*Al-Rasheed University College*
*Department of Dentistry*
*2st Stage*

# PRACTICAL BIOCHEMISTRY

## lab 9
## Total Protein

# Total Protein

***Plasma proteins*** are proteins present in blood plasma. They serve many different functions, including transport of lipids, hormones, vitamins and minerals in the circulatory system and the regulation of a cellular activity and functioning of the immune system. Other blood proteins act as enzymes.

***Serum total protein*** is a biochemical test for measuring the total amount of protein in blood plasma or serum, protein in the plasma is made of Albumin and Globulin (which is made of $\alpha_1$ , $\alpha_2$ , $\beta$ and $\gamma$).

***Serum albumin*** accounts for 55% of blood proteins, and is a major contributor to maintaining the osmotic pressure of plasma to assist in the transport of lipids and steroid hormones.

***Globulins*** make up 38% of blood proteins and transport ions, hormones, and lipids assisting in immune function.

***Fibrinogen***; conversion of fibrinogen to insoluble fibrin is essential for blood clotting.

The remainder of the plasma proteins are regulatory proteins, such as enzymes, proenzymes, and hormones. ***All blood proteins are synthesized in liver except for the gamma globulins.***

*High blood protein is not a specific disease or condition in itself*. It's usually a laboratory finding during the evaluation of a particular condition or symptom.

- ✓ For instance, although high blood protein is found in people who are dehydrated, the real problem is that the blood plasma is actually more concentrated.
- ✓ Certain proteins in the blood may be elevated as the body fights an infection or some other inflammation.
- ✓ People with certain bone marrow diseases, such as multiple myeloma, may have high blood protein levels before they show any other symptoms.

## *Normal range:*

- Normal range of total protein: 70 g/L
- Normal range of total albumin: 40 g/L

## Function of proteins:

Proteins are large, complicated molecules that are vital to the function of all cells and tissues. They are made in many places throughout the body and circulate in the blood.

1. Inflammatory response and control infection.
2. Antibodies (immunoglobulins) and the complement proteins from part of the immune system.
3. Transport: albumin and specific binding proteins transport many hormones, vitamins, lipids, bilirubin and drugs
4. Plasma proteins maintain the osmotic pressure of plasma.
5. Protein coagulation factors control hemostasis.

## Functions of various proteins:

☒ ***Albumin:***

1. Maintain the colloidal osmotic pressure.
2. Albumin also transports drugs, hormones, and enzymes.
3. Albumin measures the liver function. In liver diseases, its concentration will be markedly low when there is liver cell damage.

☒ ***Globulins:***

1. These are the main component of immunoglobulins (Antibodies).
2. Some are transporting proteins like thyroid and cortisol binding protein.
3. Haptoglobin binds hemoglobin during hemolysis.
4. They may also act as a transport vehicle.

### *Total Serum Protein:*

A total serum protein test measures the total amount of Protein in the blood it also measures the amounts of two major groups of proteins in the blood: albumin and globulin.

***Types:***

i. Albumin.
ii. α1-globulin (α1 antitrypsin)
iii. α2-globulin (haptoglobulin)
iv. β-globulin (transferrin, fibrinogen)
v. γ-globulin (Immunoglobulins)

☒ The Albumin / Globulin ratio is usually between (1.2 to 1.5).

## *Serum protein electrophoresis (SPEP)*

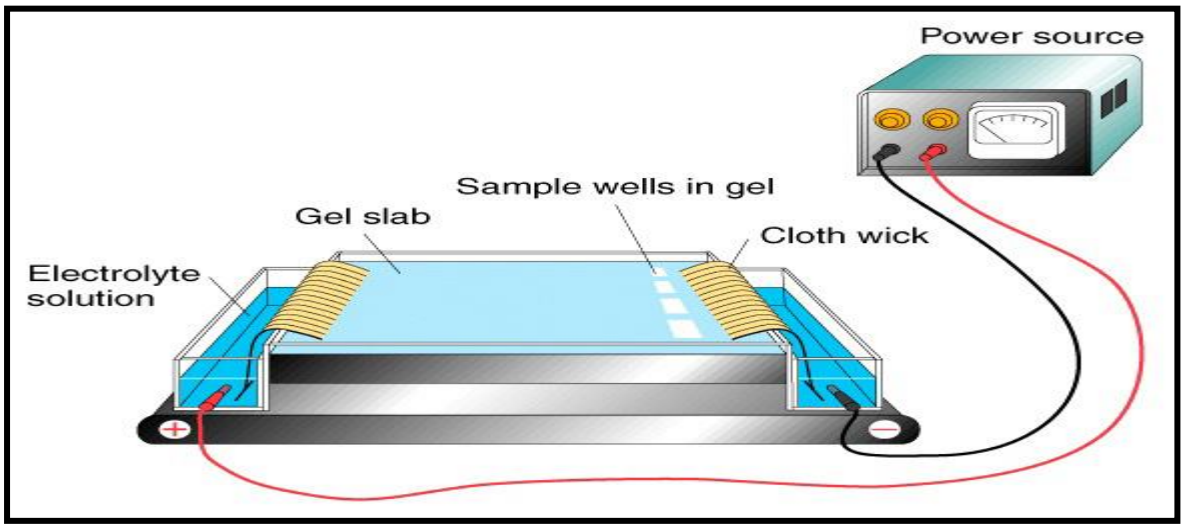
The serum protein electrophoresis (SPEP) test measures specific proteins in the blood to help identify some diseases. Proteins are substances made up of smaller building blocks called amino acids.

