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NARODOWA STRATEGIA SPÓJNOŚCI

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BIOPHYSICS

Prezentacja multimedialna współfinansowana przez Unię Europejską w ramach Europejskiego Funduszu Społecznego w projekcie pt.

„Innowacyjna dydaktyka bez ograniczeń - zintegrowany rozwój Politechniki Łódzkiej - zarządzanie Uczelnią, nowoczesna oferta edukacyjna i wzmacniania zdolności do zatrudniania osób niepełnosprawnych"

Politechnika Łódzka

Politechnika Łódzka, ul. Żeromskiego 116, 90-924 Łódź, tel. (042) 631 28 83
www.kapitalludzki.p.lodz.pl

Biomolecules (3)

Bogdan Walkowiak

Department of Biophysics
Institute of Materials Science and Engineering
Technical University of Lodz

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Monomers & Polymers (1)

Other than water, biomolecules fall into 4 classes:

- proteins
- nucleic acids
- polysaccharides
- lipids

Each class contains small molecules (= **monomers**),
joined together to make large molecules (= **polymers**);
Only a few types of monomers; billions of different polymers exist

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Monomers & Polymers (2)

Condensation Reactions: involve release of water H_2O, joining together of two monomers by covalent bond to form polymer. Occurs in **biosynthesis**.

General formula: A-OH + H-B   A-B + H_2O

Hydrolysis reactions: reverse of condensation. Involves adding water to split covalent bond, release of two smaller molecules. Occurs in **digestion**.

General formula: A-B + H_2O A-OH + H-B

Note: A and B could be amino acids, nucleic acids, sugars, etc.

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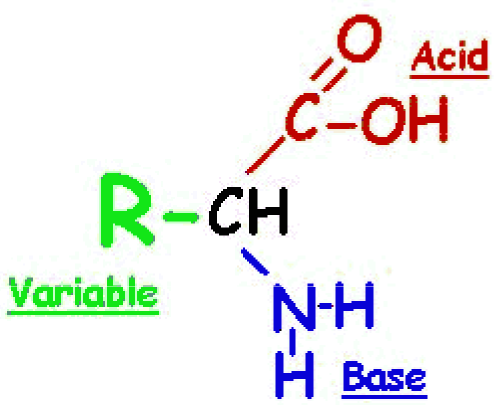
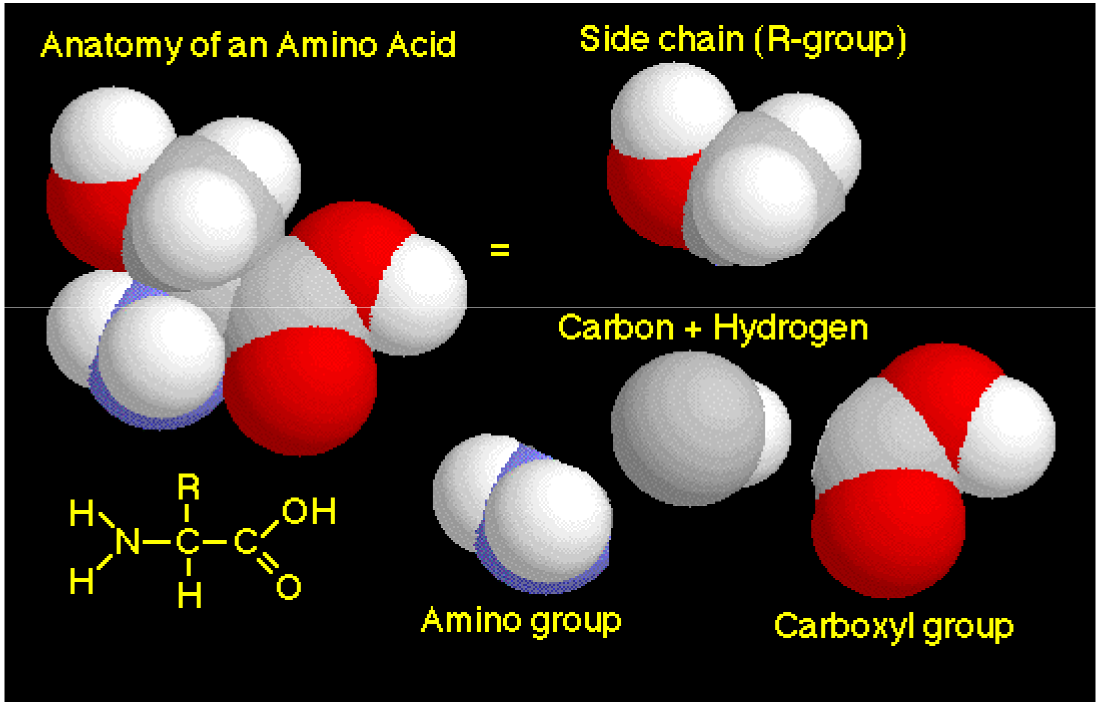
Amino Acids



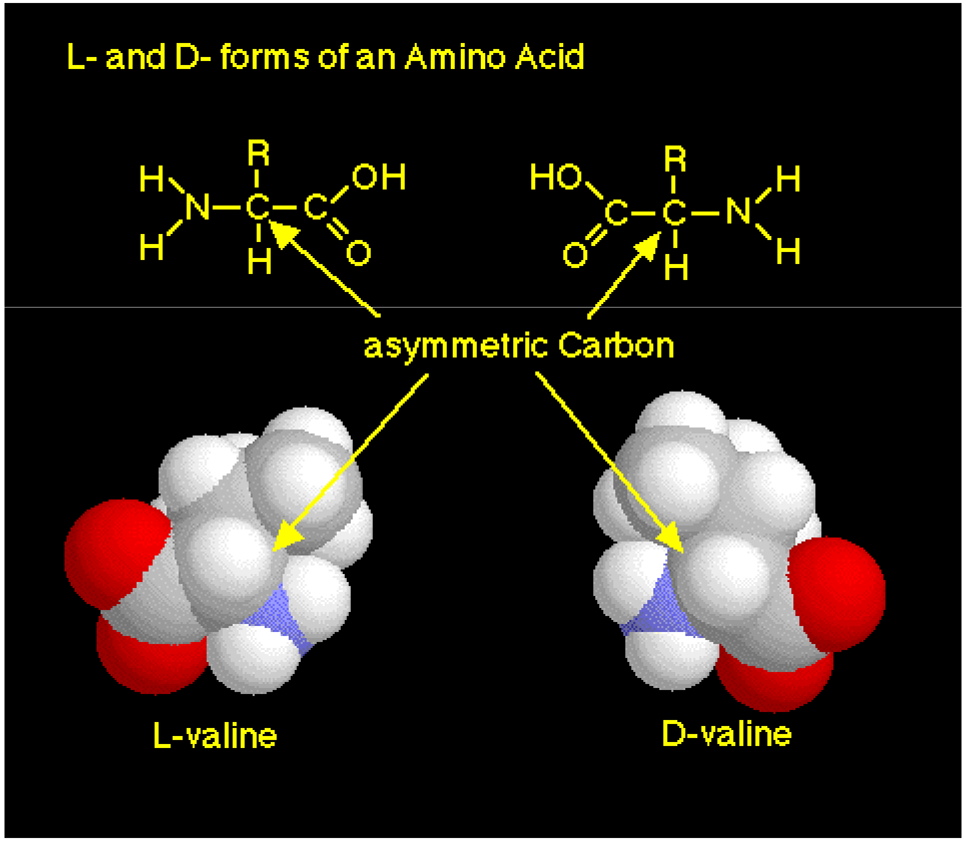
A theoretical amino acid



Source: INTERNET

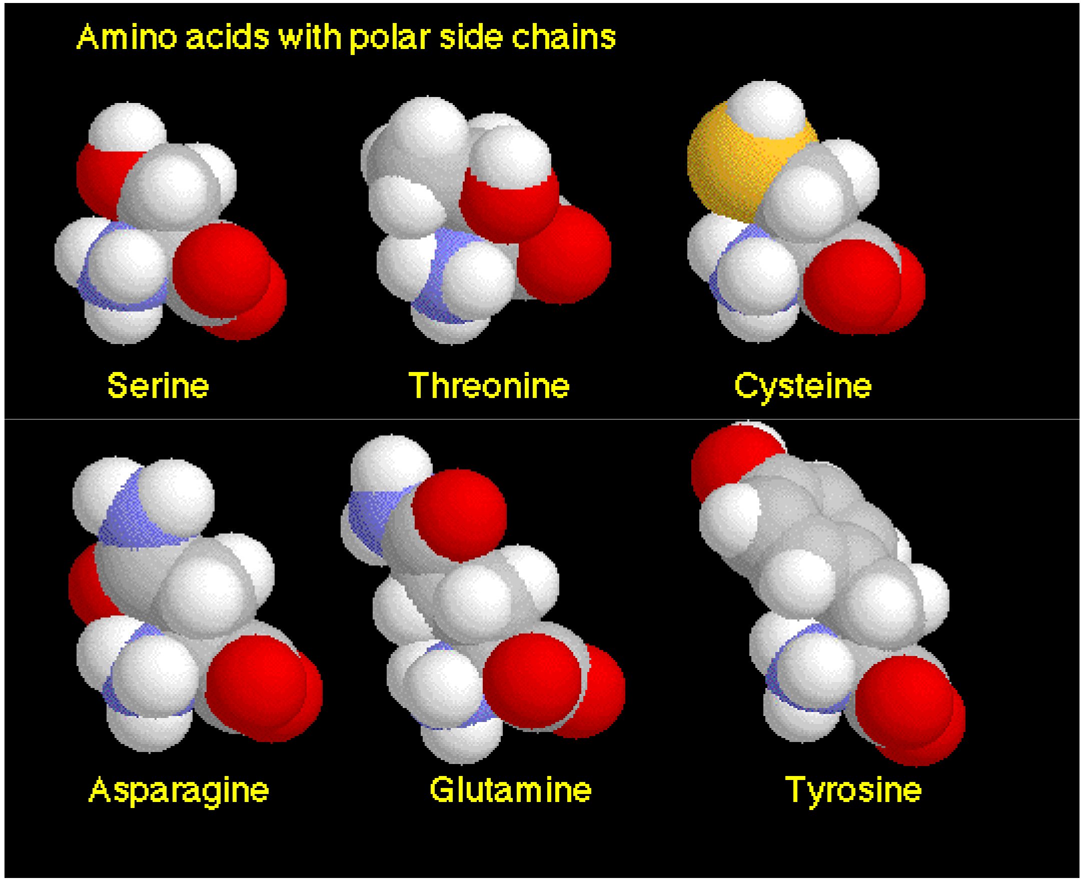
Peptides and Peptide bond

Isomeric forms of AA



Source: INTERNET

Amino Acids with Polar Side Chains



Source: INTERNET

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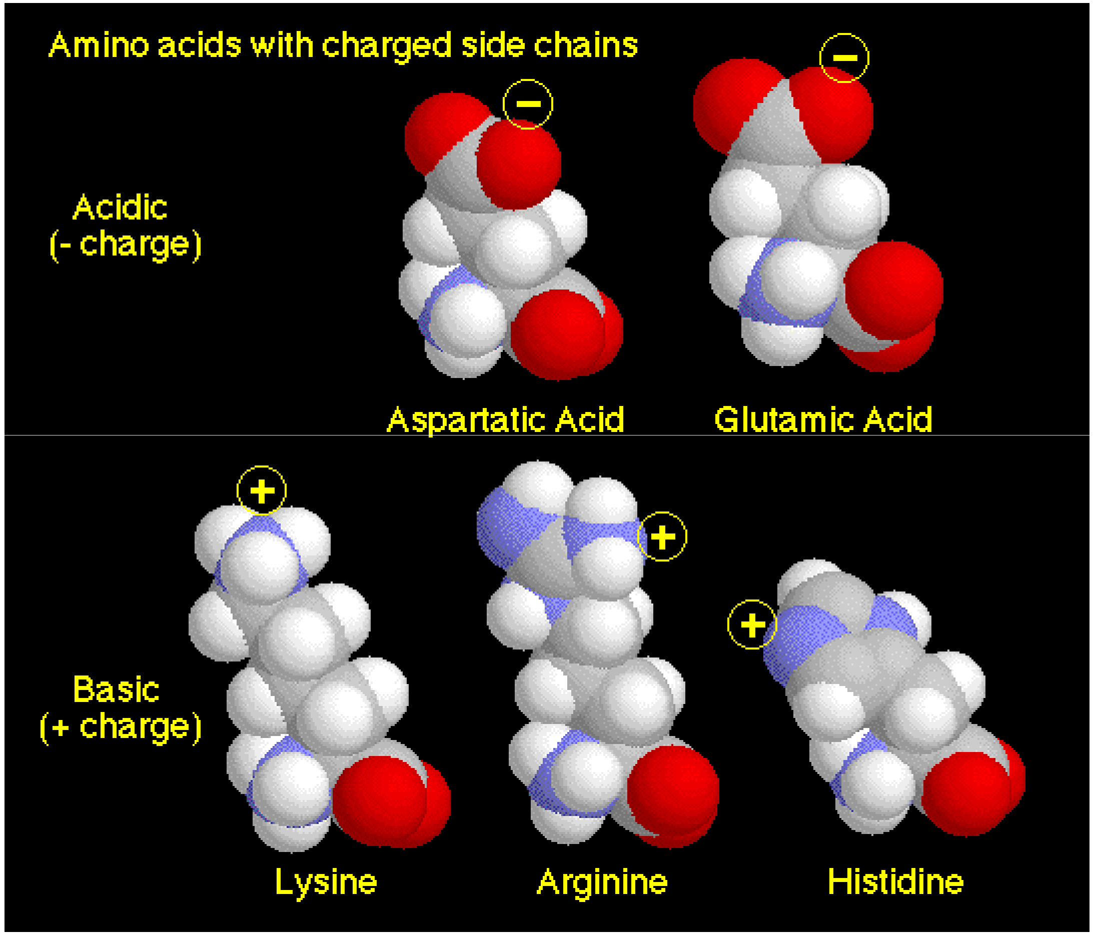
Amino Acids with Charged Side Chains



