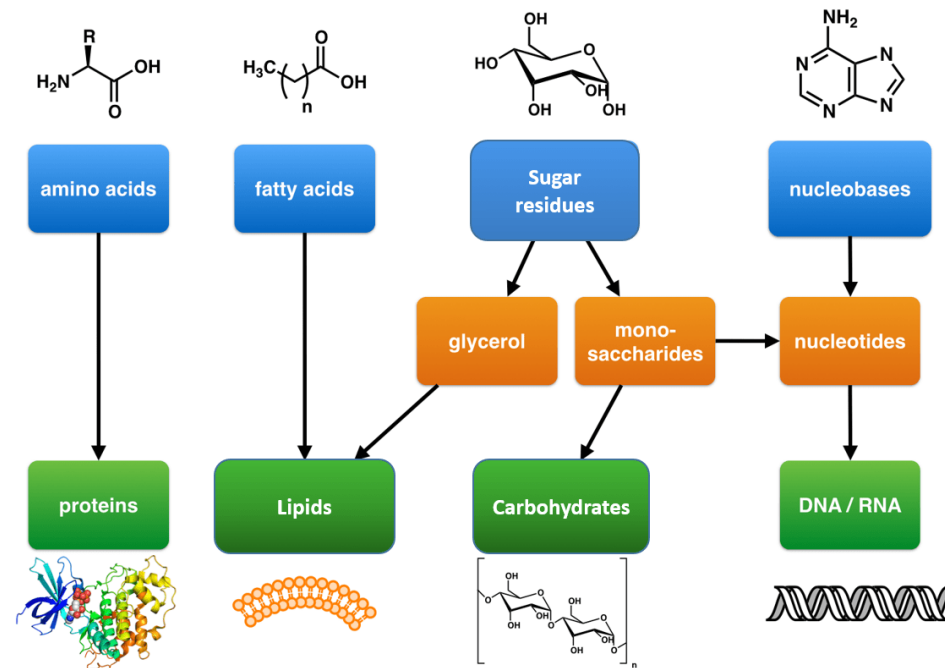


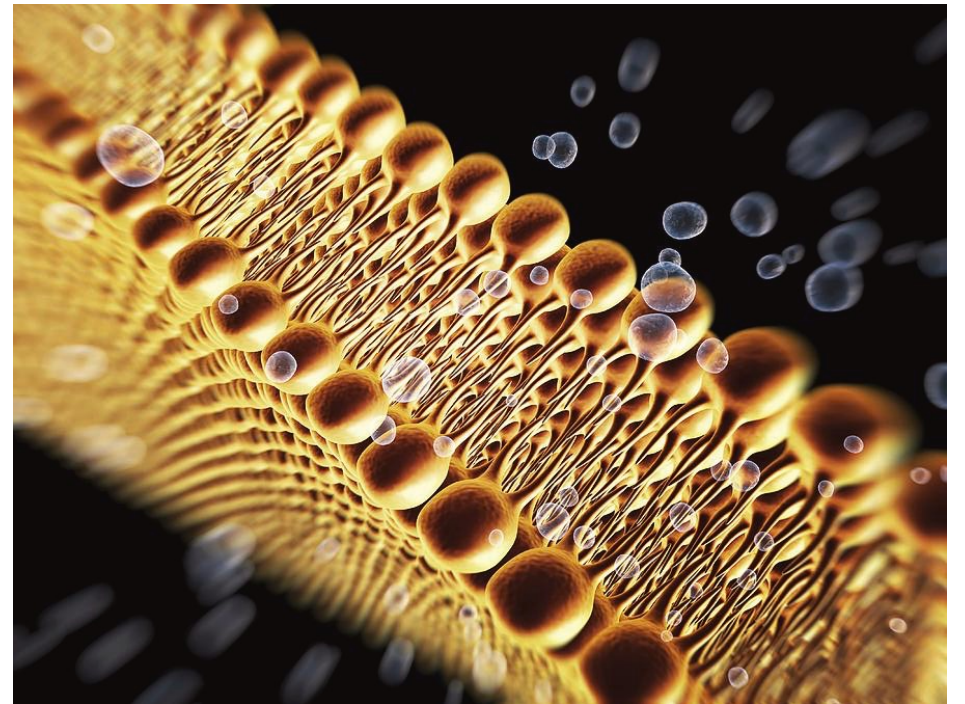
# Lesson 2

## Recognizing Macromolecules



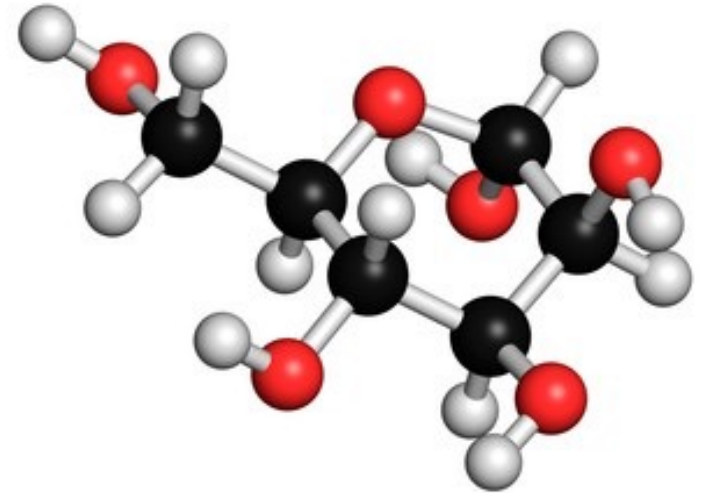
# Recognizing macromolecules

- 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



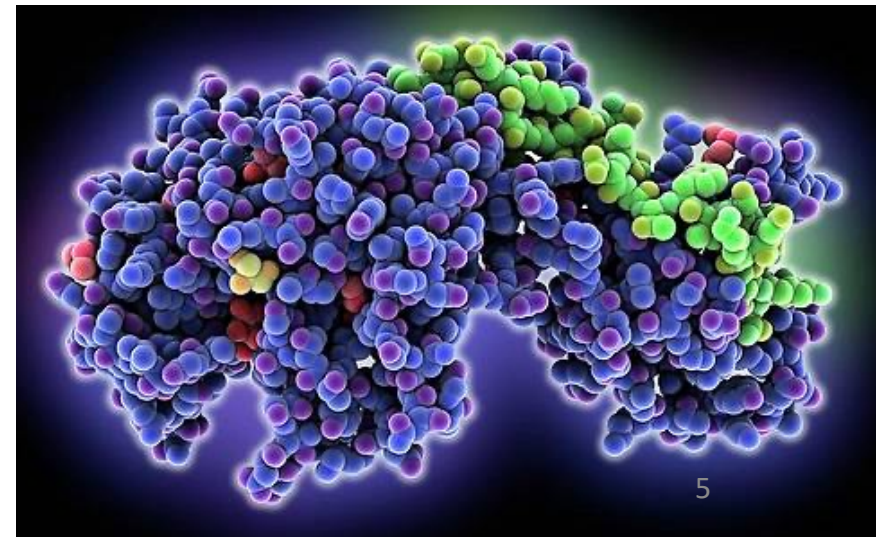
# Recognizing macromolecules

- 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**

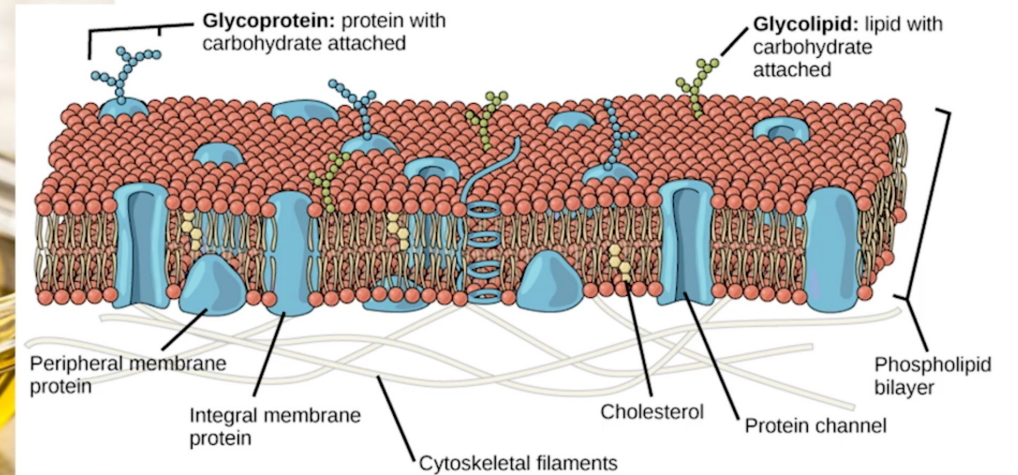


# Recognizing macromolecules

- 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

