◉Sheet ○Slides

Subject:	Biochemistry
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Number:	1

Plasma proteins:

Before talking about plasma proteins we have to define the plasma, so what is the plasma?

- Plasma is the Liquid substance of the blood where the cells are suspending and is composed mainly from water.
    - in any blood sample we have (plasma + RBCs + WBCs + platelets)

Plasma proteins are found in the plasma 😮 so how can we get the plasma out from any blood sample?

- **By centrifugation:** molecules are separated (sediment) depending on their densities, shapes, sizes and the speed of the centrifuge. (Plasma will be above the cells and the platelets)
- Leaving the blood sample in a test tube for a while will lead to sediment the RBCs with the WBCs which called **hematocrit** (the packed cell volume)

☆ if you have a blood sample and you let it sediment by its own or by centrifugation you will have 2 parts (cellular part and liquid part) The cellular part is about 45% of the blood sample volume (47% in males, 42% in females)

☆ The rate at which red blood cells sediment in a period of one hour is called **erythrocyte sedimentation rate ESR**.

- The **ESR** for a 100mL normal blood sample is 1 hour.

- ESR can be used as a diagnostic value for many assays and diseases (it is not specific for a certain disease)

Higher ESR will lead to shorter time to sediment the RBCs. and this can be in a diagnostic value (if there is an inflammatory process / pregnancy the ESR will increase)

Different components of the blood: -

- Cellular part (platelets, RBCs, WBCs)
- Liquid part (plasma)
    - In the plasma we can find almost everything; anything you obtain from the outside it reaches the tissue through the blood (through the plasma) and anything in the tissue should be secreted through blood (through the plasma).
    - Amino acids, nutrients, proteins, nitrogenous wastes, gases, electrolytes, organic and inorganic molecules. All of these can be found in the plasma but we will focus on plasma proteins.

Plasma is composed mainly from water (92% of the plasma sample is water and 8% is solid [the organic and inorganic materials]).

- The main component of these solids is plasma proteins.

Plasma proteins: -

- **The normal concentration of the total plasma proteins is 6-8 g/dl. 1dl = 100 ml**

- Simple & conjugated proteins (glycoproteins & lipoproteins).
- Organic.
- More than 500 plasma proteins have been identified.
- **Plasma proteins: Albumin, Globulins & Fibrinogen**

☆ after we extract the plasma from the blood sample (by centrifugation or left it to sediment by its own) how can we separate the plasma proteins from each other?

- By using purification techniques (we should know the structure the shape and the charges of the plasma proteins).

☆ We have two techniques which are used to separate plasma proteins from each other: -

- **<u>Salting out</u>:** when we add high concentration of salt (ammonium sulfate), the salt will compete with the protein for the water molecules because it has a better solubility, so the proteins lose their attachment with water (their solubility in water decreases), thus the hydrophobic parts of the proteins will attach to each other and precipitate. Crude technique >> proteins of the same solubility precipitate at the same time.

  ☆ the results are in 3 major groups (Albumin, **Globulins & Fibrinogen)**

- **<u>Electrophoresis</u>:** in this technique, proteins are moving according to their shape, size and molecular weight. (as we have fibrinogen in the plasma {which causes clotting in the blood sample, and it is a very big molecule and it is hard for it to move freely within the gel, and it affect other proteins movement in the gel. Figure 1} we have to get rid out of the fibrinogen and other clotting factors from the plasma in order to do the electrophoresis on the plasma sample.

  ☆ **the plasma sample which has no fibrinogen or clotting factors in it is called <u>serum</u>**
  So the serum is a defebrinated plasma.

  So, the proteins in the serum (plasma without fibrinogen) will move in the gel according to their molecular weight (SDS-PAGE technique) from the negative electrode to the positive electrode. figure2
  The fastest protein is the one with lowest MW >> albumin