Source: INTERNET

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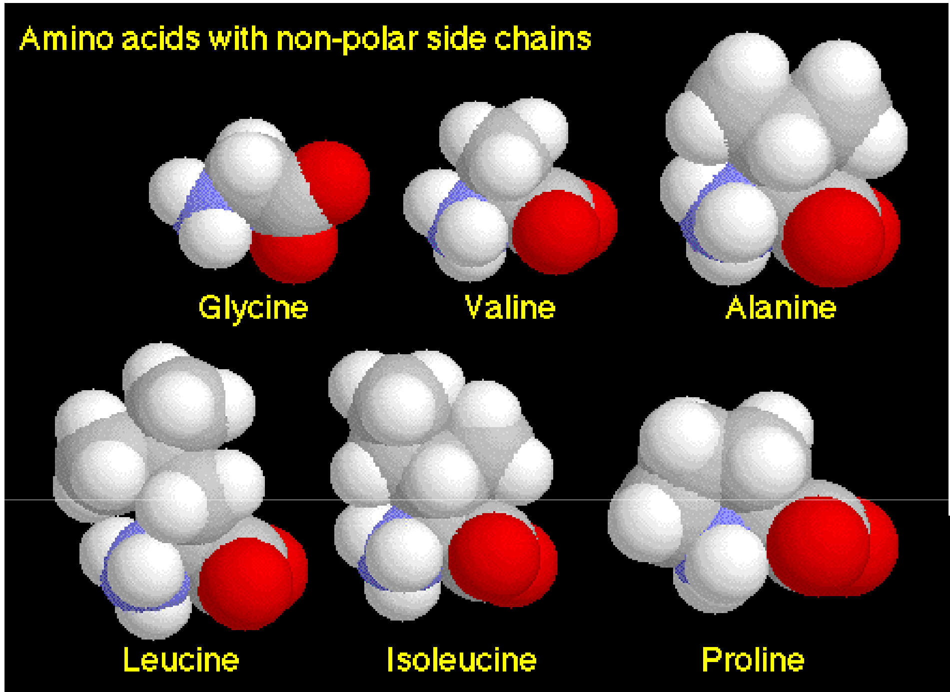
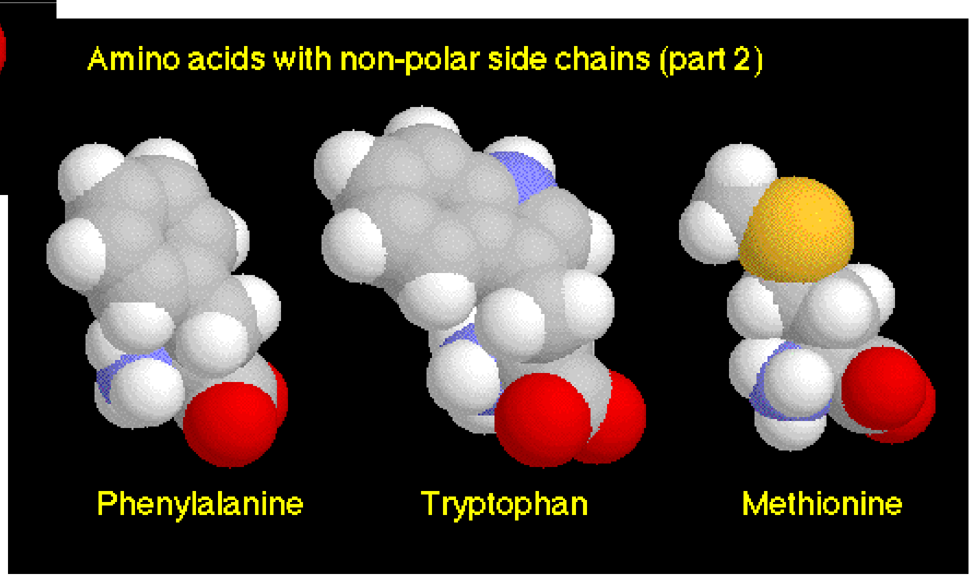
Amino Acids with non Polar Side Chains





Source: INTERNET

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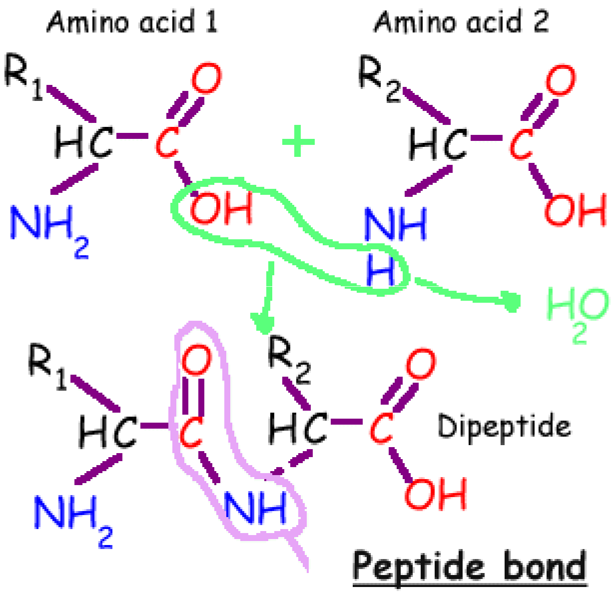
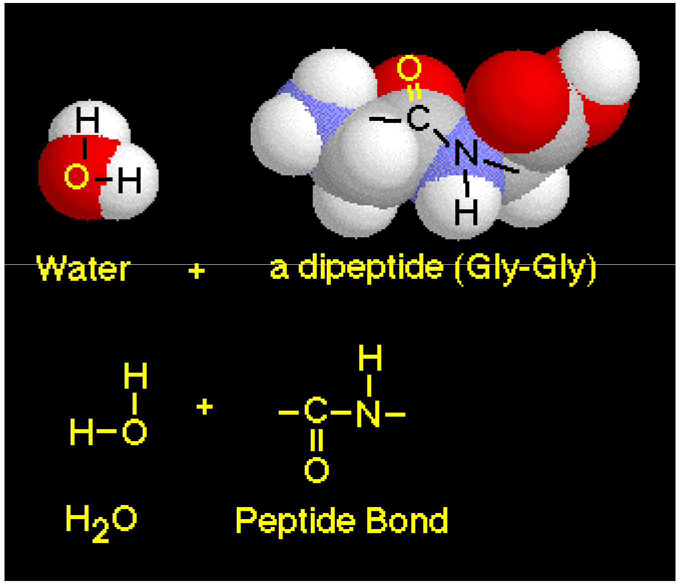
Peptides and Peptide bond





Source: INTERNET

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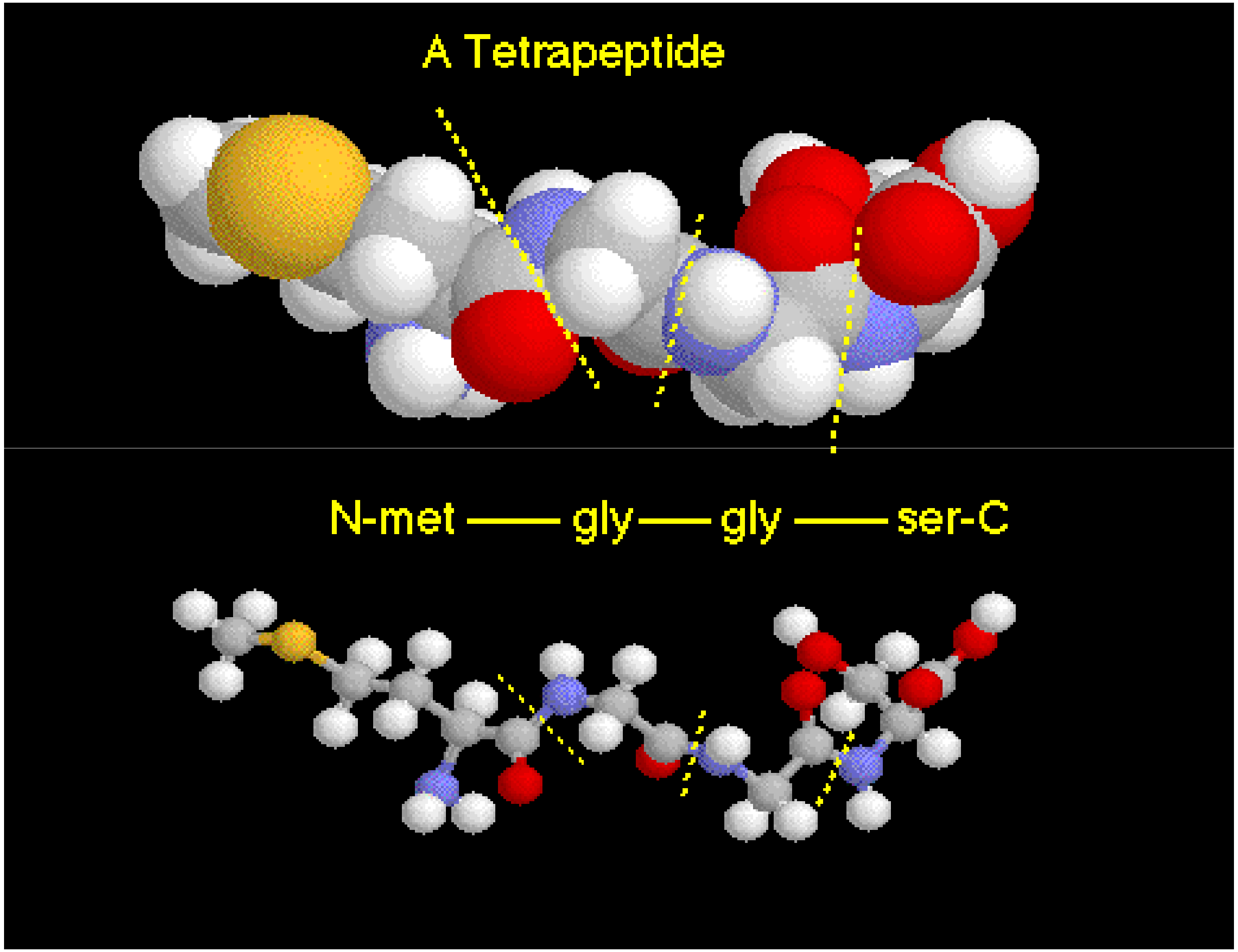
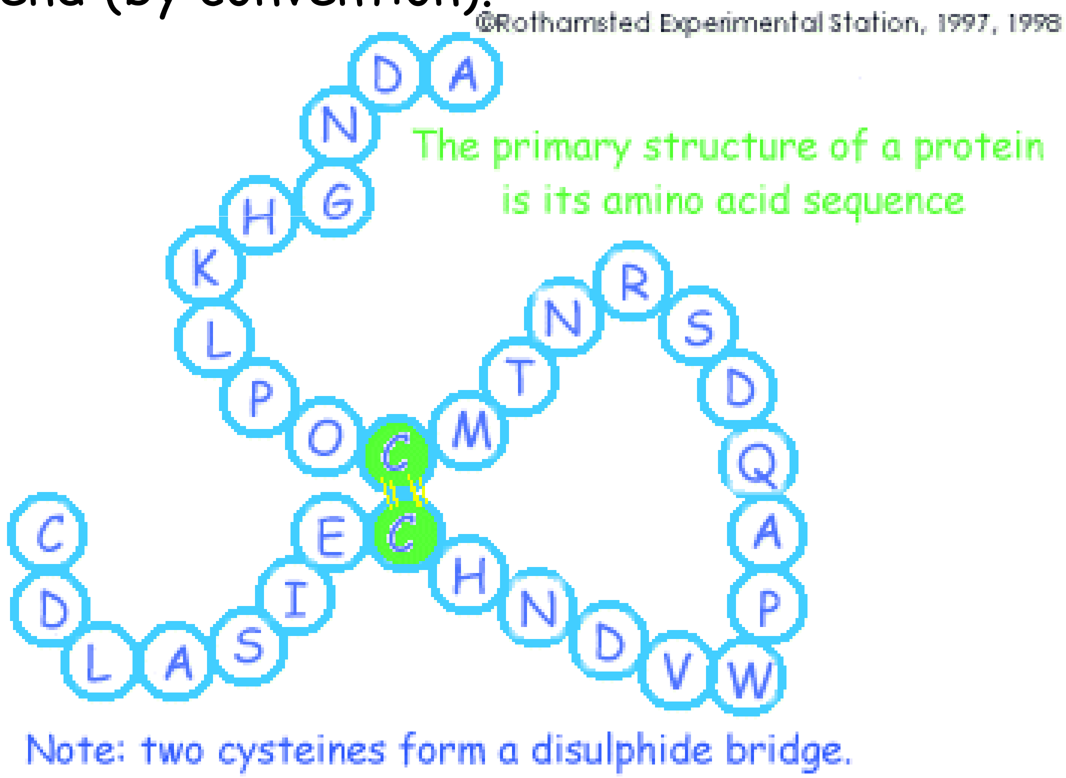
Tetrapeptide



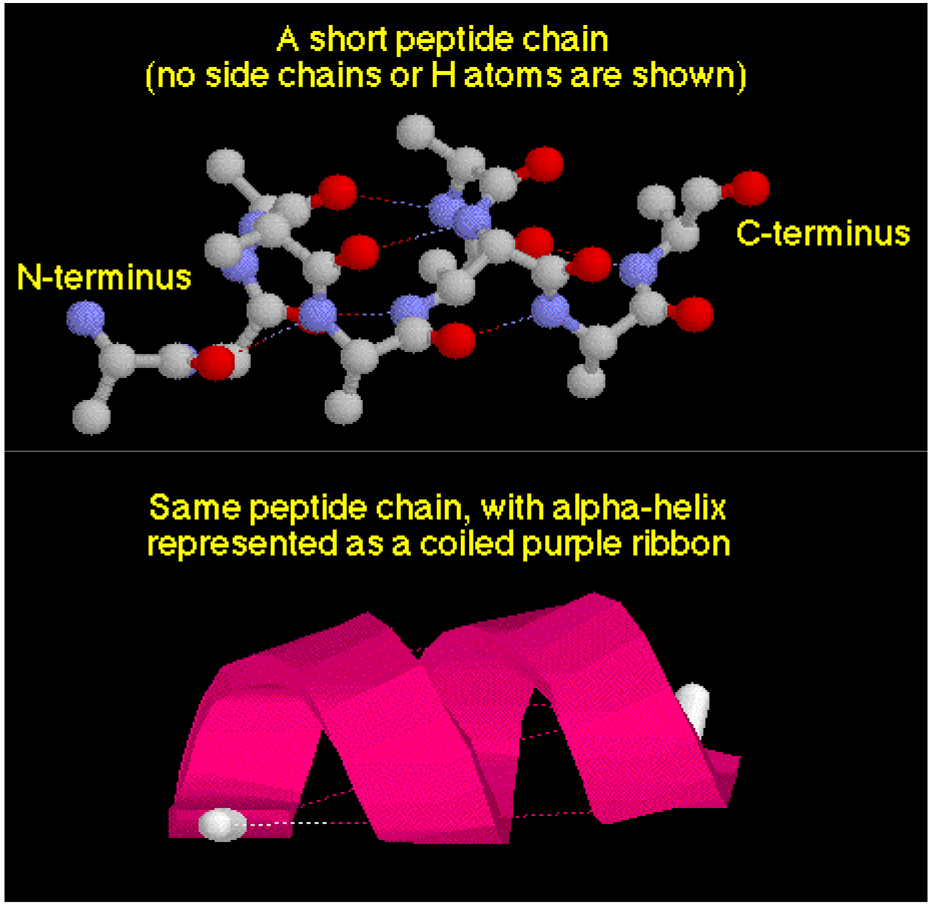
Source: INTERNET

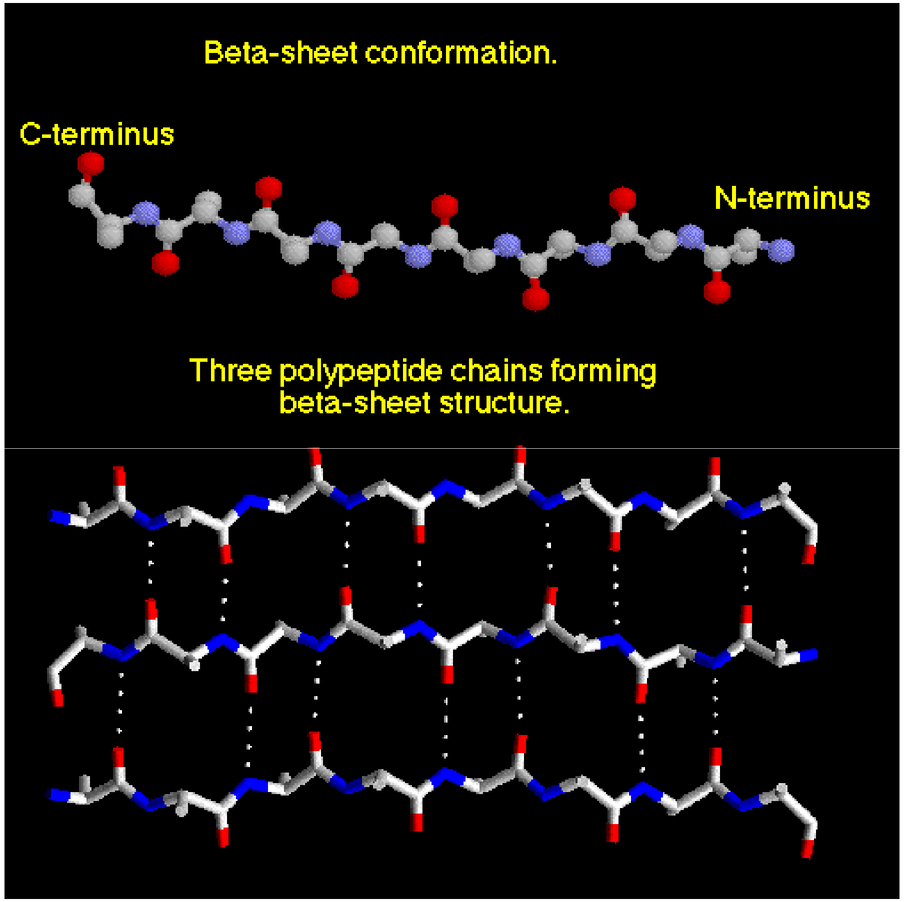
Primary structure

Protein have multiple levels of structure. The most basic is its primary structure. A protein's primary structure is simply the order of its amino acids. Note that this order is always written from amino end to carboxyl end (by convention).



