Plasma proteins

By

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Overview

- Plasma proteins are proteins present in blood plasma. These contain not only simple proteins but also conjugated proteins such as glycoproteins(IG) and lipoproteins .
- They serve many different functions, including transport of lipids, hormones, vitamines and minerals, others have protective function as immunoglobulins (Ab) or act as enzymes.

Major Types:

Albumin *(60%)*

Major component of osmotic pressure of plasma

Globulins *(35%)*

Antibodies (immunoglobulin) and transport proteins

Fibrinogens *(4%)*

Functions in blood clotting

Other *(<1%)*

Various roles (α-1-antitrypsin, coagulation factors, etc.)

Types of plasma proteins

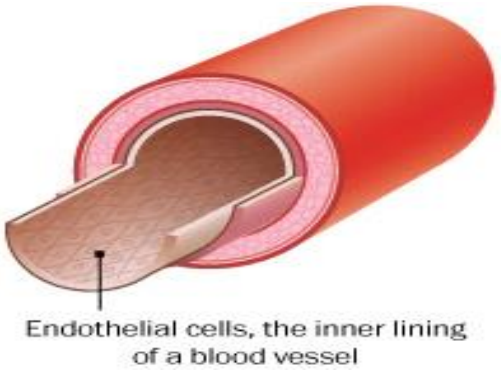
- 1) Albumin
- 2) globulins:
  - α1 globulin(α1 antitrypsin- α1 fetoprotein)
  - α2 globulin (ceruloplasmin- haptoglobulin)
  - β1 globulin (transferin)
  - β2 globulin (microglobulin)
  - ¥ globulin
- 3) Fibrinogen

Plasma protein synthesis

- Hepatocytes of liver synthesize many plasma proteins,
- those of complement system are also made by macrophages.
- Immunoglobulins are mainly derived from the B lymphocytes of the immune system.

Plasma protein catabolism

- Most plasma proteins are taken up by pinocytosis into capillary endothelial cells.



- Small molecular-weight proteins are lost passively through the renal glomeruli and intestinal wall.