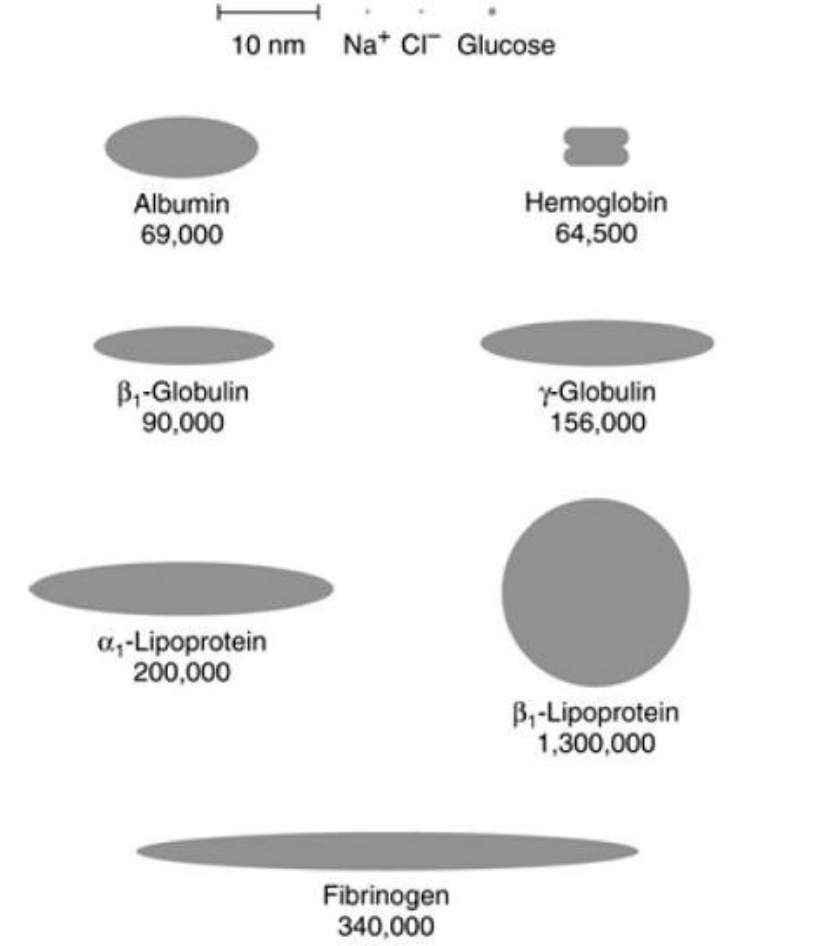


figure 1

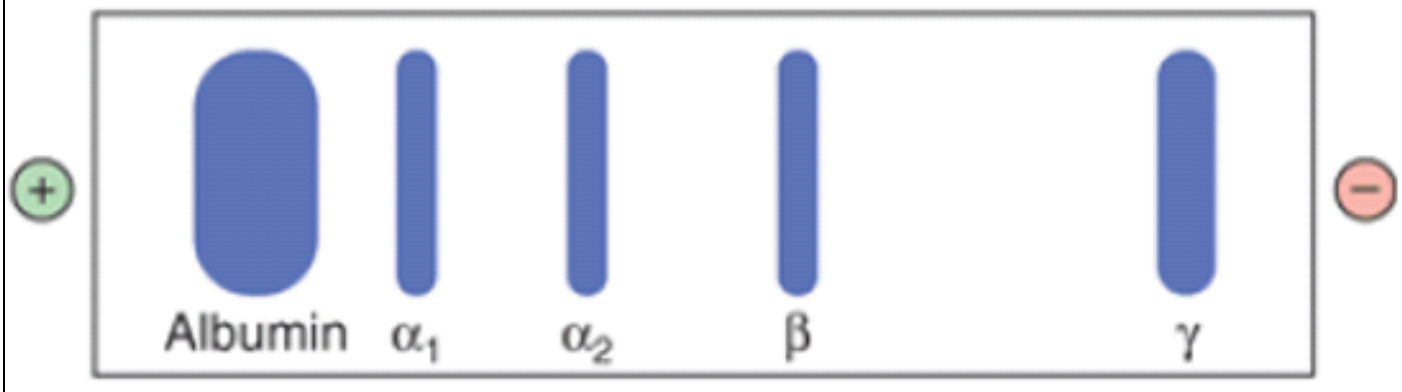


Figure 2

☆ **in this technique we have five bands (albumin, α1, α2, β, and γ). The α β γ** are all globulin proteins.

By looking at figure 2 we can conclude that:

- Number of different bands indicates the number of different proteins.
- The size of the band indicates the concentration of the protein.
- Albumin is the main component of the plasma proteins

☆**Densitometer**: is a scanner can detect how much quantity you have in each band (by calculating the density of each band in the gel) after that you end up by having the densities represented as peaks.

