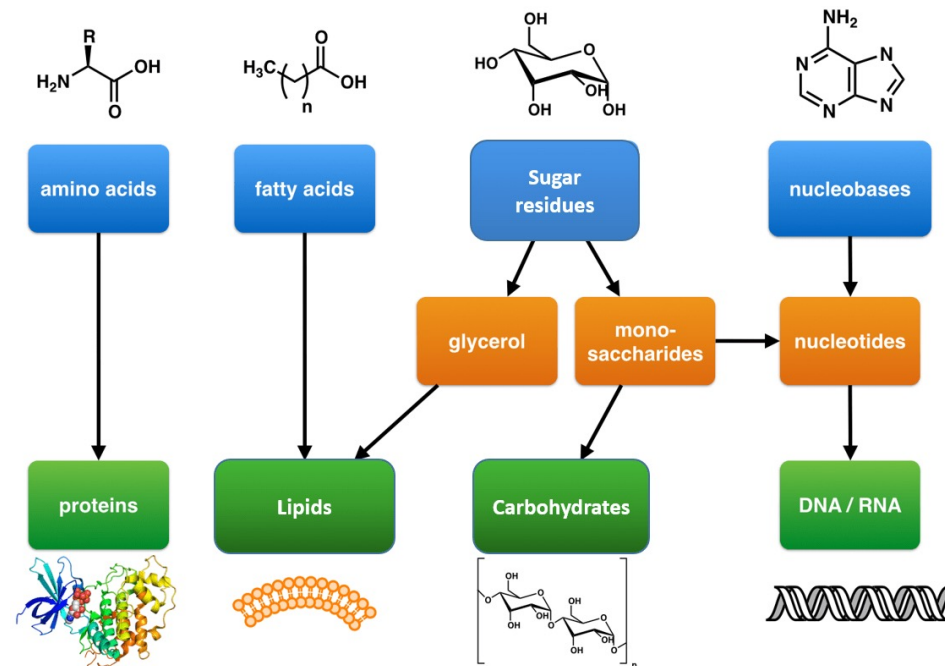


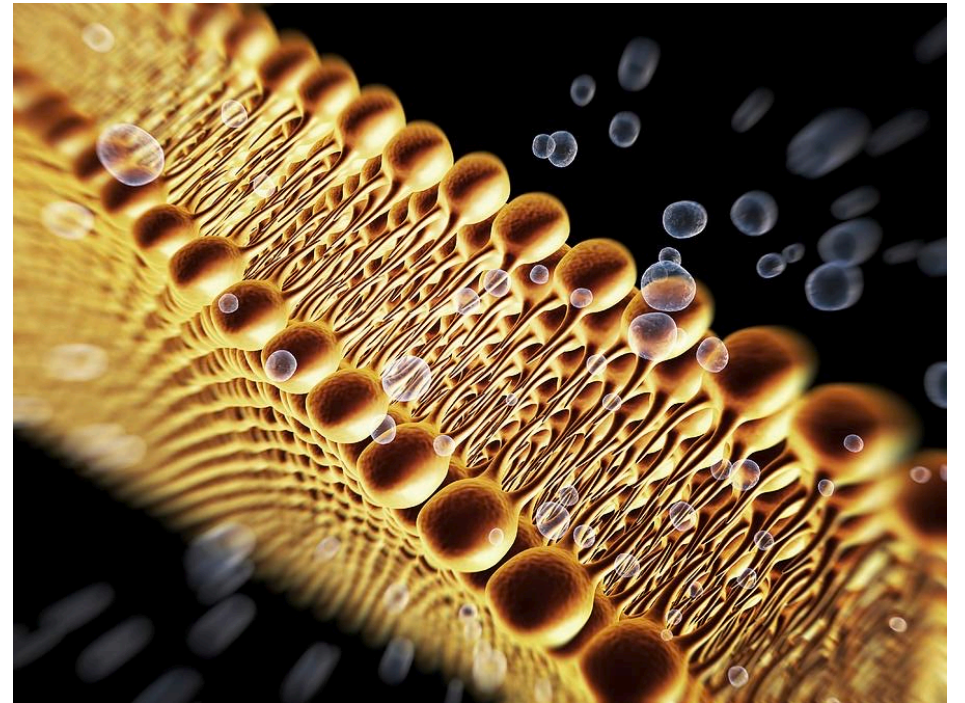
Lesson 2

Recognizing Macromolecules



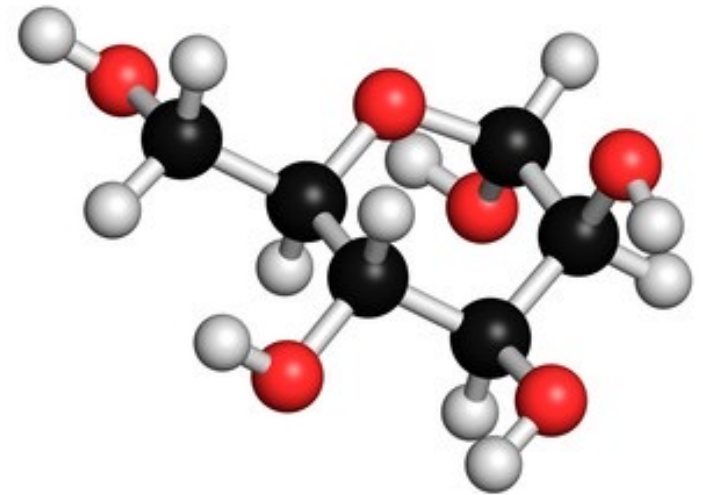
Recognizing macromolecules

- Macro = big → Macromolecules = BIG molecules
- 4 major classes of macromolecules in cells:
 - Lipids