Function of plasma proteins

- **1) Nutritive function:**

Plasma proteins act as a source of protein for the tissues

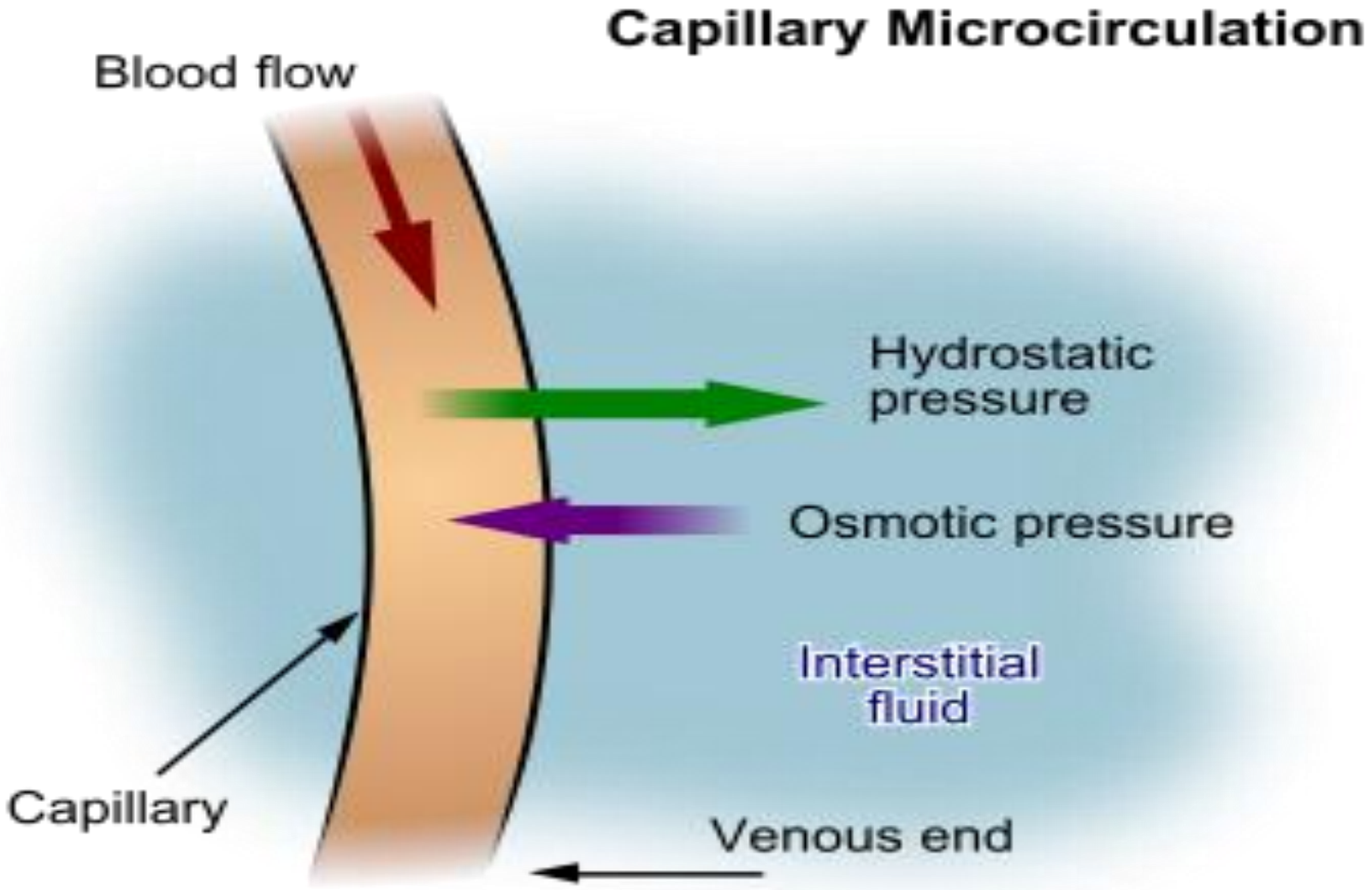
- **2) Transport: e.g**

- Transferrin transport iron
- Ceruloplasmin transport copper
- Albumin transport fatty acids, bilirubin , calcium, hormones and drugs
- Retinol binding protein transport retinol
- Lipoproteins transport lipid

2)Osmotic pressure regulation:

Plasma proteins mainly albumin are colloidal and non-diffusable and exert a colloidal osmotic pressure which helps to maintain a proper water balance between the tissues and blood.

Decrease in albumin level result in loss of water from blood and its entery into interstitial fluid and the tissues.


Capillary Microcirculation
Blood flow
Hydrostatic pressure
Osmotic pressure
Interstitial fluid
Capillary
Venous end

- **3)Catalytic function(enzymes):**

e.g: lipases for removal of lipids from blood.

- **4)Protective function:**

➢ Immunoglobulins combine with foreign antigen and remove them

➢ Enzyme inhibitors remove enzyme by forming complexes with them e.g: α1antitrypsin combines with trypsin and protect the tissues from enzyme of inflamatory cells such as: lungs

