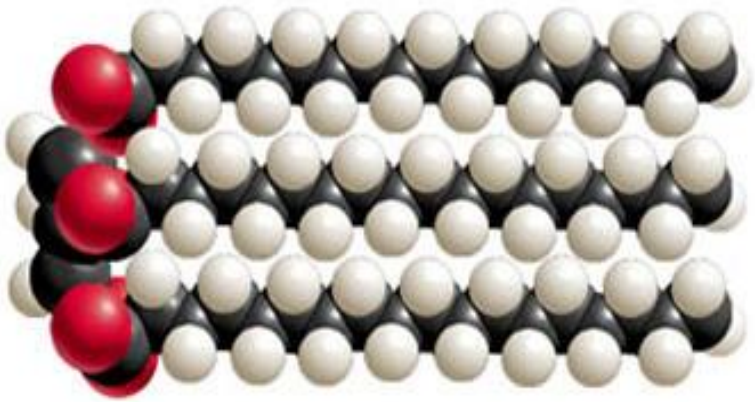


a. Formation of a fat

Fats (triglycerides)

- Made of 1 glycerol and 3 fatty acids (**triacylglycerol**)
  - Glycerol = 3-carbon alcohol (3-OH's)
  - Fatty Acid:
    - Long-chain carboxylic acid, usually 16 or 18 C's
    - mostly hydrocarbon units (high energy storage)