Recognizing macromolecules

- Macro = big → Macromolecules = BIG molecules
- 4 major classes of macromolecules in cells:
 - Lipids
 - Carbohydrates



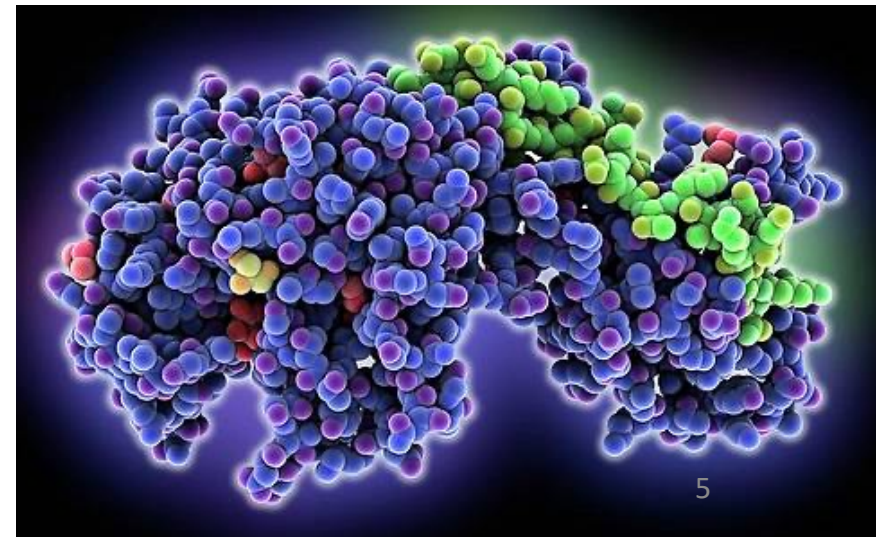
Recognizing macromolecules

- Macro = big → Macromolecules = BIG molecules
- 4 major classes of macromolecules in cells:
 - Lipids
 - Carbohydrates
 - Nucleic acids



Recognizing macromolecules

- Macro = big → Macromolecules = BIG molecules
- 4 major classes of macromolecules in cells:
 - Lipids
 - Carbohydrates
 - Nucleic acids
 - **Proteins**

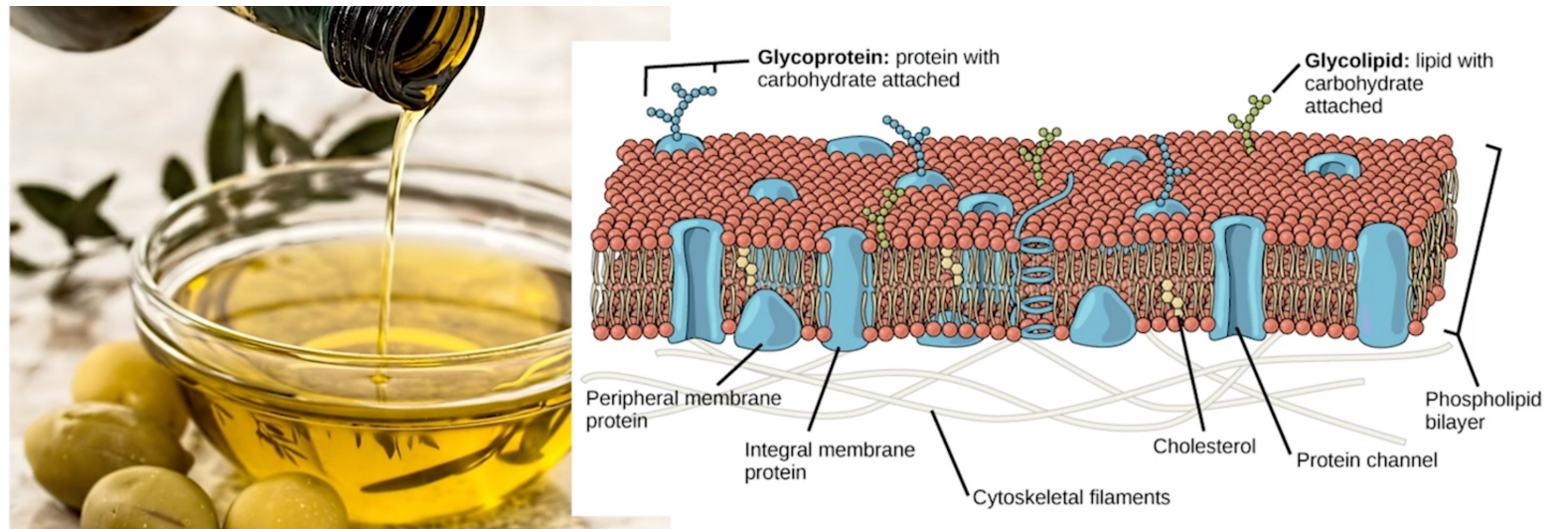


Recognizing macromolecules

- Macro = big → Macromolecules = BIG molecules
- 4 major classes of macromolecules in cells:
 - Lipids
 - Carbohydrates
 - Nucleic acids
 - Proteins
- They are often polymers → (monomer = M, polymer = M_n)

