Biological Chemistry Department

Biological Chemistry

CONJUGATED PROTEINS

Speciality: Pharmacy for foreign students (Language of instructions – English)

Lecturer: ass. prof. Kravchenko G.B.

Lecture Plan

1. Conjugated proteins classification.
2. Chromoproteins.

2.1. Hemoproteins, structure and functions.

3. Glycoproteins and proteoglycans, structure and functions.
4. Lipoproteins, structure and functions.
5. Metaloproteins, structure and functions.
6. Phosphoproteins, structure and functions.

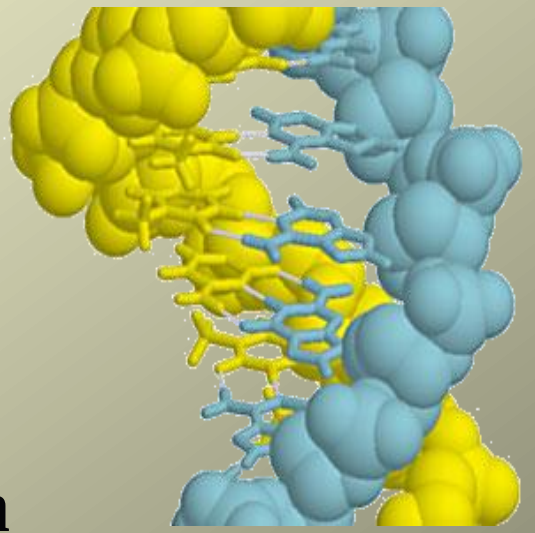
<u>Individual work</u>

1. Glycoproteins as pharmaceutical preparations.

Information Resources

1. Biological Chemistry: Textbook / A.L. Zagayko, L.M. Voronina, G.B. Kravchenko, K.V. Strel`chenko. – Kharkiv: NUPh; Original, 2011. – 33-47 p.
2. Training Journal for Licensed Exam "KROK-1": Study Material in Biological Chemistry. – Kharkiv: NUPh, 2017. – 18-26 p.
3. Laboratory Manual on Biochemistry. Kharkiv: NUPh, 2017. - 29-31 p.
4. Hemoglobin and Myoglobin: The Medical Biochemistry Page. Available on: https://themedicalbiochemistrypage.org/hemoglobin-myoglobin.php.
5. Lipoproteins: The Medical Biochemistry Page. Available on: https://themedicalbiochemistrypage.org/lipoproteins.php.

On the basis of composition, proteins are classified as simple or conjugated. Simple proteins contain only amino acids.



Each conjugated protein consists of a simple protein combined with nonprotein component.

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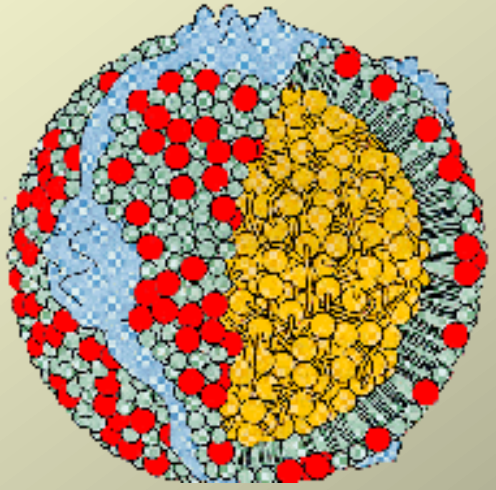

The nonprotein component is called a prosthetic group. A protein without its prosthetic group is called an apoprotein. A protein molecule combined with its prosthetic group is reffered to as a holoprotein.

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CLASSIFICATION

-Glycoproteins and Proteoglycans (contain a carbohydrate component)

-Lipoproteins (contain lipid molecules)

-Chromoproteins: (contain colored component – pigment, for example hemoproteins)

-Metaloproteins (contain metal ions)

-Phosphoproteins (contain phosphate groups)

-Nucleoproteins (contain nucleic acids)

Hemoproteins

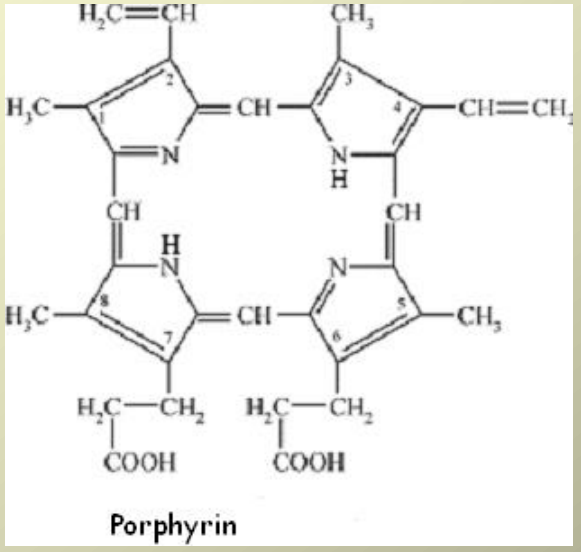
Unoxidizable –

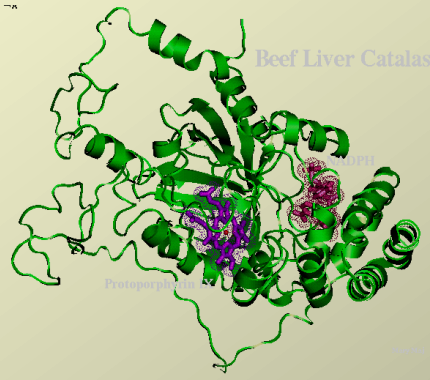
respiratory pigment

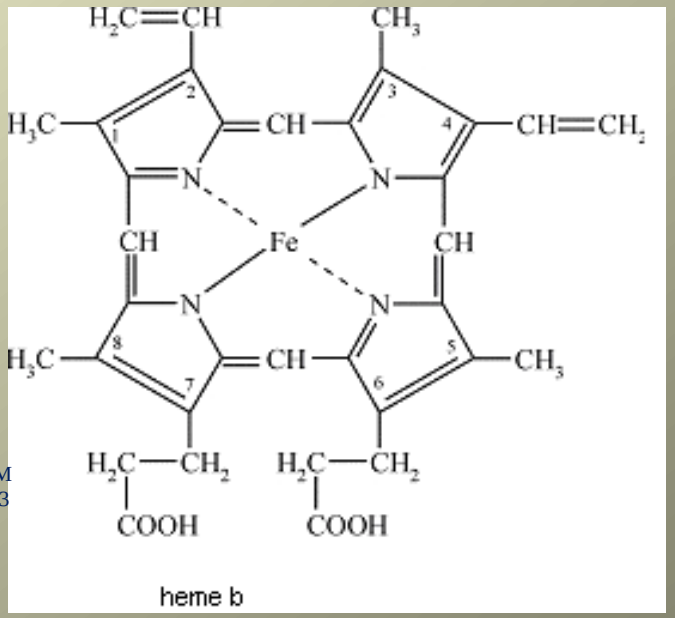
Fe2+

Hemoglobin

Myoglobin







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Oxidizable

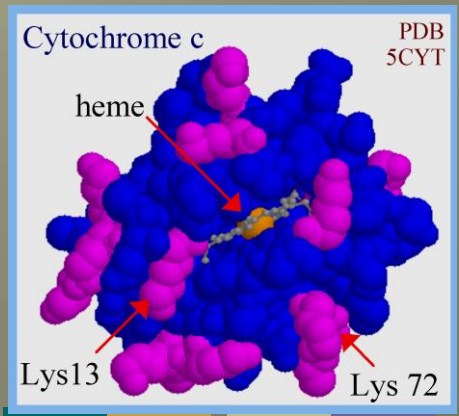
Enzymes and coenzymes

Fe2+↔ Fe3+

Enzymes:

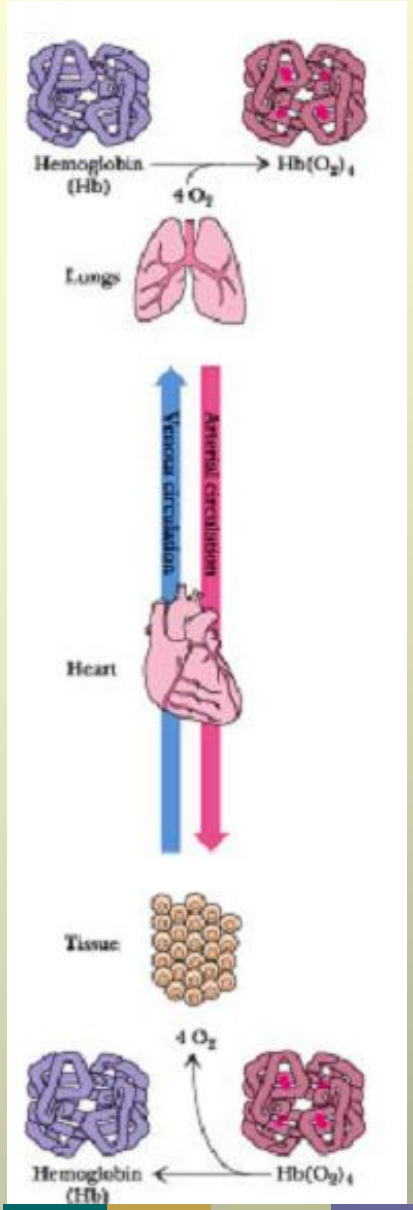
Catalase

Cytochrome and etc.

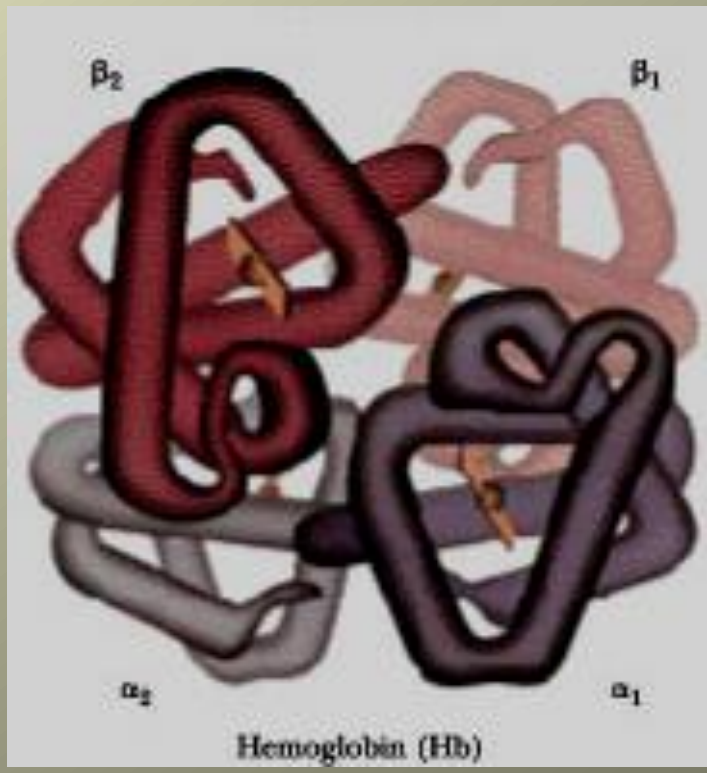


Hemoglobin (HbA)

primary function is to transport oxygen from lungs to every tissue in the body and remove CO_2 from them. HbA is composed of two αchains and two β-chains.



The four chains of hemoglobin, arranged in two identical subunits - $\alpha_1\beta_1$ and $\alpha_2\ \beta_2$ -are held together by noncovalent interactions. The association between the chains is primarly hydropobic in nature, but hydrogen bonds and several salt bridges are also important.