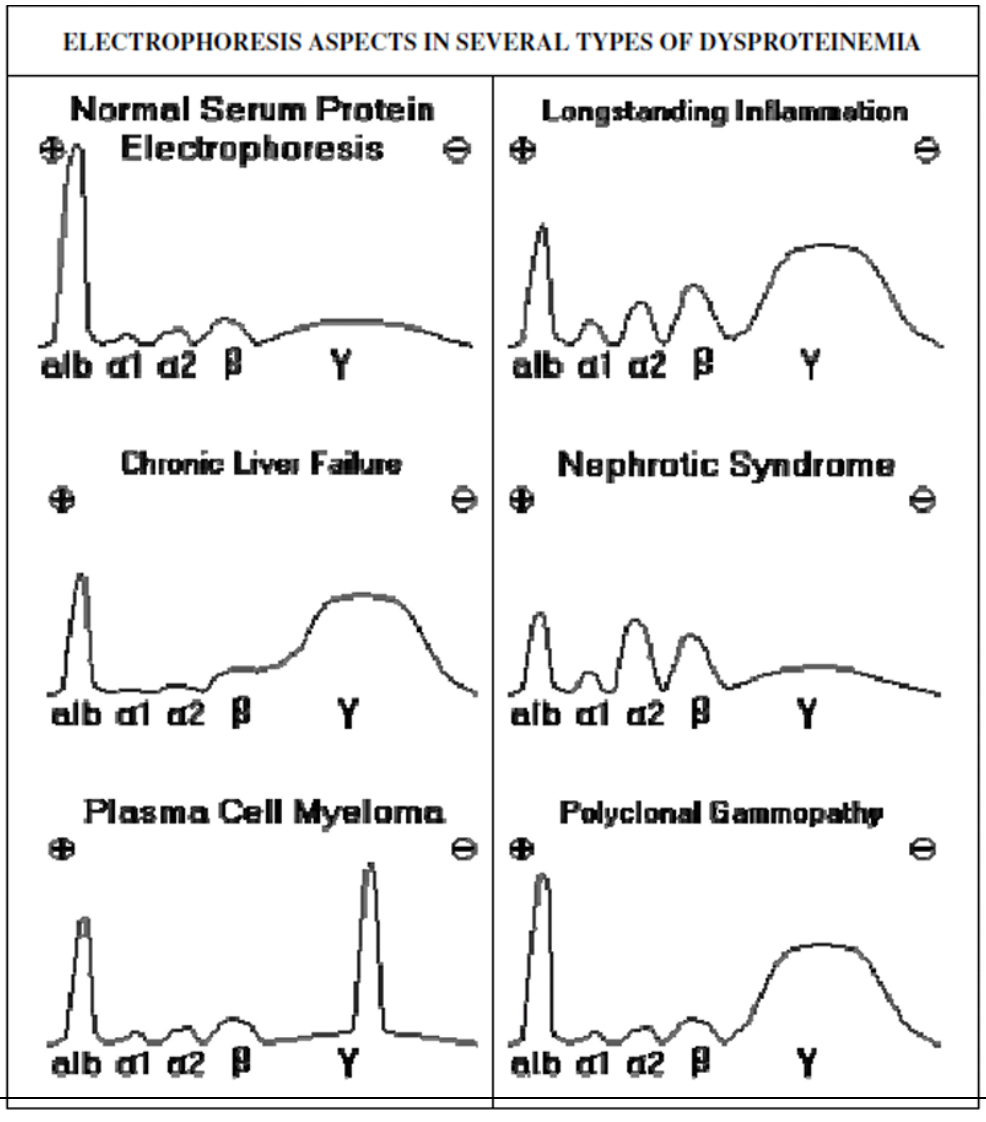


Figure 3

When you look at the normal serum protein electrophoresis in figure3 you can conclude that:

- Albumin has the lowest MW >> close from the positive electrode
- Albumin has the highest concentration >> highest peak

We have proteins in the alpha 1 band, alpha 2 band, beta band, Gama band, all of these are globulin proteins

• the Gama globulins are the antibodies (immunoglobulins), and they have the highest MW

☆ Globulins (3 bands):

• α band:

• α1 region consists mostly of α1-antitrypsin, **inhibits trypsin** (protease).