Lipids

- Membranes, signals, energy storage, protection
- Non-polar (hydrophobic) (**key attribute**)
- Or amphipathic (partly polar)
- Long chain or small



cell membranes

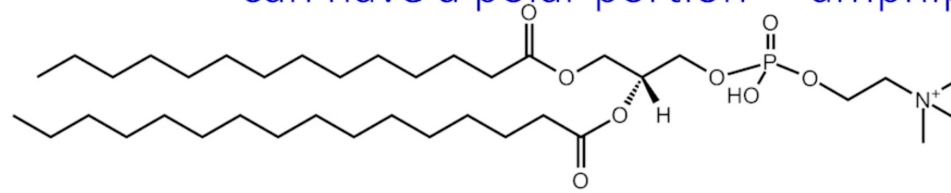
lipid functions

signaling

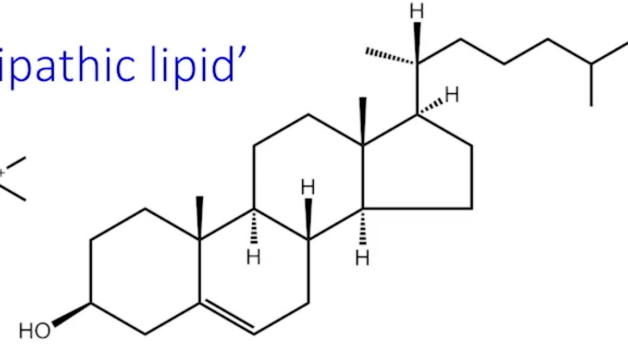


Lipids

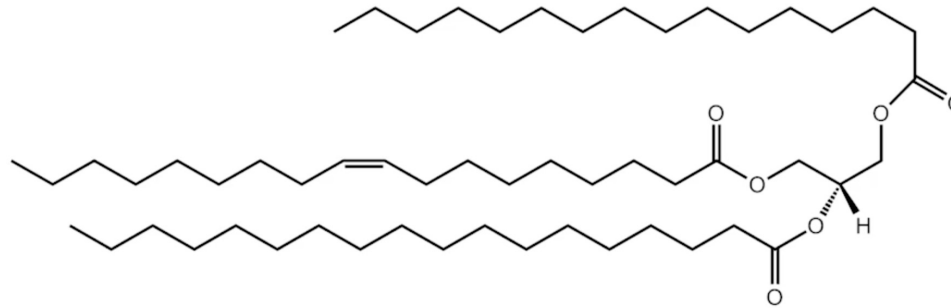
Lipids **non-polar (hydrophobic)**
can have a **polar portion = 'amphipathic lipid'**



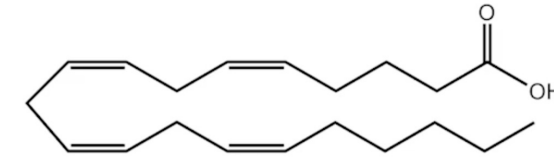
1-myristoyl-2-palmitoyl-*sn*-glycerophosphocholine
(Glycerophospholipids)



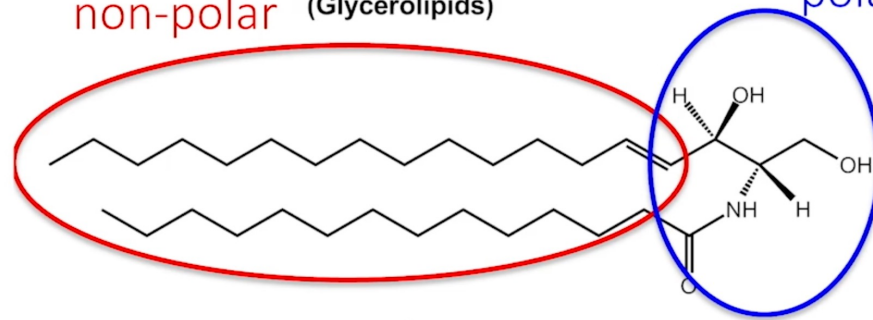
Cholesterol (Sterol lipids)



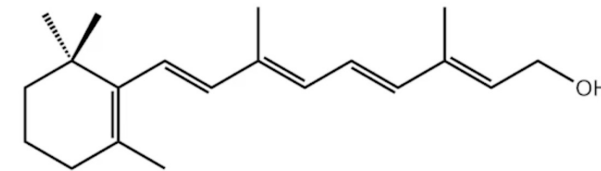
1-oleoyl-2-stearoyl-3-palmitoyl-*sn*-glycerol
non-polar (Glycerolipids)



Arachidonic acid (Fatty acyls)



N-myristoyl-sphing-4-enine
(Sphingolipids)



Retinol (Prenol lipids)