Primary and secondary structures





Source: INTERNET

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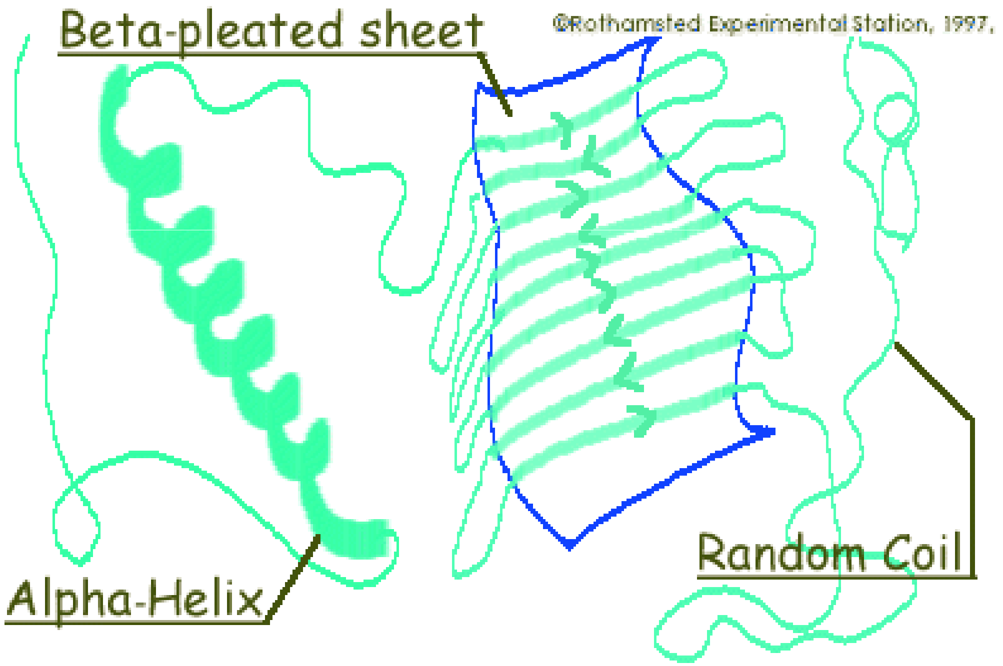
Secondary structure

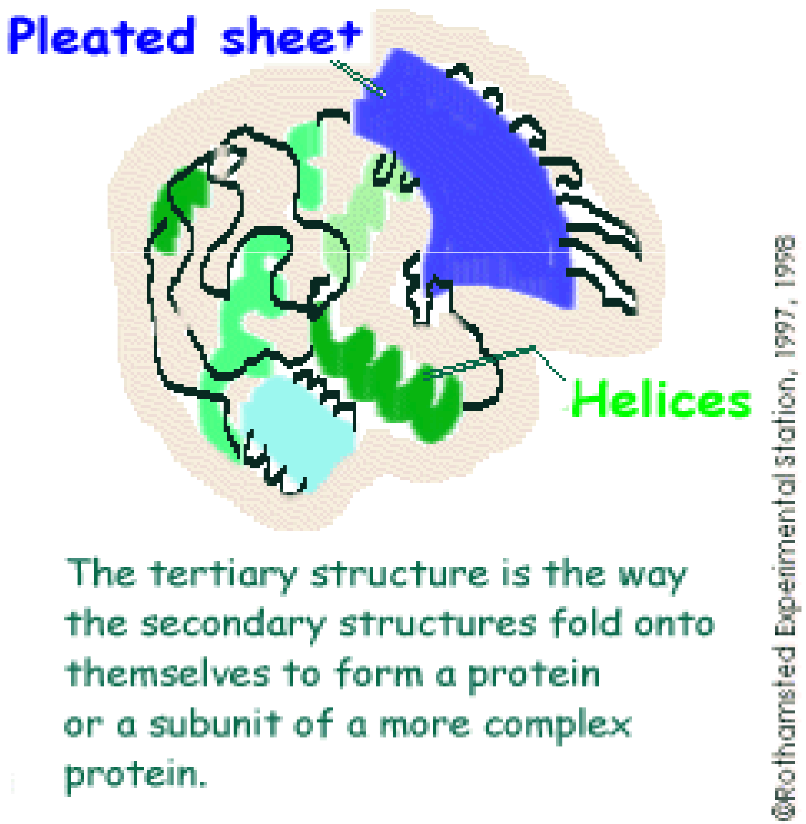
Protein secondary structure refers to certain common repeating structures found in proteins. There are two types of secondary structures: alpha-helix and beta-pleated sheet.



The secondary structure is observed in a localised portion of a protein.

Tertiary structure

Tertiary structure is the full 3-dimensional folded structure of the polypeptide chain.



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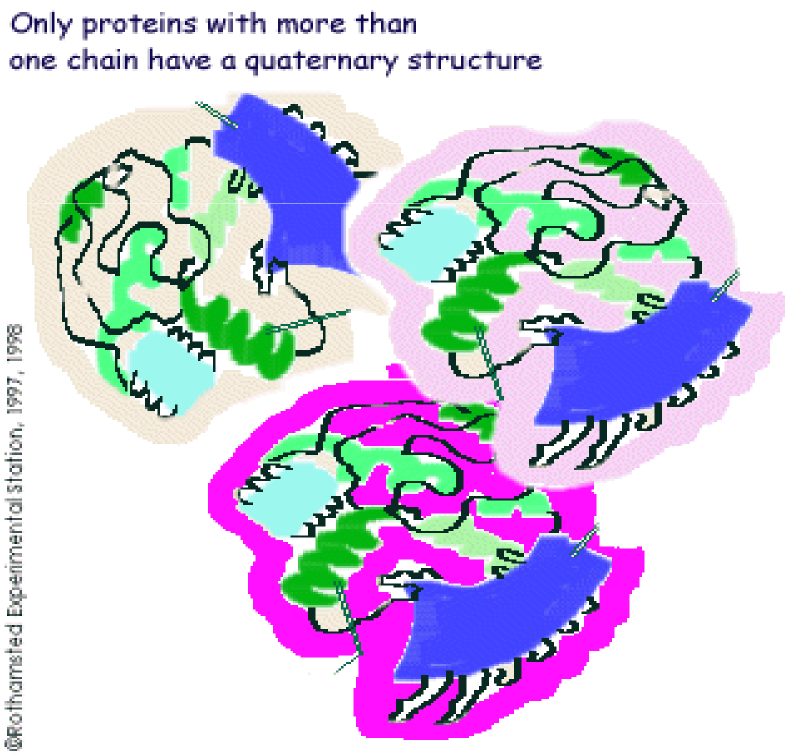
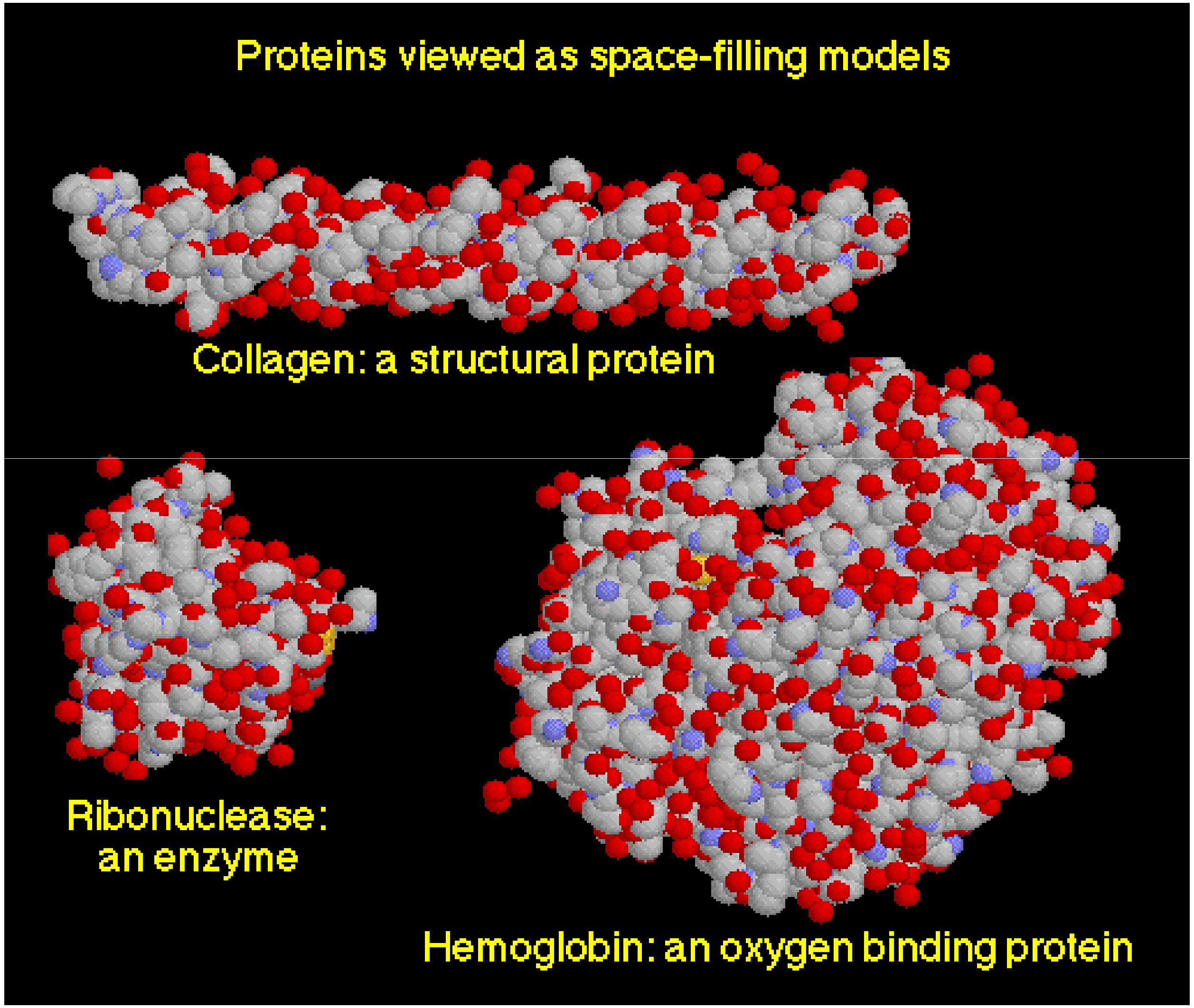
Quaternary structure

Quaternary Structure is the combination of two or more chains, to form a complete unit. The interactions between the chains are not different from those in tertiary structure, but are distinguished only by being interchain rather than intrachain.