Proteins carry a positive or a negative electrical charge, and they move in fluid when placed in an electrical field. Serum protein electrophoresis uses an electrical field to separate the proteins in the blood serum into groups of similar size, shape, and charge.

Blood serum contains two major protein groups: ***albumin*** and ***globulin***. Using protein electrophoresis, these two groups can be separated into five smaller groups (fractions):

- ***Albumin***: Albumin helps carry some medicines and other substances through the blood and is important for tissue growth and healing. More than half of the protein in blood serum is albumin.
- ***Alpha-1 globulin***: High-density lipoprotein (HDL), the "good" type of cholesterol, is included in this fraction.
- ***Alpha-2 globulin***: A protein called haptoglobin, which binds with hemoglobin, is included in the alpha-2 globulin fraction.
- ***Beta globulin***: Beta globulin proteins help carry substances, such as iron, through the bloodstream and help fight infection.
- ***Gamma globulin***: These proteins are also called antibodies. They help prevent and fight infection. Gamma globulins bind to foreign substances, such as bacteria or viruses, causing them to be destroyed by the immune system.

Each of these five protein groups moves at a different rate in an electrical field and together form a specific pattern. This pattern helps identify some diseases.



## *Principle of Electrophoresis*

1. This is basically separation or migration of charged solutes of particles in liquid medium under the influence of electrical field.
2. Chemical substances carrying charges because of ionization moves towards either cathode (Negative electrode) or anode (Positive electrode). So, the protein ions (cation) moves towards the cathode, and negative ions (anion) moves towards the anode.
3. Serum Electrophoresis can separate the various components of blood proteins into bands or zones according to their electrical charge under the influence of electrical current.
4. Electrophoresis diagnoses monoclonal band.

- *These different bands have a different zone with characteristic presence of different proteins. e.g.*

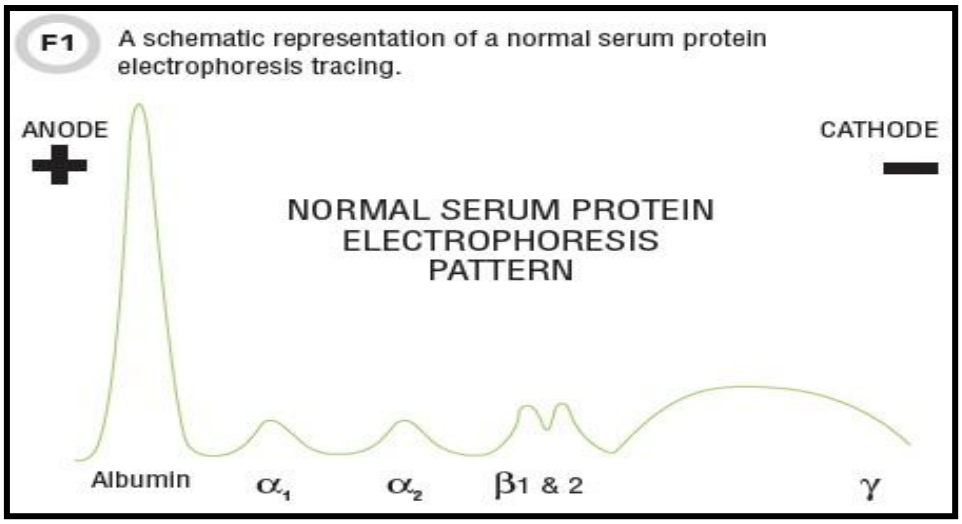
1. Albumin zone shows the only albumin.
2. alpha1- zone shows:

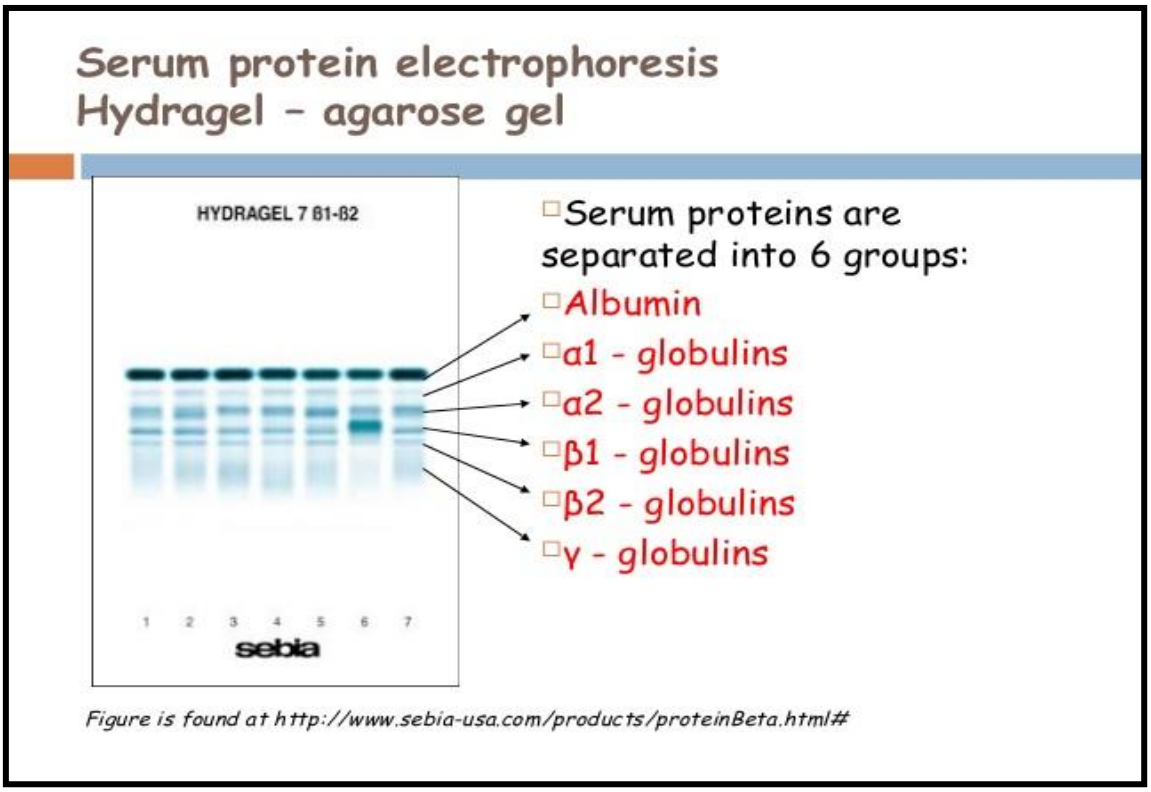
   *1-alpha1 – lipoprotein. 2-High-density lipoprotein. 3- Alpha 1-antitrypsin.*
3. alpha 2 zone shows:

   *1-alpha 2 macroglobulins. 2-Haptoglobin. 3- β-lipoprotein.*
4. beta zone shows:

   *1-Transferrin.*
5. gamma zone shows:

   *1-Fibrinogen. 2- IgA. 3- IgM. 4-IgG.*

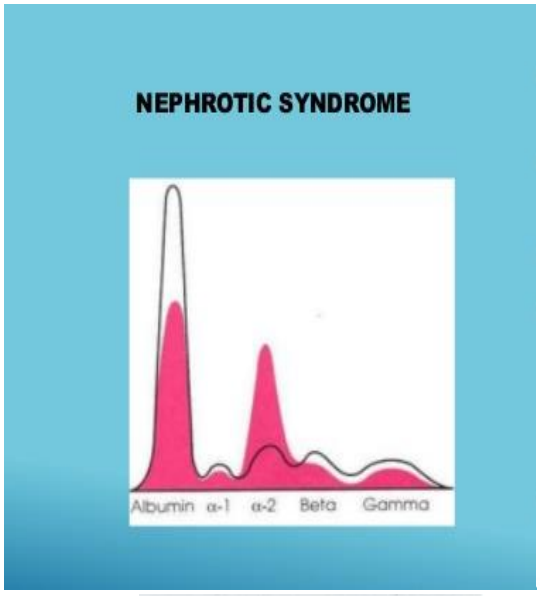


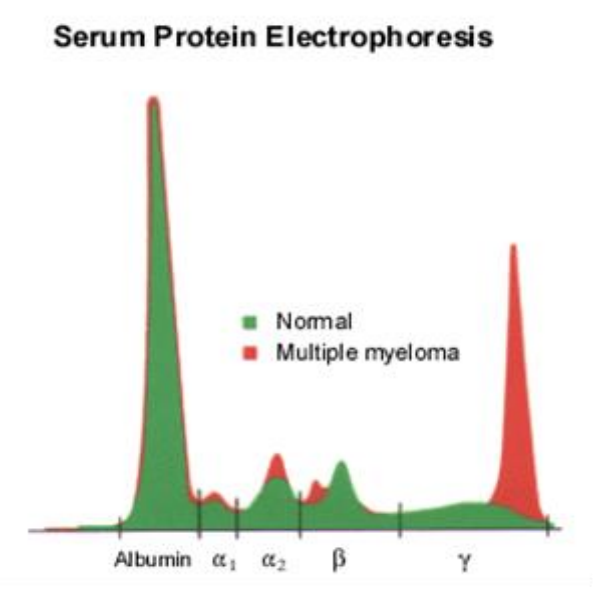



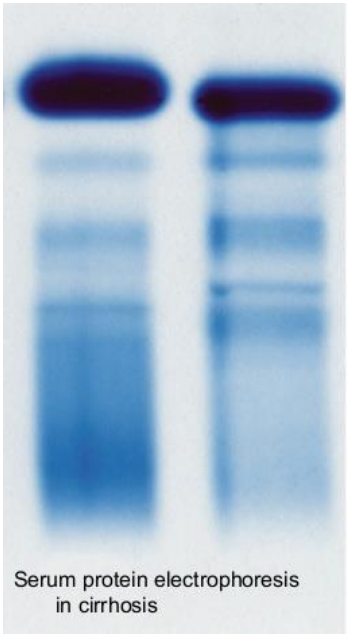

## *Why we need this test*

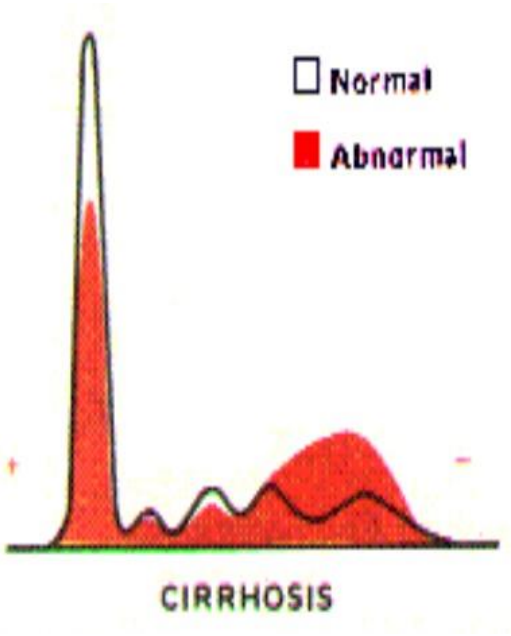
Serum protein electrophoresis is most often done to help diagnose and monitor a wide variety of conditions. These include:

a. Some forms of cancer.
b. Problems with the kidneys or liver.
c. Problems with the immune system.
d. Conditions that lead to poor nutrition.




## *Hypoalbuminemia*

***Hypoalbuminemia*** is a medical condition where blood levels of albumin are abnormally low. It is a type of hypoproteinemia.

Albumin is a major protein in the human body, making up about 55% of total human plasma protein by mass. Many hormones, drugs, and other molecules are mostly bound to albumin in the blood stream and must be released before becoming biologically active. For example, calcium binds to albumin and hypoalbuminemia leads to an increase in free ionized calcium.

Albumin is synthesized in the liver, and low serum albumin may be indicative of ***liver failure*** or diseases such as ***cirrhosis*** or ***chronic hepatitis***.

Hypoalbuminemia can also present as part of the nephrotic syndrome, in which protein is lost in the urine due to kidney damage.

The serum albumin level is part of a standard panel of liver function tests. Levels below 3.5 grams per deciliter are generally considered low.

***Hypoalbuminemia can be caused by:***

1. Liver disease; cirrhosis of the liver is most common
2. Excess excretion by the kidneys (as in nephrotic syndrome)
3. Excess loss in bowel (protein-losing enteropathy)
4. Burns (plasma loss in the absence of skin barrier)
5. Acute disease states (referred to as a negative acute-phase protein)
6. Malnutrition

## *Hypoalbuminemia*

Hyperalbuminemia is an increased concentration of albumin in the blood. Typically, this condition is due to dehydration.

- Dehydration is the only clinical situation, which produce an increase in albumin concentration.
- Chronic dehydration needs to be treated with zinc as well as with water. Zinc reduces cell swelling caused by decreased intake of water (hypotonicity) and also increases retention of salt. Hyperalbuminemia is also associated with high protein diets.