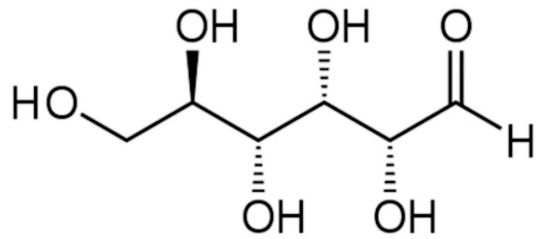
Carbohydrates

- Energy, information, structure
- Basic chemical formula CH_2O ($\text{C}_6\text{H}_{12}\text{O}_6$)
- Monomer M = monosaccharides (sugars)
- Polymers = polysaccharides (glycogen, starch, cellulose...)
- Ms joined by glycosidic bonds C-O-C

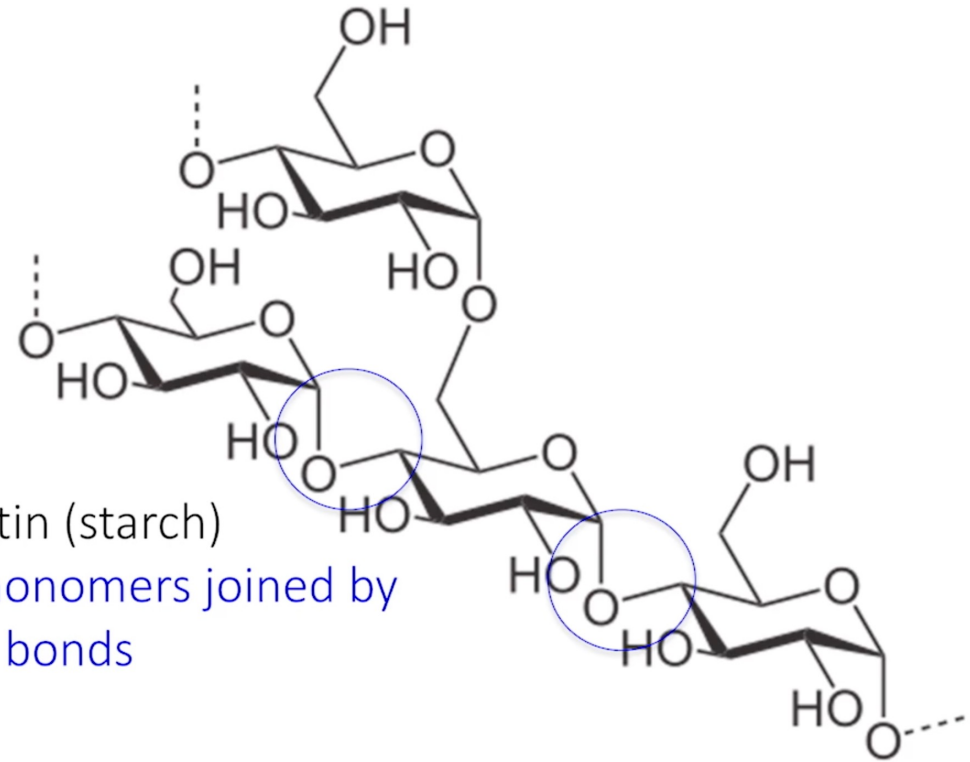
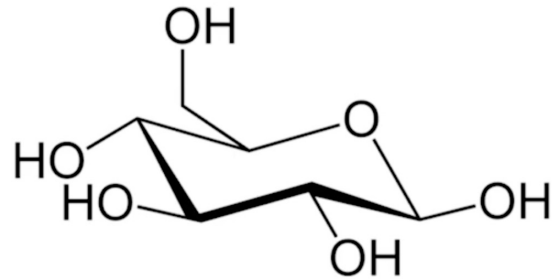


Carbohydrates

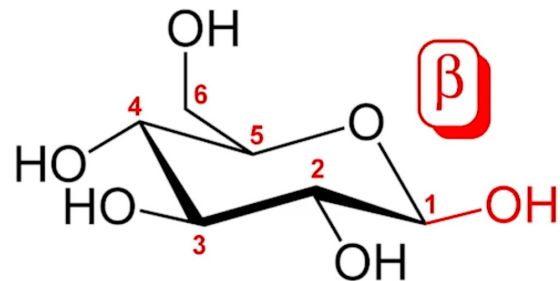
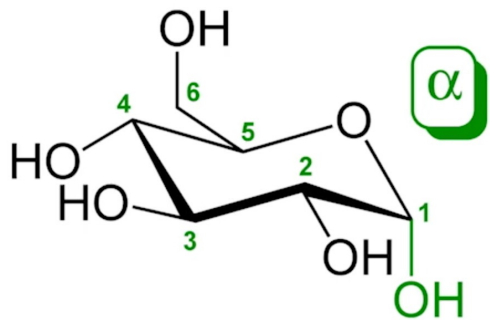
Glucose isomers



