

PLASMA PROTEINS

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What makes up our blood?

- **RED BLOOD CELLS** (Erythrocytes) – The most abundant cells in our blood; they are produced in the bone marrow and contain a protein called hemoglobin that carries oxygen to our cells.
- **WHITE BLOOD CELLS** (Leukocytes) – They are part of the immune system and destroy infectious agents called pathogens.
- **SERUM** – This is the yellowish liquid portion of blood that contains electrolytes, nutrients and vitamins, hormones and proteins such as antibodies.
(**PLASMA** – Includes all above contents & clotting factors)
- **PLATELETS** (Thrombocytes) – The clotting factors that are carried in the plasma; they clot together in a process called coagulation to seal a wound and prevent a loss of blood.

Blood Proteins - Functions

- They play a vital role in varied bodily processes.
- **Transport** of lipids, hormones, vitamins and metals in the circulatory system.
- **Storage:** Ferritin is a storage protein that stores iron and releases it as and when required.
- **Protective function:** Specialized proteins called Antibodies help in fighting off pathogens or foreign invaders, some proteins act as carriers of molecules.
- **Osmotic regulation**

Blood Proteins - Functions

- **Catalytic function:** Blood proteins act as enzymes, complement components and protease inhibitors
- **Blood clotting:** Clotting agents also contain proteins
- **Anticoagulant activity** (Thrombolysis)
- **Buffering capacity**

Serum Proteins - Composition

- Constitutes about 6 to 8% of blood.
- The total serum protein includes 2 major protein groups called **albumin** and **globulins**.
- Serum albumin, accounts for about 55% of blood proteins
- Albumin helps to prevent fluid from leaking out of blood vessels.
- Also, it maintains the osmotic pressure of plasma and assists in the transport of lipids and steroid hormones.
- It helps in promoting the growth of tissues and facilitates the healing process.

Serum Proteins - Composition

- Globulins make up 38% of blood proteins and transport ions, hormones, and lipids assisting in immune function.
- Globulin refers to a protein group that consists of proteins three types.
 - α Globulin - $\alpha 1$ & $\alpha 2$ Globulins
 - β Globulin
 - γ Globulin
- These fractions can be quantitated using [protein electrophoresis](#).
- Globulins are an important part of the immune system.
- All blood proteins are synthesized in liver except for the [gamma globulins](#).

Normal range

Total Protein	6.0-8.3 gm/dL
Albumin	3.8-5.0 gm/dL
Globulin	2.3-3.5 gm/dL
Alpha-1 globulin	0.1-0.3 gm/dL
Alpha-2 globulin	0.6-1.0 gm/dL
Beta globulin	0.7-1.1 gm/dL
Gamma globulin	0.7-1.6 gm/dL

Albumin/globulin (A/G) ratio 1.1-1.4

Under different pathological conditions the protein levels and the A/G ratio depart from the normal range.

Higher or lower than the normal reference range, is usually indicative of certain ailments.