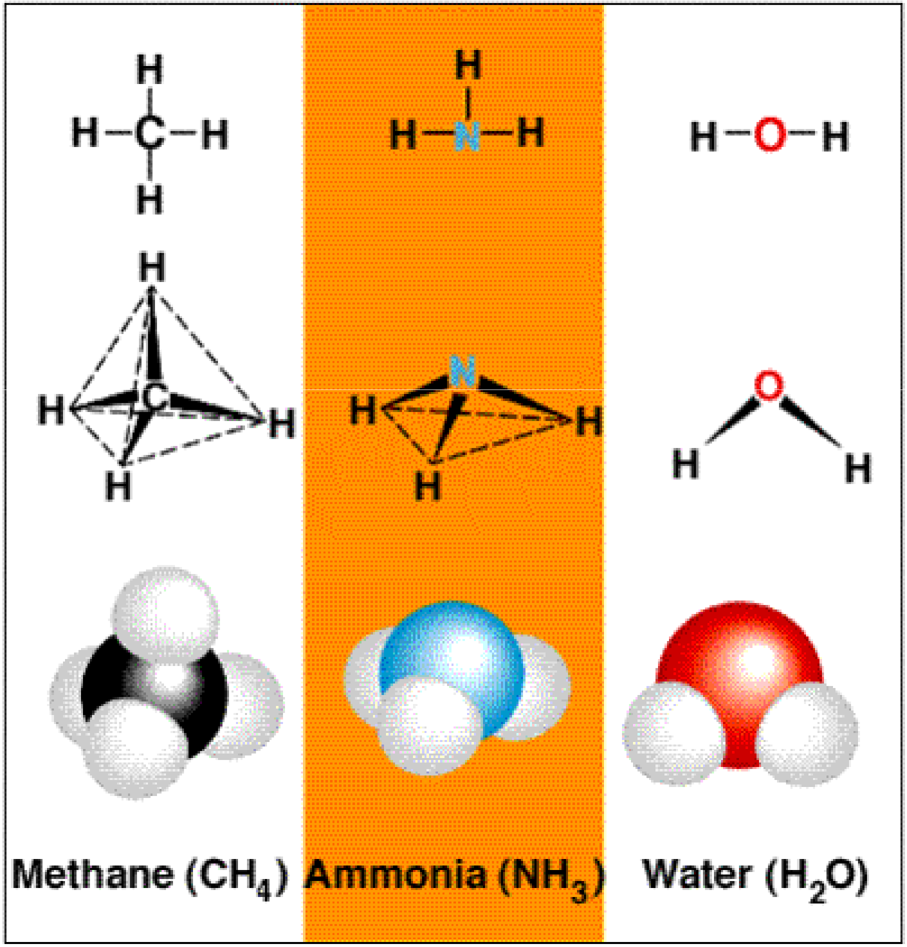
Types of proteins



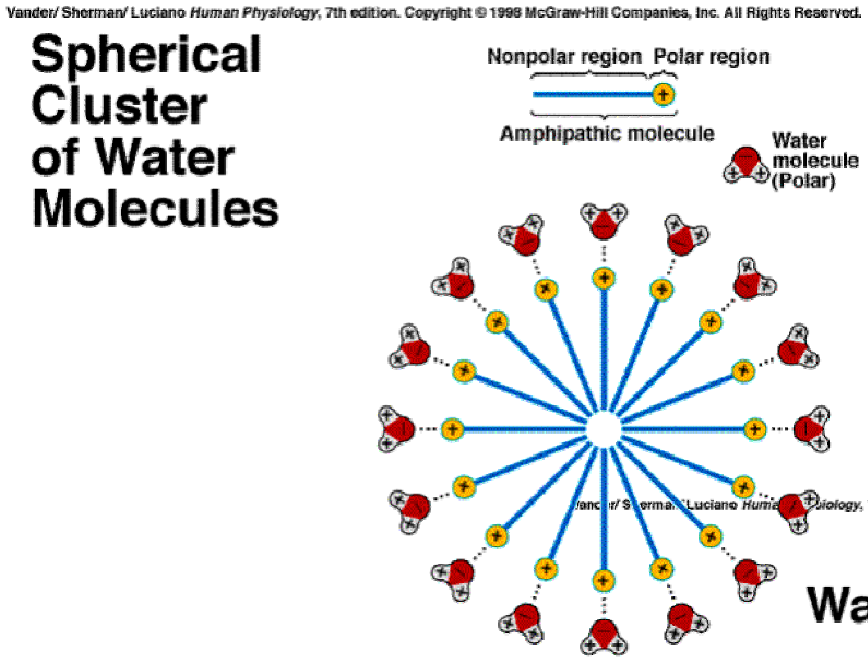
Source: INTERNET

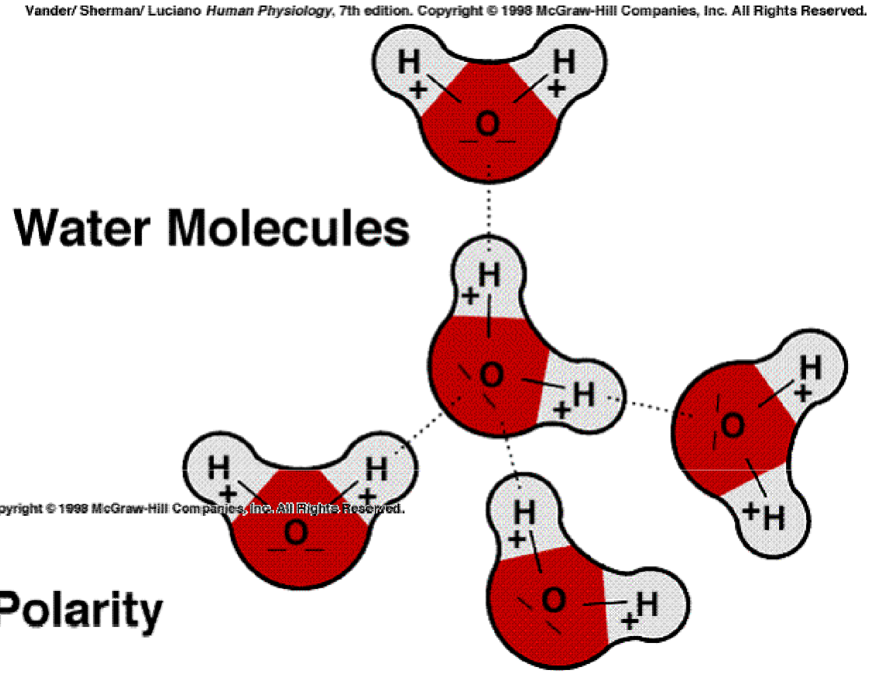
Chemical bonds

Covalent Bonds

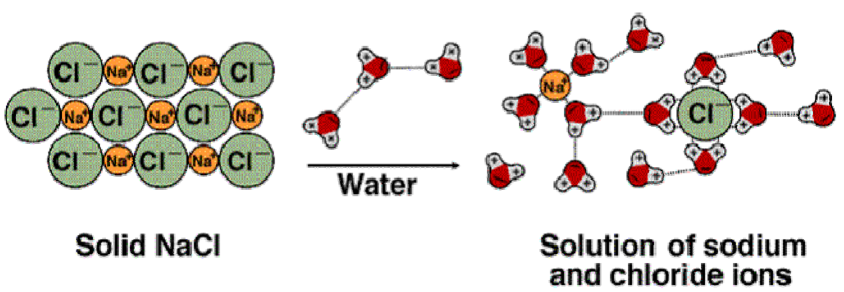


Ionic and Hydrogen bonds



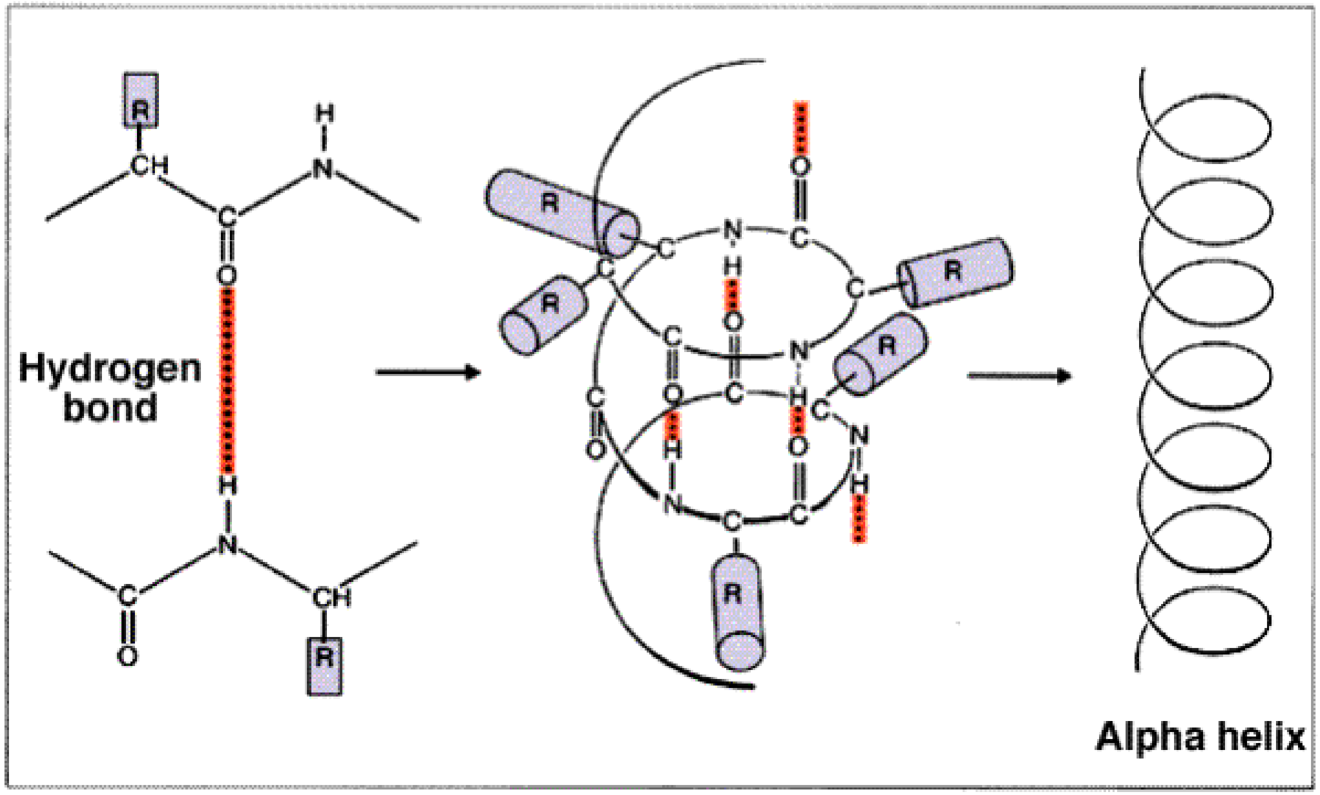


Water Polarity

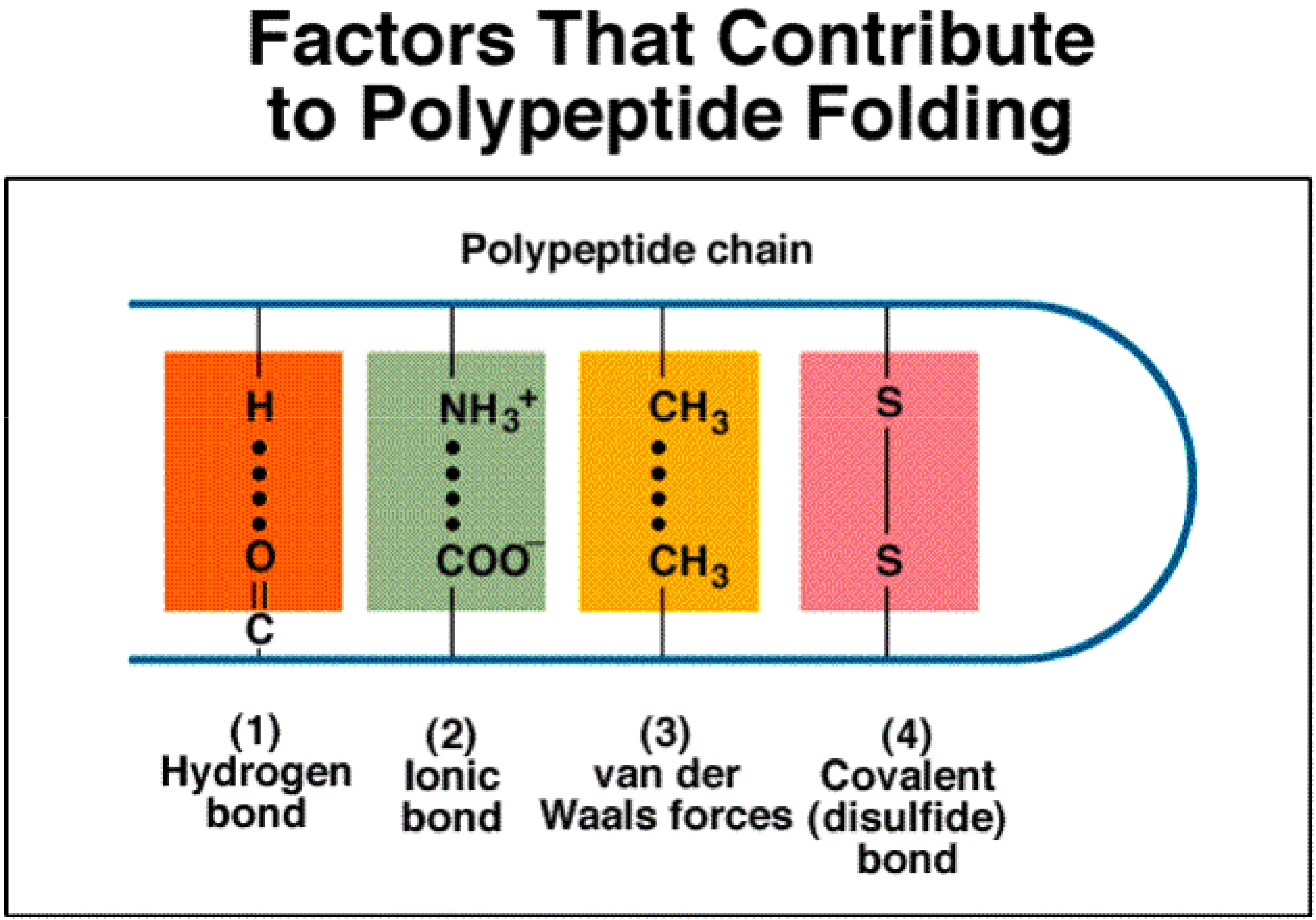


Hydrogen bonds

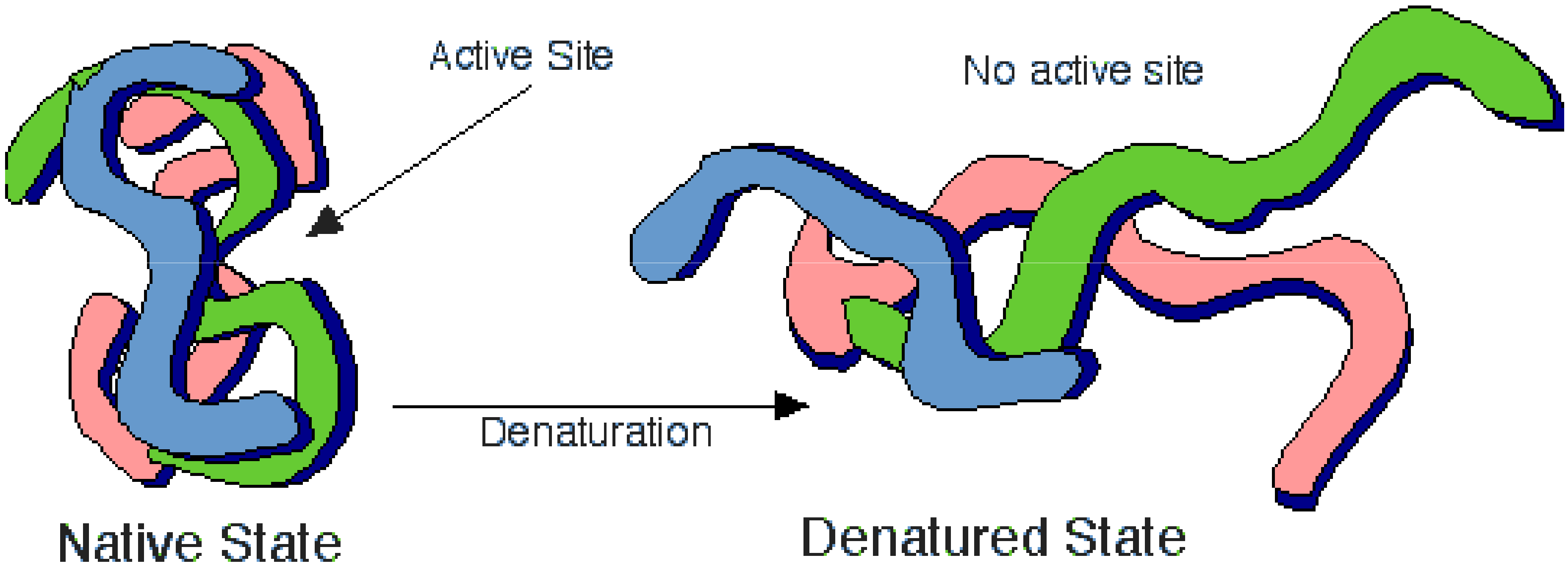
Hydrogen Bonds



Bonds important for biomolecular structure

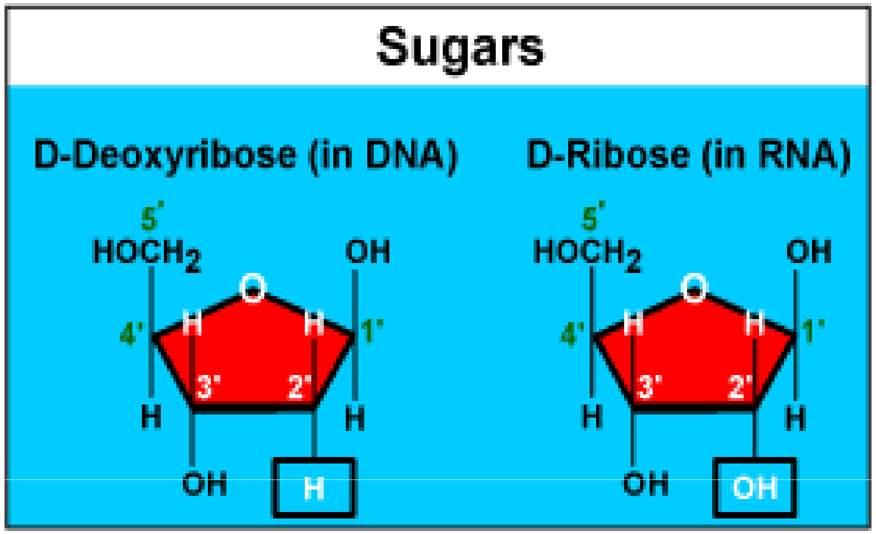