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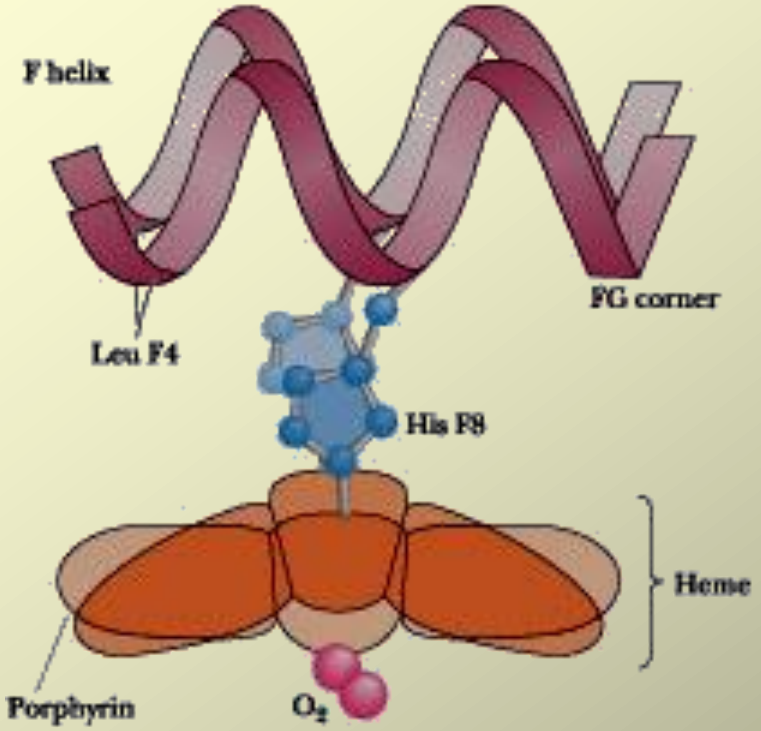

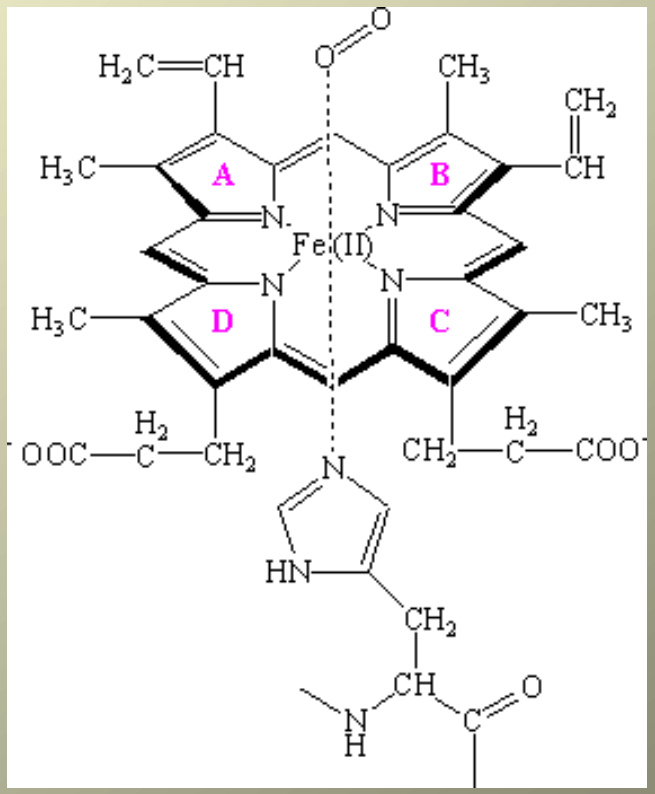

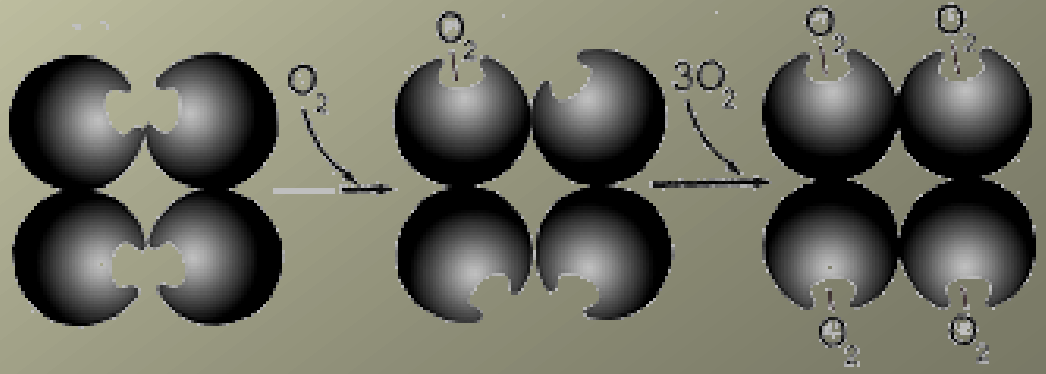

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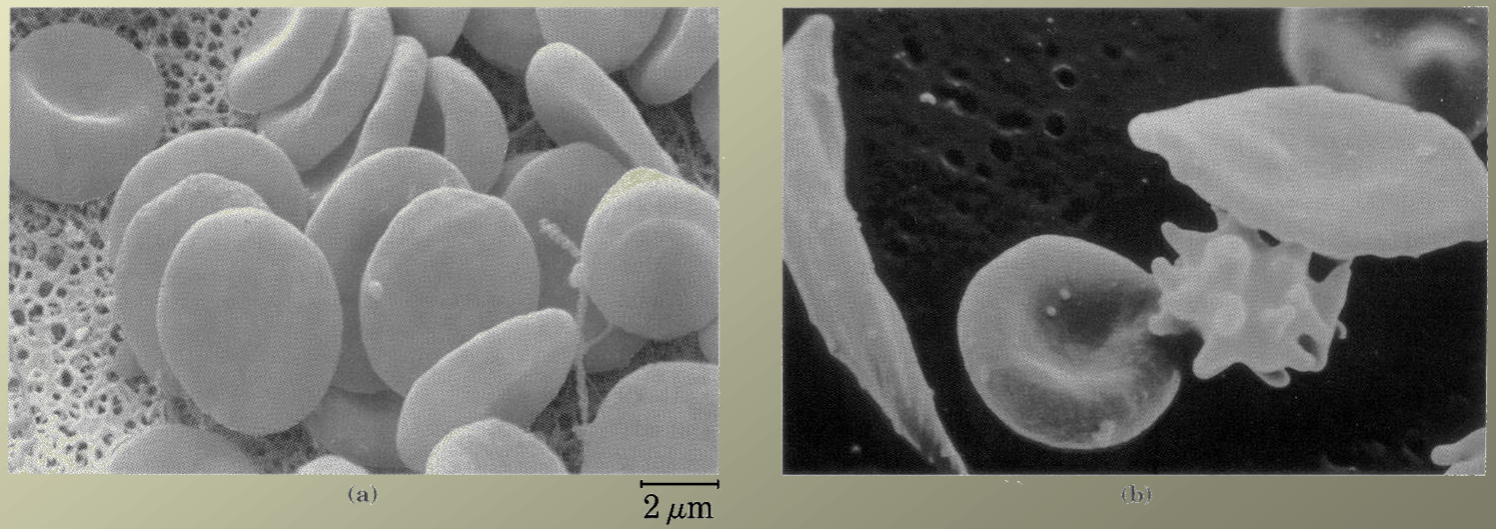
Sickle-cell anemia

Of the mutations leading to qualitative alterations in hemoglobin, the missense mutation in the β-globin gene that causes sickle cell anemia is the most common. The mutation causing sickle cell anemia is a single nucleotide substitution (A to T) in the codon for amino acid 6. The change is converts a glutamic acid codon (GAG) to a valine codon (GTG). The form of hemoglobin is persons with sickle cell anemia is referred to as HbS.



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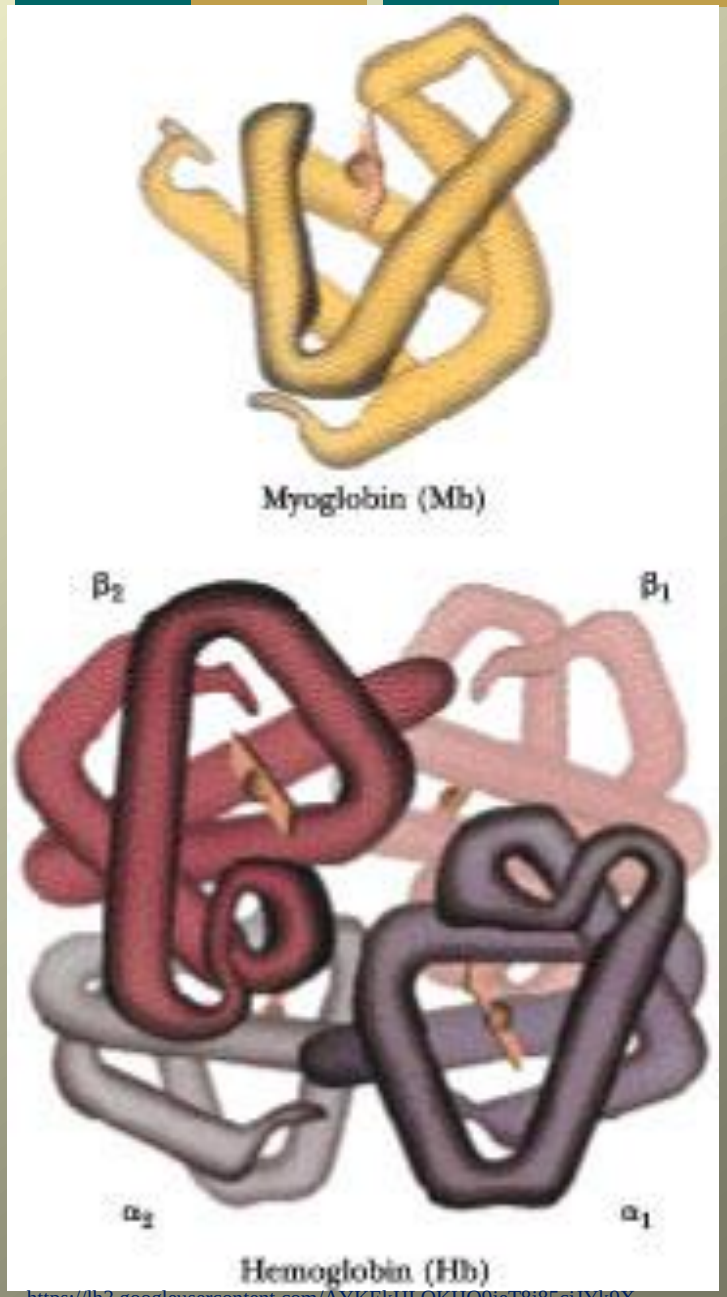
Myoglobin

Myoglobin is a monomeric heme protein found mainly in muscle tissue where it serves as an intracellular storage site for oxygen. During periods of oxygen deprivation oxymyoglobin releases its bound oxygen which is then used for metabolic purposes.