- **5)Blood clotting:**

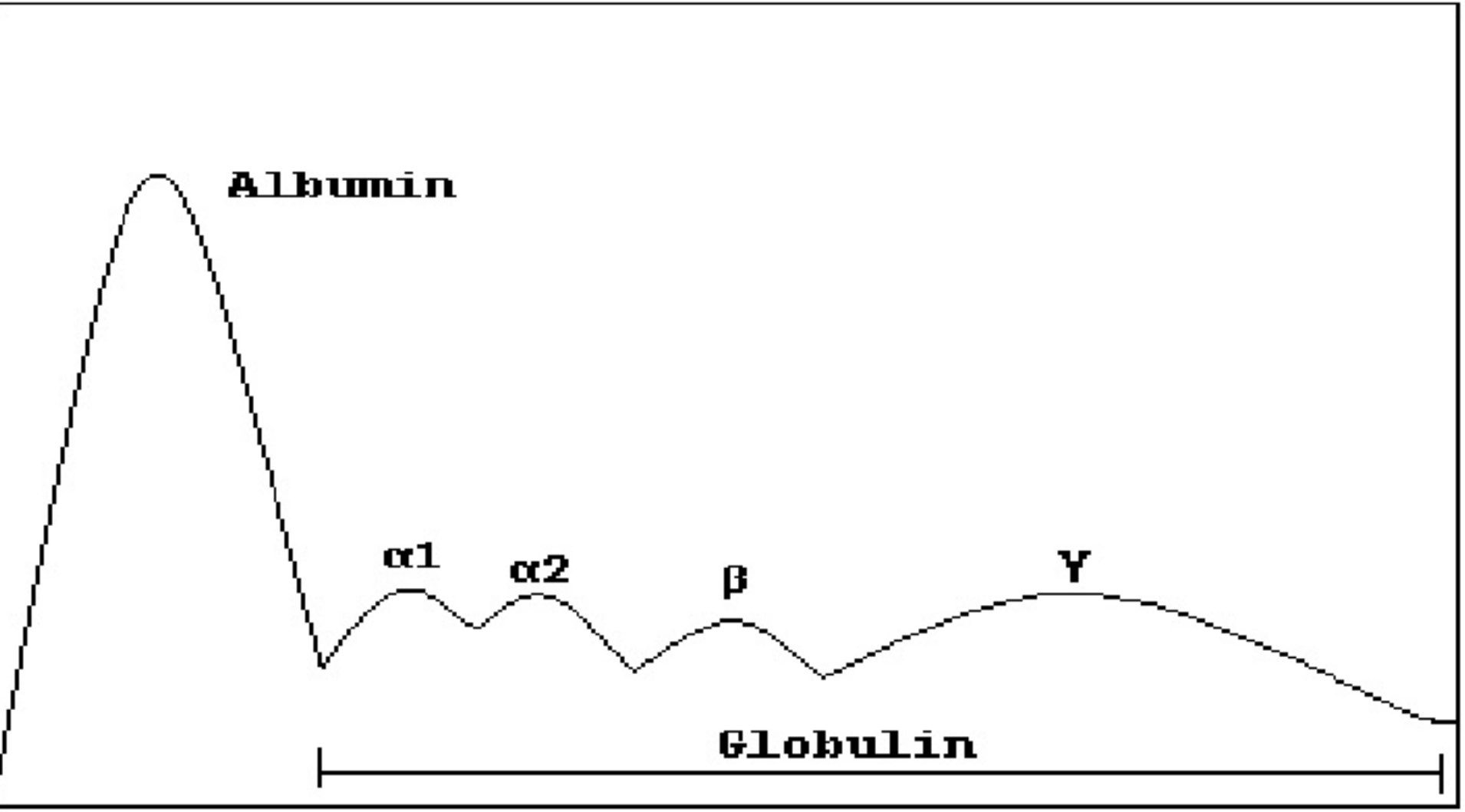
many factors are involved in clotting mechanism and prevent loss of blood e.g: clotting factor, thrompin, fibrinogen.

Excess of deficiency leads to diseases like hemophilia.

Method of assessing plasma proteins

- Plasma proteins may be expressed either as concentrations(e.g: g/L) or as activities of those proteins that have defined function, such as clotting times for prothrompin .
- Laboratories are able to measure total serum protein conc. and also quantify serum proteins by method named Electrophoresis that separate proteins in form of band according to the their diffrerent electrical charges .

Separation of Plasma proteins by Electrophoresis



Albumin

- Is the most abundant plasma protein produced in the liver with a molecular weight 65kDa and costitute 55% of human plasma protein and its half life about 18-20 days. The major effect of albumin within the blood is to maintain colloid osmotic pressure.

- Albumin transport important blood constituents such as drugs, hormones and enzyme. When affects liver cells. The hepatocytes loss their ability to synthesize albumin, serum albumin level is greatly decrease. Becuase the t1/2 of albumin is 18-20 days, severe impairment of hepatic albumin synthesis may not be recognized until after that period.