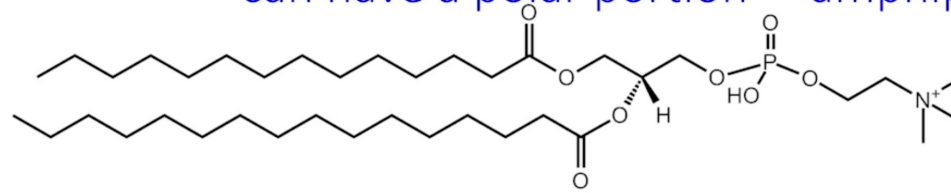
lipid functions

signaling

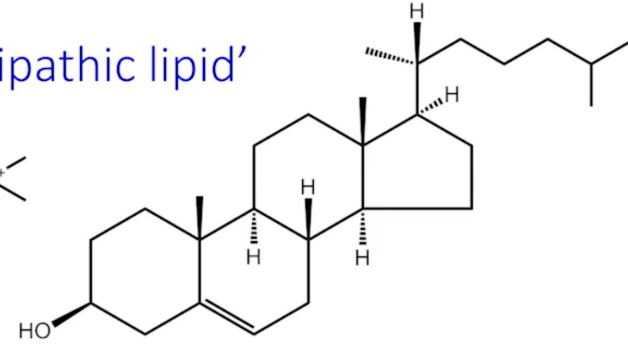


# Lipids

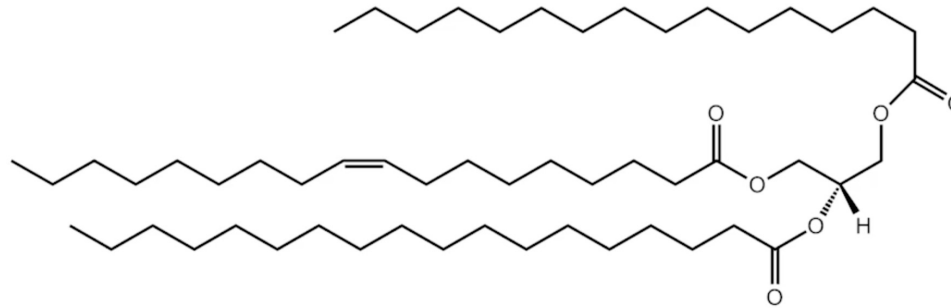
Lipids **non-polar (hydrophobic)**  
can have a **polar portion = 'amphipathic lipid'**



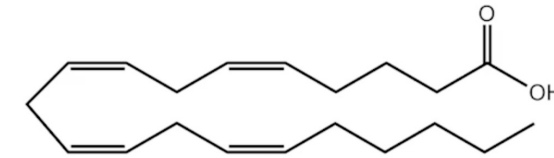
1-myristoyl-2-palmitoyl-*sn*-glycerophosphocholine  
(Glycerophospholipids)



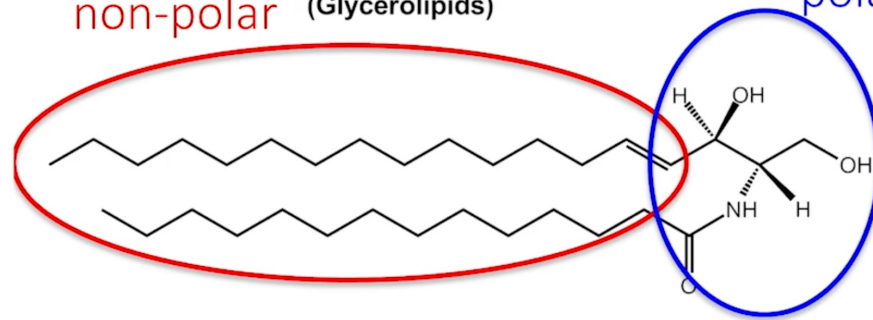
Cholesterol (Sterol lipids)



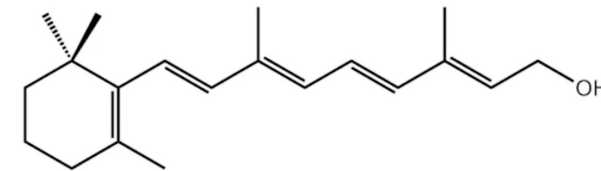
1-oleoyl-2-stearoyl-3-palmitoyl-*sn*-glycerol  
**non-polar** (Glycerolipids)



Arachidonic acid (Fatty acyls)



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



Retinol (Prenol lipids)



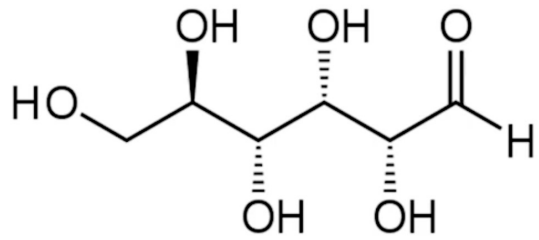
# Carbohydrates

- Energy, information, structure
- Basic chemical formula  $\text{CH}_2\text{O}$  ( $\text{C}_6\text{H}_{12}\text{O}_6$ )
- Monomer M = monosaccharides (sugars)
- Polymers = polysaccharides (glycogen, starch, cellulose...)
- Ms joined by glycosidic bonds C-O-C