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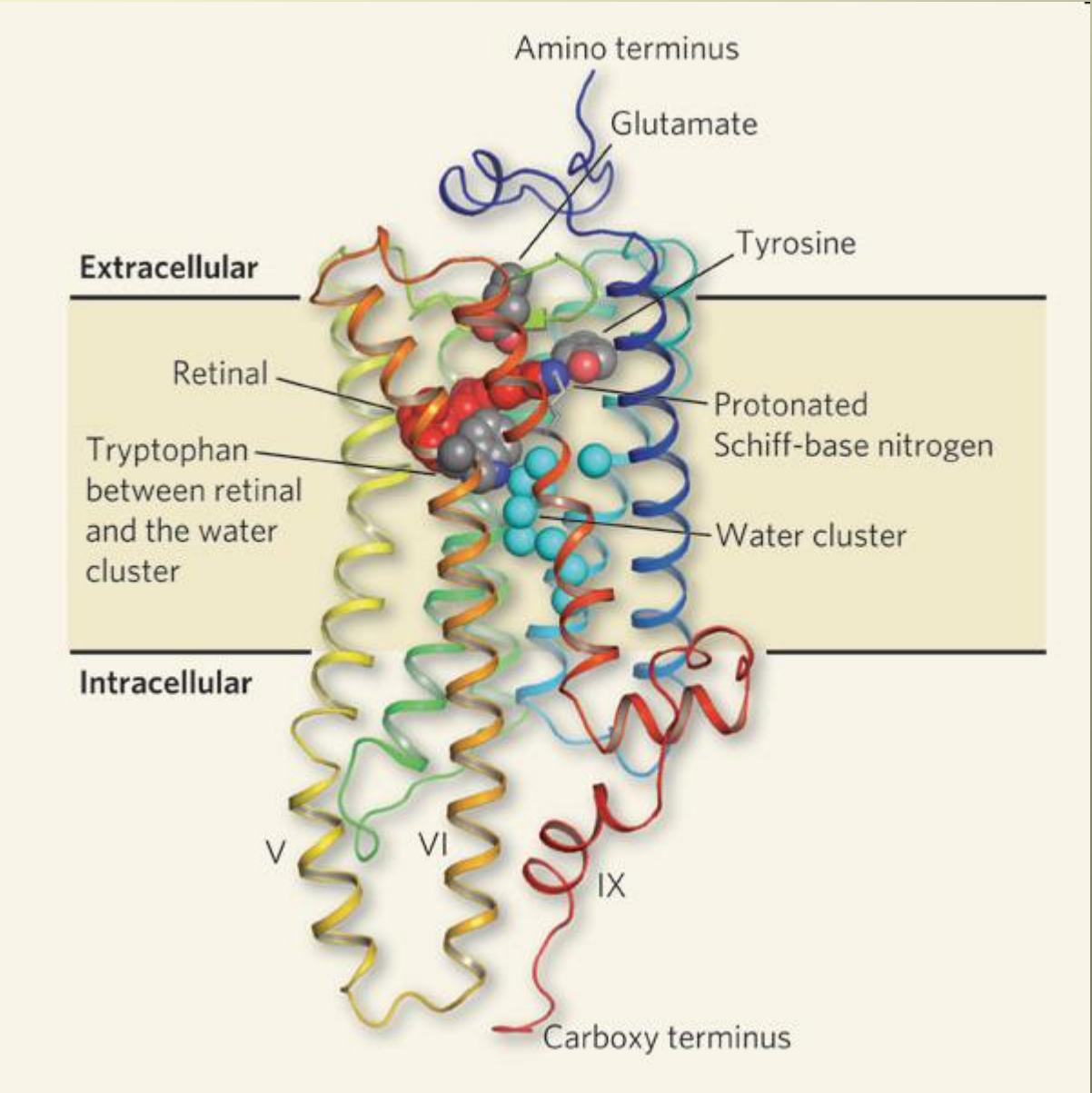
Retinalproteins

Rhodopsin – visual pigment



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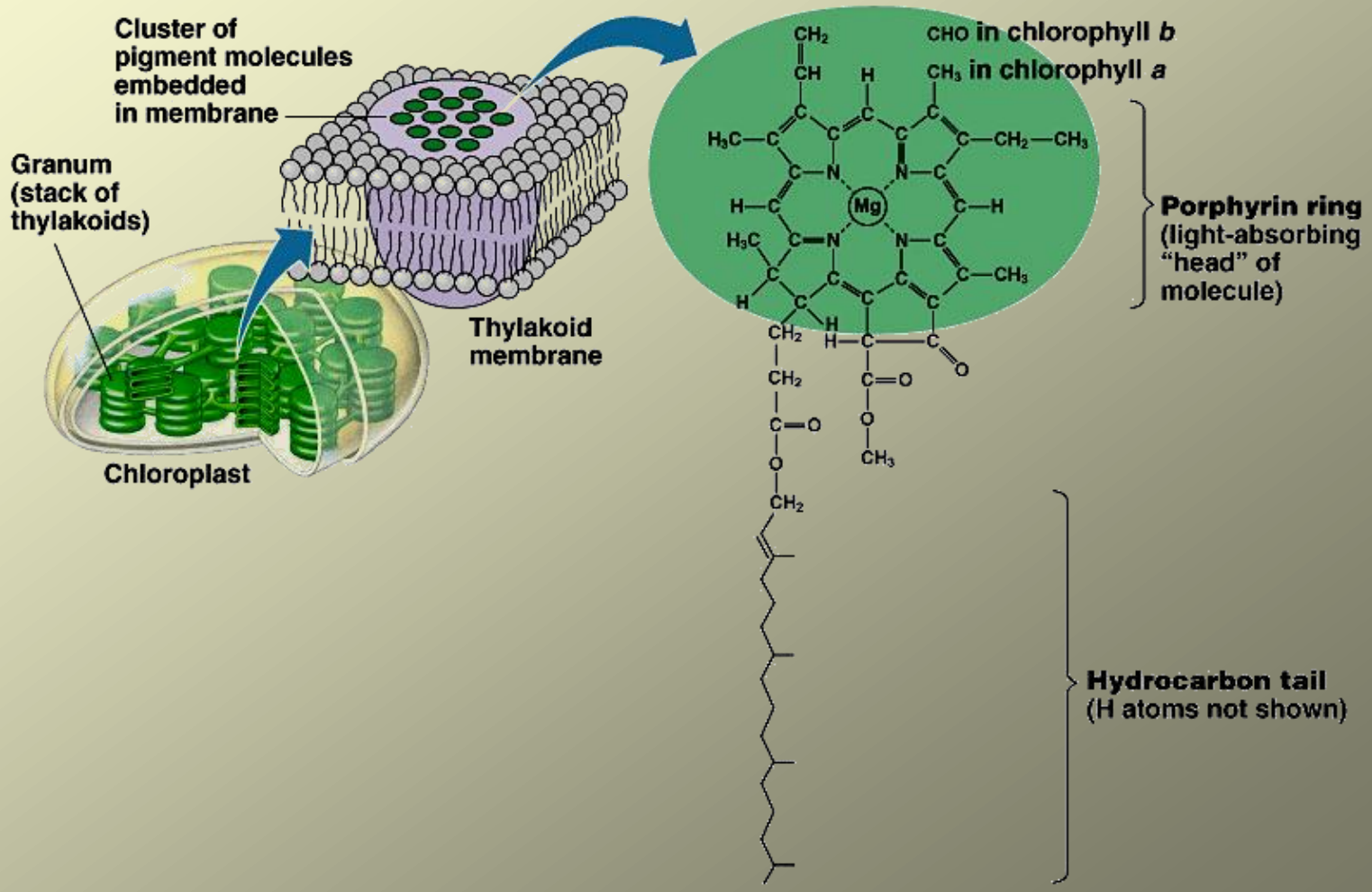
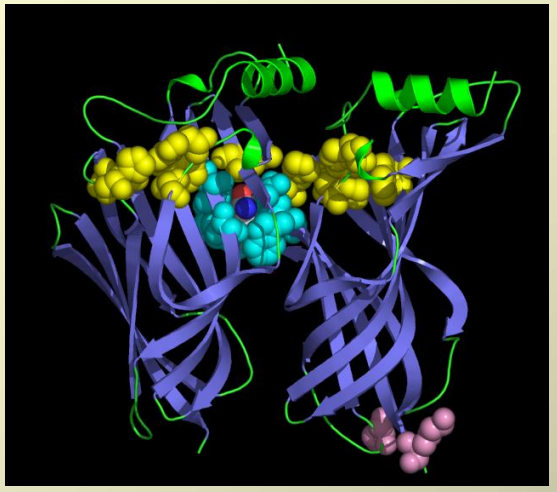
Chlorophyllproteins



Cobamidproteins



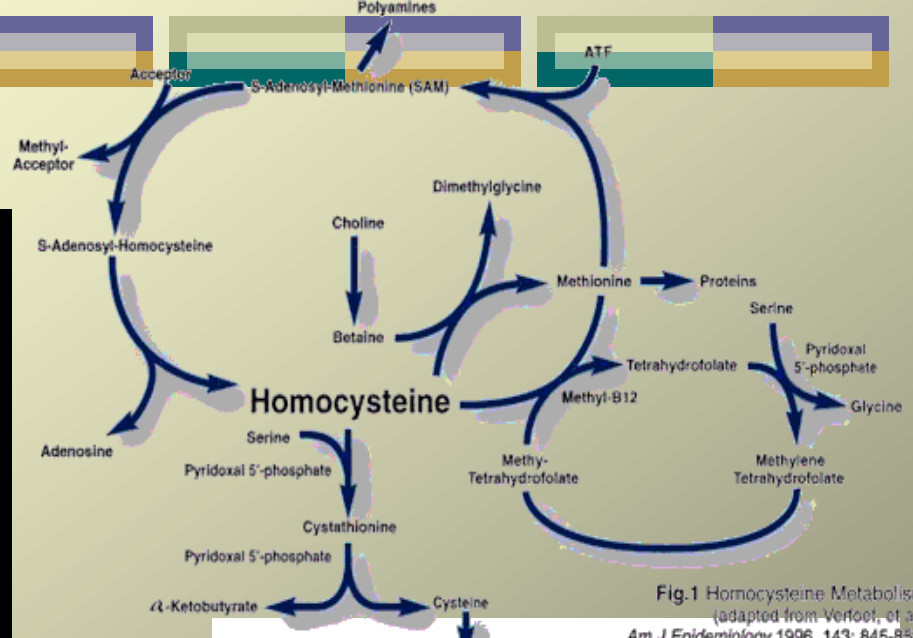
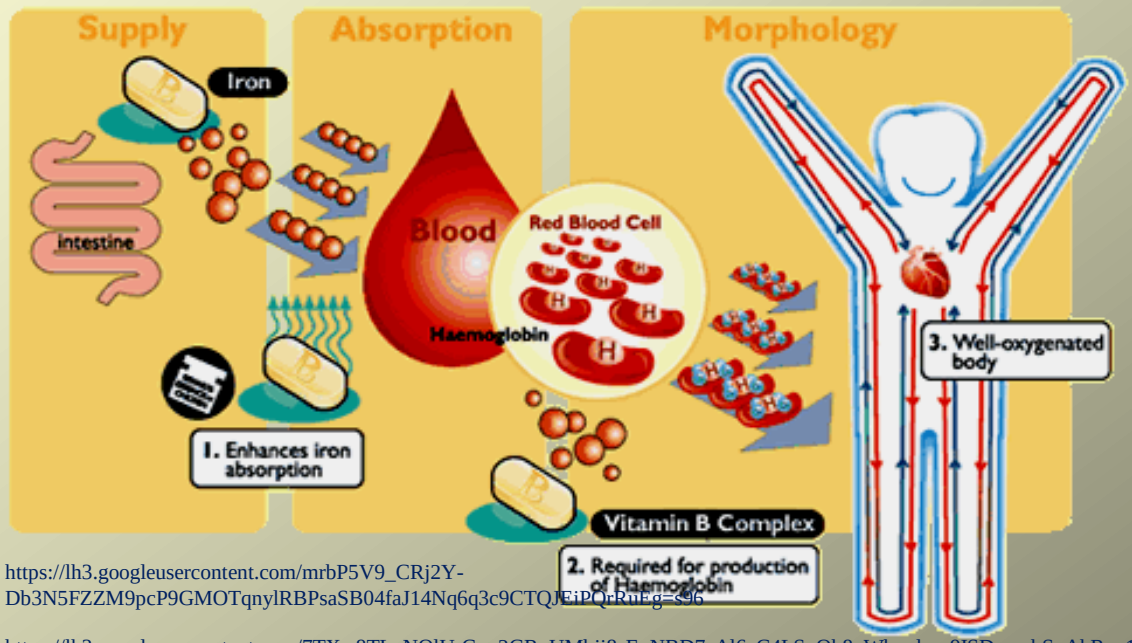
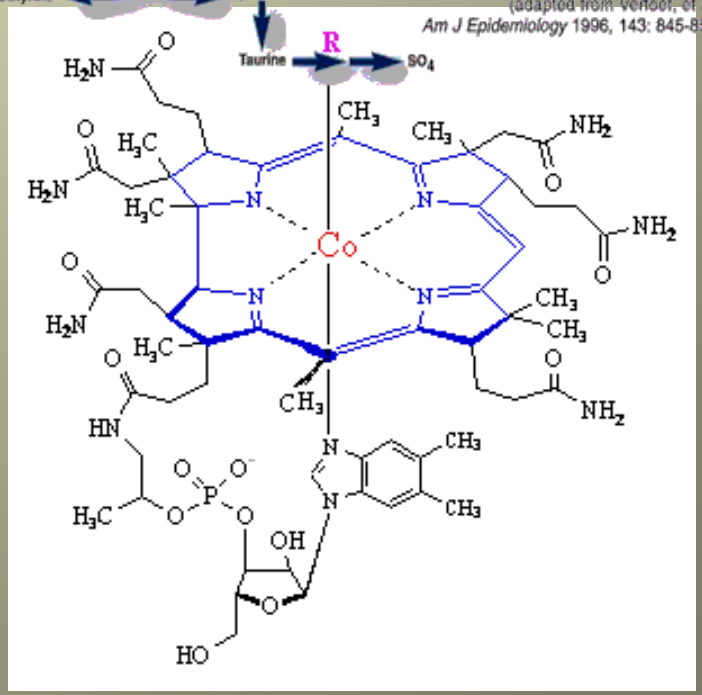