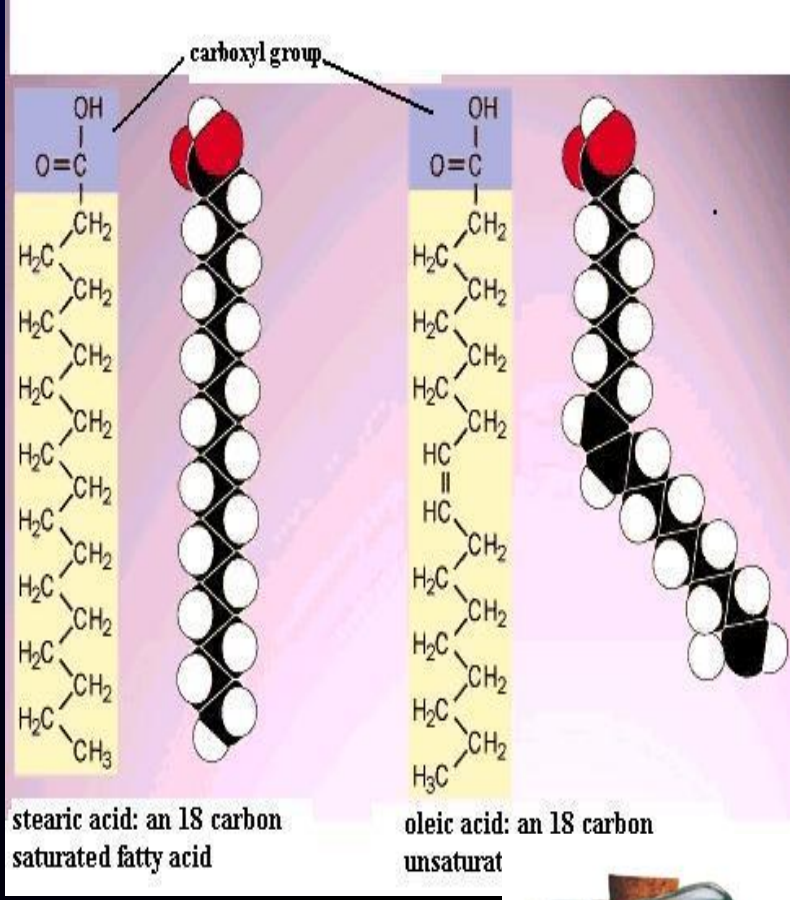




c. Types of fats

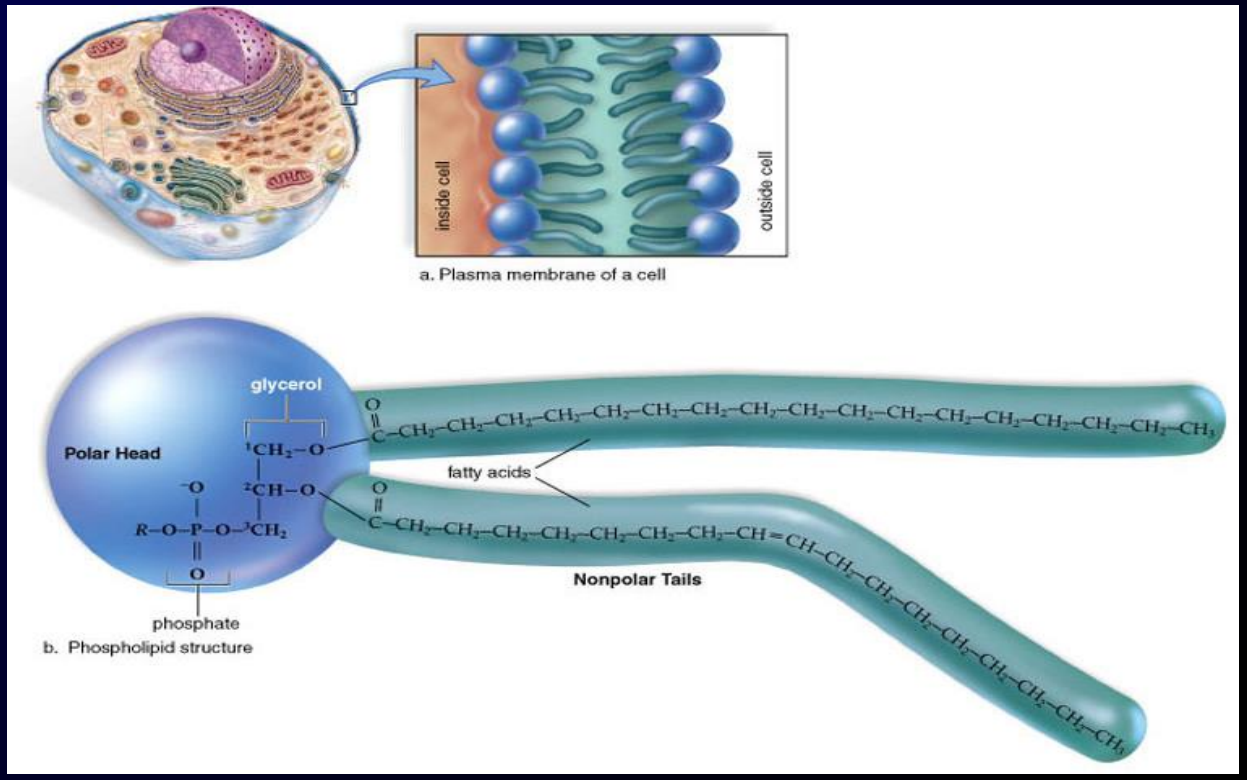
Saturated *vs* Unsaturated

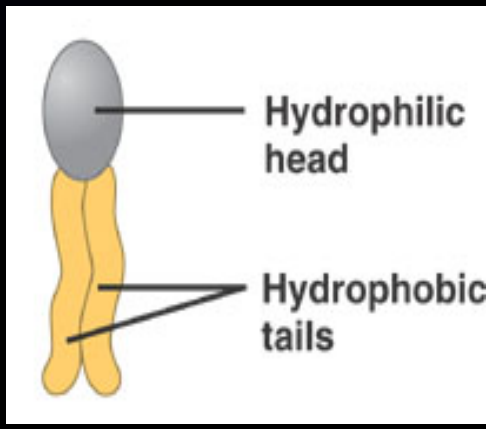
- **Saturated** Fats means all carbons are saturated with hydrogens and no C=C double bonds
  - Higher energy, higher melting point (e.g. butter)
  - You can saturate fats by adding hydrogens, "hydrogenation" (Crisco!) (Oxidation or Reduction?)
- **Unsaturated** means there are C=C double bonds somewhere in the fatty acid chain
  - Cis double bonds create "kinks" in the chains
  - Lower energy, lower melting point (e.g. oil)



