

(a) A ribbon model

(b) A space-filling model

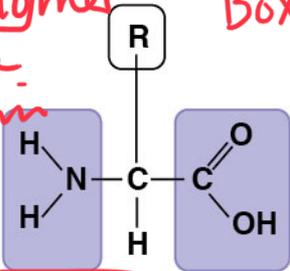
(c) A wireframe model

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*Water causes proteins to fold into a functional form.*

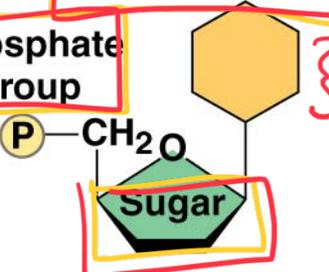
# Ch. 3b: The Structure and Function of Macromolecules

4 macromolecules proteins, carbohydrates, fats, nucleic acids

1 Components	Examples	Functions
<p><i>monomer of a protein</i></p> <p><i>Boxcar</i></p>  <p><b>Amino acid monomer (20 types)</b></p>	<p><i>train → polymer</i></p> <ul style="list-style-type: none"> <li>Enzymes</li> <li>Structural proteins</li> <li>Storage proteins</li> <li>Transport proteins</li> <li>Hormones</li> <li>Receptor proteins</li> <li>Motor proteins</li> <li>Defensive proteins</li> </ul>	<ul style="list-style-type: none"> <li>Catalyze chemical reactions</li> <li>Provide structural support</li> <li>Store amino acids</li> <li>Transport substances</li> <li>Coordinate organismal responses</li> <li>Receive signals from outside cell</li> <li>Function in cell movement</li> <li>Protect against disease</li> </ul>

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Proteins monomer: amino acid polymer: polypeptide (protein)

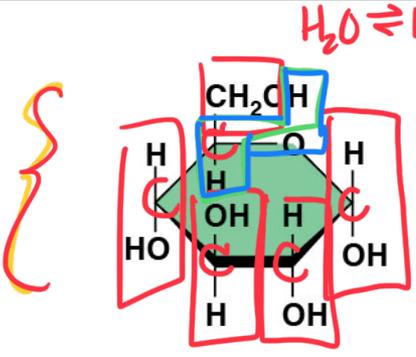
Components	Examples	Functions
<p><b>Nitrogenous base</b></p> <p><b>Phosphate group</b></p>  <p><b>Nucleotide monomer</b></p>	<p><b>DNA:</b> </p> <ul style="list-style-type: none"> <li>Sugar = deoxyribose</li> <li>Nitrogenous bases = C, G, A, T</li> <li>Usually double-stranded</li> </ul> <p><b>RNA:</b> </p> <ul style="list-style-type: none"> <li>Sugar = ribose</li> <li>Nitrogenous bases = C, G, A, U</li> <li>Usually single-stranded</li> </ul>	<p><u>Stores hereditary information</u></p> <p>Various functions in gene expression, including carrying instructions from DNA to ribosomes</p>

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Nucleic acid (DNA) monomer: nucleic acid polymer: polynucleotide

Carbohydrates are sugars  
 carbon ↓ water



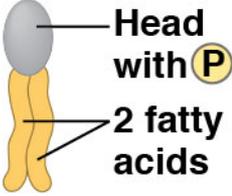
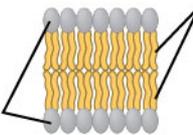
Components	Examples	Functions
 <p>Glucose          Monosaccharide monomer</p>	<p>Monosaccharides: glucose, fructose</p>	<p>Fuel; carbon sources that can be converted to other molecules or combined into polymers</p>
	<p>Disaccharides: lactose, sucrose</p>	
	<p>Polysaccharides:</p> <ul style="list-style-type: none"> <li>• Cellulose (plants)</li> <li>• Starch (plants)</li> <li>• Glycogen (animals)</li> <li>• Chitin (animals and fungi)</li> </ul>	<ul style="list-style-type: none"> <li>• Strengthens plant cell walls</li> <li>• Stores glucose for energy</li> <li>• Stores glucose for energy</li> <li>• Strengthens exoskeletons and fungal cell walls</li> </ul>

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Monomer - monosaccharide      Polymer - polysaccharide