Fig.1 Homocysteine Metabolism (adapted from Verhoef, et al., *Am J Epidemiology* 1996, 143: 845-859)





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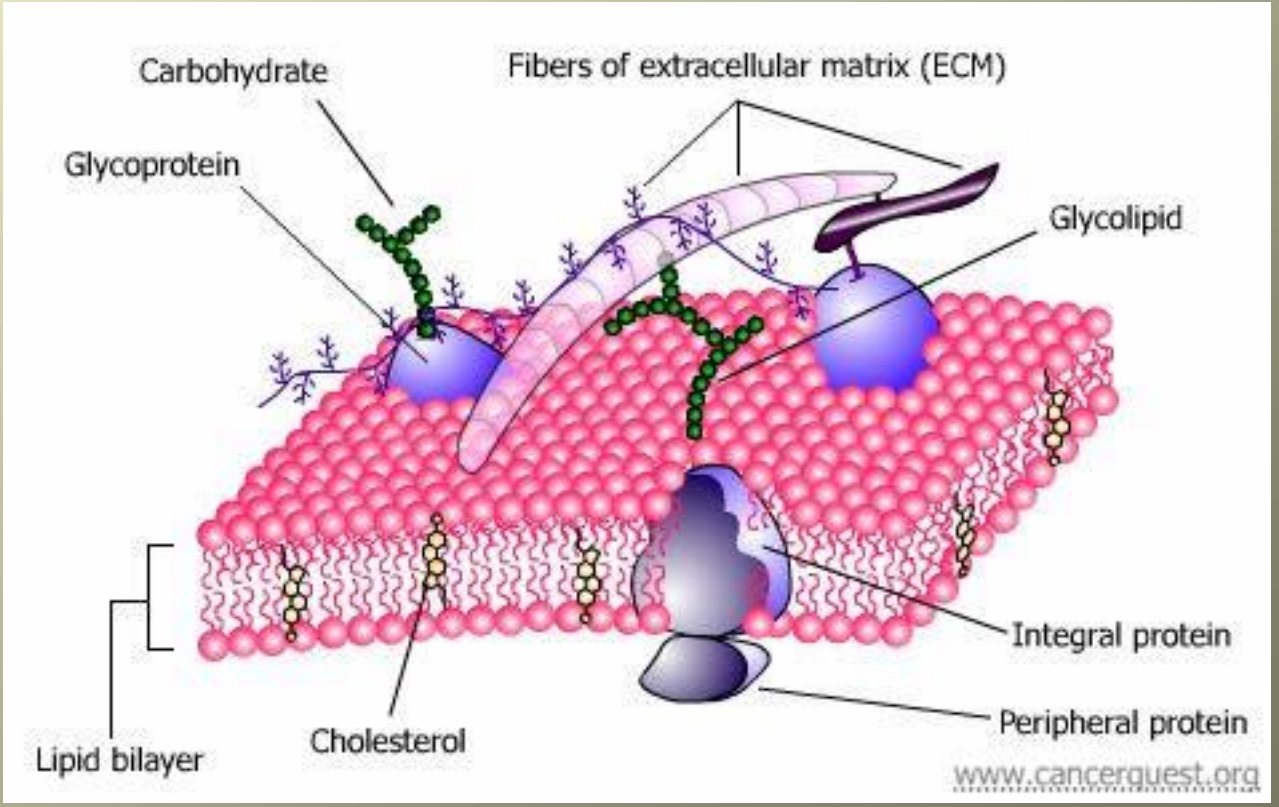
Glycoproteins

The carbohydrate chains covalently attached to glycoproteins are generally oligosaccharides of much lower molecular weight than the proteoglycans. The carbohydrate portion commonly constitutes from 1% to about 70% of a glycoprotein by weight, and never 99% as in the proteoglycans.

Glycoproteins are a diverse group of molecules that are ubiquitous constituents of most living organisms.



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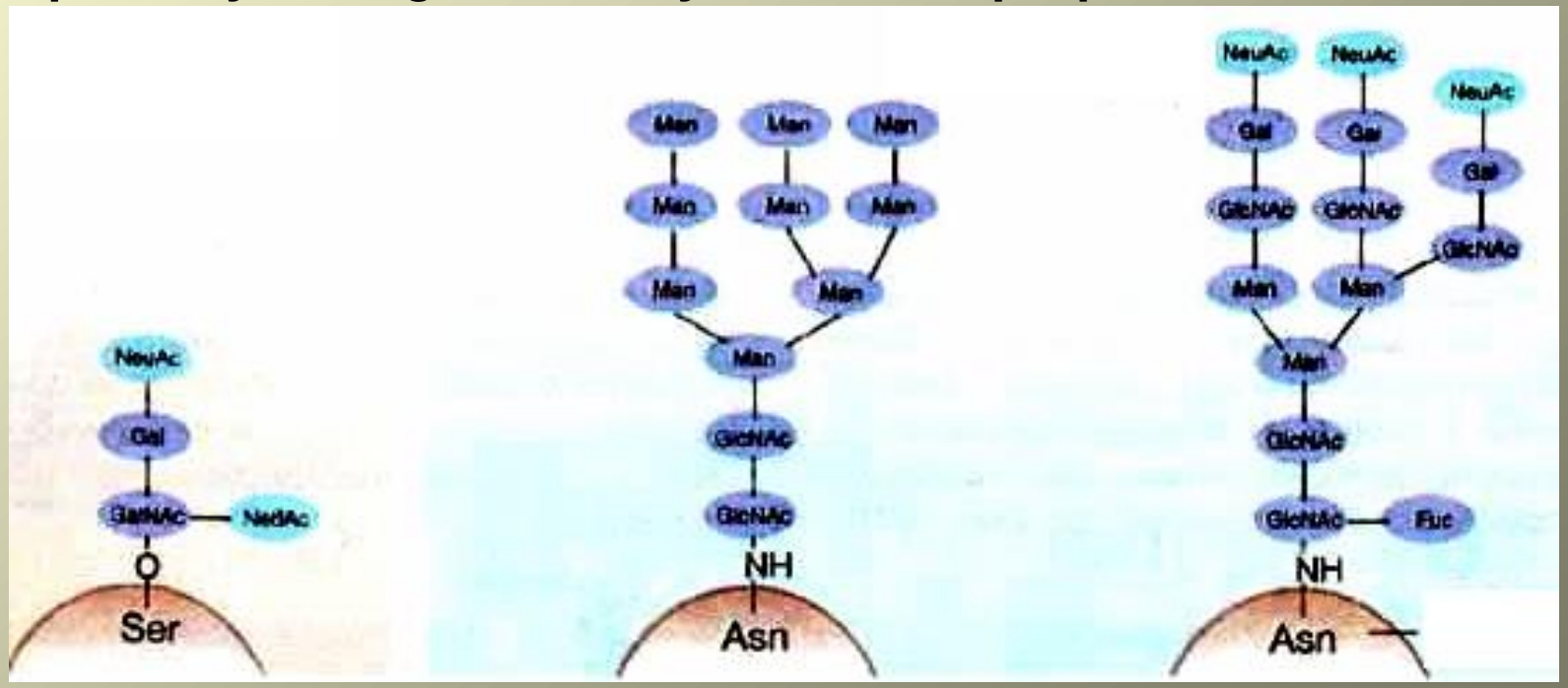
- Complex recognition phenomena such as cell-molecule, cell-virus, and cell-cell interactions.

-Transport proteins (transferrin, ceruloplasmin)

- Number of hormones (follicle-stimulating hormone)

-Many enzymes (ribonuclease)

-Different properties: protection from denaturation, resistance to proteolysis, high viscosity, antifreeze properties.



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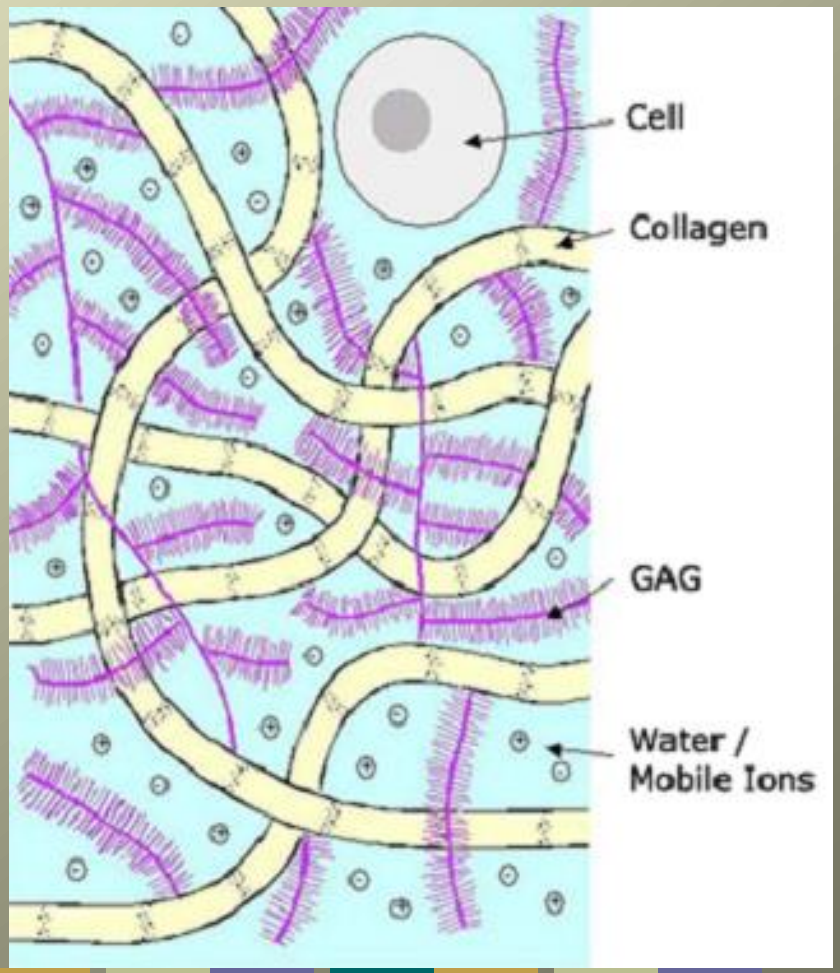
Proteoglycans

This molecules are found predominantly in the extracellular matrix of tissues.