Phospholipids

- Used to construct the cell membrane
- Also with glycerol backbone but only two fatty acids

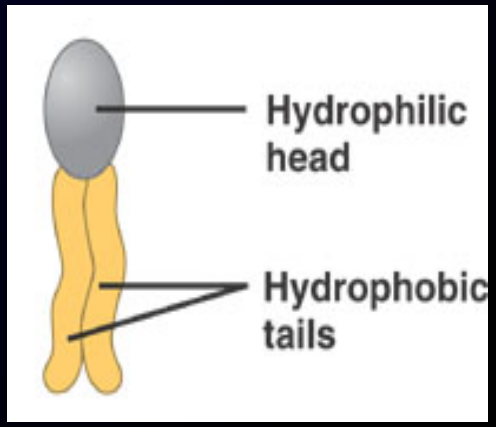


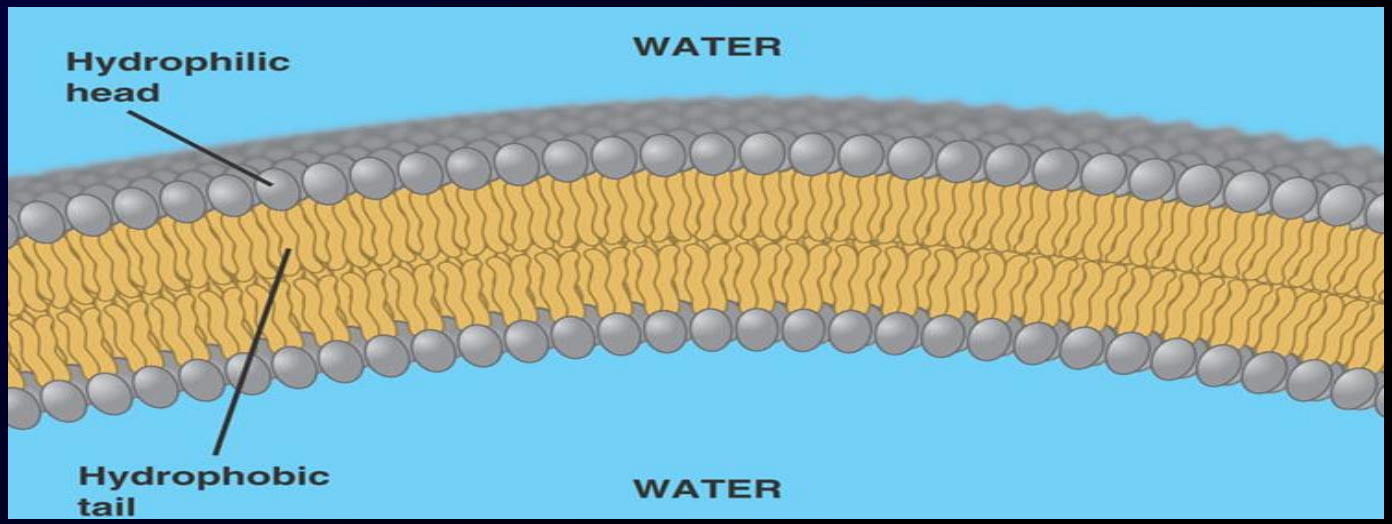


- This creates a polar (hydrophilic) “head” and non-polar (hydrophobic) tails

Phospholipids

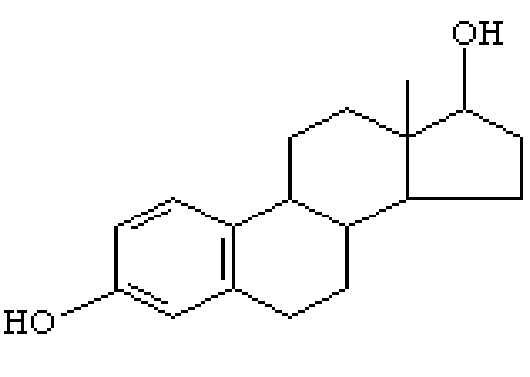
- In water, forms “lipid bilayer” with hydrophobic tails facing each other