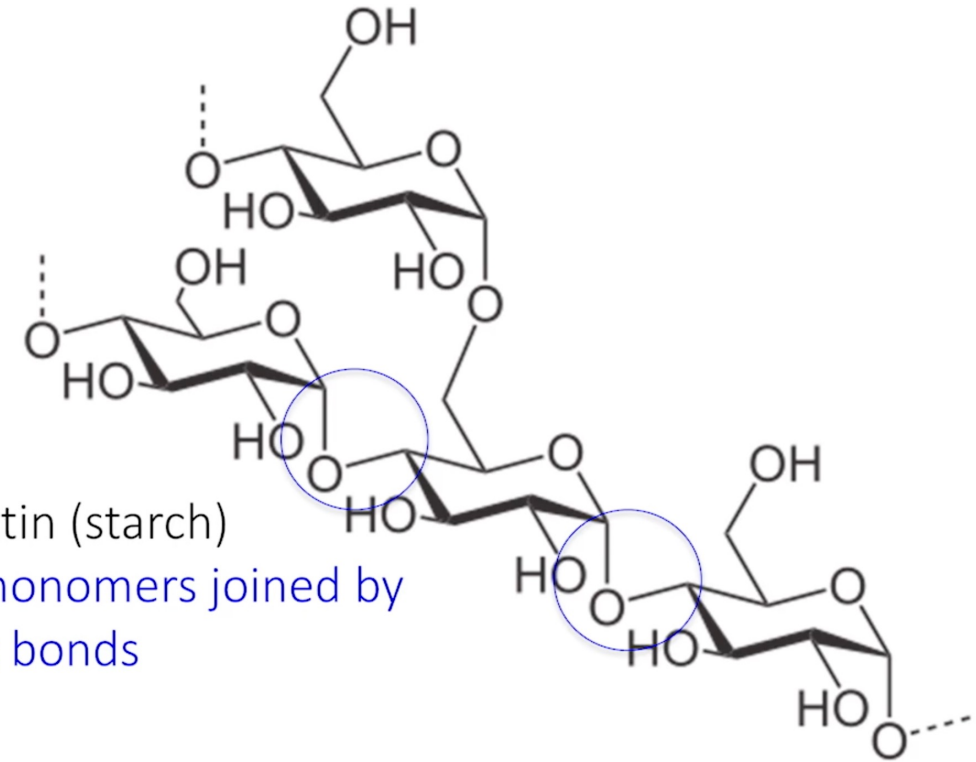
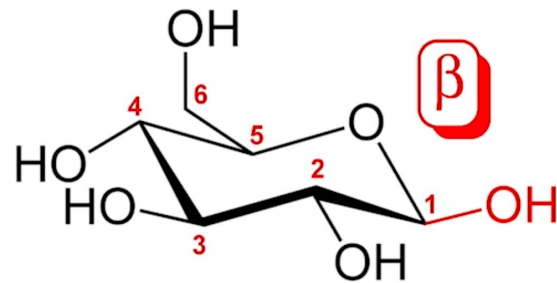
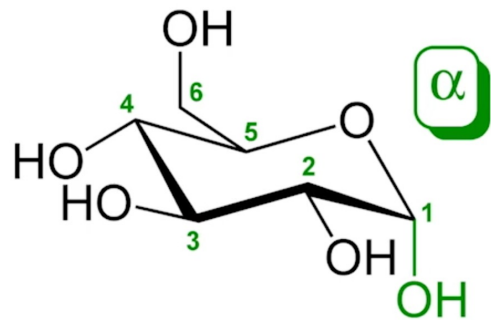
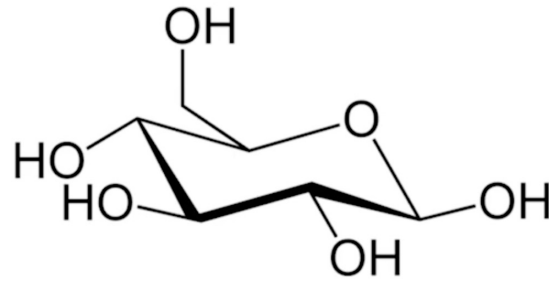