All proteoglicans contain glycosaminoglycans (GAGs).

The specific GAGs of physiological significance are:
hyaluronic acid,
dermatan sulfate,
chondroitin sulfate,
heparin, heparan sulfate,
and keratan sulfate.



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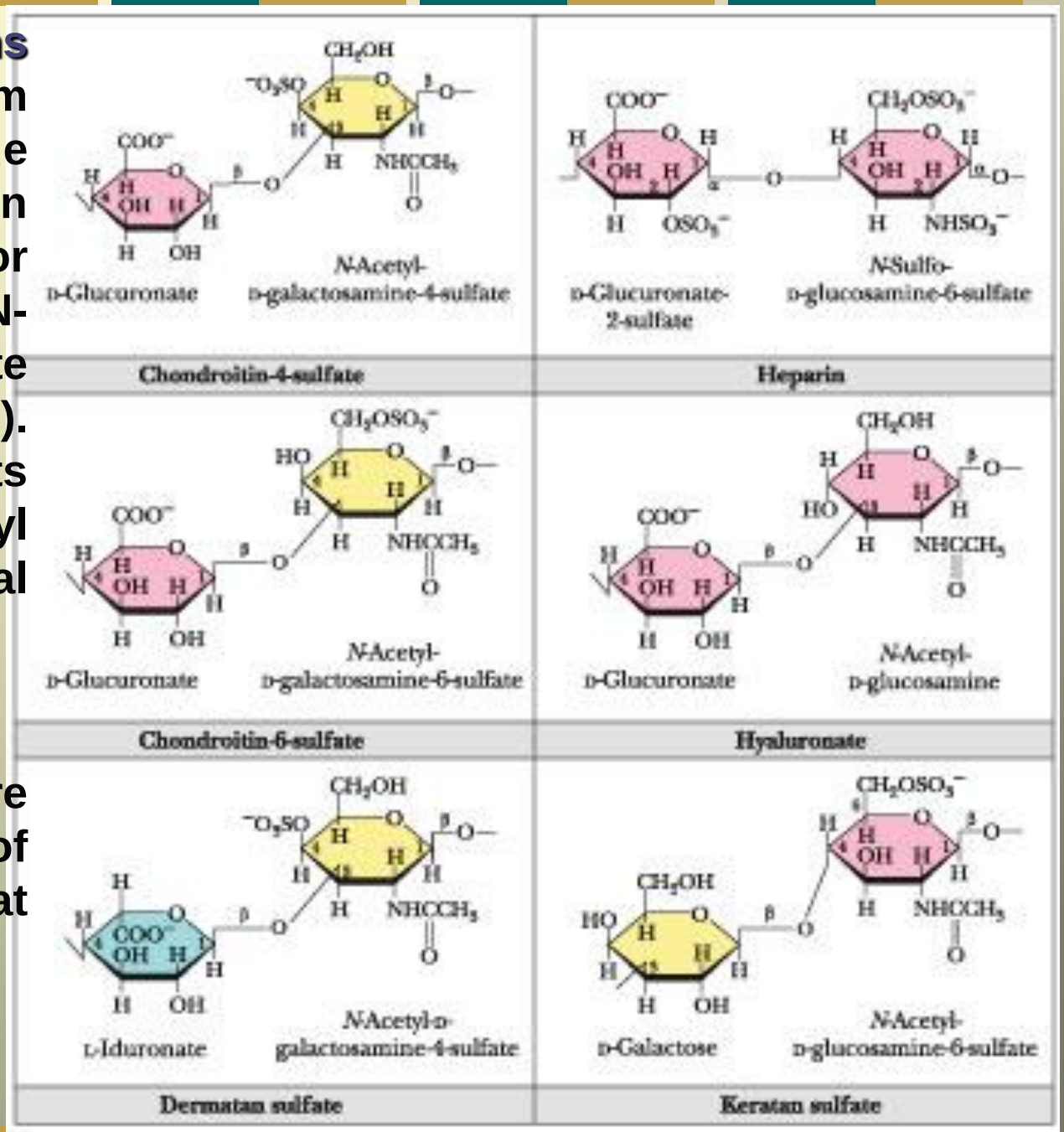
Glycosaminoglycans

are formed from repeating disaccharide arrays. This units contain a hexuronic acid (or uronic acid) and N-acetylhexosamine sulfate (or N-acetilglucosamine). Many disaccharide units contain both carboxyl and sulfate functional groups.

All the GAGs therefore have large numbers of negative charges at physiological pH.



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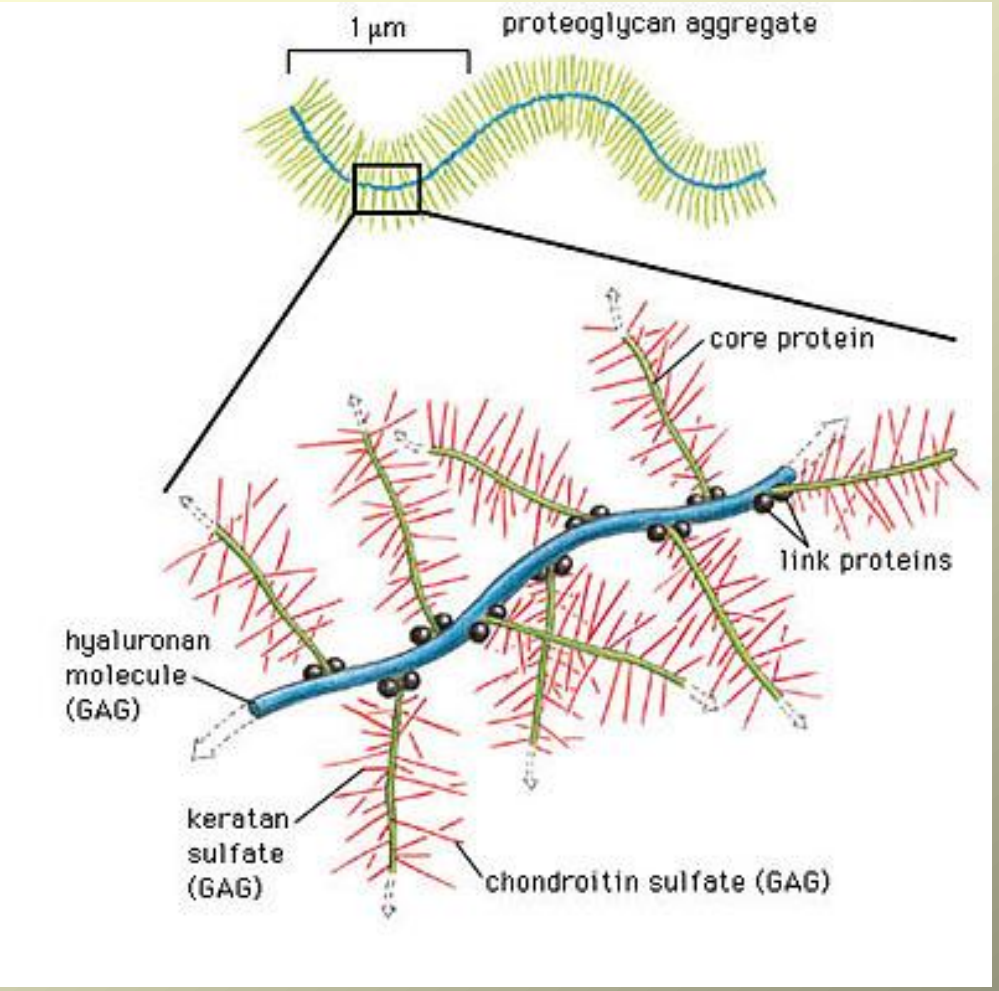
Along with the high viscosity of GAGs comes low compressibility, which makes these molecules ideal for a lubricating fluid in the joints. At the same time, their rigidity provides structural integrity to cells and provides passageways between cells, allowing for cell migration.



Hyaluronates are important components of the vitreous humor in the eye and of synovial fluid, the lubricant fluid of joints in the body.

The chondroitins and keratan sulfate are found in tendons, cartilage, and other connective tissue, whereas dermatan sulfate, as its name implies, is a component of the extracellular matrix of skin.

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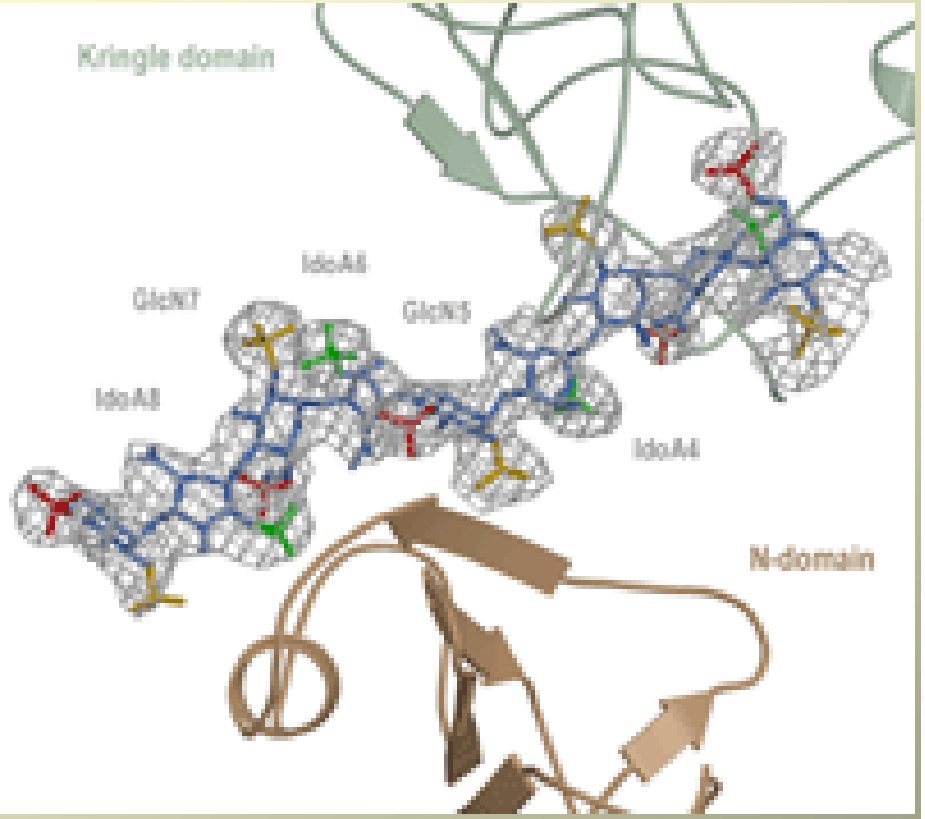
Heparin, is a natural anticoagulant substance. It binds strongly to antithrombin III and inhibits blood clotting.