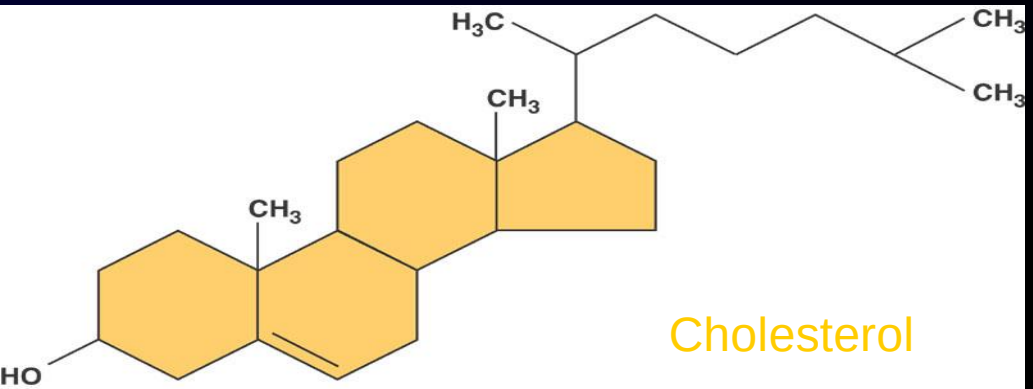


Steroids

- Lipids made of a carbon skeleton of four fused rings
- **Cholesterol** is the main steroid in animal cells
  - Important for animal cell membranes
  - Precursor to all steroid hormones:
    - Estrogen
    - Progesterone
    - Testosterone (androgen)
    - Cortisol (hydrocortizone)



Oestrogen (35)



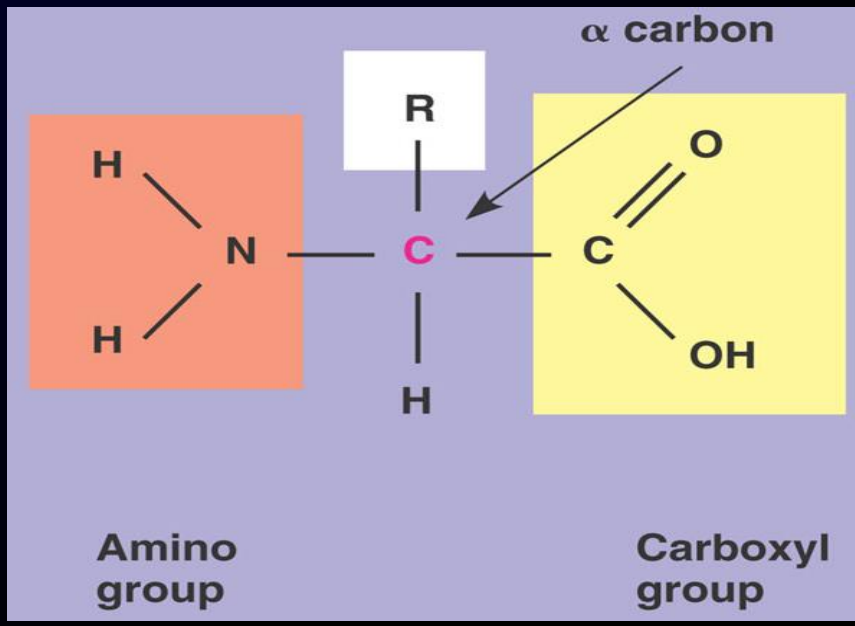
Cholesterol

Proteins

- The most diverse Macromolecule
- 50% of the dry weight of cells
- **Polypeptide** is a polymer of amino acids
- A **protein** is a polypeptide (or more than one) folded into a functional conformation. (Conformation = shape. Shape = function!)