open chain



amylopectin (starch)
glucose monomers joined by
glycosidic bonds
C-O-C



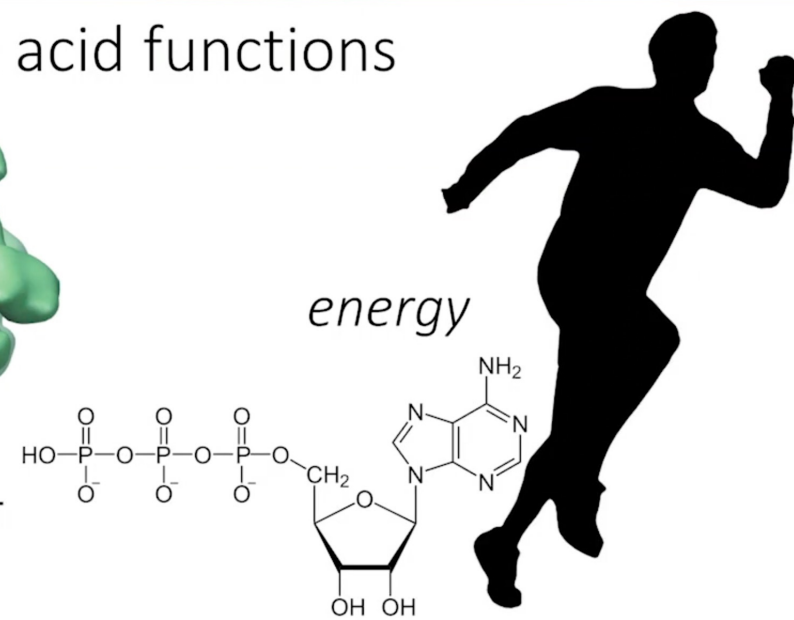
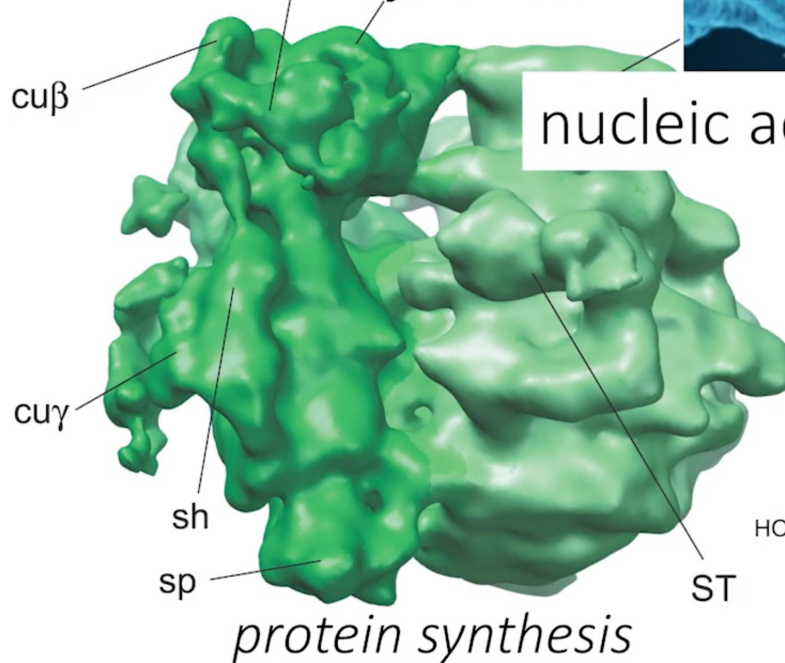
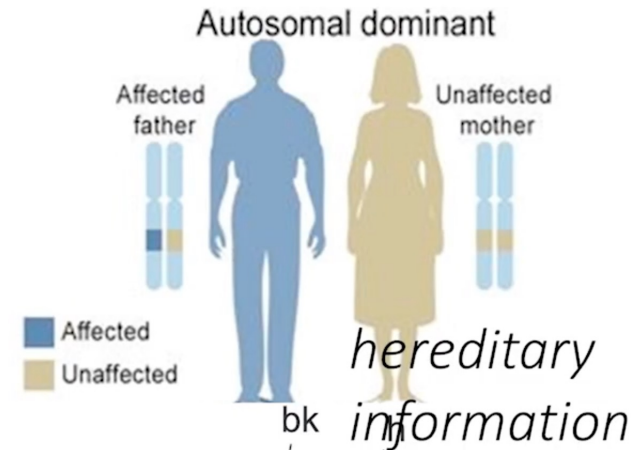
In starch → α -1,4 in cellulose → β -1,4 WHAT CAN WE DIGEST AND WHY?

Nucleic acids

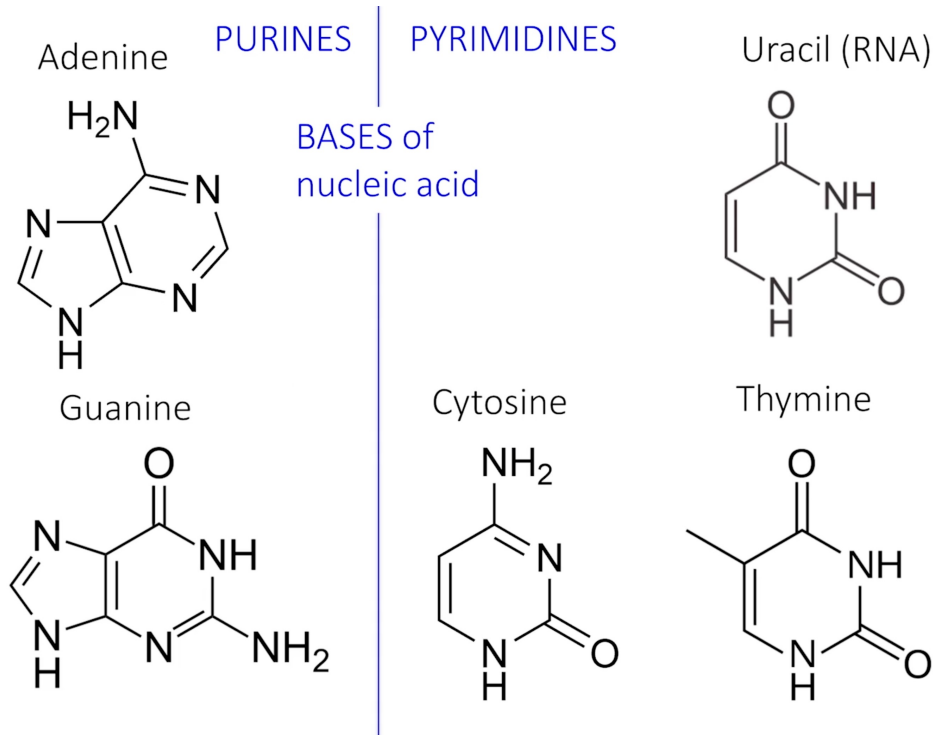
- Hereditary information (genes), energy
- Monomer M = nucleotides
- Polymers = DNA or RNA
- The nucleotide structure is stereotypical:

Phosphate-sugar-base (P-S-B)

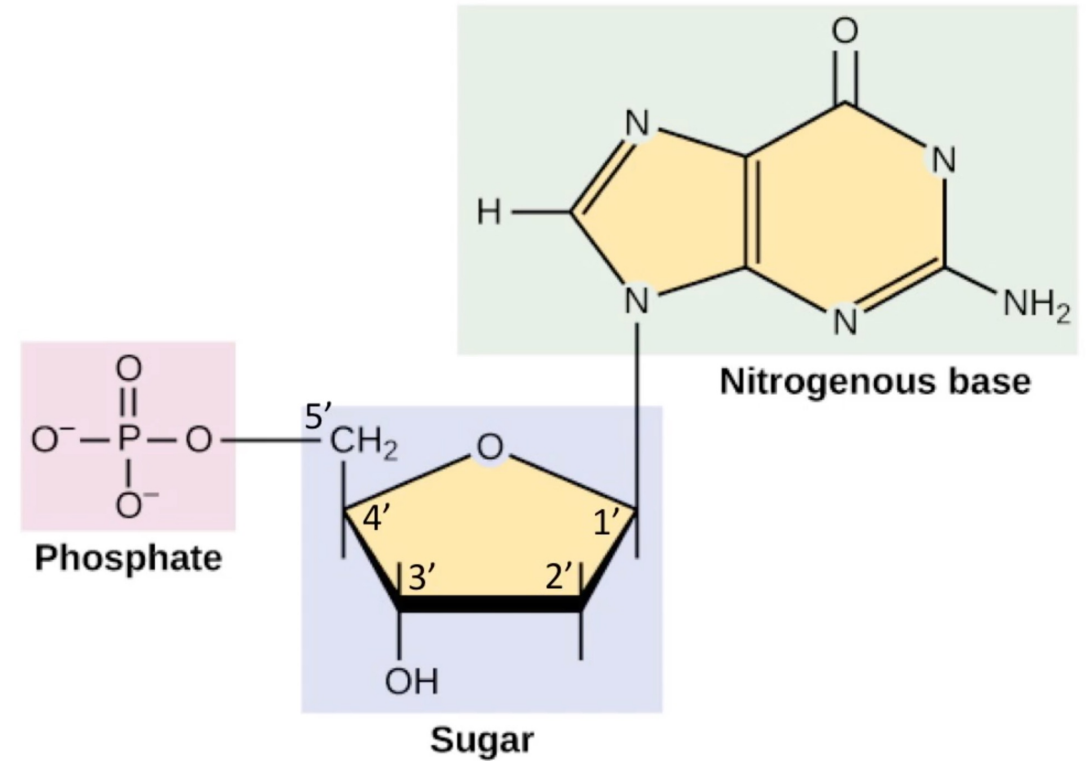
- Sugar = (5C) ribose (RNA) or deoxyribose (DNA)
- 5 bases:
 - Adenine (A), Guanine (G) = PURINES
 - Cytosine (C), Thymine (T), Uracil (U) = PYRIMIDINES
- A,G,C,T = DNA
- A,G,C,U = RNA



Nucleic acids



Nucleotide

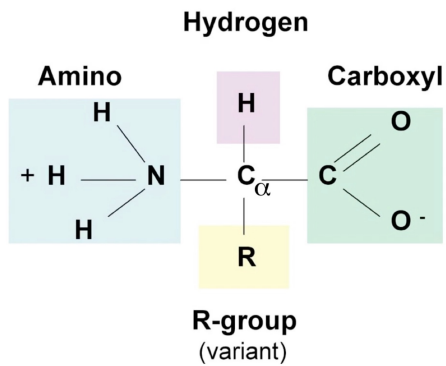


Note that the carbon atoms of the sugar are called C1', C2' etc
C1' is where the base attaches
C2' can have attached a H (as here, for DNA) or a OH group (for RNA)
C3' is very important and where the next nucleotide will join
C5' is where the phosphate group attaches