# Fats (Lipids)

Monomer: Fatty acid  
 Polymer: Triacylglycerol

Components	Examples	Functions
<p>Glycerol</p>  <p>3 fatty acids</p>	<p><b>Triacylglycerols</b> (fats or oils):              glycerol + three fatty acids</p>	<p>Important energy source</p> 
 <p>Head with P</p> <p>2 fatty acids</p>	<p>Phospholipids: glycerol + phosphate group + two fatty acids</p>	<p>Lipid bilayers of membranes</p>  <p>Hydrophilic heads</p> <p>Hydrophobic tails</p>
 <p>Steroid backbone</p>	<p>Steroids: four fused rings with attached chemical groups</p>	<ul style="list-style-type: none"> <li>• Component of cell membranes (cholesterol)</li> <li>• Signaling molecules that travel through the body (hormones)</li> </ul>

# You Must Know

- The role of **dehydration synthesis** in the formation of organic compounds and **hydrolysis** in the digestion of organic compounds.
- How the sequence and subcomponents of the four groups of organic compounds determine their properties.
- The cellular functions of carbs, lipids, proteins, and nucleic acids.
- How changes in these organic molecules would affect their function.

# You Must Know

- The 4 structural levels of proteins and how changes at any levels can affect the activity of the protein.
- How proteins reach their final shape (**conformation**), the **denaturing** impact that heat and pH can have on protein structure, and how these changes may affect the organism.
- Directionality influences structure and function of polymers, such as nucleic acids (5' and 3' ends) and proteins (amino and carboxyl ends).

## Monomers

- Small organic
- Used for building blocks of polymers
- Connects with condensation reaction (dehydration synthesis)

*single*  
*Boxcars*

## Polymers

- Long molecules of monomers
- With many identical or similar blocks linked by covalent bonds

*Trains*

## Macromolecules

- Giant molecules
- 2 or more polymers bonded together

*- Protein*  
*- Nucleic Acids*  
*- Carbohydrates*  
*- Fats*

ie. amino acid → peptide → polypeptide →  
protein

smaller



larger

*without water* *Build*  
**Dehydration Synthesis**  
(Condensation Reaction)