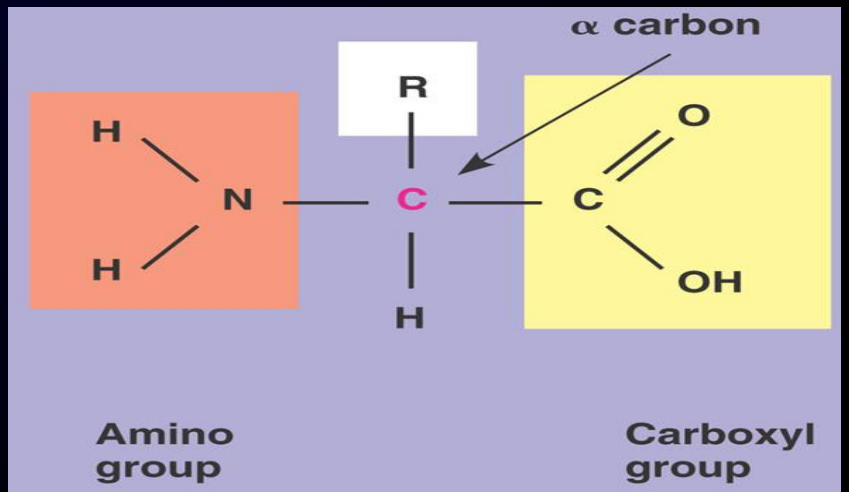
Amino Acids

- 20 that commonly appear in nature
- Each has an amino group, a carboxyl group, and a unique side chain
  - At neutral pH, both the amino group and carboxyl group are ionized!
- The Sequence of amino acids in a protein dictates shape, function, etc.

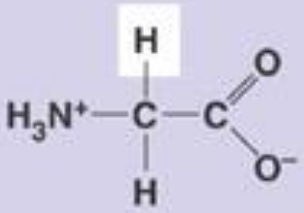


Amino Acids

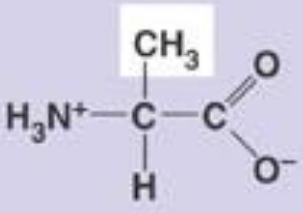
- Three general categories of **side chains**
  - Non polar (hydrophobic)
  - Polar (hydrophilic)
  - Charged (either acid or basic)
- A certain region of a protein has a certain characteristic (e.g., hydrophobic) because the amino acid side chains have that characteristic



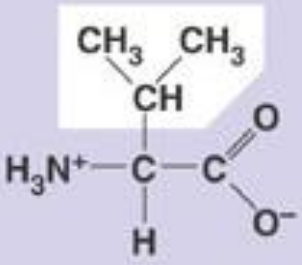
Nonpolar amino acids



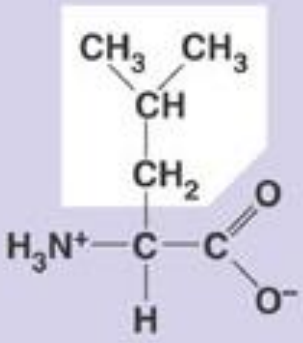
Glycine (Gly)



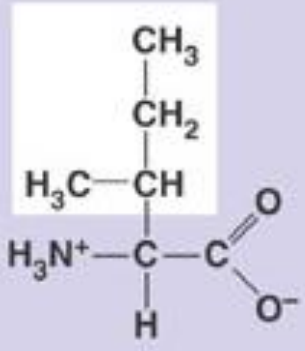
Alanine (Ala)



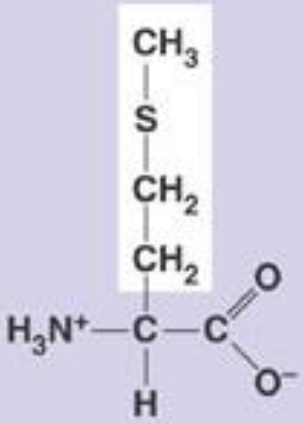
Valine (Val)