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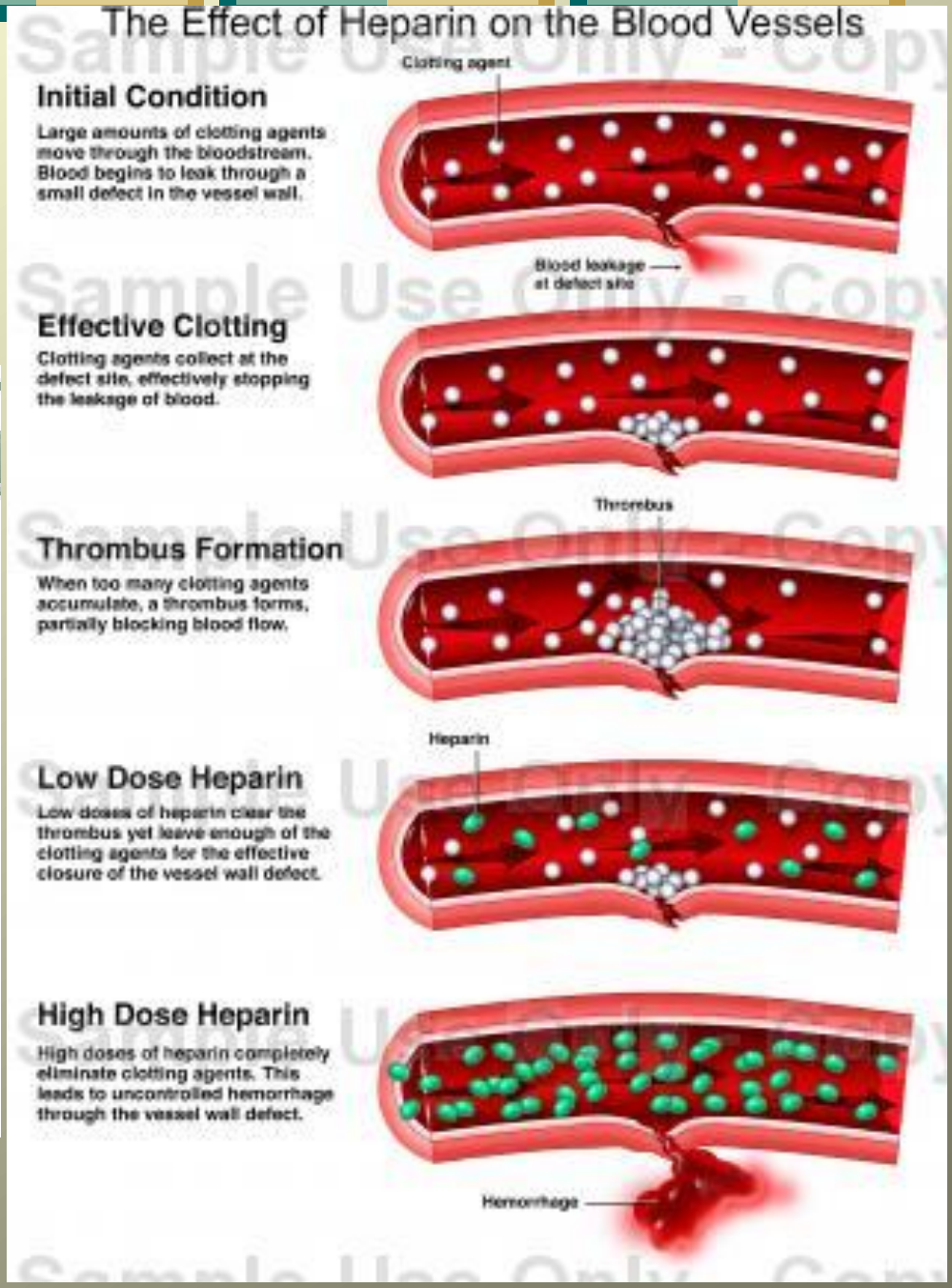
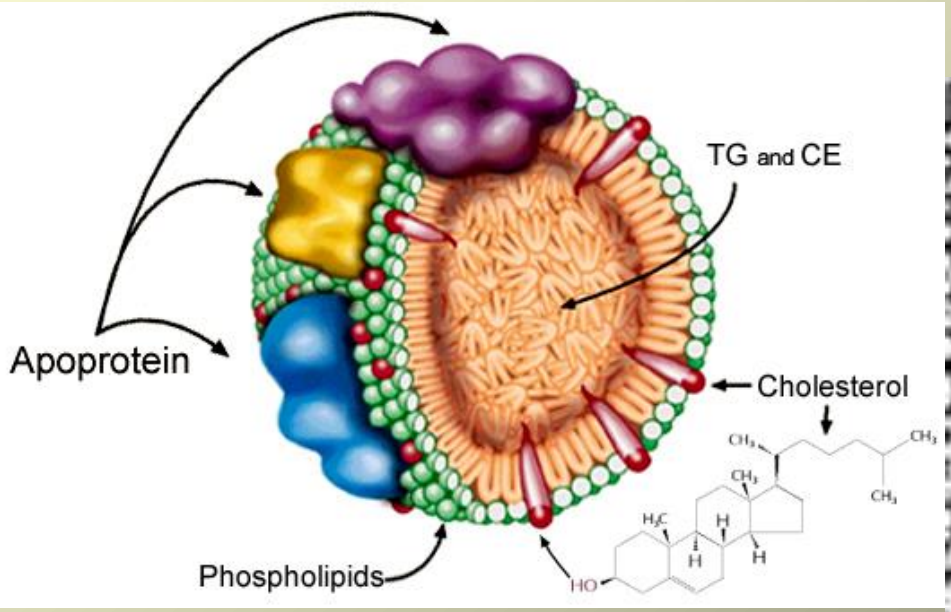


LIPOPROTEINS

group of molecular complexes found in the blood plasma of mammals.

Plasma lipoproteins transport lipid molecules (triacylglicerols, phospholipids, and cholesterol) through the bloodstream from one organ to another.



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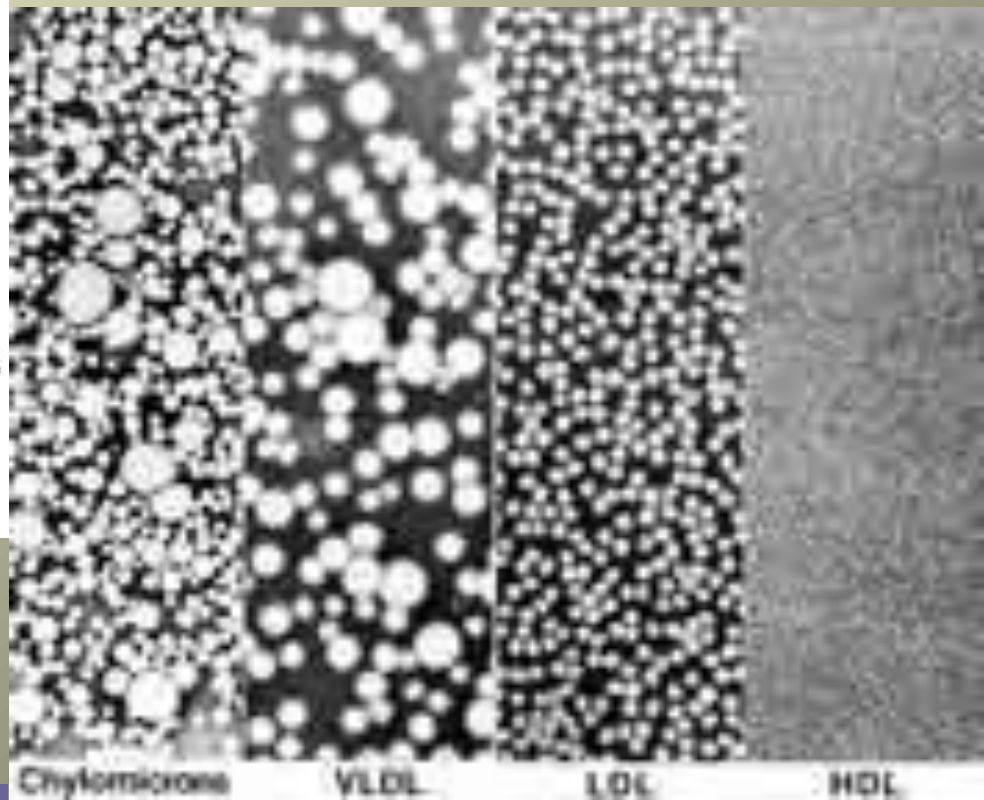
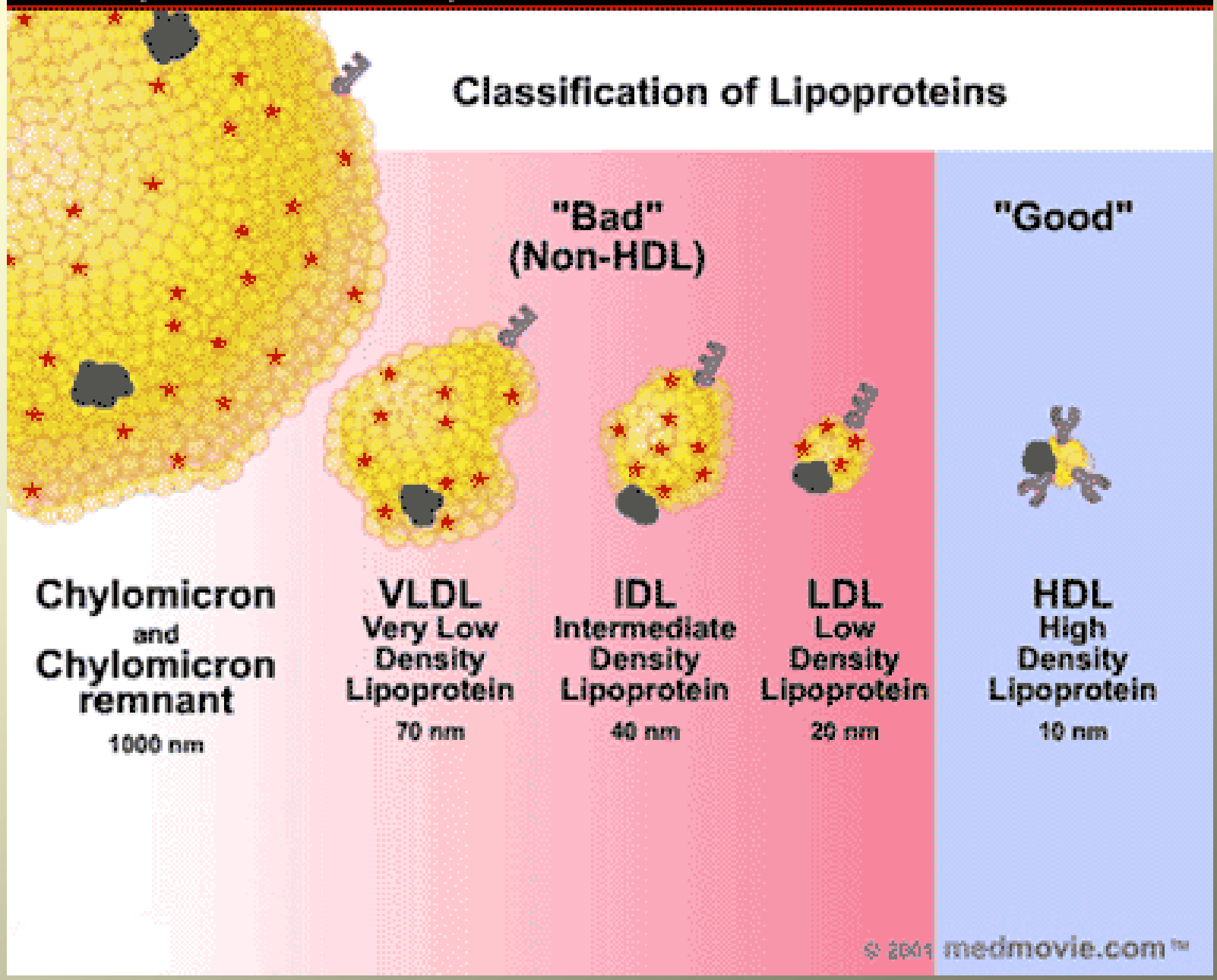
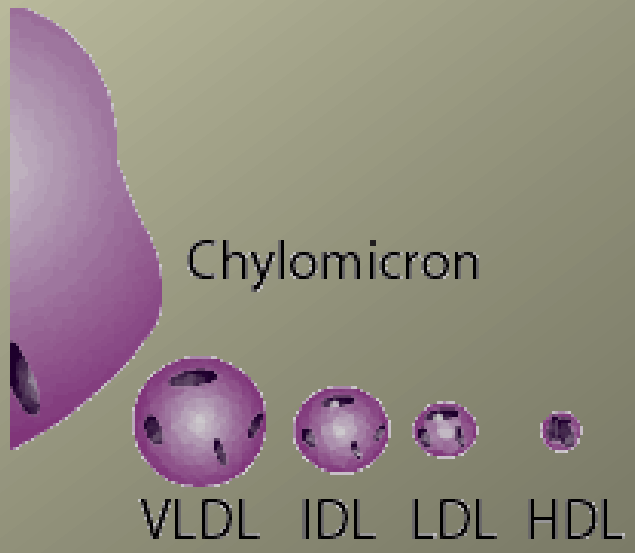