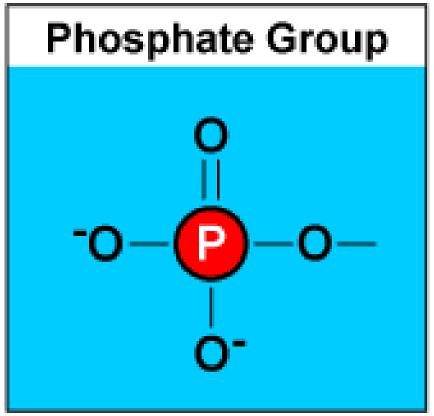
Protein folding and unfolding

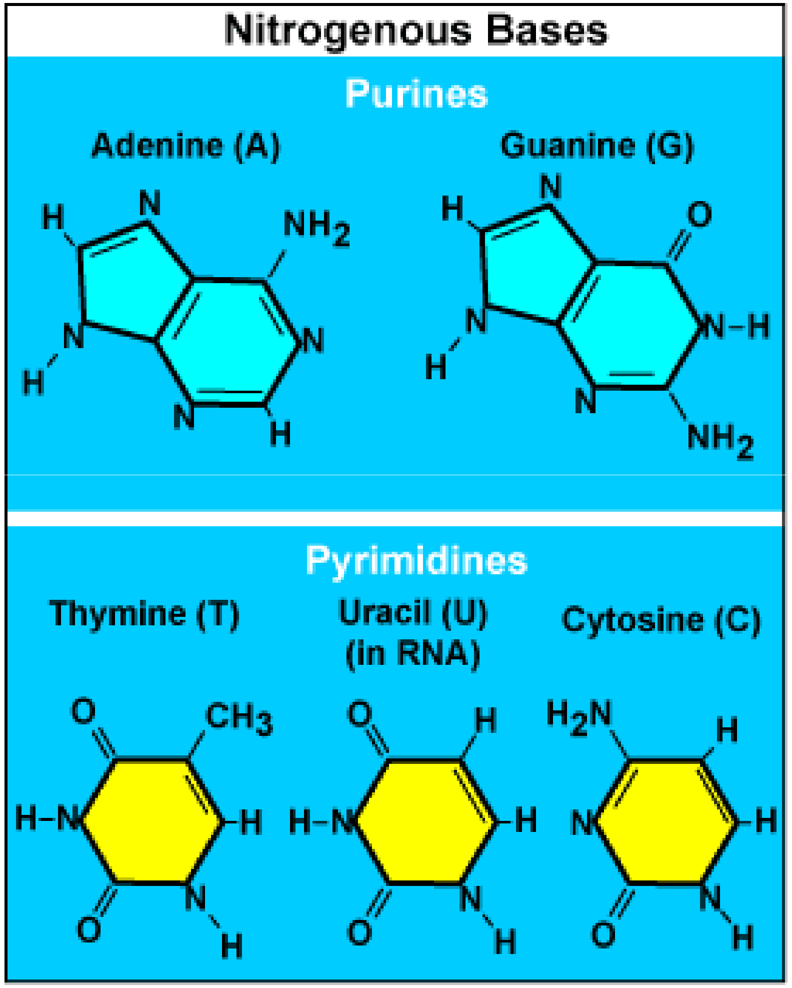


Unknown author of the graphics

Nucleotide Subunits of DNA and RNA

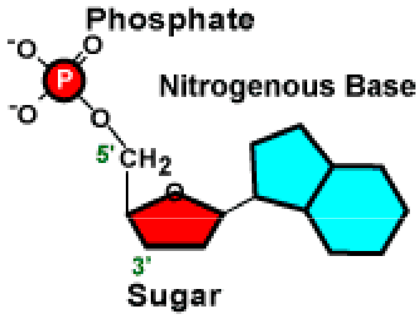




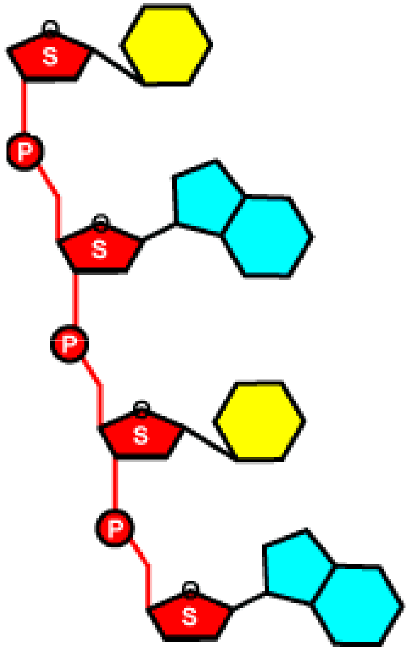


Source: INTERNET

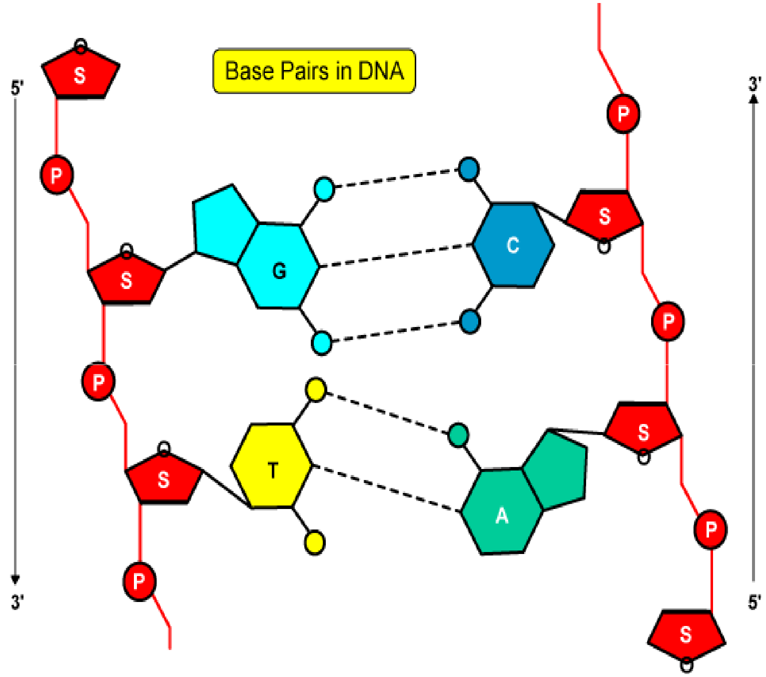
Organization of DNA Molecule (1)



Nucleotide

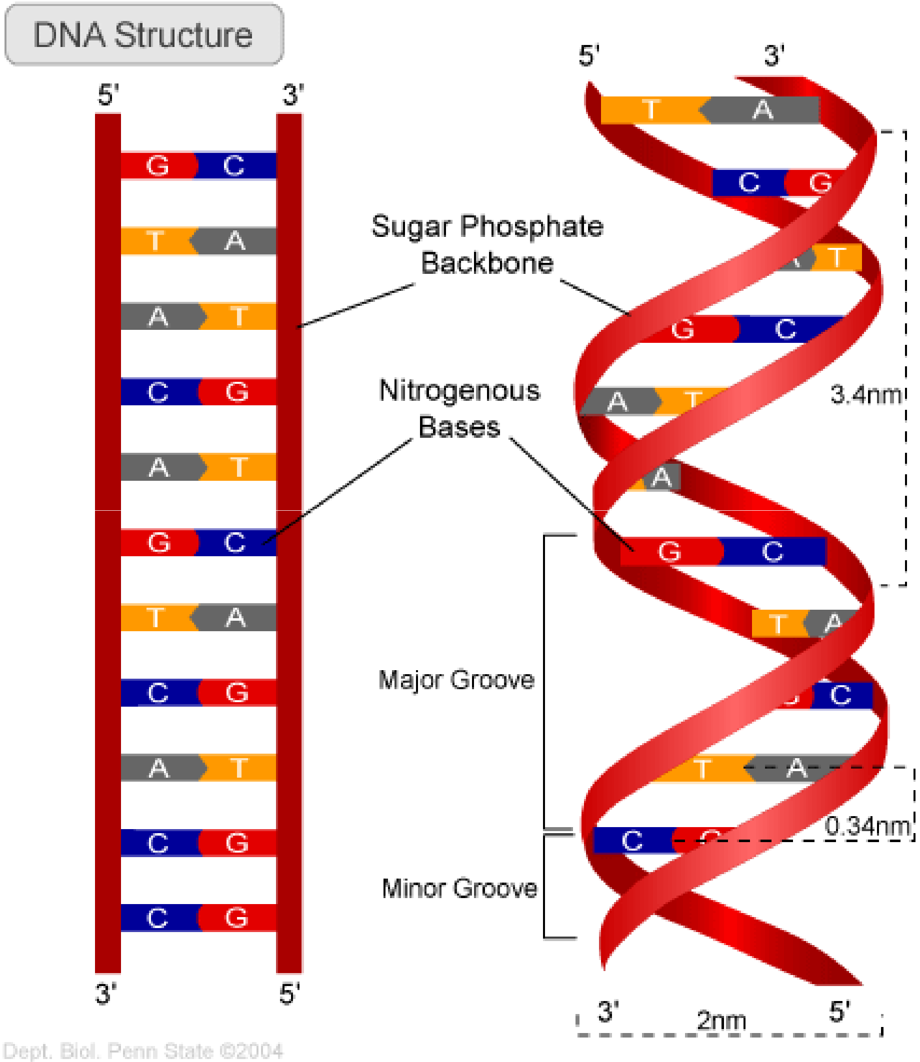


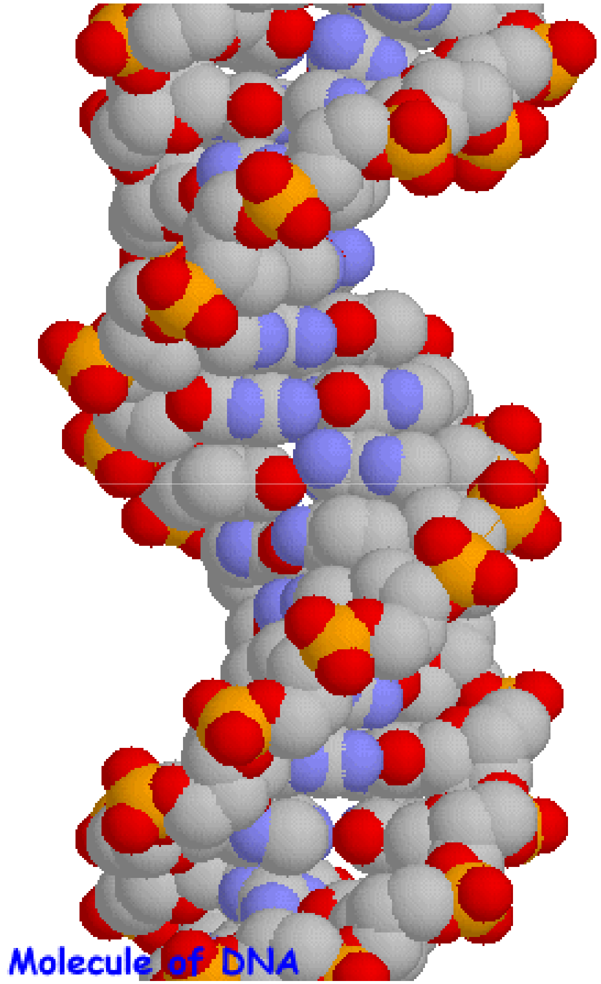
Single Strand Nucleic Acid



Source: INTERNET

Organization of DNA Molecule (2)