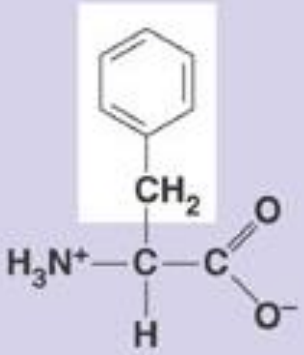
Leucine (Leu)



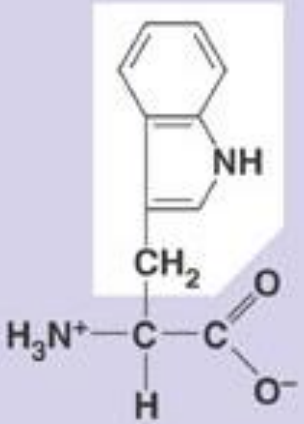
Isoleucine (Ile)



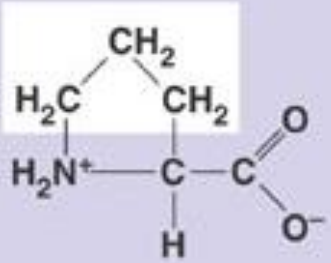
Methionine (Met)



Phenylalanine (Phe)

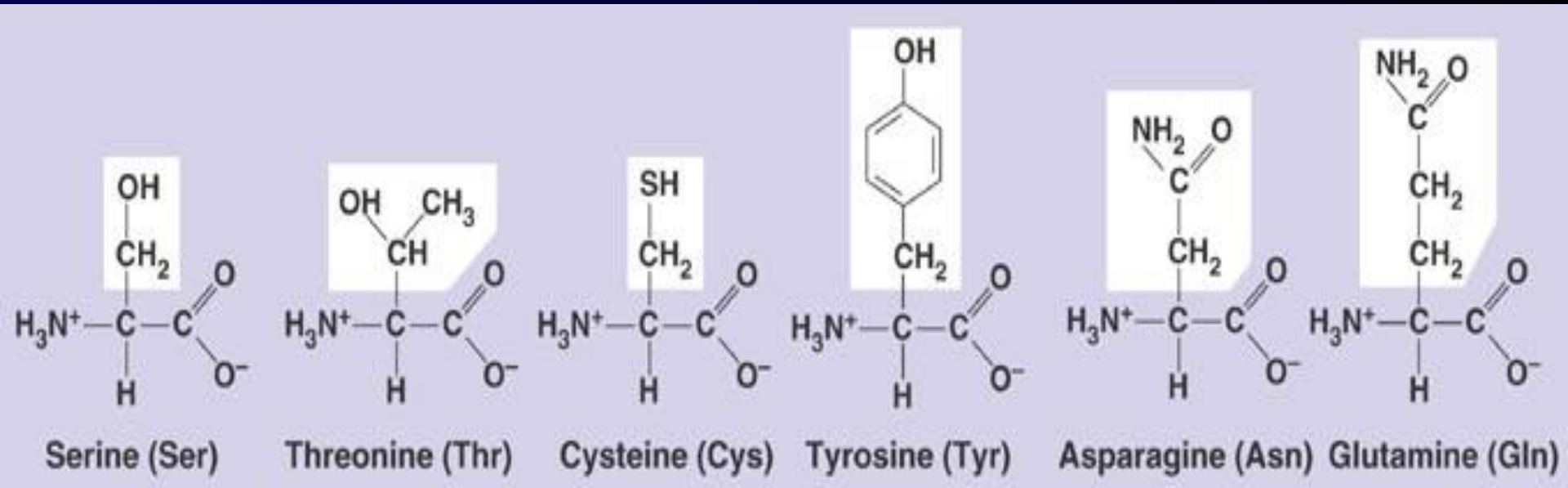


Tryptophan (Trp)