Hypoalbuminaemia

- **Hypoalbuminaemia** low level of albumin in the blood.
- **Causes:**
- **1)Dilutional hypoalbuminaemia:** result from artefactual changes due to taking blood from the arm into which infusion is flowing, adminstration of excess protein-free fluid or fluid retention in oedematous states during late pregnancy.

- **2) Redistribution of albumin:**

Redistribution of albumin from plasma into interstitial fluid space result from :

❖Recumbency: plasma albumin conc. may be lower by 5-10% in recumbent than in upright position

❖Increase capillary permeability like in postoperative patient.

- **3)decrease synthesis of albumin as in:**

❖Malnutrition

❖Malabsorption

❖Impairment of synthesis of albumin due to chronic liver disease like in cirrhosis.

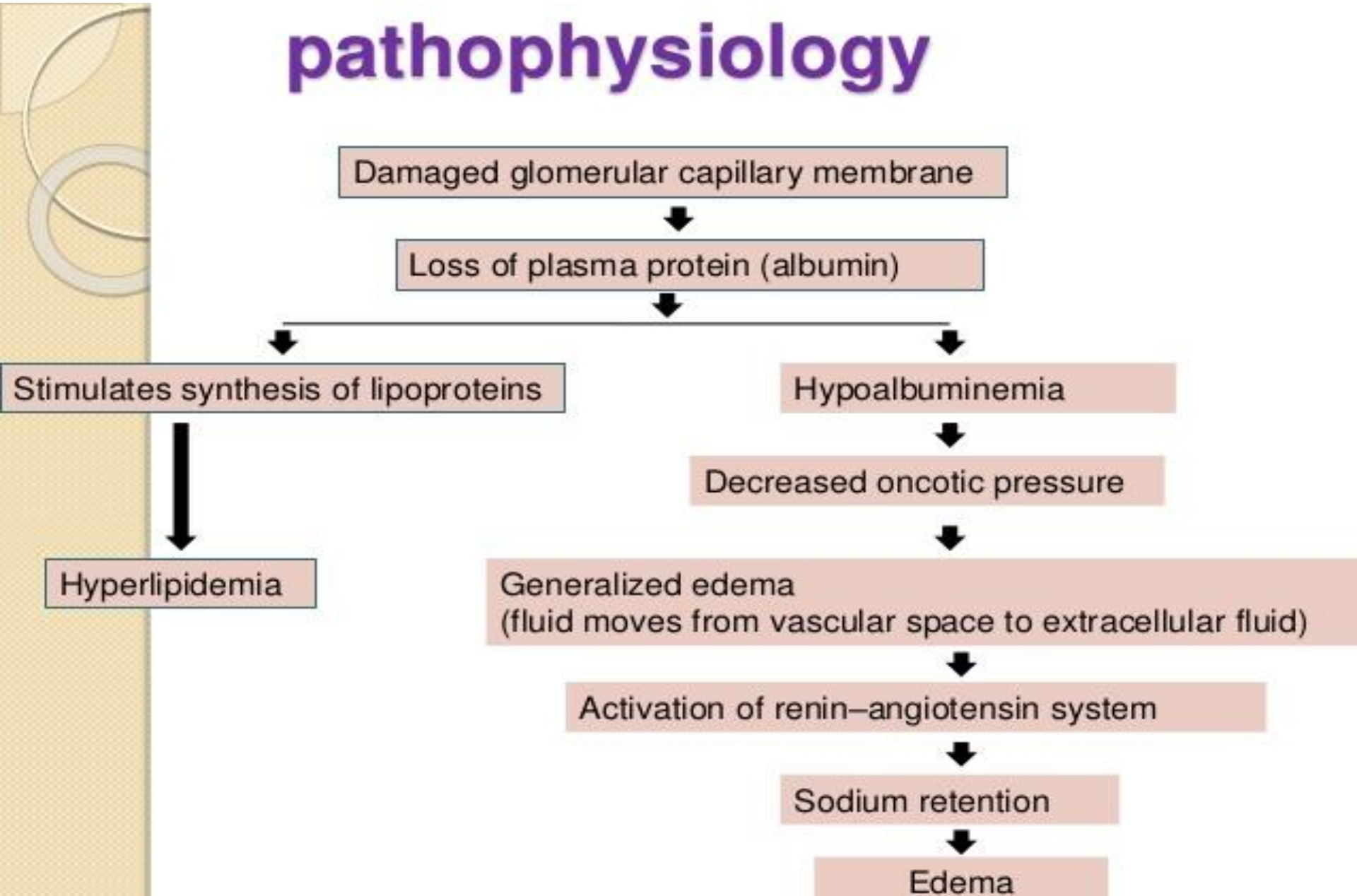
- **4)Increase loss of albumin from the body:**
- From the skin like in burns and psoriasis
- From the intestinal wall like in ptotein lossing enteropathy.
- From the glumeruli in nephrotic syndrome.