Classification of Lipoproteins



Lipoproteins differ in the ratio of protein to lipids, & in the particular apoproteins & lipids that they contain. They are classified based on their density:

- **Chylomicron** (largest; lowest in density due to high lipid/protein ratio; highest % weight triacylglycerols)
- **VLDL** (very low density lipoprotein; 2nd highest in triacylglycerols as % of weight)
- **IDL** (intermediate density lipoprotein)
- **LDL** (low density lipoprotein, highest in cholesteryl esters as % of weight)
- **HDL** (high density lipoprotein; highest in density due to high protein/lipid ratio)



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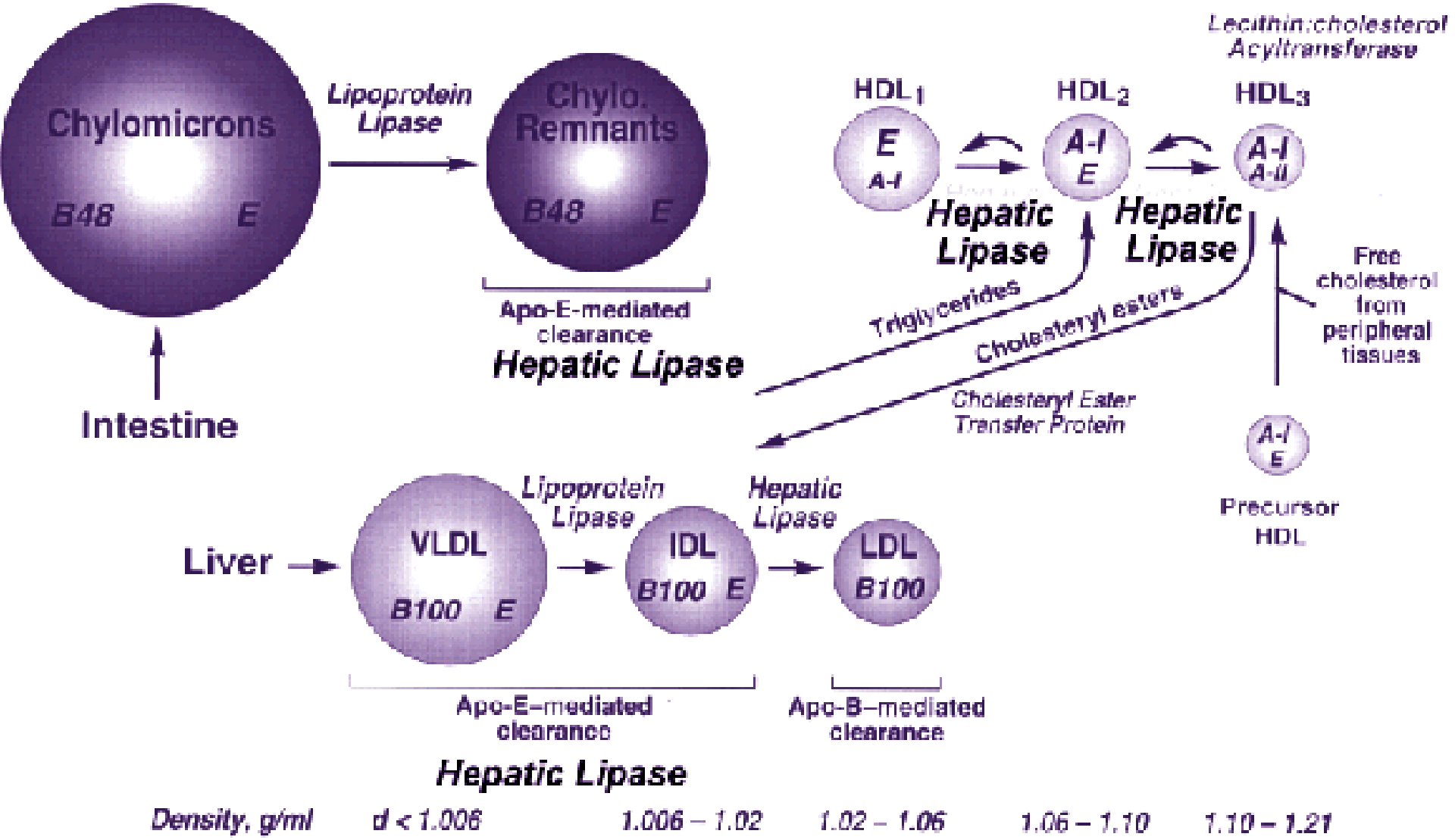

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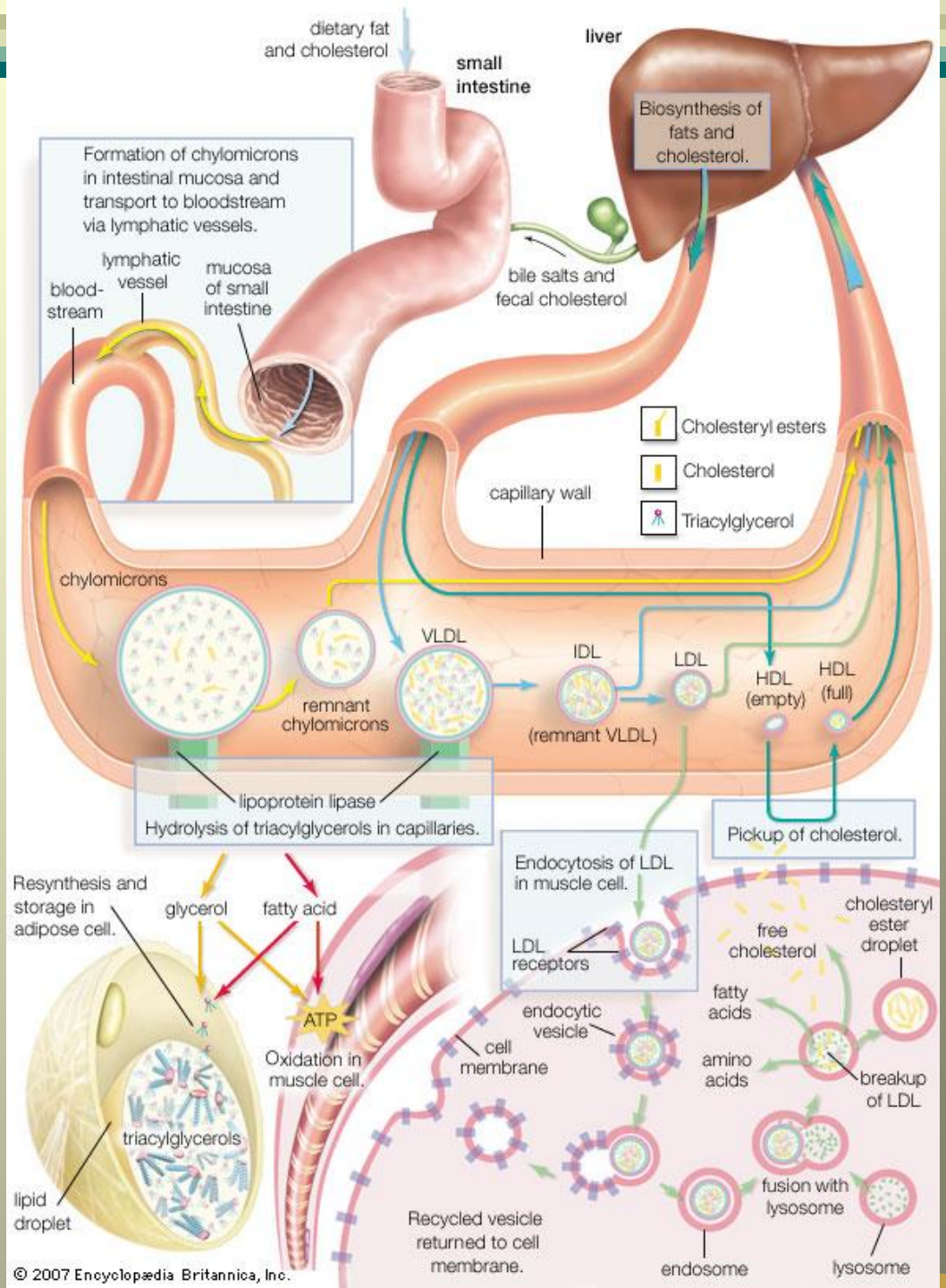