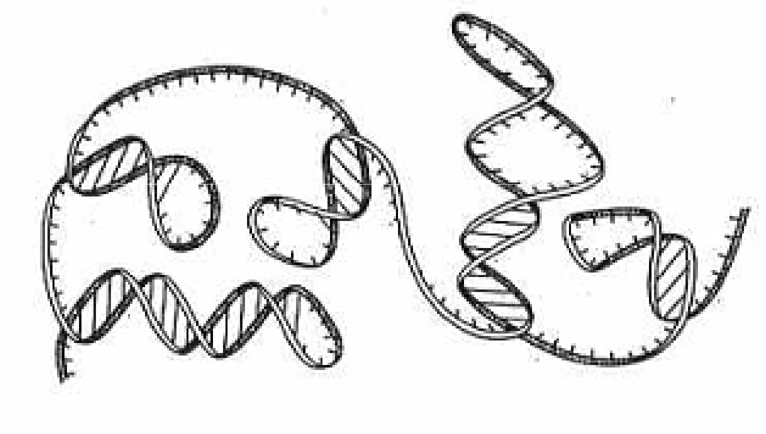




©Rothamsted Experimental Station, 1997, 1998

Source: INTERNET

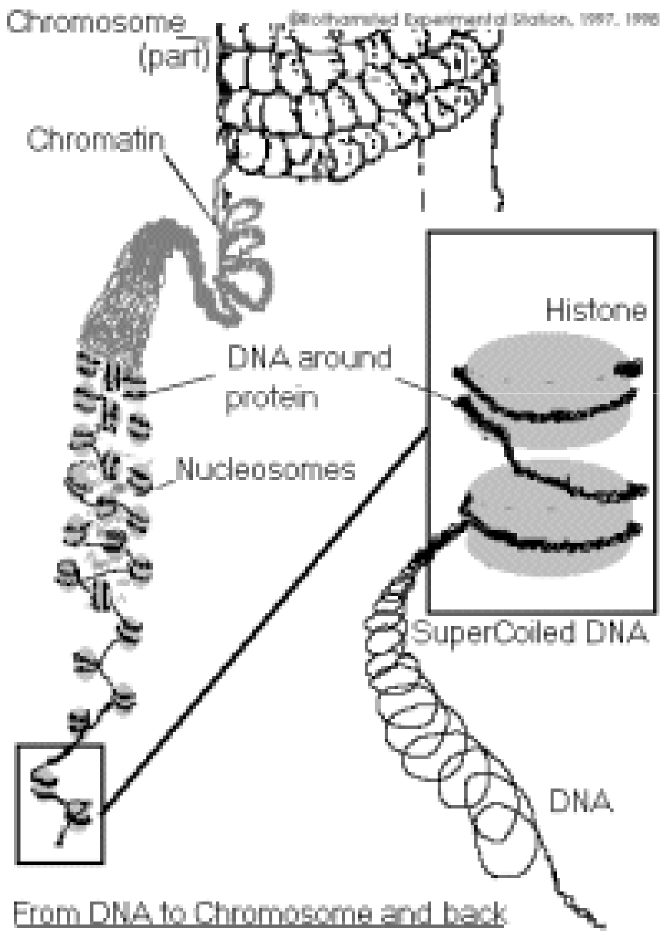
Organization of RNA Molecule

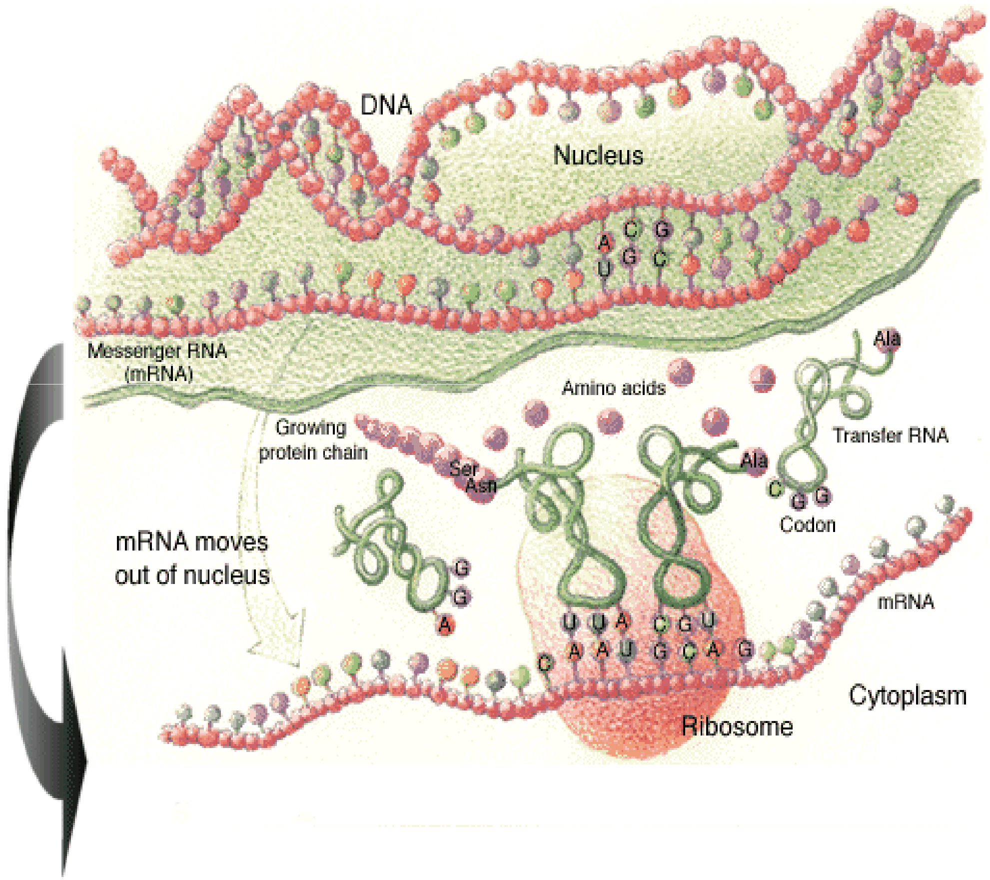


A, U, C, G

Source: INTERNET

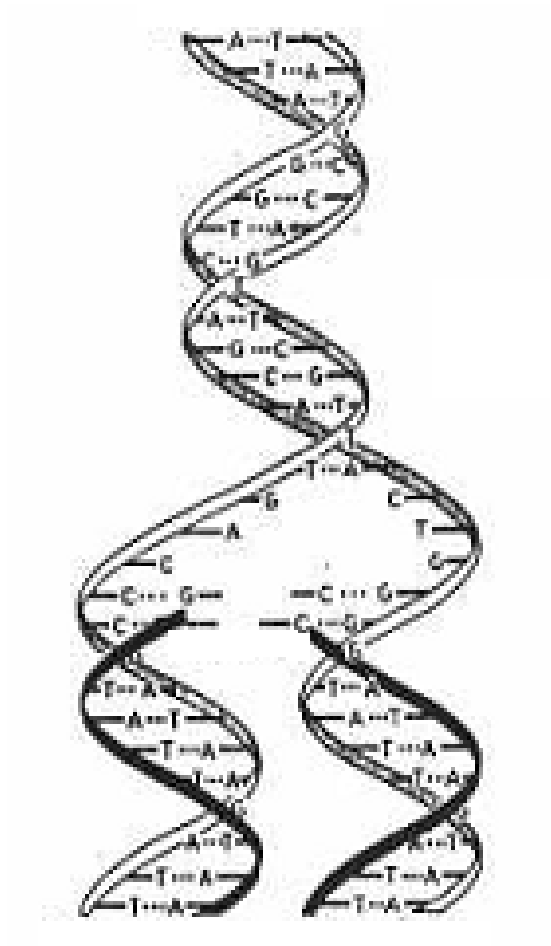
Transcription and Translation

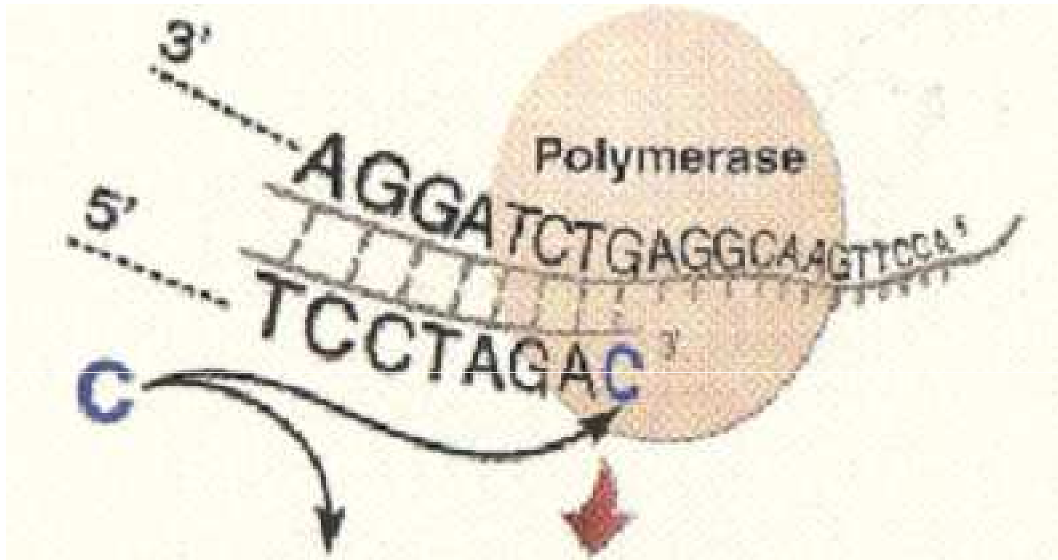




Source: INTERNET

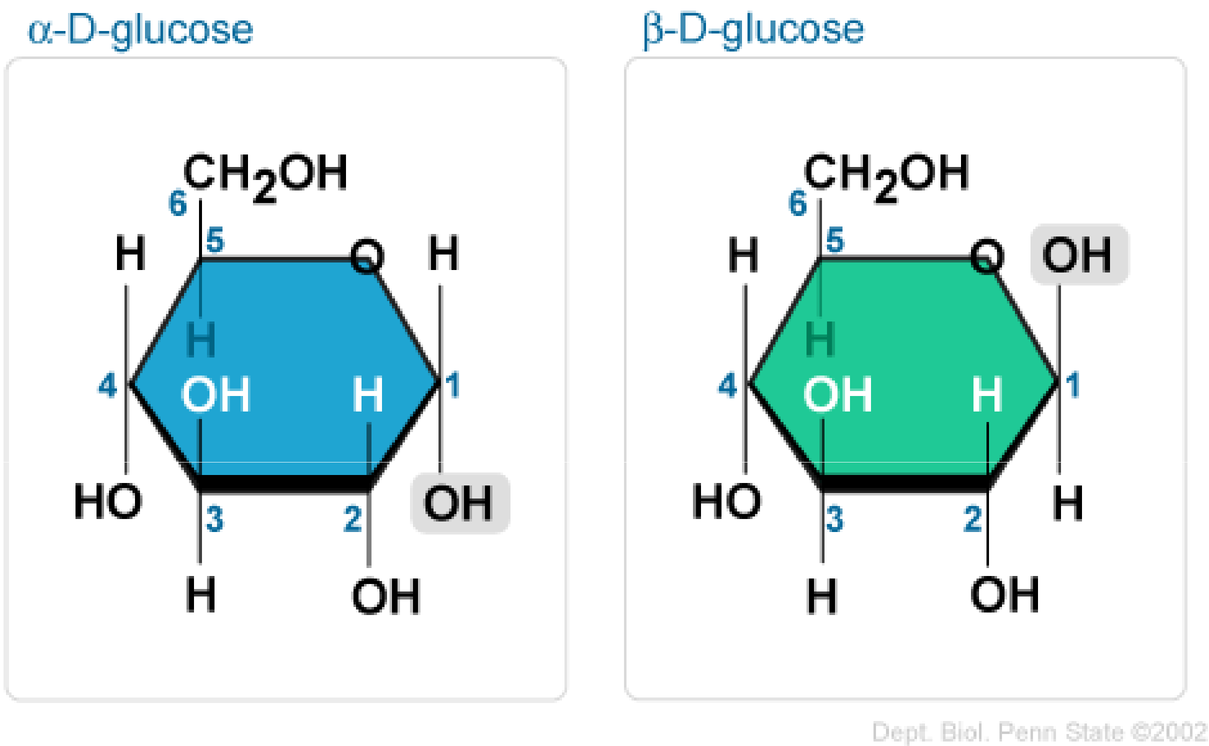
DNA Replication





Not identical but complementary

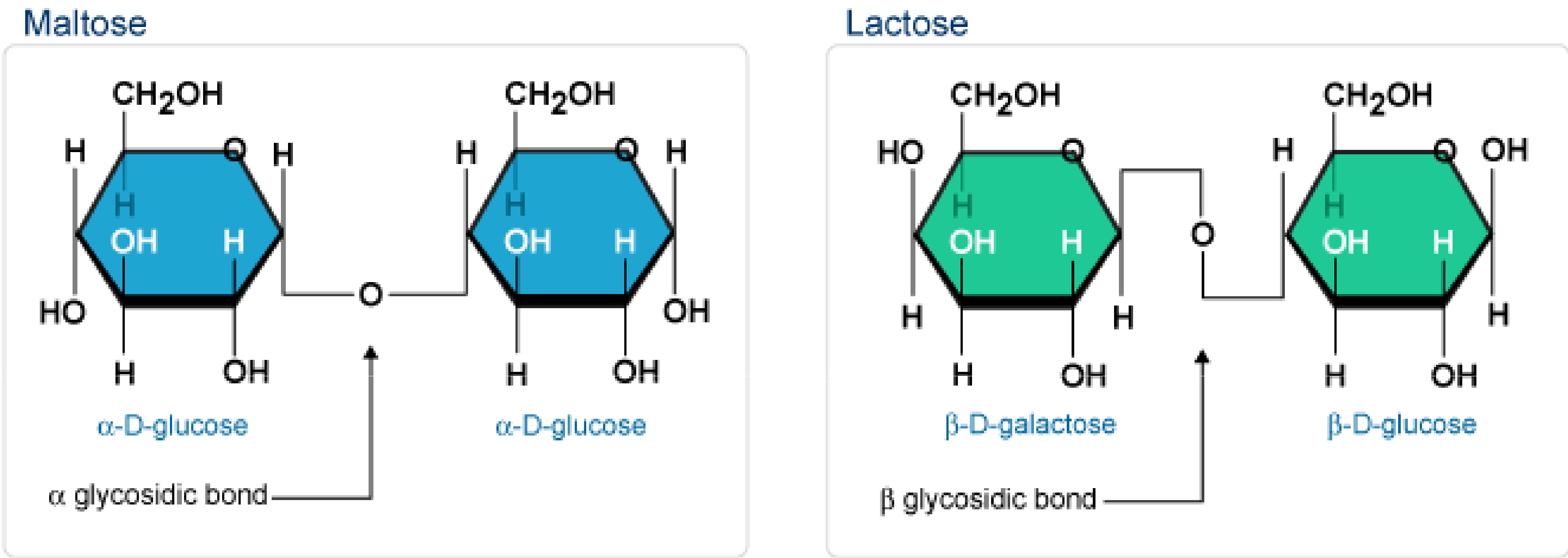
Monosaccharides



Alpha and beta configurations of D-glucose α-D-glucose is shown in blue and β-D-glucose is shown in green. The carbons are numbered. Note the hydroxyl groups at the first-position carbons.

Source: INTERNET

Disaccharides

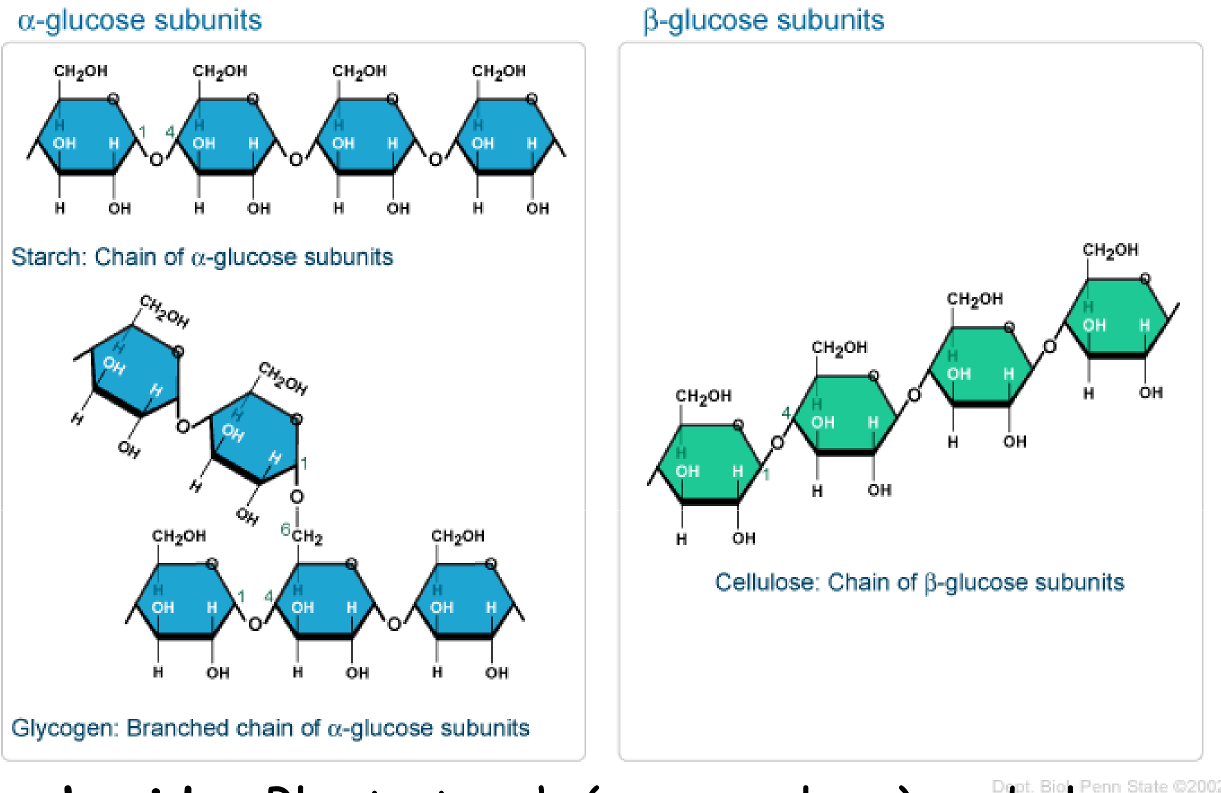


Dept. Biol. Penn State ©2002

Common disaccharides Maltose and lactose are shown. α-D-glucose is shown in blue and β-D-glucose and β-D-galactose are shown in green. The α glycosidic bond in maltose and β glycosidic bond in lactose are indicated.

Source: INTERNET

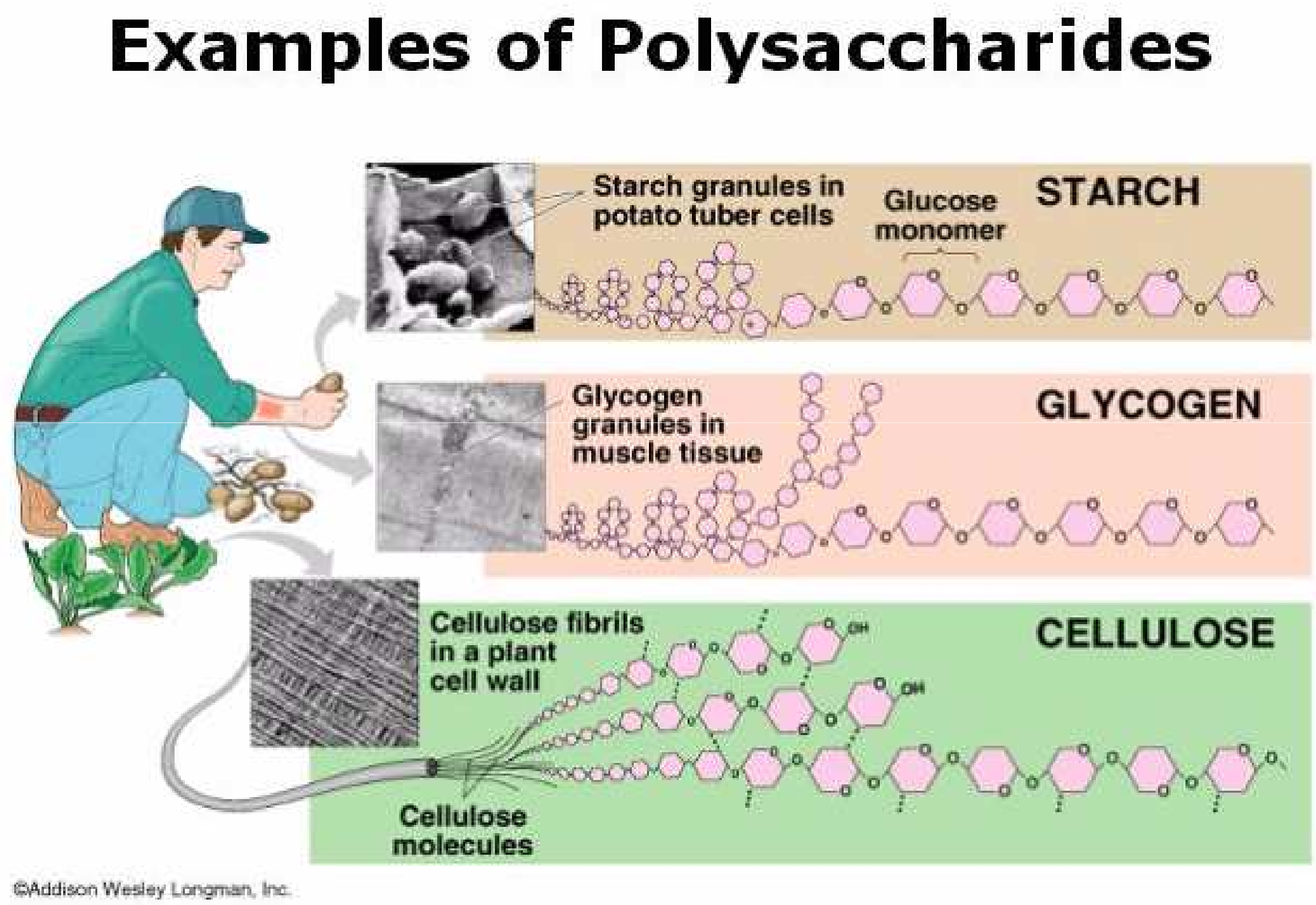
Polysaccharides (1)



Common polysaccharides Plant starch (e.g. amylose) and glycogen are both composed of α-D-glucose subunits linked through α glycosidic bonds. Starch is an unbranched polymer, whereas glycogen is branched, with 1 → 6 linkages. Cellulose is composed of β-D-glucose subunits linked through β glycosidic bonds.

