

Al-Mustaqbal University

College of Engineering and Technologies

Biomedical Engineering Department



Systemic Physiology II

Lecture: 2

The Plasma and Plasma Proteins

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The plasma

-Plasma is homogenous, slightly alkaline fluid, which contains, in addition to the waste substances produce from the tissues, dissolved gases, inorganic salts, protein, carbohydrate & lipids that are in transit to various parts of the body.

-Serum has the same composition as plasma except that its fibrinogen & clotting factors have been removed.

Plasma proteins

-The plasma proteins consist of albumin, globulin & fibrinogen fractions.

-The globulin fraction is subdivided into numerous components, which are-

$\alpha 1$; $\alpha 2$; B 1 ; B 2 & gamma globulins.

-The albumin; α & B globulins & fibrinogen are manufactured in the liver; while gamma globulin are manufactured in plasma cells.

-Normally, total plasma proteins in human adults range in concentration from 6 to 8.0 gm /d1 (d1 = deciliter).

-The capillary walls are relatively impermeable to the proteins in plasma, & the proteins therefore exert on osmotic force of about 25 mm Hg across the capillary wall (oncotic pressure) that tend to pull water into the blood.

-The plasma proteins are also responsible for 15% of the buffering capacity of the blood, because of the weak ionization of their substituent – COOH & - NH₂ groups.

Albumin

- Is the major protein of human plasma.
- Albumin, synthesized by the parenchymal cells of the liver is normally present at an average concentration of about four gm /dI/ (range 3.5 –5.0 gm/dI/).
- When the concentration of albumin is severely reduced (as in liver disease because of protein synthesis is depressed; or in nephritis because large amounts of albumin are lost in the urine), this lead to decrease in the plasma oncotic pressure, so excess extracellular fluid may accumulate.
- In extracellular tissues, the fluid accumulation is described as edema.
- Whereas in closed body cavities it is described as either ascites (in the peritoneal cavities) or effusion (in the pleural or pericardial cavities).
- Albumin is also the carrier for substances; these substances include normal components of blood, such as bilirubin & fatty acids as well as exogenous agents such as drugs.

Haptoglobin

- Haptoglobin is composed of two α - chains & only one form of B- chain of polypeptides.
- The B- chain contains the site with which the molecule binds hemoglobin.
- The molecular weight is about 85,000 Daltons.
- Their biological function is in the metabolism of plasma Hb by preventing its glomerular filtration & confining its uptake to the liver.

Haemopexin

- It binds heme in equimolar ratio (1:1 ratio).
- The hemopexin – heme complex is removed from the blood by the liver.

Ceruloplasmin

- Ceruloplasmin is a copper – containing protein that has enzyme activities (ex... copper oxidase, histaminase & ferrous oxidase).
- It is important in maintenance of Cu^{+2} homoeostasis & serve in Cu^{+2} transport, & carries 90% of the copper present in plasma.
- Albumin carries the other 10% of plasma copper.
- Inherited Wilson's disease, plasma ceruloplasmin is markedly reduced & Cu^{+2} levels increase in brain & liver with resultant neurological changes & liver damage.

Transferrin

- Two molecules of ferric iron bind to each molecule of transferrin.
- The major function of transferrin are the transport of iron in the circulation to sites where iron is required & prevention of loss of iron through the kidney.
- Transferrin transport iron to its storage sites & to the bone marrow to release the iron to the target cell.

Ferritin

- Ferritin contains approximately 23% iron.
- Ferritin is the storage form of iron in the tissues, which is found principally in the reticulo-endothelial cells of the liver, spleen & bone marrow.
- Normally, there is a little ferritin in human plasma.
- However, in patients with excess iron, the amount of ferritin in plasma is markedly elevated.

Fibrinogen

- Fibrinogen is six times more viscous than albumin & is mainly responsible for blood viscosity.
- It is also essential in blood clotting process.
- Serum has no fibrinogen so total plasma protein minus serum proteins give a measure of fibrinogen.

Immunoglobulins (Igs)

- The antibodies are gamma globulins called immunoglobulins; usually they constitute about 20% of all plasma proteins.
- There are five major groups of immunoglobulins in the serum, which are - IgA; IgG; IgM; IgD & IgE "(DAMGE)" which are produce by the lymphocyte – plasma cell system.
- All the immunoglobulins are composed of combinations of light & heavy polypeptide chains, most of which are a combination of two light & two heavy chains, some of the immunoglobulins have combinations of

as many as ten heavy & ten light chains, which gives rise to the much larger molecular weight immunoglobulins.

-Yet, in all immunoglobulins, each heavy chain is paralleled by a light chain at one of its ends, thus forming a heavy – light pair & there are always at least two such pairs in each immunoglobulin molecule.

-Antibodies are protein synthesized by plasma cells, due to immune responses, B- lymphocytes that have been stimulated by antigens to differentiate into plasma cells, which are secrete different classes of immunoglobulins.

-Antibodies provide a major defense against infectious agents.

The ionic constituents of plasma

-The ionic constituents of plasma maintain the pH of blood within physiological limits.

-The chief inorganic cation of plasma is sodium -Plasma also contains small amounts of potassium, calcium, magnesium & hydrogen ions.

-The principle anion of plasma is chloride, & ionic equilibrium is maintained by the presence of other anions, including bicarbonate, phosphate, sulfate, plasma protein & organic acids.

Enzymes of plasma

-Most plasma enzymes do not have metabolic roles in plasma, except for the enzymes concerned in blood coagulation.

-Serum enzyme levels are often useful in the diagnosis of particular diseases or abnormal physiological conditions, such as the level of

plasma, acid phosphatase becomes very high in cases of prostatic cancer, & high alkaline phosphatase is found in cases of hepatic obstruction.

Function of plasma proteins

(1):-They act as protein reserve to the body, & can be used to supply body protein in states of starvation.

(2):-The plasma proteins increase the viscosity of the blood.

(3)-Plasma proteins exert on osmotic pressure of about 25 mm Hg, (oncotic pressure) which plays an important role in the reabsorption of tissue fluid.

(4):-They are important in transporting certain hormones, drugs & other substances in the blood.

(5):-They also have the ability on neutralize both acids & alkalis that is they act as a buffer.

(6):-Globulins acts as defense mechanism through formation of antibodies.