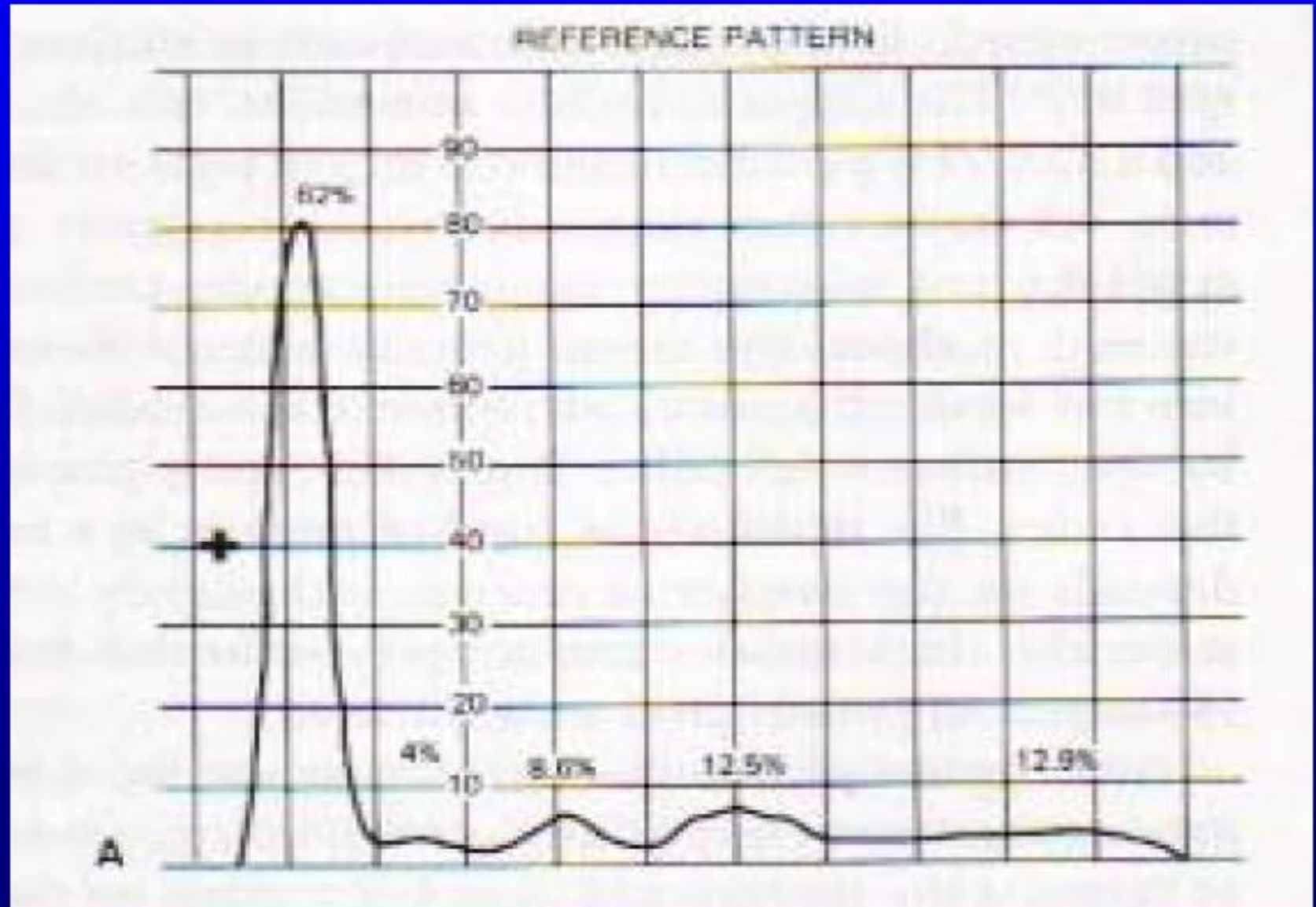
Characterization of Proteins Fractions

The protein fraction in plasma can be separated by and estimated using the following methods:

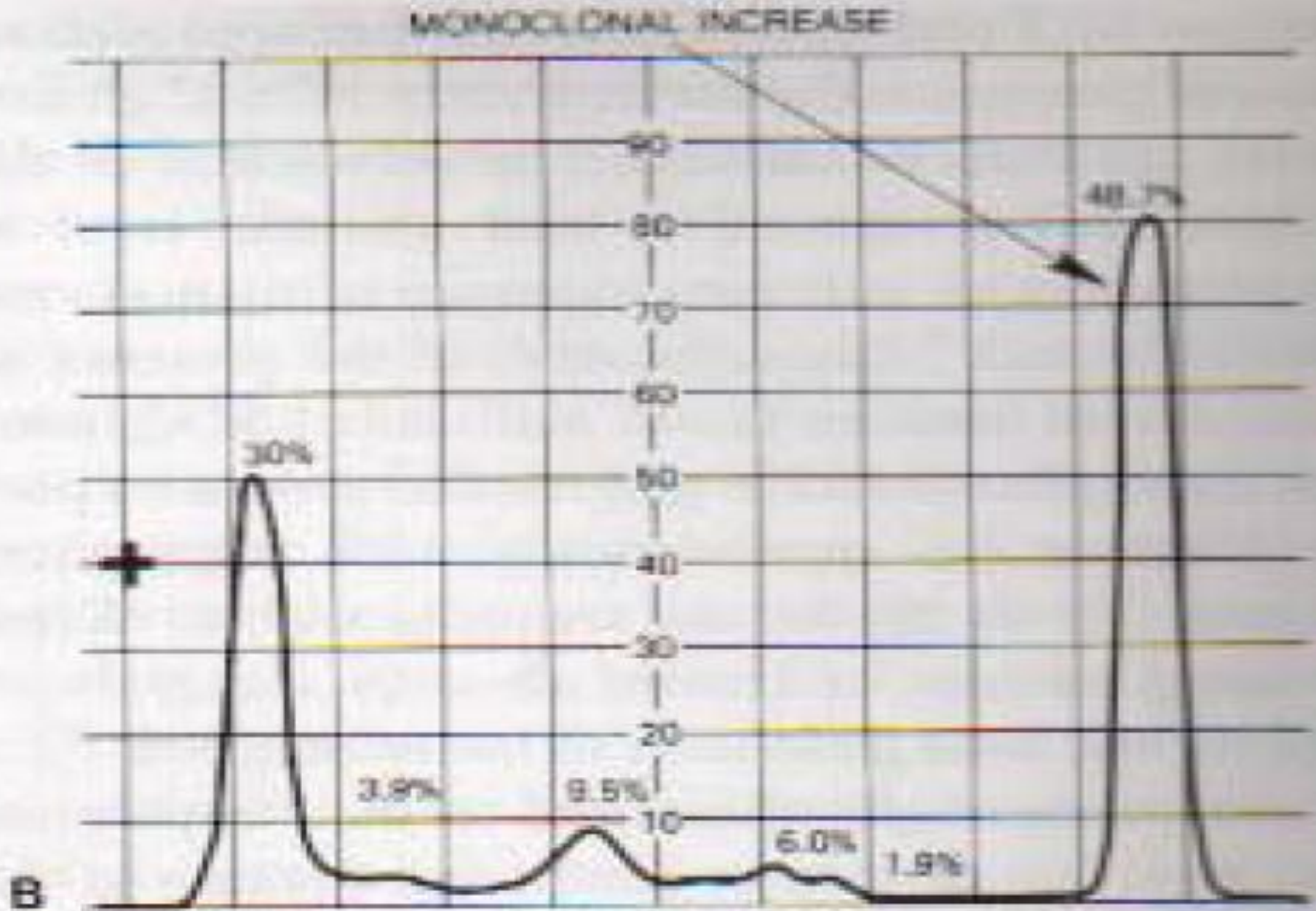
- Zone electrophoresis (Separation in stabilizing media)
- Immunochemical methods
- Chemical methods
- Ultracentrifugation (Physical Techniques)