# Carbohydrates

## Glucose isomers



open chain



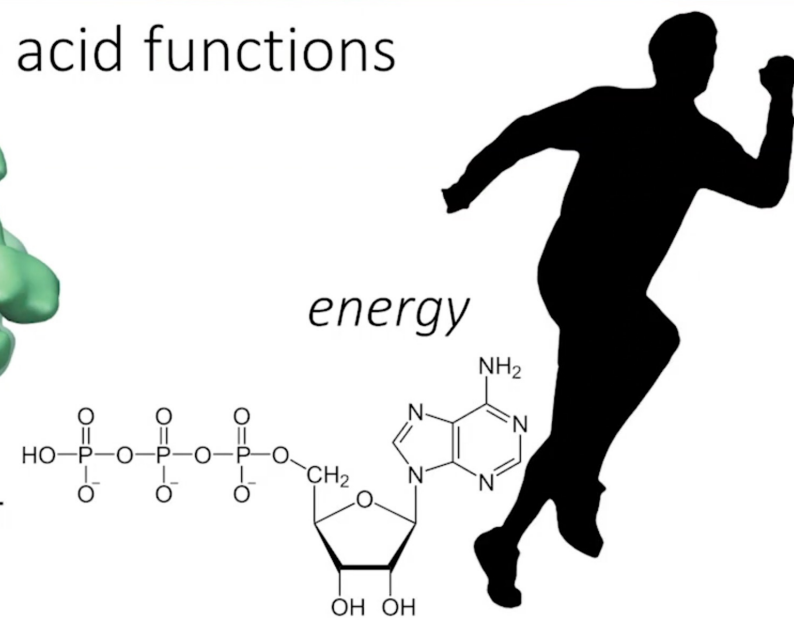
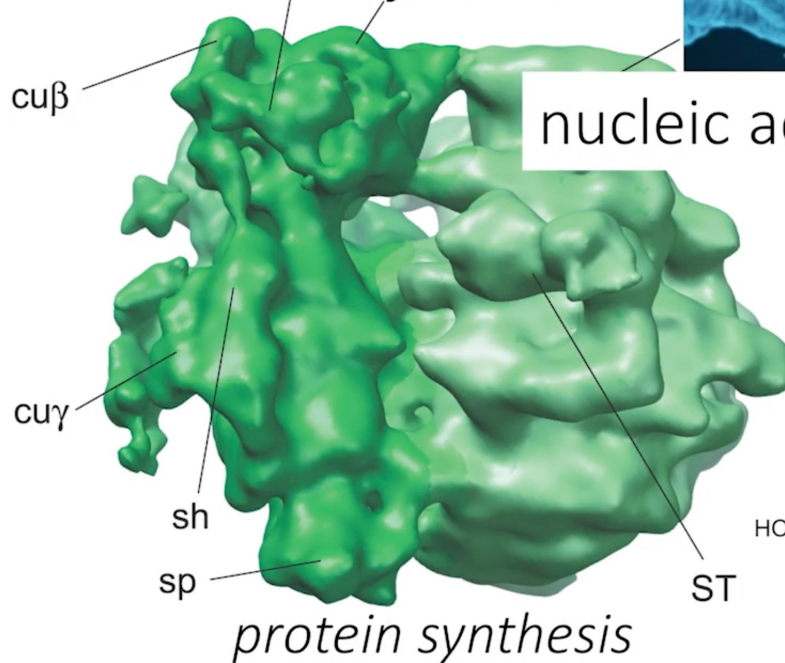
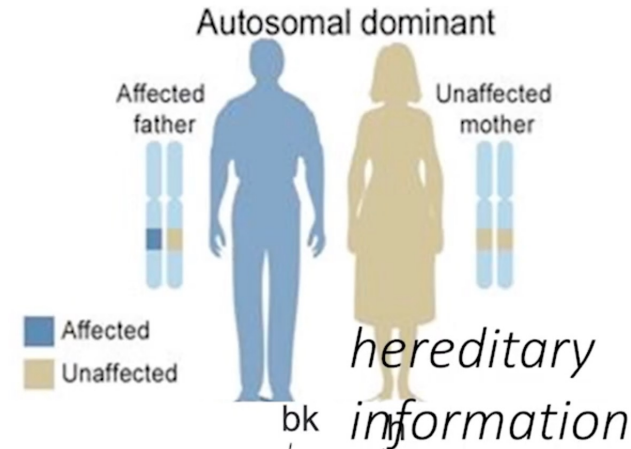
In starch → α-1,4 in cellulose → β-1,4 WHAT CAN WE DIGEST AND WHY?

# Nucleic acids

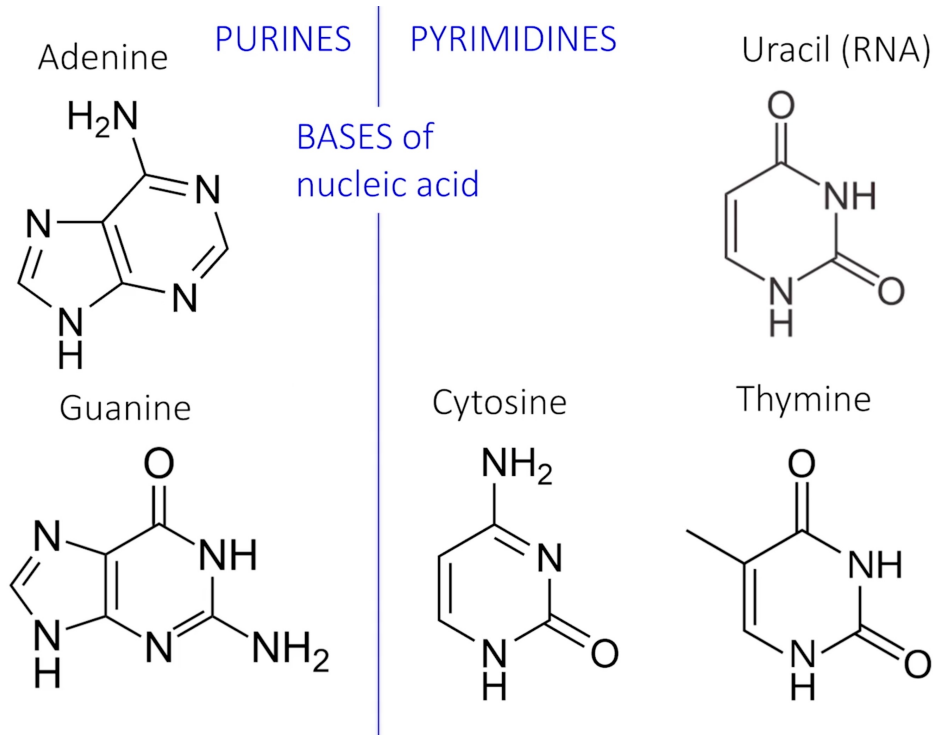
- Hereditary information (genes), energy
- Monomer M = nucleotides
- Polymers = DNA or RNA
- The nucleotide structure is stereotypical:

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

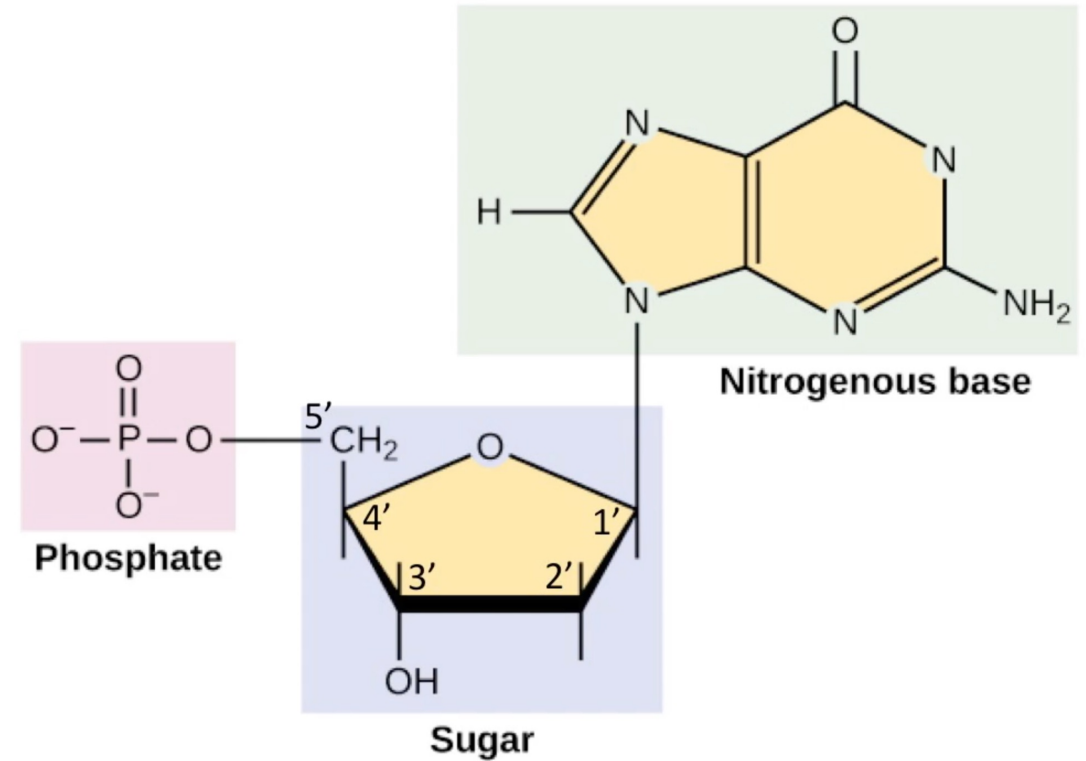
- Sugar = (5C) ribose (RNA) or deoxyribose (DNA)
- 5 bases:
  - Adenine (A), Guanine (G) = PURINES
  - Cytosine (C), Thymine (T), Uracil (U) = PYRIMIDINES
- A,G,C,T = DNA
- A,G,C,U = RNA



# Nucleic acids



## Nucleotide

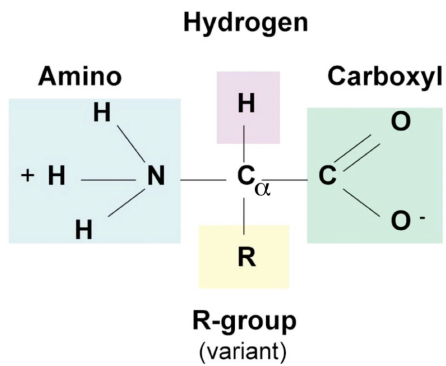


Note that the carbon atoms of the sugar are called C1', C2' etc  
C1' is where the base attaches  
C2' can have attached a H (as here, for DNA) or a OH group (for RNA)  
C3' is very important and where the next nucleotide will join  
C5' is where the phosphate group attaches