• α2 region is mostly haptoglobin, α2-macroglobulin, & ceruloplasmin

• β band: transferrin, LDL, complement system proteins

• γ band: the immuno-globulins

☆ Albumin is the main component of the plasma proteins (50% - 60% of the total plasma proteins)

☆ Remember that **the normal concentration of the total plasma proteins is 6-8 g/dl, so the normal concentration of the albumin is 3.5-5 g/dl.**

☆ **all of the plasma proteins are synthesized in the liver except the immunoglobulins which are synthesized by the plasma cells (the mature form of B-lymphocytes) in bone marrow, lymph nodes and spleen.**

›› if someone has liver failure then all of plasma proteins concentration will decrease except for immunoglobulins (the concentration stays normal and may increase). Figure 3

›› in inflammatory processes the concentration of the immunoglobulins increases. Figure 3

››if someone has deficiency in immunoglobulins then the concentration of them will decrease

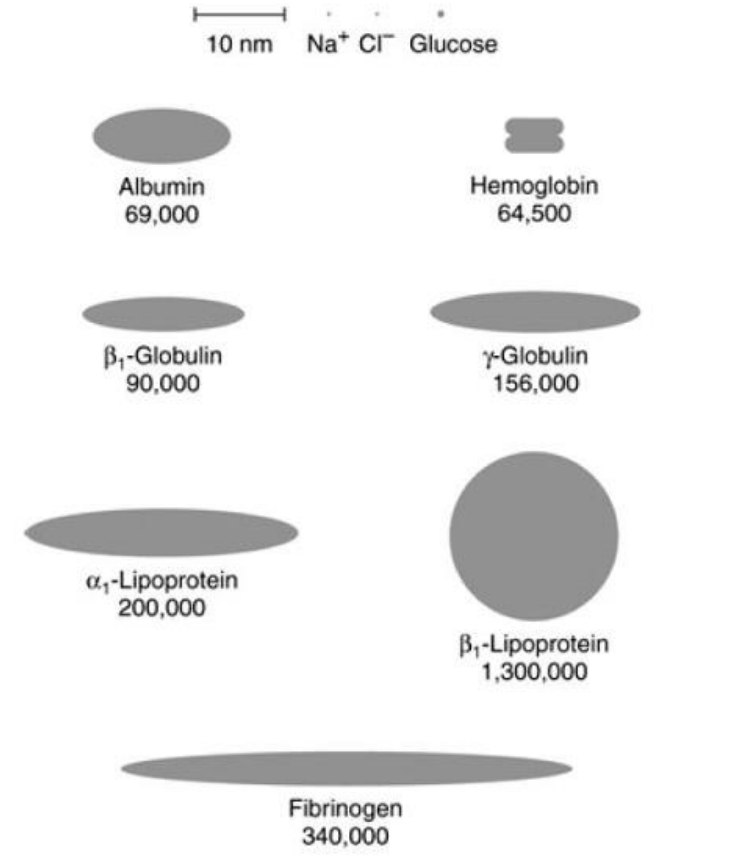
›› in case you have kidney failure (the kidney filtrate and reabsorb) then the proteins are excreted with the urine thus the concentration of albumin and globulins proteins will decrease. Figure 3 Nephrotic syndrome.

›› in the case of cancer affecting the plasma cells then the Gama band will increase sharply more than the other bands (very high peak). figure 3

☆ **plasma proteins are synthesized as immature plasma proteins (inactive state)** Why?

We need them to be prepared for the work, also because they are synthesized in one place and transport to different place, the action place. (they have to be transported form the liver to the plasma and they take short time to be synthesized and excreted, about 0.5 hour to many hours).

☆ Most of the plasma proteins are glycoproteins (connected to carbohydrates) [the importance is to increase the solubility for the protein to move in the plasma and to <u>increase the viscosity of the watery media</u>] except for albumin; because we have high amount of the albumin protein and if it was glycosylated it will increase the viscosity too much thus it is hard for the blood to move.



The shape of the albumin is oval while the fibrinogen is stretched.

What will happen if the albumin was stretched in shape?

If the albumin was stretched in shape it will have high surface area >> high solubility in water >> higher viscosity.

Sorry for any mistakes ☺☺