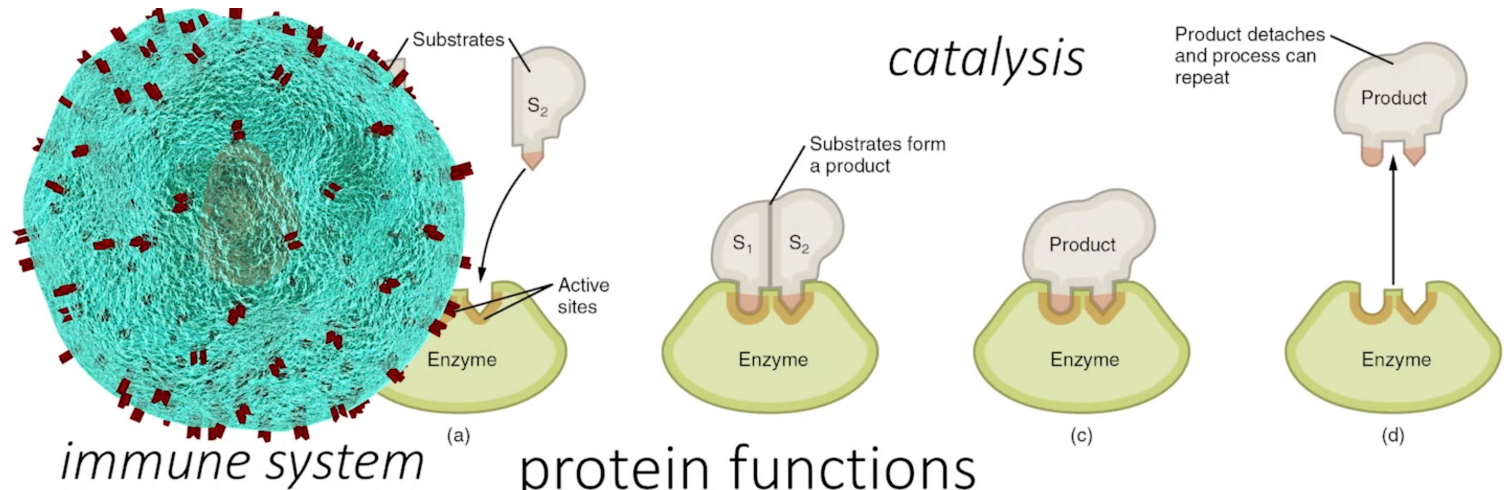
Proteins

- Everything except genes
- Monomer M = amino acids
- 20 natural common amino acids
- Polymer = protein
- Amino acid structure:

Alpha C + NH₂ + COOH + R (side group)

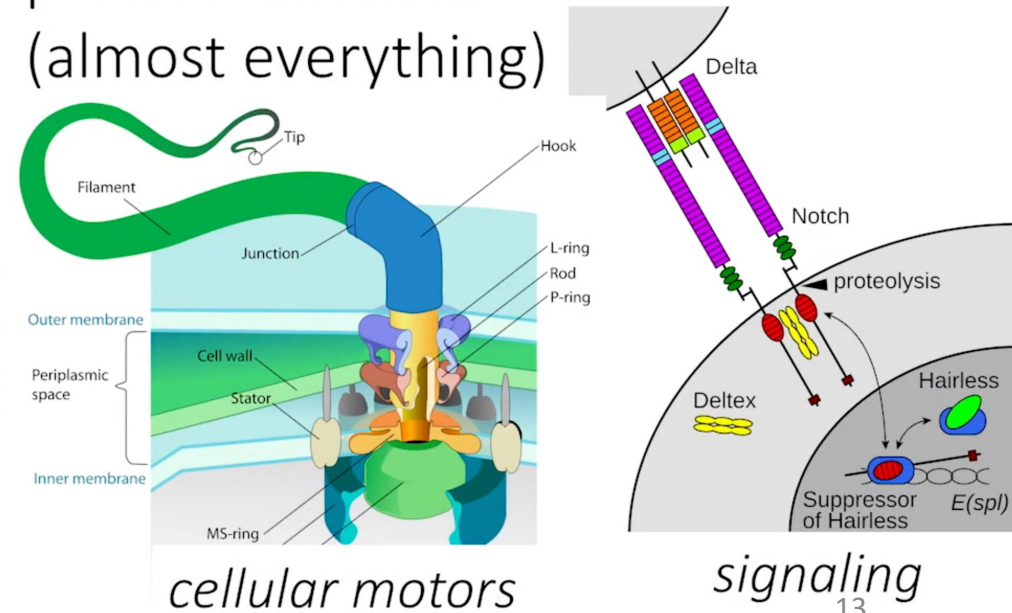
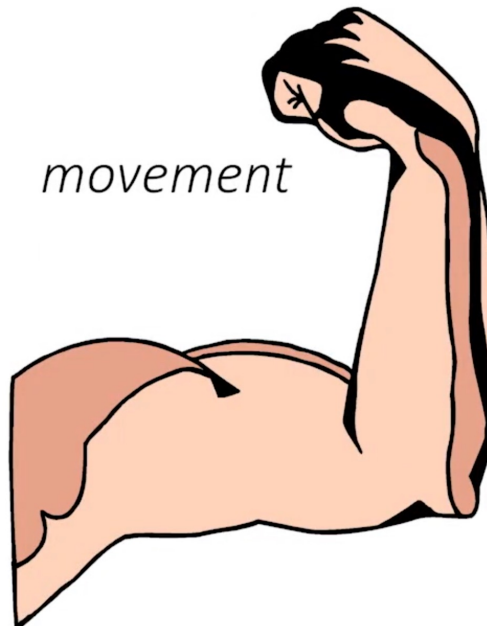