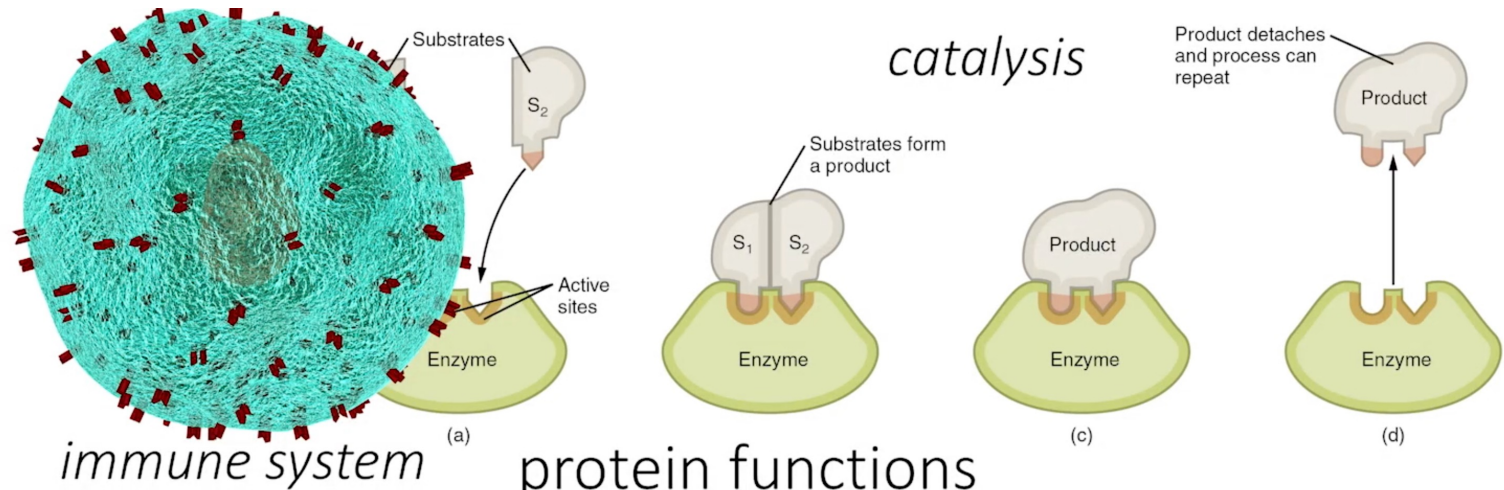
# Proteins

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

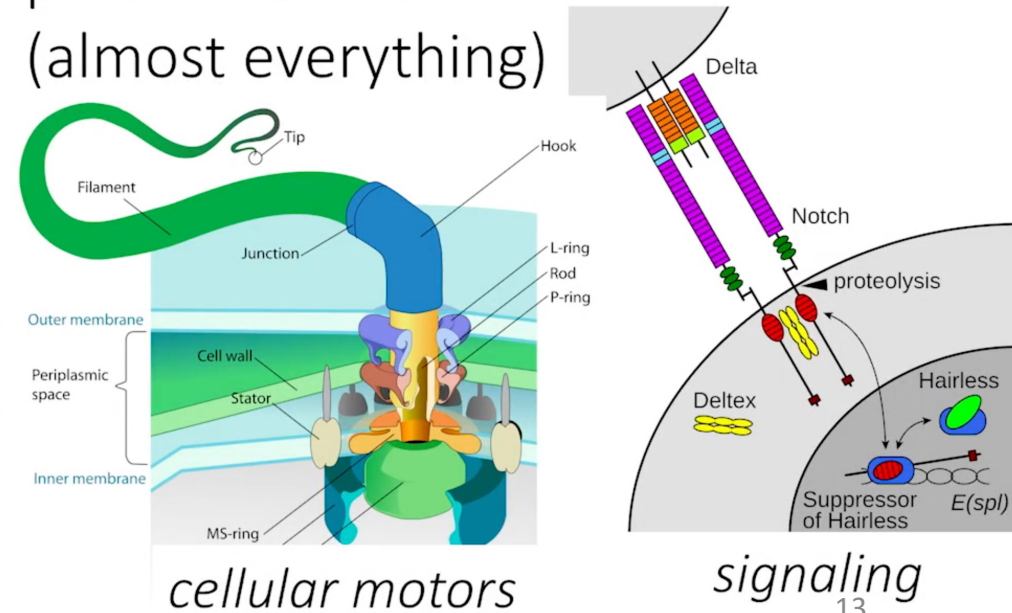
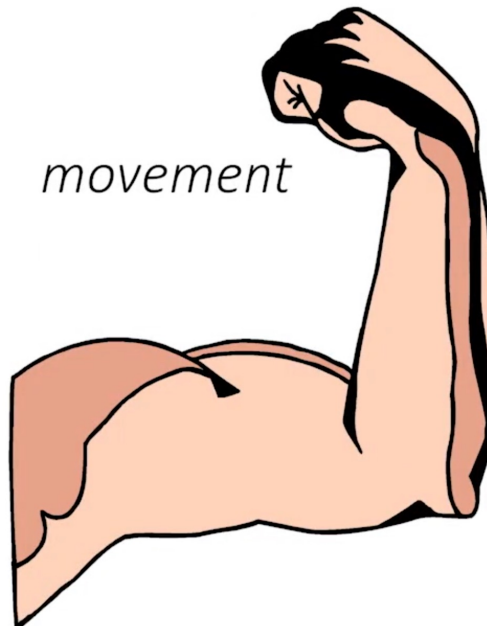
Alpha C + NH<sub>2</sub> + COOH + R (side group)



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



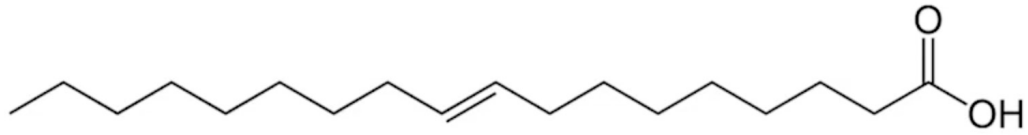
protein functions  
(almost everything)