Make polymers

Monomers → Polymers

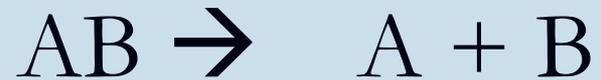


*Connect monomers by losing water*

*water* *to cut*  
*to cut with water*  
**Hydrolysis**

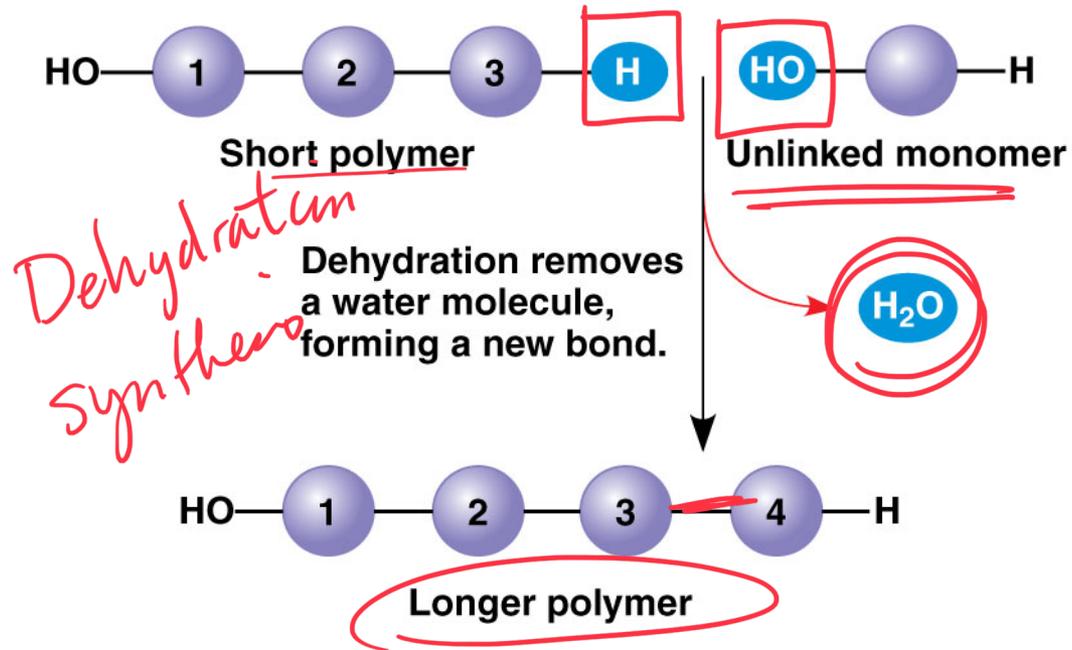
Breakdown polymers

Polymers → Monomers

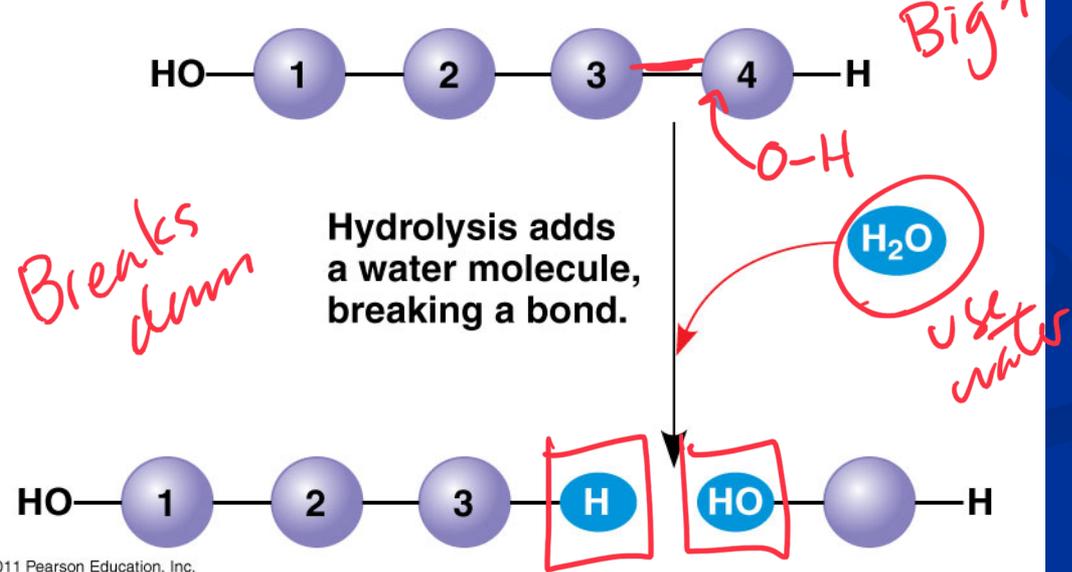


*Breakdown polymers into monomers by adding water*

(a) Dehydration reaction: synthesizing a polymer



(b) Hydrolysis: breaking down a polymer

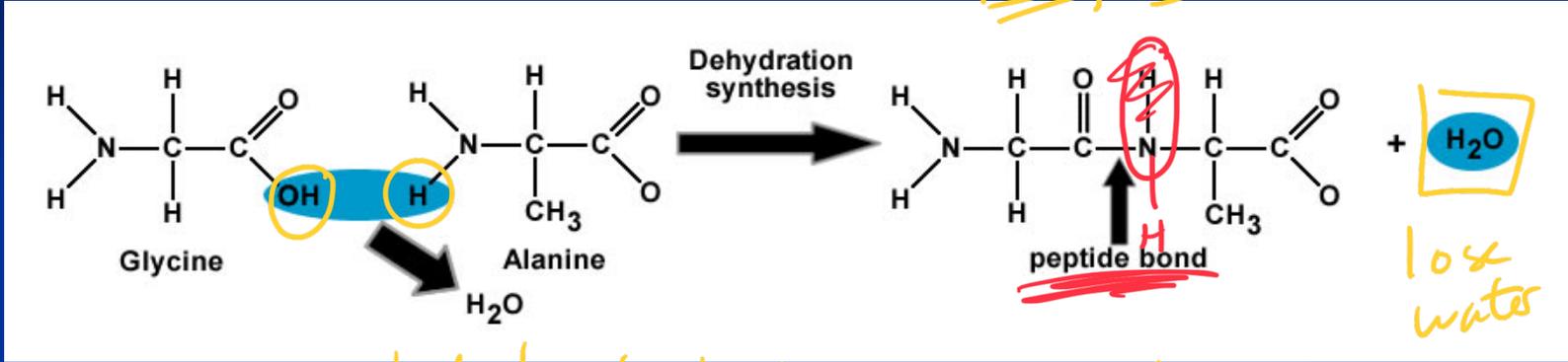


# Dehydration Synthesis

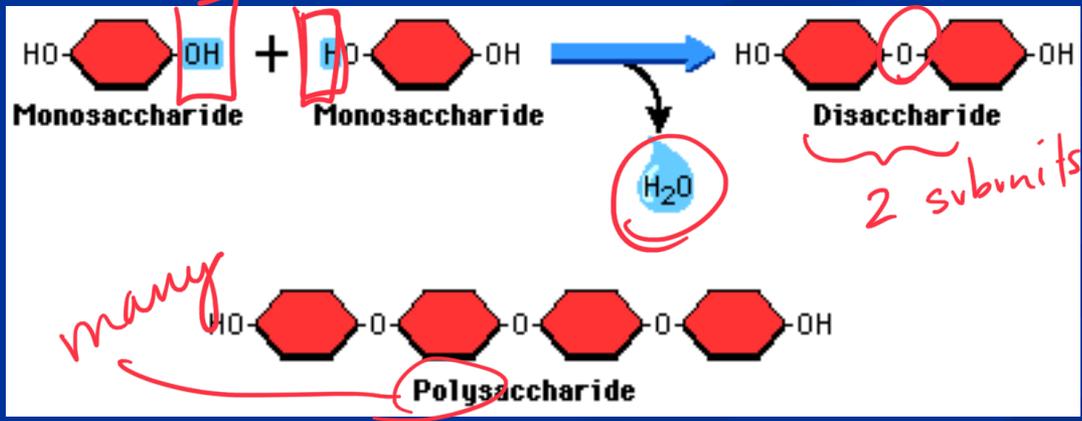