Consequences of hypoalbuminaemia

- 1) As a result of hypoalbuminaemia, there is reduction in plasma oncotic pressure. Thus fluid flows from the capillaries into the interstitial space and produce oedema..
- 2) Binding functions: Albumin binds calcium, bilirubin, free fatty acid and no. of drugs like salicylates and pencillin.

A marked reduction in plasma albumin by reducing the binding capacity ,may increase the plasma free conc. of those substances leading to toxic effect.

Nephrotic syndrome

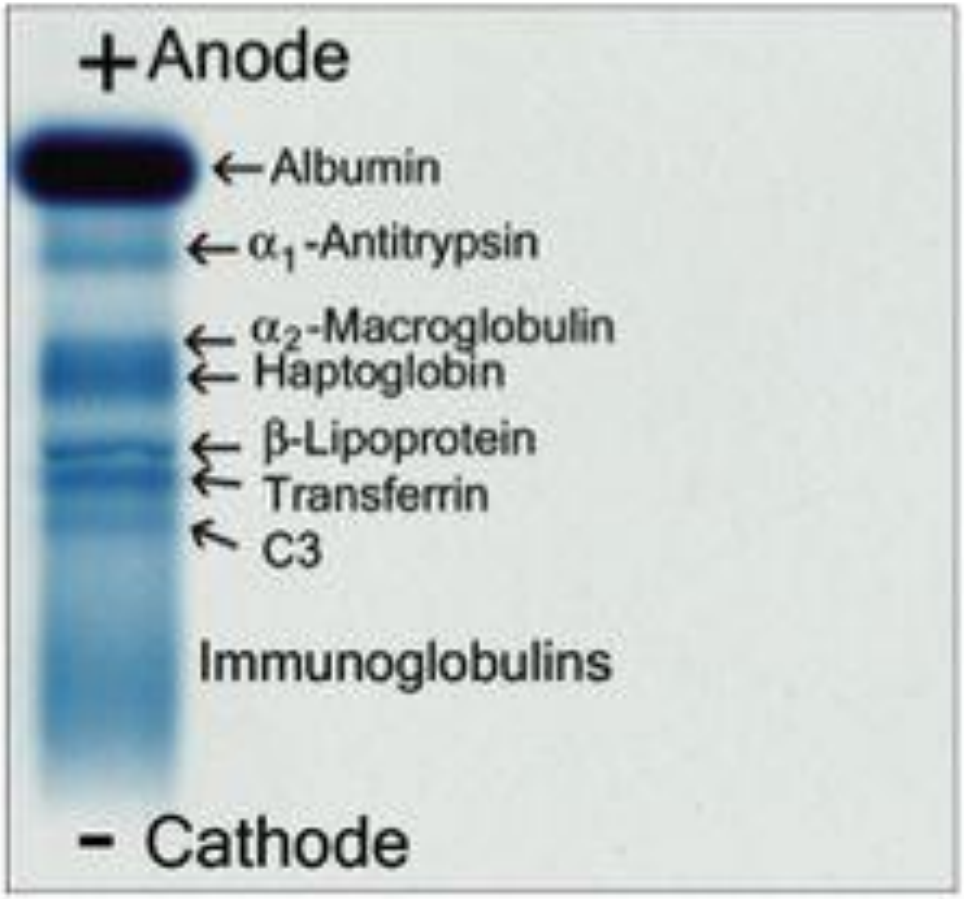


❑ High albumin (Hyperalbuminemia)

this condition is due to:

- ❖abrupt dehydration due to vomitting, dirrrhea.
- ❖Increase of (10-20)% within 30 minutes of becoming upright after a period of recumbency.
- ❖Multiple myeloma.