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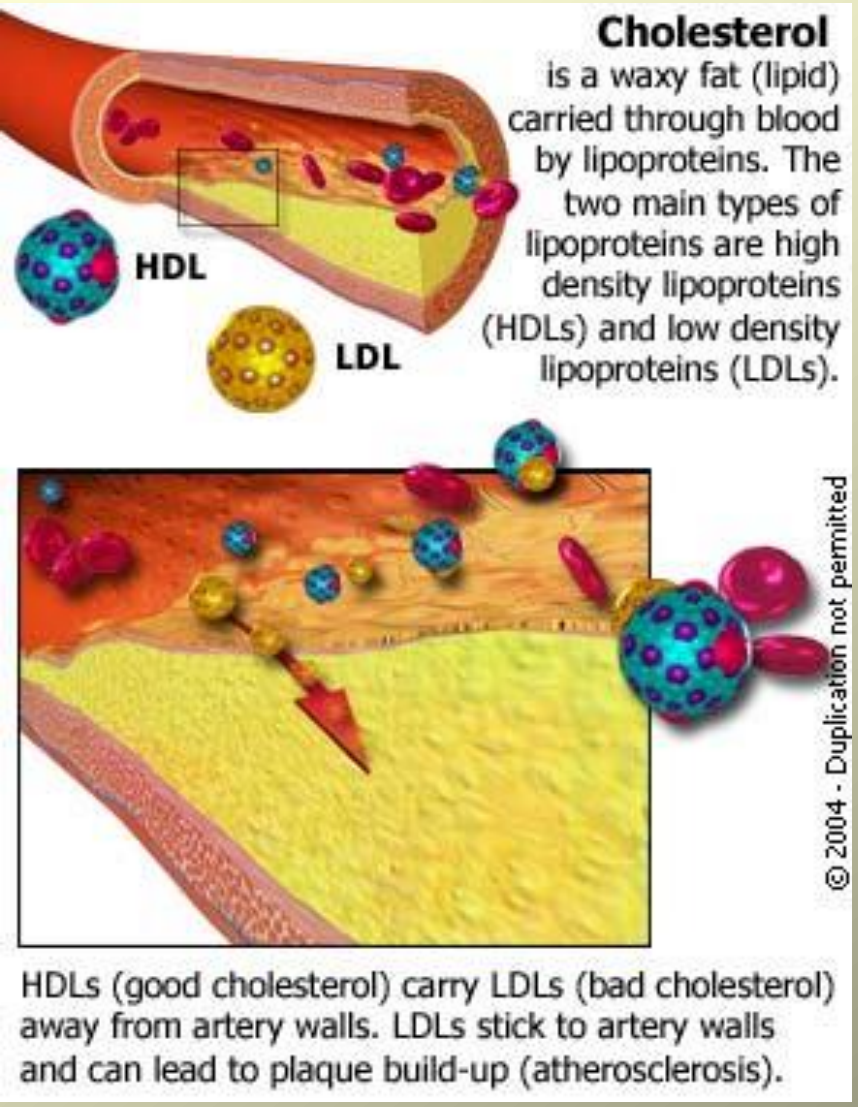
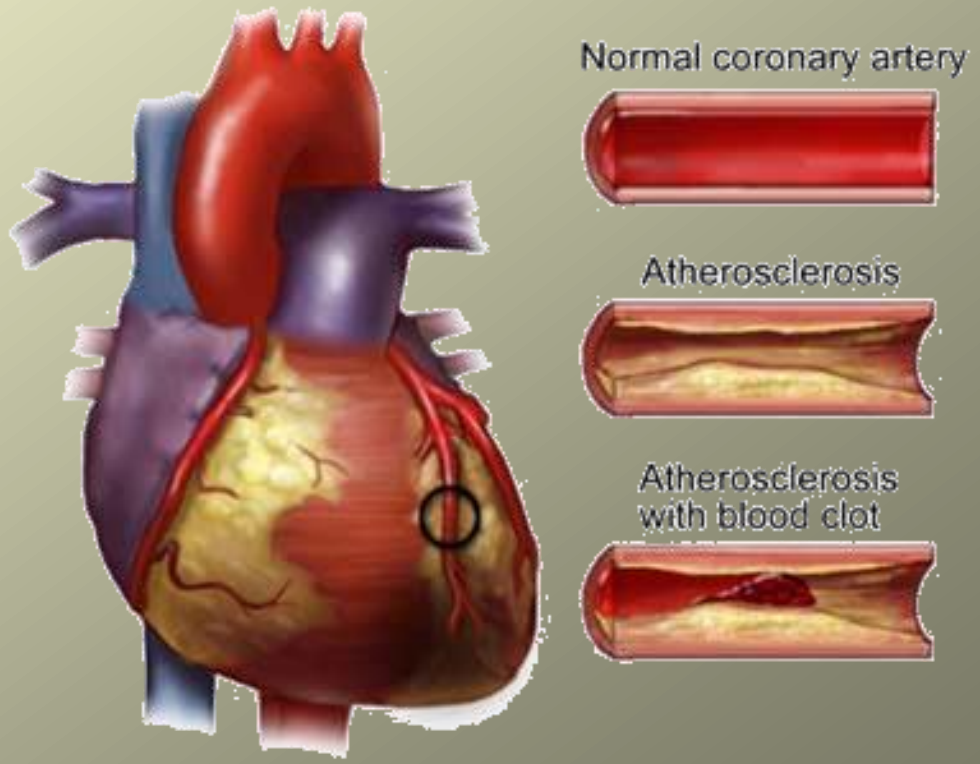
Lipoproteins and atherosclerosis



LDL и VLDL – atherogenic

HDL- antiatherogenic



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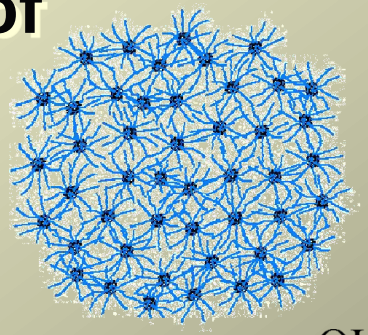
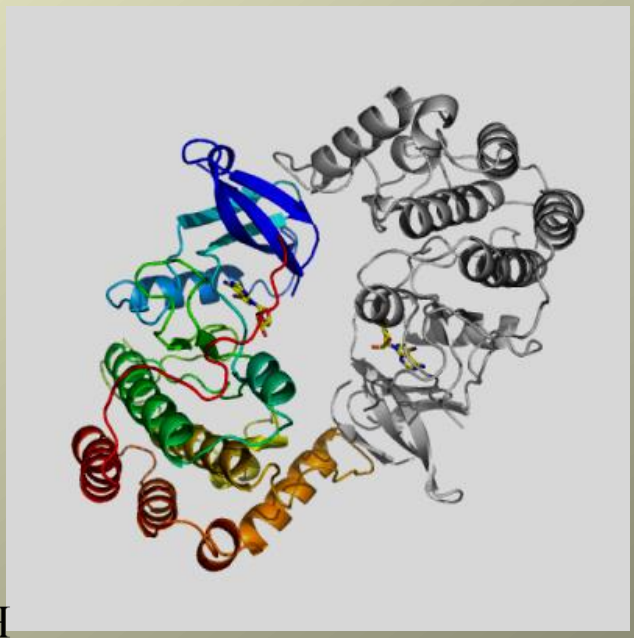
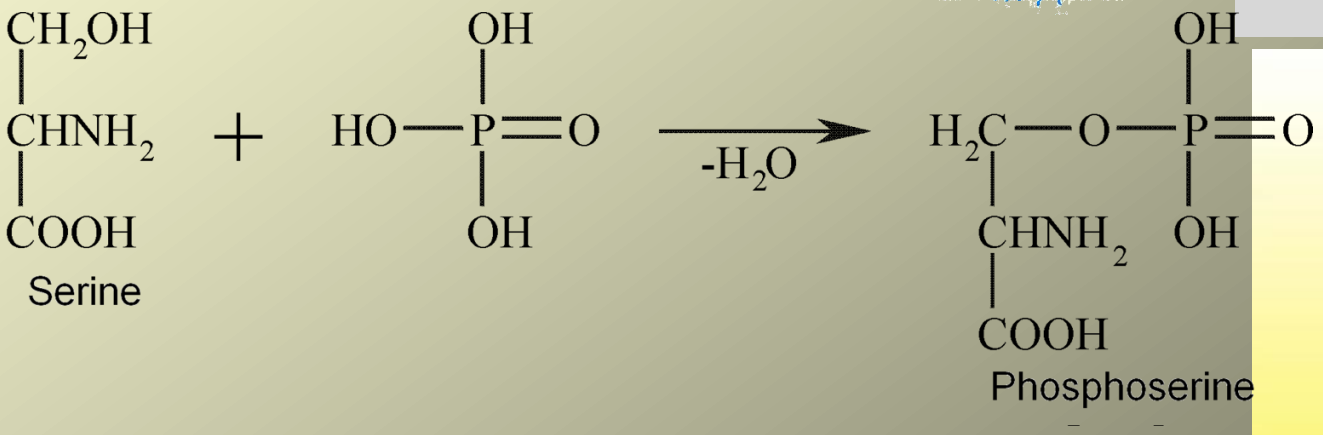
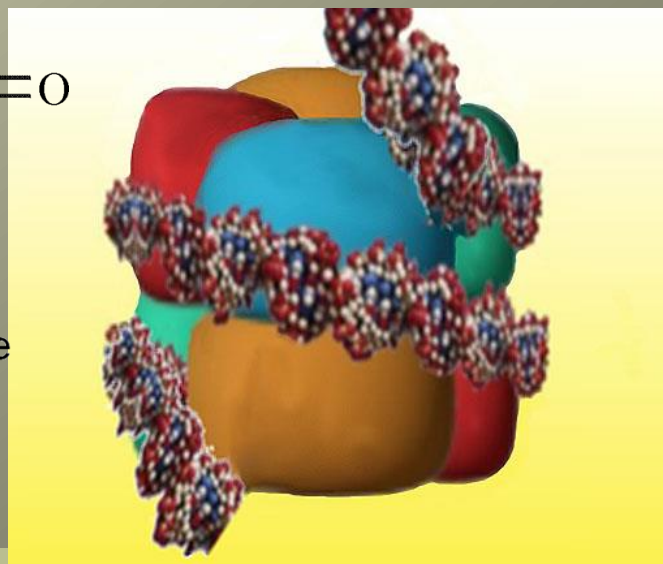
Phosphoproteins

1) Nutritious (casein)
2) Structural (histones)
3) Enzymes (regulation of the enzyme activity)









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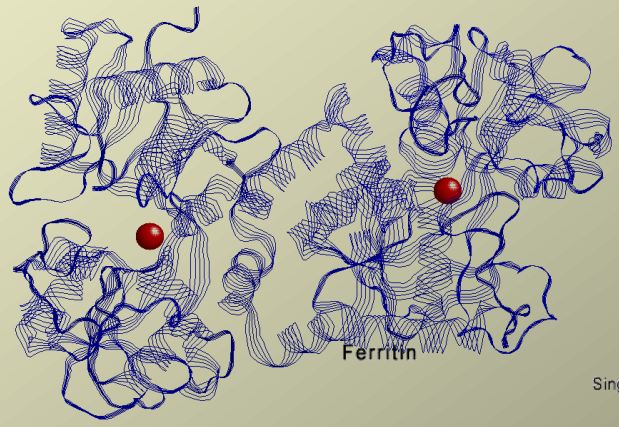
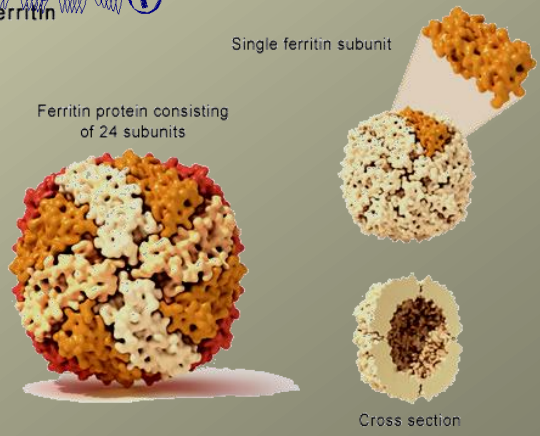
Metalloproteins

1) Transport (transferrin)

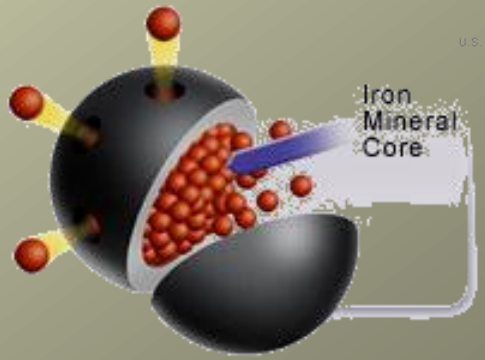


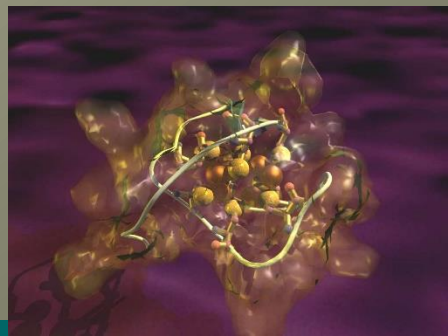
2) Storage (ferritin)



3) Enzymes (alcohol dehydrogenase)

4) Neutralizing





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Conclusions

1. Based upon the chemical composition proteins are divided into two major classes: simple proteins, which are composed of amino acids and additional organic and inorganic groupings.
2. Conjugated proteins include glycoproteins, which contain carbohydrates, lipoproteins, which contain lipids, chromoproteins, which contains pigments, etc.
3. In living organisms conjugated proteins serve a great mount of functions.

Do you have any questions?

Thank you for your attention!