monomers  
amino acids



polymer  
polypeptide



peptide bonds link amino acids



Small  
↓  
big  
Lose H<sub>2</sub>O

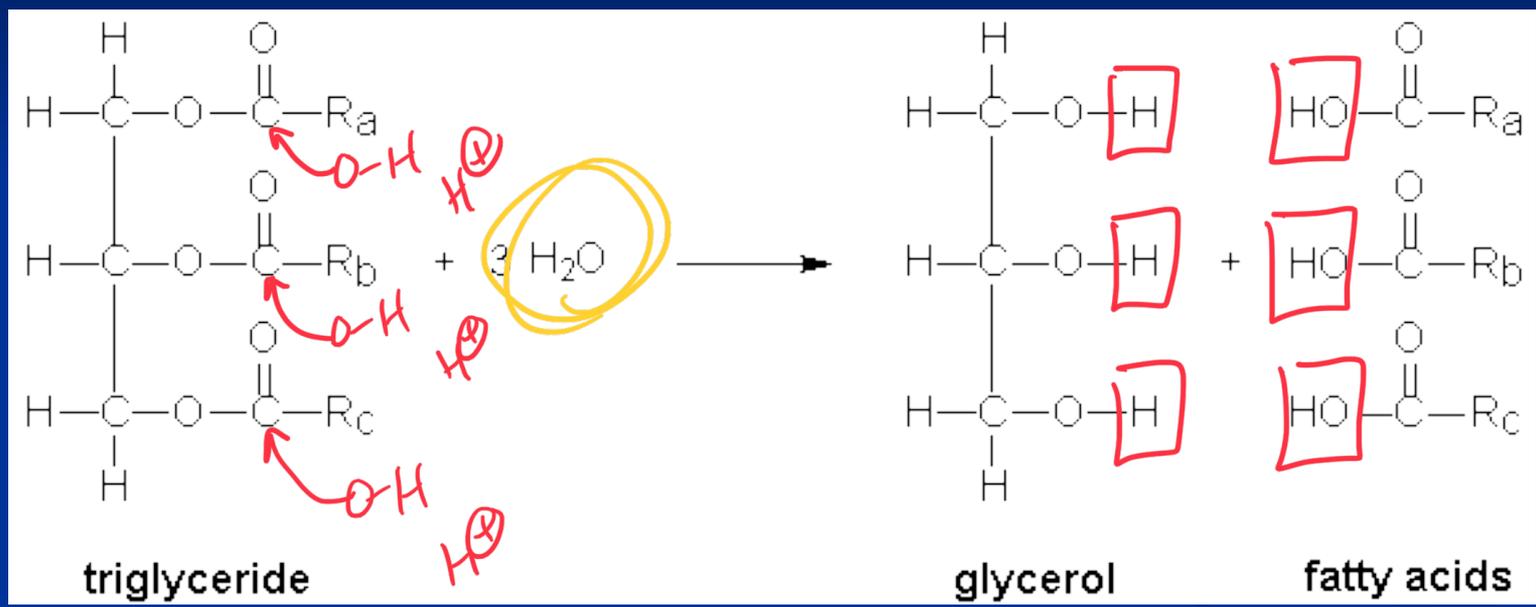
many

Fats

# Hydrolysis

Triacylglycerol

cutting with water

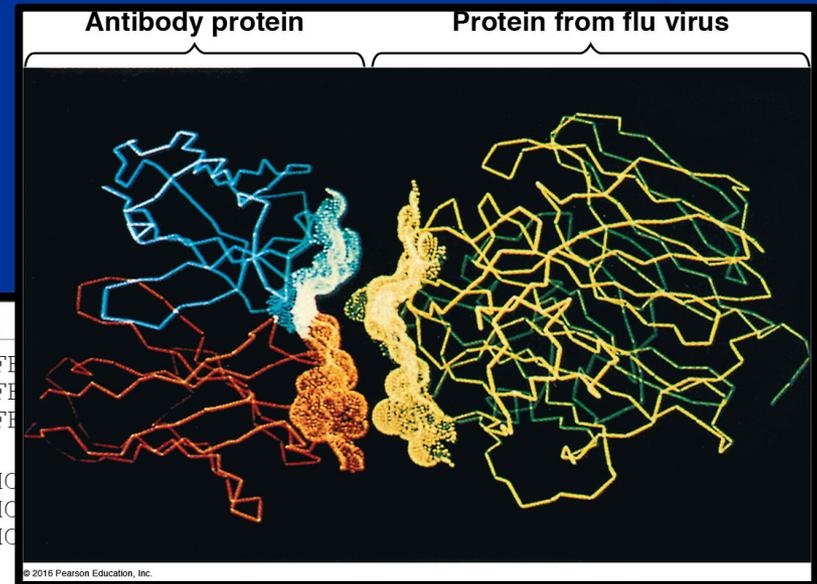
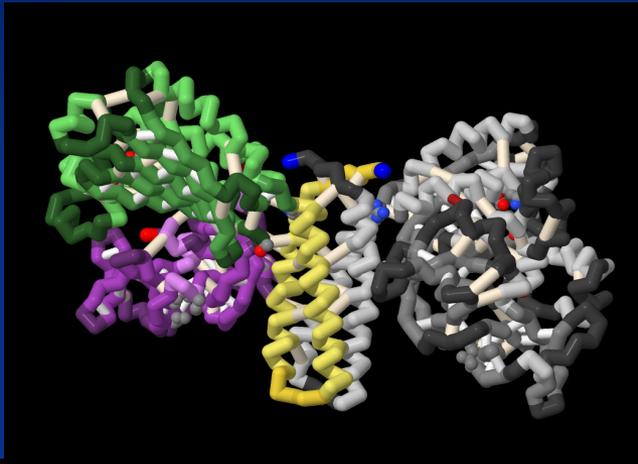


polymer



monomers

# Proteomics: Analysis of proteins and sequences



Species	Alignment
Human	1 VHL...QR FFF
Monkey	1 VHLTPEEKNA VTTLWGKVVN DEVGGEALGR LLLVYPWTQR FFF
Gibbon	1 VHLTPEEKSA VTALWGKVVN DEVGGEALGR LLLVYPWTQR FFF
Human	51 PDAVMGNPKV KAHGKKVLGA FSDGLAHLDN LKGTFFATLSE LHC
Monkey	51 PDAVMGNPKV KAHGKKVLGA FSDGLNHLDN LKGTFFAQLSE LHC
Gibbon	51 PDAVMGNPKV KAHGKKVLGA FSDGLAHLDN LKGTFFAQLSE LHC
Human	101 ENFRLLGNVL VCVLAHHFGK EFTPPVQAAY QKVVAGVANA LAHKYH
Monkey	101 ENFKLLGNVL VCVLAHHFGK EFTPQVQAAY QKVVAGVANA LAHKYH
Gibbon	101 ENFRLLGNVL VCVLAHHFGK EFTPQVQAAY QKVVAGVANA LAHKYH

Data from Human: <http://www.ncbi.nlm.nih.gov/protein/AAA21113.1>; rhesus monkey: <http://www.ncbi.nlm.nih.gov/protein/122634>; gibbon: <http://www.ncbi.nlm.nih.gov/protein/122616>