- R can be polar, non-polar, charged, uncharged
- Three or one letter code:
 - Valine = VAL
 - Valine = V



immune system

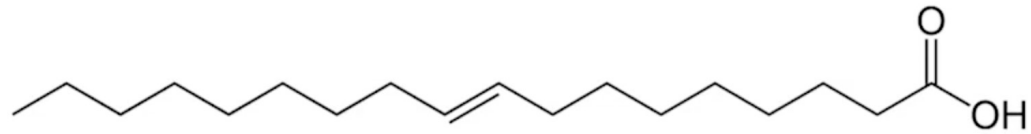
protein functions
(almost everything)



Proteins

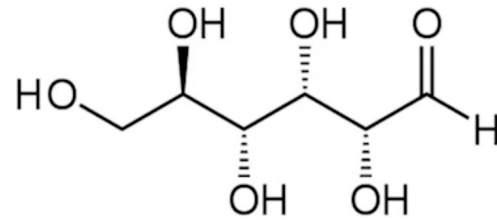
	AMINO ACID			AMINO ACID					
Nonpolar, aliphatic R groups	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{H} \end{array}$ <p>Glycine</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{CH}_3 \end{array}$ <p>Alanine</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{CH} \\ \quad \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$ <p>Valine</p>	Positively charged R groups	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{NH}_3^+ \end{array}$ <p>Lysine</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{NH} \\ \\ \text{C} = \text{NH}_2^+ \\ \\ \text{NH}_2 \end{array}$ <p>Arginine</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{CH}_2 \\ \\ \text{C} - \text{NH}^+ \\ \quad \\ \text{C} \quad \text{CH} \\ \quad // \\ \text{H} \quad \text{NH}^+ \end{array}$ <p>Histidine</p>		
	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{CH}_2 \\ \\ \text{CH} \\ \quad \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$ <p>Leucine</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{S} \\ \\ \text{CH}_3 \end{array}$ <p>Methionine</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{H} - \text{C} - \text{CH}_3 \\ \\ \text{CH}_2 \\ \\ \text{CH}_3 \end{array}$ <p>Isoleucine</p>		Negatively charged R groups	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{CH}_2 \\ \\ \text{COO}^- \end{array}$ <p>Aspartate</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{COO}^- \end{array}$ <p>Glutamate</p>		
	Polar, uncharged R groups	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{CH}_2\text{OH} \end{array}$ <p>Serine</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{CH}_3 \end{array}$ <p>Threonine</p>			$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{CH}_2 \\ \\ \text{SH} \end{array}$ <p>Cysteine</p>	Nonpolar, aromatic R groups	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{CH}_2 \\ \\ \text{C}_6\text{H}_5 \end{array}$ <p>Phenylalanine</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{CH}_2 \\ \\ \text{C}_6\text{H}_4 \\ \\ \text{OH} \end{array}$ <p>Tyrosine</p>
		$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_2\text{N}^+ - \text{C} - \text{H} \\ \quad \\ \text{H}_2\text{C} \quad \text{CH}_2 \\ \quad \\ \text{H}_2\text{C} \quad \text{CH}_2 \end{array}$ <p>Proline</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{CH}_2 \\ \\ \text{C} \\ \quad \\ \text{H}_2\text{N} \quad \text{O} \end{array}$ <p>Asparagine</p>		$\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{C} \\ \quad \\ \text{H}_2\text{N} \quad \text{O} \end{array}$ <p>Glutamine</p>				

Recognizing macromolecules - review



trans-oleic acid

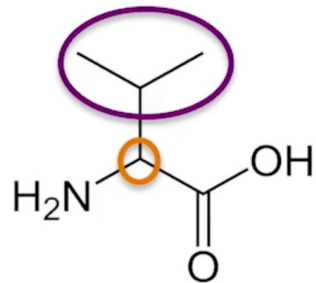
Lipids: **nonpolar**/hydrophobic



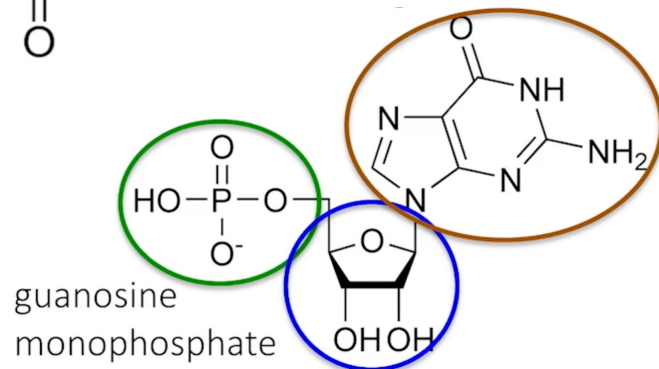
glucose

Carbohydrates: **CH₂O** formula/**polar**

valine



Proteins: M = **amino acid** = **α C bonded to NH₂, COOH and R**, R = polar/nonpolar



guanosine monophosphate

Nucleic acids: M = **nucleotide** = **phosphate + sugar + base, polar**

Recognizing macromolecules

- Take assignment 2: **Recognizing Macromolecules**