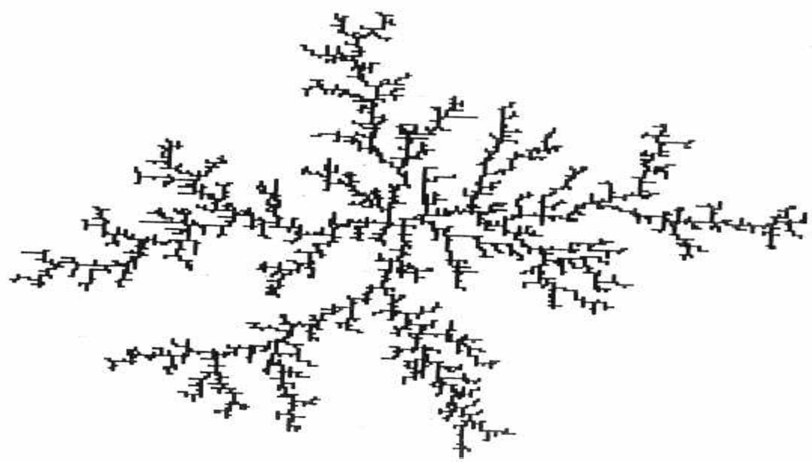
Source: INTERNET

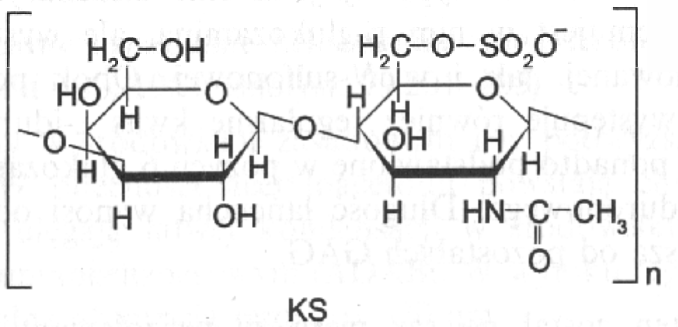
Polysaccharides (2)



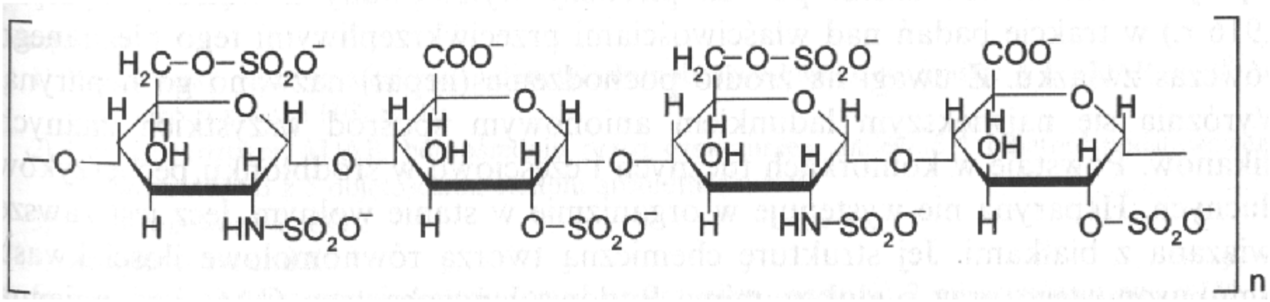
Polysaccharides (3)

Fractal like structure
of polysaccharide



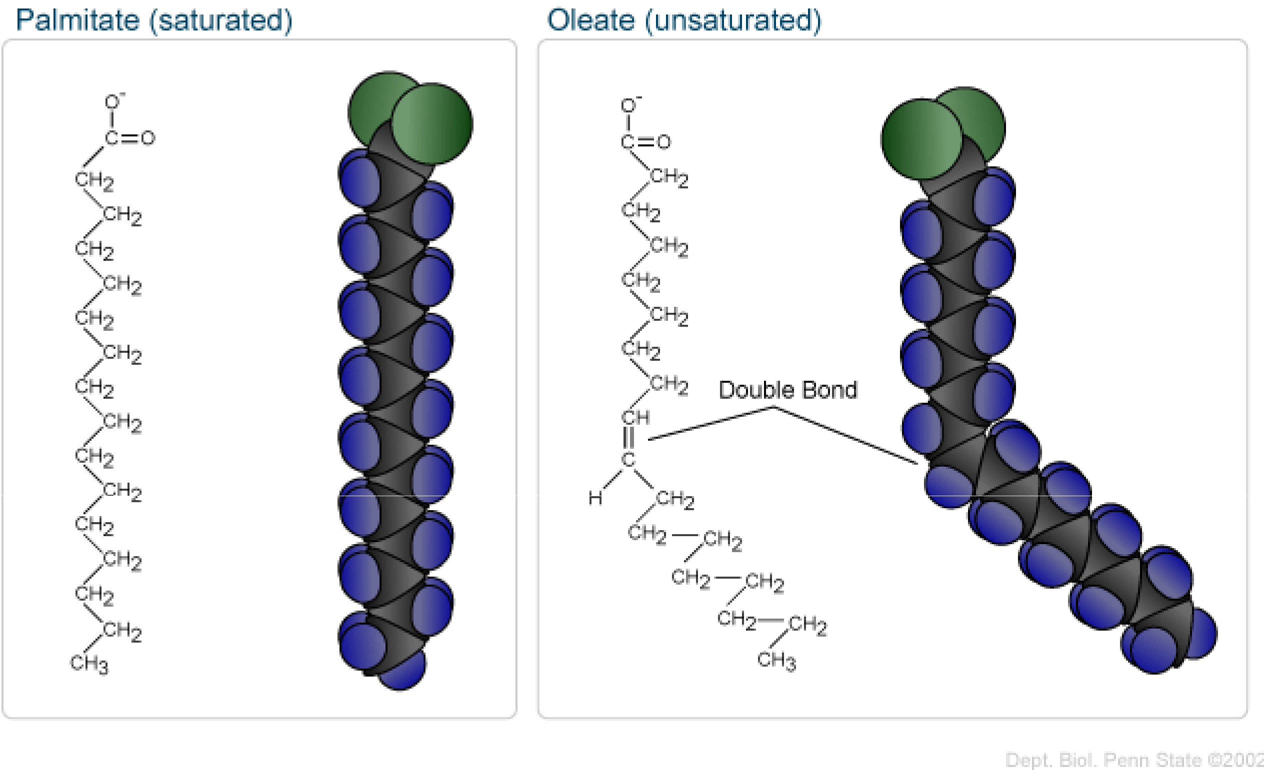


Keratin sulphate subunit



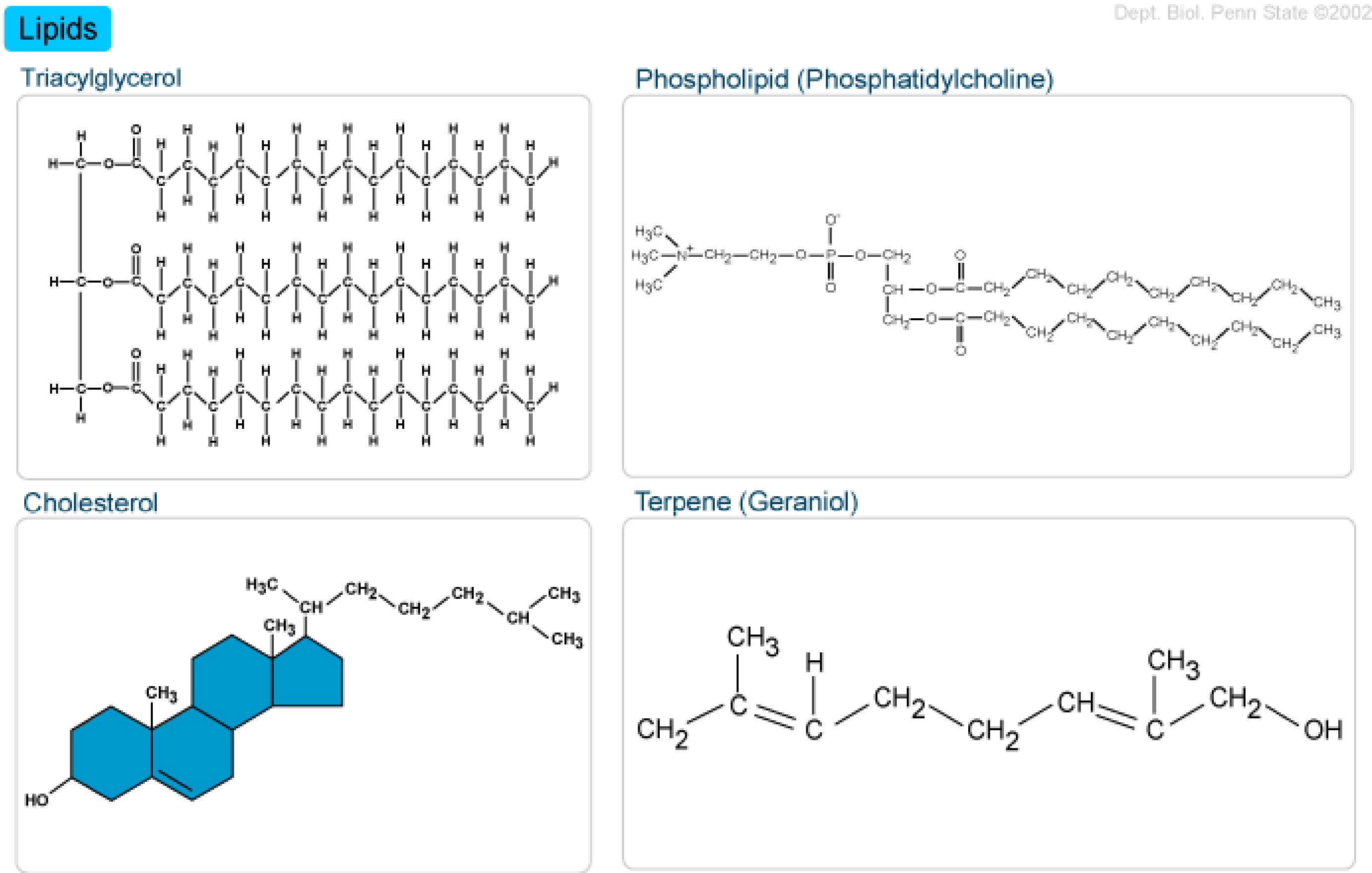
Heparin subunit

Lipids (1)



Saturated and unsaturated fatty acids. The chemical composition and structure of two fatty acids, one saturated (palmitate) and one unsaturated (oleate), are shown. Note that the double bond in oleate causes a kink in the molecule. Carbon atoms are shown in black, hydrogen atoms are shown in blue, and oxygen atoms are shown in green. Source: INTERNET

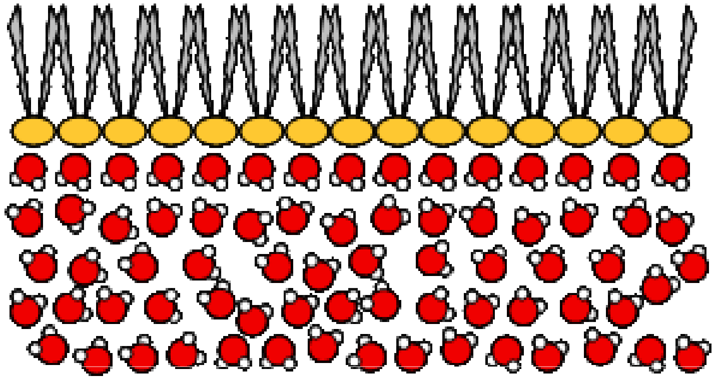
Lipids (2)



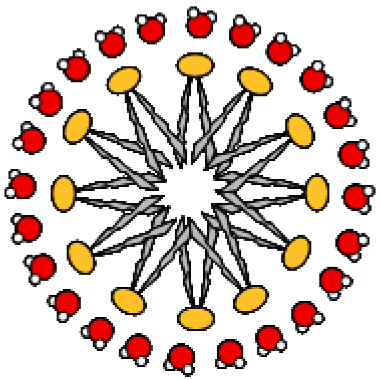
Four types of lipids The chemical structures of four different lipids are shown. A triacylglycerol, a phospholipid (phoshphotidylcholine), a sterol (cholesterol) and a terpene (geraniol).

Source: INTERNET

Model of Membranes (1)



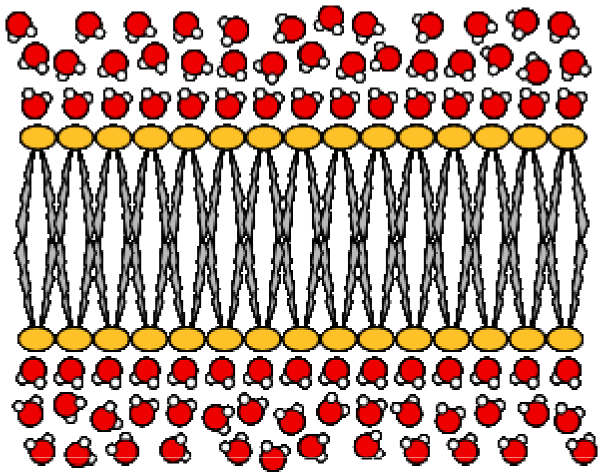
Langmuir's monolayers (1920)
Langmuir showed that if phospholipids are dissolved in benzene they could be dispersed as a monolayer on the surface of water in a Langmuir trough.

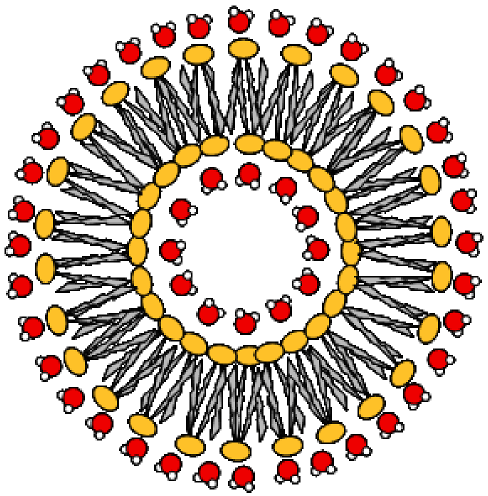


Micelles
If shaken with water, phospholipids (like detergents) will form micelles. These are colloids in an aqueous suspension. Micelles have a hydrophilic outside and hydrophobic inside.