# Proteins

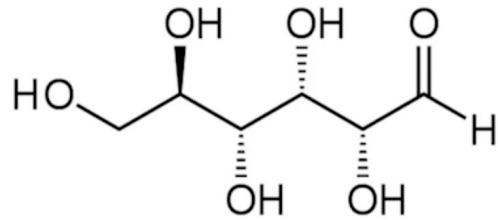
	AMINO ACID			
Nonpolar, aliphatic R groups	$\begin{array}{c} \text{COO}^- \\   \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\   \\ \text{H} \end{array}$ <p>Glycine</p>	$\begin{array}{c} \text{COO}^- \\   \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\   \\ \text{CH}_3 \end{array}$ <p>Alanine</p>	$\begin{array}{c} \text{COO}^- \\   \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\   \\ \text{CH} \\   \quad   \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$ <p>Valine</p>	
	$\begin{array}{c} \text{COO}^- \\   \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\   \\ \text{CH}_2 \\   \\ \text{CH} \\   \quad   \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$ <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>	
	$\begin{array}{c} \text{COO}^- \\   \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\   \\ \text{CH}_2\text{OH} \end{array}$ <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>	
	$\begin{array}{c} \text{COO}^- \\   \\ \text{C} \\ / \quad \backslash \\ \text{H}_2\text{N}^+ \quad \text{CH}_2 \\   \quad   \\ \text{H}_2\text{C} \quad \text{CH}_2 \end{array}$ <p>Proline</p>	$\begin{array}{c} \text{COO}^- \\   \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\   \\ \text{CH}_2 \\   \\ \text{C} \\ / \quad \backslash \\ \text{H}_2\text{N} \quad \text{O} \end{array}$ <p>Asparagine</p>	$\begin{array}{c} \text{COO}^- \\   \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\   \\ \text{CH}_2 \\   \\ \text{CH}_2 \\   \\ \text{C} \\ / \quad \backslash \\ \text{H}_2\text{N} \quad \text{O} \end{array}$ <p>Glutamine</p>	
	Positively charged R groups	$\begin{array}{c} \text{COO}^- \\   \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\   \\ \text{CH}_2 \\   \\ \text{CH}_2 \\   \\ \text{CH}_2 \\   \\ \text{CH}_2 \\   \\ \text{CH}_2 \\   \\ \text{NH}_3^+ \end{array}$ <p>Lysine</p>	$\begin{array}{c} \text{COO}^- \\   \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\   \\ \text{CH}_2 \\   \\ \text{CH}_2 \\   \\ \text{CH}_2 \\   \\ \text{CH}_2 \\   \\ \text{NH} \\   \\ \text{C} = \text{NH}_2^+ \\   \\ \text{NH}_2 \end{array}$ <p>Arginine</p>	$\begin{array}{c} \text{COO}^- \\   \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\   \\ \text{CH}_2 \\   \\ \text{C} - \text{NH}^+ \\ / \quad \backslash \\ \quad \quad \text{CH} \\ \quad \quad // \\ \quad \quad \text{NH}^+ \\   \\ \text{H} \end{array}$ <p>Histidine</p>
		$\begin{array}{c} \text{COO}^- \\   \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\   \\ \text{CH}_2 \\   \\ \text{COO}^- \end{array}$ <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>	
$\begin{array}{c} \text{COO}^- \\   \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\   \\ \text{CH}_2 \\   \\ \text{C}_6\text{H}_5 \end{array}$ <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>	$\begin{array}{c} \text{COO}^- \\   \\ \text{H}_3\text{N}^+ - \text{C} - \text{H} \\   \\ \text{CH}_2 \\   \\ \text{C}_8\text{H}_6\text{N}_2 \end{array}$ <p>Tryptophan</p>	
<p>Nonpolar, aromatic R groups</p>				

# Recognizing macromolecules - review



trans-oleic acid

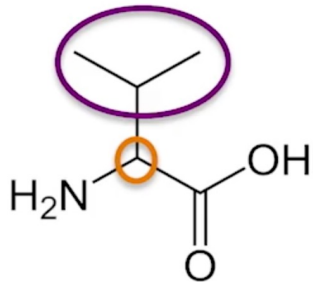
**Lipids:** **nonpolar**/hydrophobic



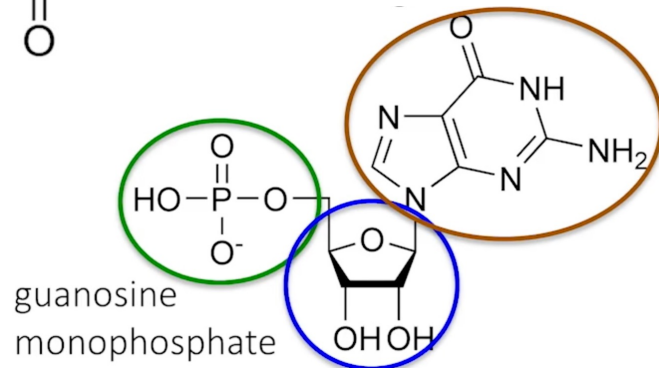
glucose

**Carbohydrates:** **CH<sub>2</sub>O** formula/**polar**

valine



**Proteins:** M = **amino acid** = **αC bonded to NH<sub>2</sub>, COOH and R**, R = polar/nonpolar



guanosine monophosphate

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