Electrophoresis: Separation under an electric field in a solid e.g. paper, starch, cellulose, Acrylamide etc. Separates plasma proteins into: Albumin, α_1 globulins, α_2 globulins, γ globulins and fibrinogen.

NORMAL SERUM PROTEIN ELECTROPHORESIS



CHANGES IN SERUM PROTEIN PATTERN



Hyperproteinaemia

Total serum protein level > 6.0 gm/dL

- Total serum protein level > 9.0 gm/dL
- Higher-than-normal levels may be due to:
 - Chronic inflammation or infection, including HIV and hepatitis B or C
 - Multiple myeloma (Cancer)
(plasma cells grow out of control in the bone marrow and form tumors in the areas of solid bone)
 - Waldenstrom's disease
(Macroglobulinemia of Waldenstrom is a cancer of the B lymphocytes. It is associated with the overproduction of proteins called IgM antibodies).

Hypoproteinaemia

Total serum protein level < 6.0 gm/dL

- Lower-than-normal levels may be due to:
 - Water access caused as a result of
 - Overhydration
 - Decreased synthesis of proteins
 - Severe Liver disease (mainly albumin)*
 - Severe Malnutrition e.g. Kwashiokar*
 - Severe Malabsorption
 - Excessive loss of protein (mainly albumin):
 - From the skin after burns(extensive)
 - Through the kidney in nephrotic syndrome & Glomerulonephritis
 - Protein-losing enteropathy
- * No fall in total protein if γ -globulin is raised.

High values

- **High albumin** levels may be caused by:
 - Severe dehydration.
- **High globulin** levels may be caused by:
 - Diseases of the blood, such as multiple myeloma, Hodgkin's lymphoma, leukemia, macroglobulinemia, or hemolytic anemia.
 - An autoimmune disease, such as rheumatoid arthritis, lupus, autoimmune hepatitis, or sarcoidosis.
 - Kidney disease.
 - Liver disease.
 - Tuberculosis.
 - Any condition with an increase in immunoglobulins.

Hypoalbuminaemia (albumin <3.2 g/dL)

- **Low albumin** levels may be caused by:
- Decreased albumin synthesis:
 - A poor diet (malnutrition).
 - Kidney & Liver diseases.
- Increased albumin loss:
 - Renal disease (nephrotic syndrome) – **Proteinuria**
 - Uncontrolled diabetes.
 - Extensive burns (Loss of albumin through skin)
- Defective intake
- Gastrointestinal malabsorption syndromes ([Crohn's disease](#))
- Protein losing enteropathy (rare) – **Loss through gut**
 - Ulceration of the bowel and lymphatic obstruction.
 - Intestinal lymphangiectasis.

Acute Phase Proteins

- These proteins are indicators of inflammatory disease.
 - Positive acute phase proteins:
 - Increase during inflammation.
 - Negative acute phase proteins
 - Decrease during inflammation.
- Differential diagnosis of inflammatory disease.
- Estimation of the endpoint of therapy
- Monitoring therapeutic effectiveness.
- Follow-up of patient with malignancy.