Normal serum electrophoretic pattern



Electrophoretic patterns in disease

- 1)Parallel changes in all protein fraction:

Reduction may occcur in severe undernutrition or malabsorption, an increase may occur in haemoconcentrtion .

- 2)The acute phase pattern
- Tissue damage triggers the sequence of biochemical and cellular events associated with inflamation.These changes stimulate the synthesis what is called acute phase protein.

- α1 and α2 globulins are mostly increased, the plasma concentration of these proteins, the activity of the inflamation response and their presense responsible for the rise in ESR and increased plasma viscosity.
- 3)chronic inflamation states:
- In chronic inflamation, the usual increase in immunoglobulin synthesis may be visible as a diffuse rise in ¥ globulin.

- 4)Cirrhosis in liver :
- Albumin and α1 globulin conc. are reduced and the ¥ globulin conc. Is markdly raised, with apparent fusion of the β and ¥ band because of increased in plasma IgA conc.
- 5)α1 antitrypsin defeciency:
- The absense of α1 band or reduction in its density suggests α1-antitrypsin defeciency
- 6)Nephrotic syndrome: ???

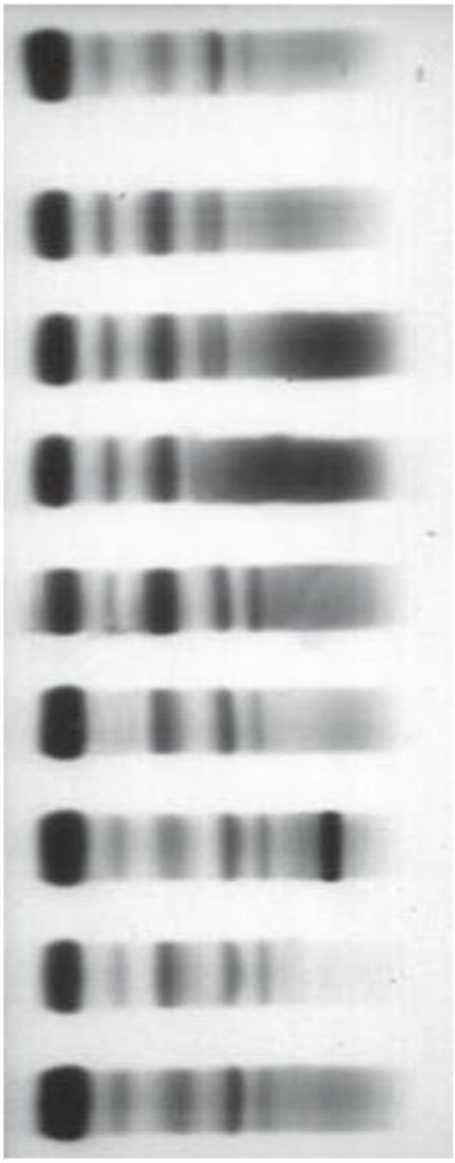


Figure 19.2 Serum protein electrophoretic patterns in disease.

α1 Globulin

- α1-antitrypsin: it inhibit the action of protease(neutrophil elastase) that can destroy alveoli and cause emphysema if not controlled.protease can found in bacteria ,fungi and virus.
- α1-fetoprotein: high level associated with spina bifida and twins. Low levels associated with Down syndrome.
- Both of those plasma proteins are acute phase proteins

α2 Globulins

- Haptoglobulin: it binds haemoglobin, it decreases in haemolytic anaemia → decrease in haemolysis.
- Ceruloplasmin: it is copper containing plasma protein
- α2 globulin(725kd): because of its high m.wt , it retained in nephrotic syndrome

β-Globulins

- Transferin: transport iron
- β-lipoproteins: transport lipid
- Fibrinogen: it is the precursor of fibrin clot.
- Hemopexin: it bind with heme, low levels are diagnostic of hemolytic anaemia.