Source: INTERNET

Model of Membranes (2)





Gortner & Grendel's bilayers (1925)
These researchers extracted the lipid from the plasma membrane of RBCs and applied them to a Langmuir trough. They covered twice the area of the original membrane showing that natural membranes are bilayers.

Liposomes
If lipids are sonicated at 20 kHz they form vesicles (liposomes) with an internal space. These can be used to deliver hydrophobic drugs to cells, and as model cells.

Source: INTERNET

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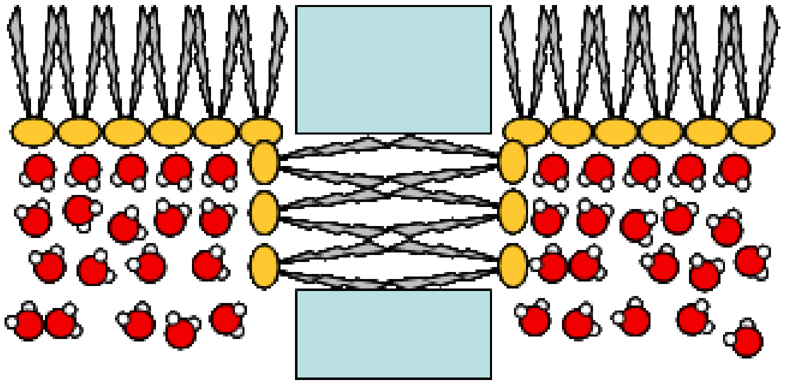
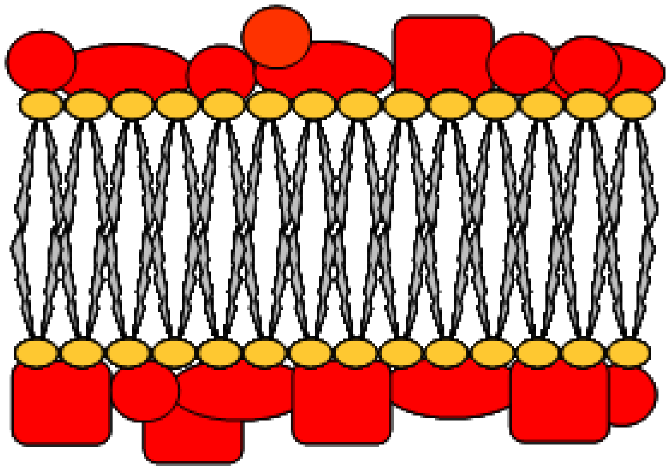
Model of Membranes (3)



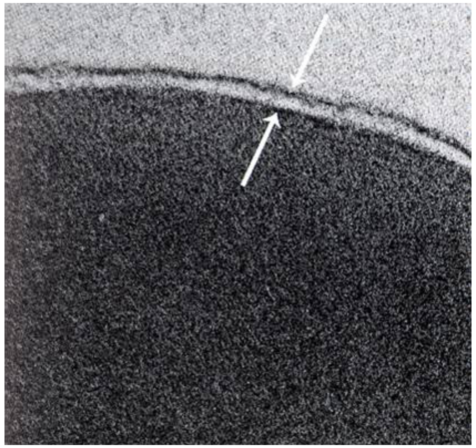
Black lipid membranes (1930)
Produced by forcing a membrane with a small hole in it through a monolayer in a Langmuir trough. Natural and black lipid membranes have similar thicknesses (*c.* 7 nm), but natural membranes are generally far more conductive. This indicates there's something else in natural membranes besides lipid.



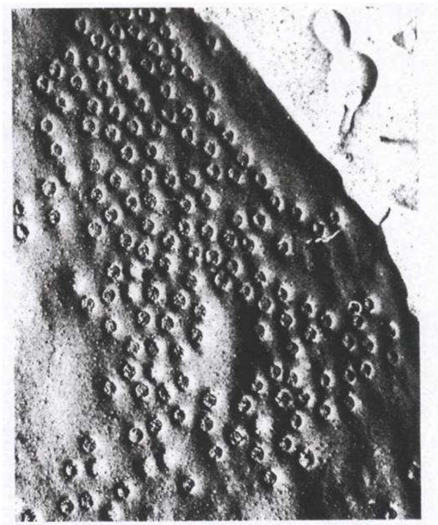
Davison & Danielli's sandwich (1935)
The earliest true model of membranes proposed a phospholipid bilayer covered in a globular protein coat.

Source: INTERNET

Model of Membranes (4)



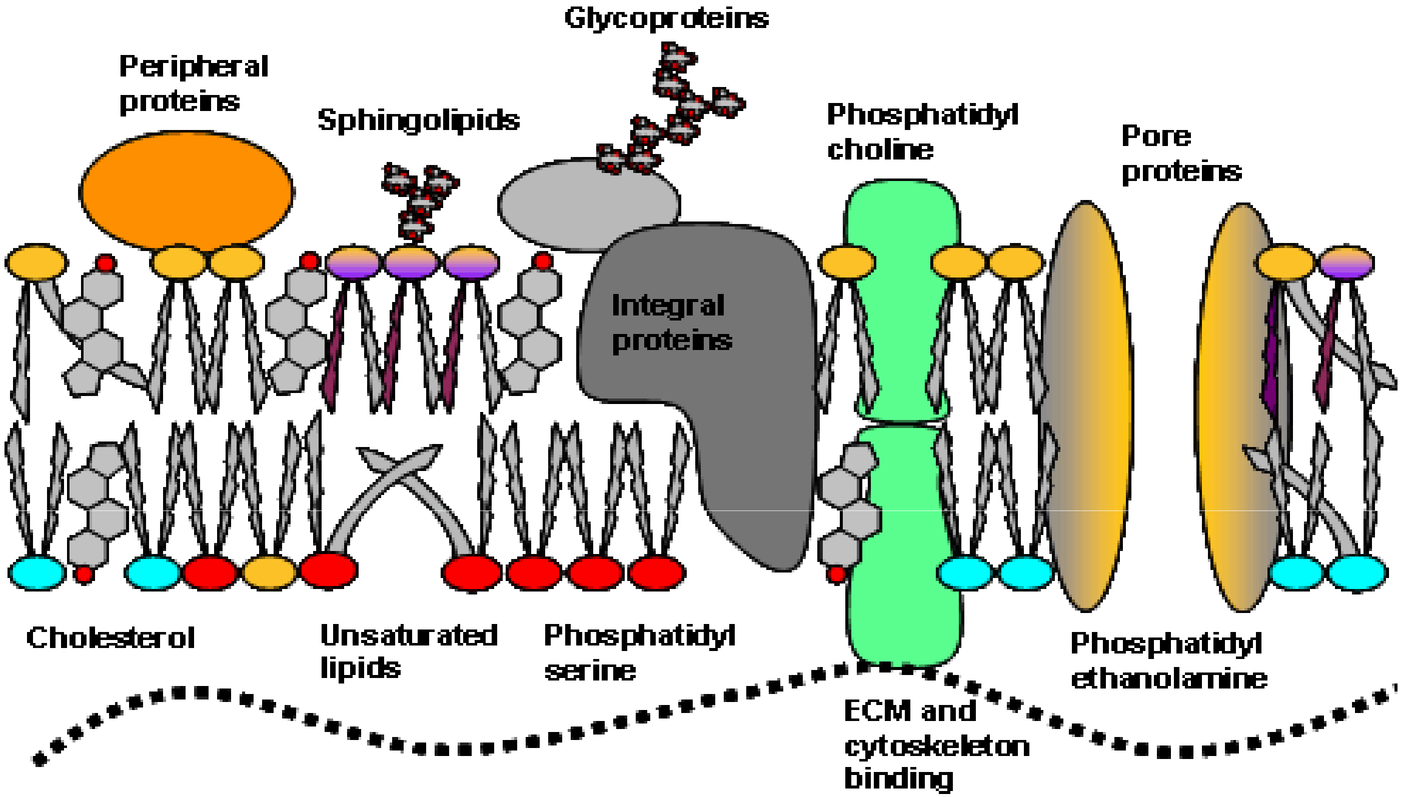
Robertson's unit membrane
Under the electron micrograph, this model appears acceptable: 7 nm thick, with lipid in the middle (white) and protein on outside (black).



But freeze-fracture scanning electron micrographs showed things inconsistent with the unit membrane, such as pores and pits. This micrograph was prepared by freezing a cell, then fracturing it with a sharp blow. The forces holding the leaflets of a membrane together are quite weak, so freeze fracture often pulls the two leaflets apart, allowing you to see the proteins that span the membrane very clearly.

Source: INTERNET

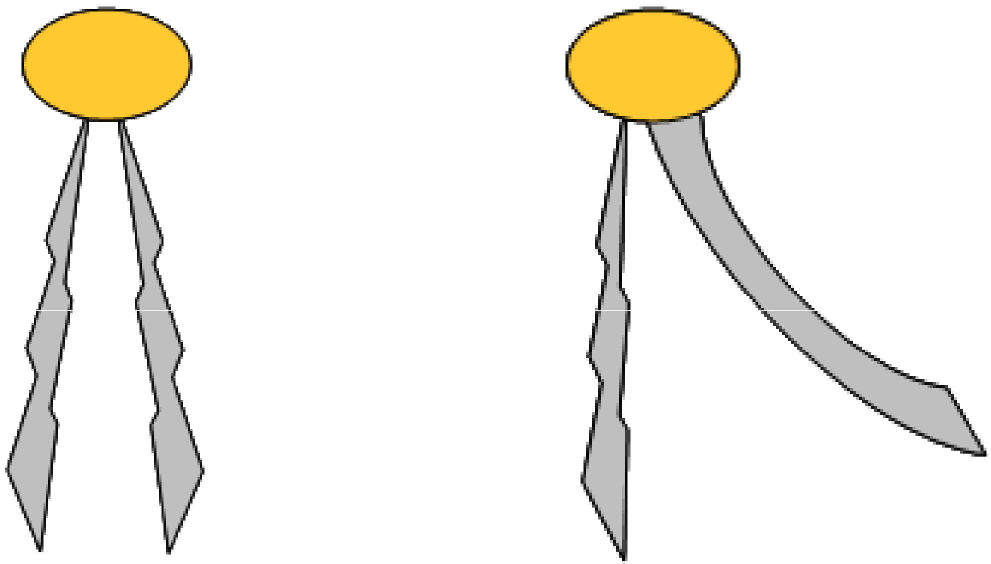
Model of Membranes (5)



Singer-Nicholson fluid mosaic (1972)
The fluid mosaic model pictures the membrane as a phospholipid bilayer with many proteins, some integral to the membrane, others attached more loosely. Note the many other components, such as cholesterol; and the attachment sites for the extracellular environment (*via* glycoproteins) and intracellular cytoskeleton.

Source: INTERNET

Model of Membranes (6)



In unsaturated fatty acids, these chains are kinked, and cannot pack so closely. This increases membrane fluidity.

Source: INTERNET

COMPARISON OF PHYSICAL PARAMETERS OF BIOLOGICAL MEMBRANE WITH LIPID BILAYER

	Lipid bilayer	Biological membrane
Thickness [nm]	6,0 – 7,5	6,0 – 10,0
El. capacity [mF/cm²]	0,4 – 1,0	0,5 – 1,3
Breakdown voltage [mV]	150 – 200	100
Surface tension coefficient [N/m]	$(0{,}5 - 2) \times 10^{-3}$	$(0{,}03 - 2) \times 10^{-3}$
Resistance [$\Omega \times cm^2$]	$10^6 - 10^9$	$10^2 - 10^5$

KAPITAŁ LUDZKI
NARODOWA STRATEGIA SPÓJNOŚCI

Projekt współfinansowany przez Unię Europejską
w ramach Europejskiego Funduszu Społecznego

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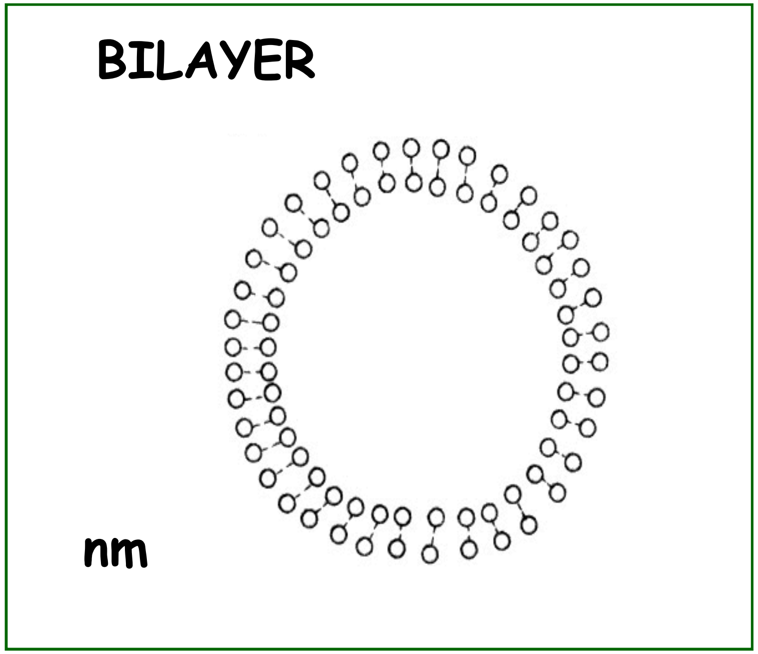
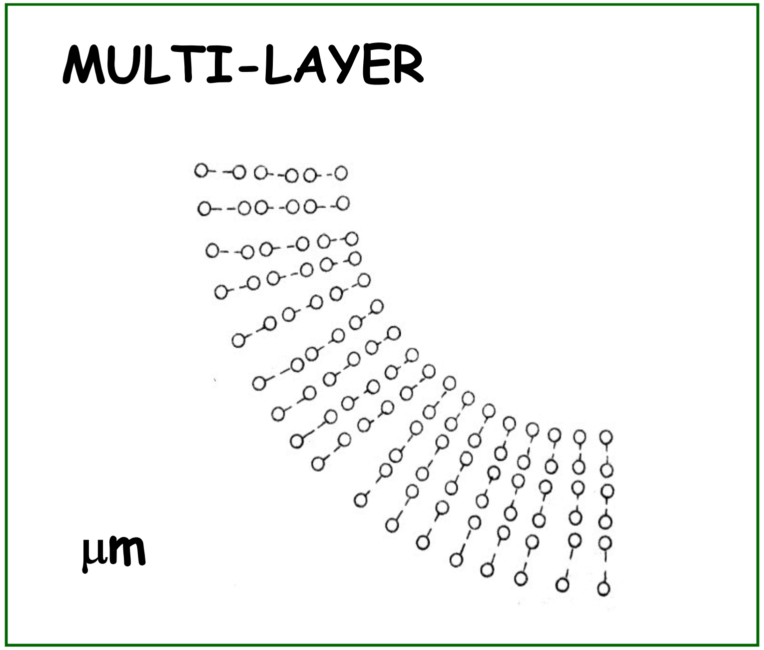
Liposomes Formation and Applications

Sonication
20 – 50 nm

Shaking
5 – 50 μm





LIPOSOMES Applications in Biology and Medicine

Examination of the properties of membrane proteins

Modelling of processes occurring in natural membranes

Possibility to incorporate additional elements into the cellular membrane

Loading poorly soluble and highly oxidative substances in water into the cell

Cell-directed application of medicines

Enhancement of immunological response

Cosmetic creams for substance transport

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BIOPHYSICS

Prezentacja multimedialna współfinansowana przez Unię Europejską w ramach Europejskiego Funduszu Społecznego w projekcie pt.

„Innowacyjna dydaktyka bez ograniczeń - zintegrowany rozwój Politechniki Łódzkiej - zarządzanie Uczelnią, nowoczesna oferta edukacyjna i wzmacniania zdolności do zatrudniania osób niepełnosprawnych"

Politechnika Łódzka

Politechnika Łódzka, ul. Żeromskiego 116, 90-924 Łódź, tel. (042) 631 28 83
www.kapitalludzki.p.lodz.pl