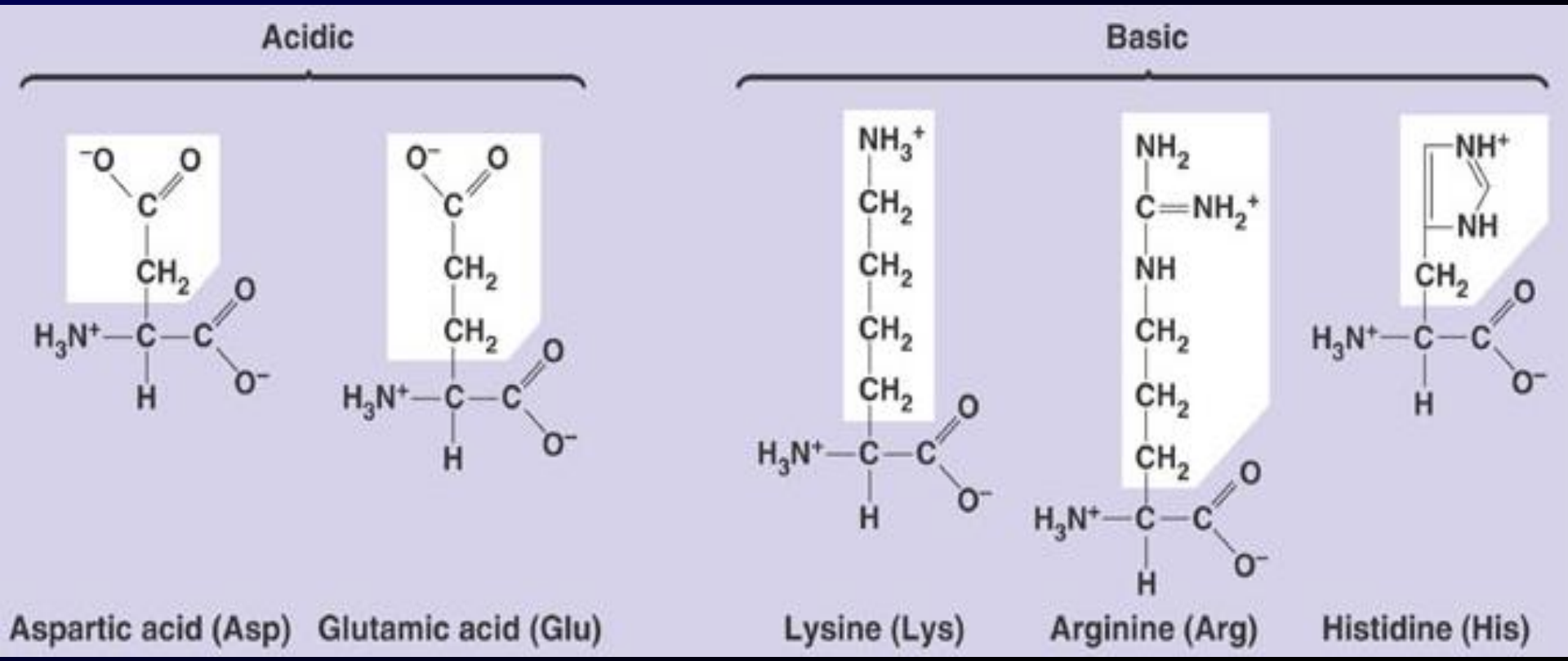


Proline (Pro)

Polar Amino Acids



Electrically Charged Amino Acids



Biological Macromolecules

	Examples	Functions	Monomer (building block)
Carbohydrates	Starch, glycogen (polysaccharides)	Energy storage, cell surface marker, cell signaling	Simple sugars (glucose, galactose)
Lipids	Triacylglycerol, cholesterol	Energy Storage, Cell Membranes, Hormones	Fatty Acids and Glycerol
Proteins	Hemoglobin, Enzymes, Collagen	Catalyze reactions, physical structure, cell signaling	Amino Acids (glycine, cysteine)
Nucleic Acids	DNA, RNA	Store Genetic Information, Gene expression	Nucleotides (A,C,G,T)

No Quiz

Catch up on your reading