

Nafith Abu Tarboush
DDS, MSc, PhD
natarboush@ju.edu.jo
www.facebook.com/natarboush

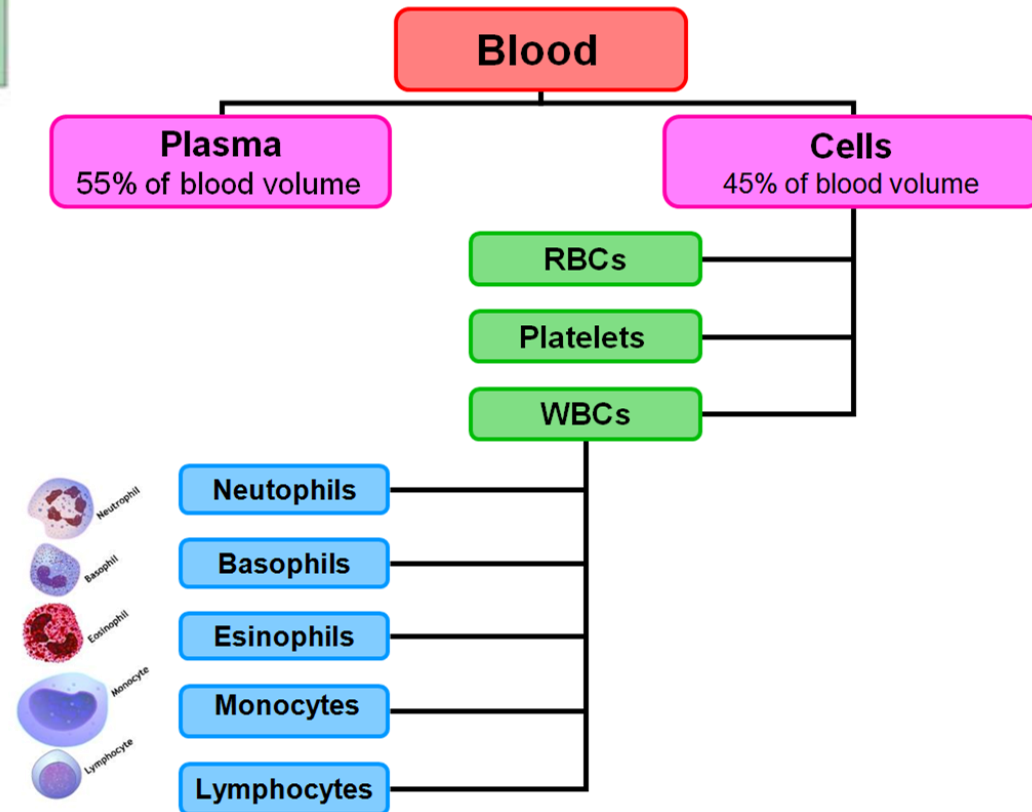
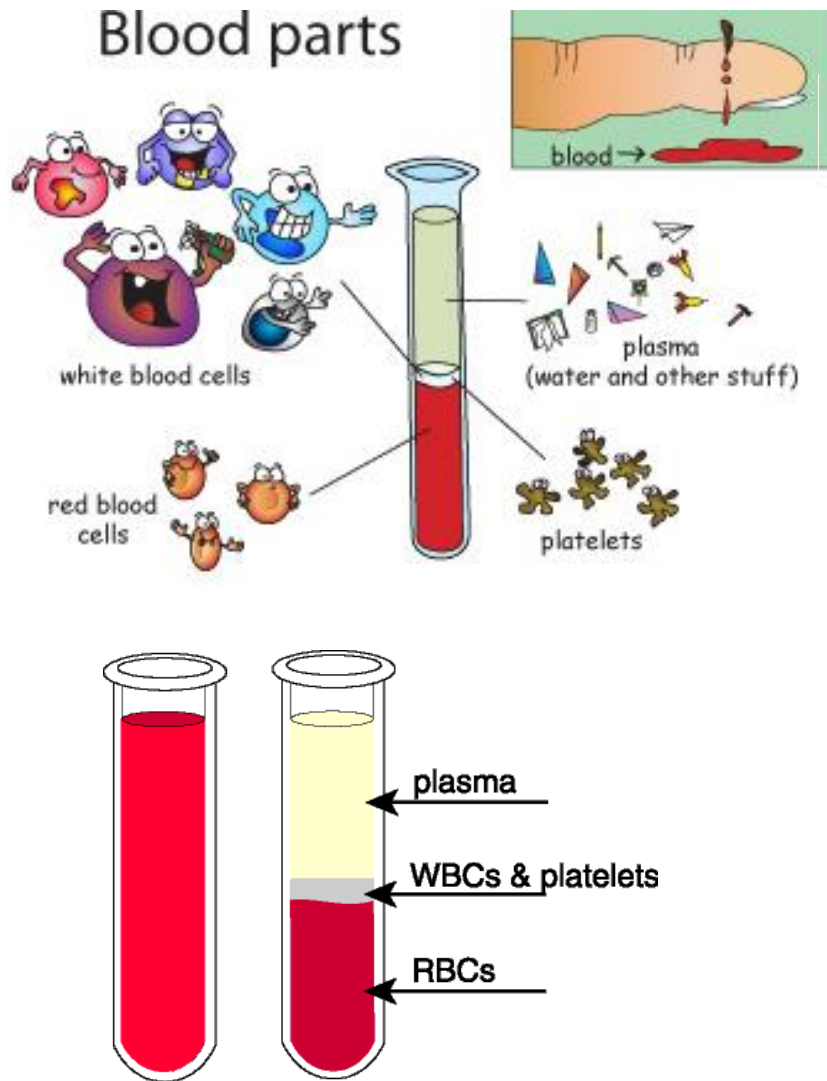
Plasma Proteins

What should we know?

1. What is plasma, and how can we get it?
2. What are the different components of plasma?
3. Plasma proteins (general functions, basis of classification, associated processes and molecules)
4. Different types:
 - Albumin & prealbumin
 - α 1-antitrypsin
 - Haptoglobin (Hp)
 - α 1-fetoprotein (AFP)
 - α 2-Macroglobulin
 - Ceruloplasmin
 - C-Reactive Protein

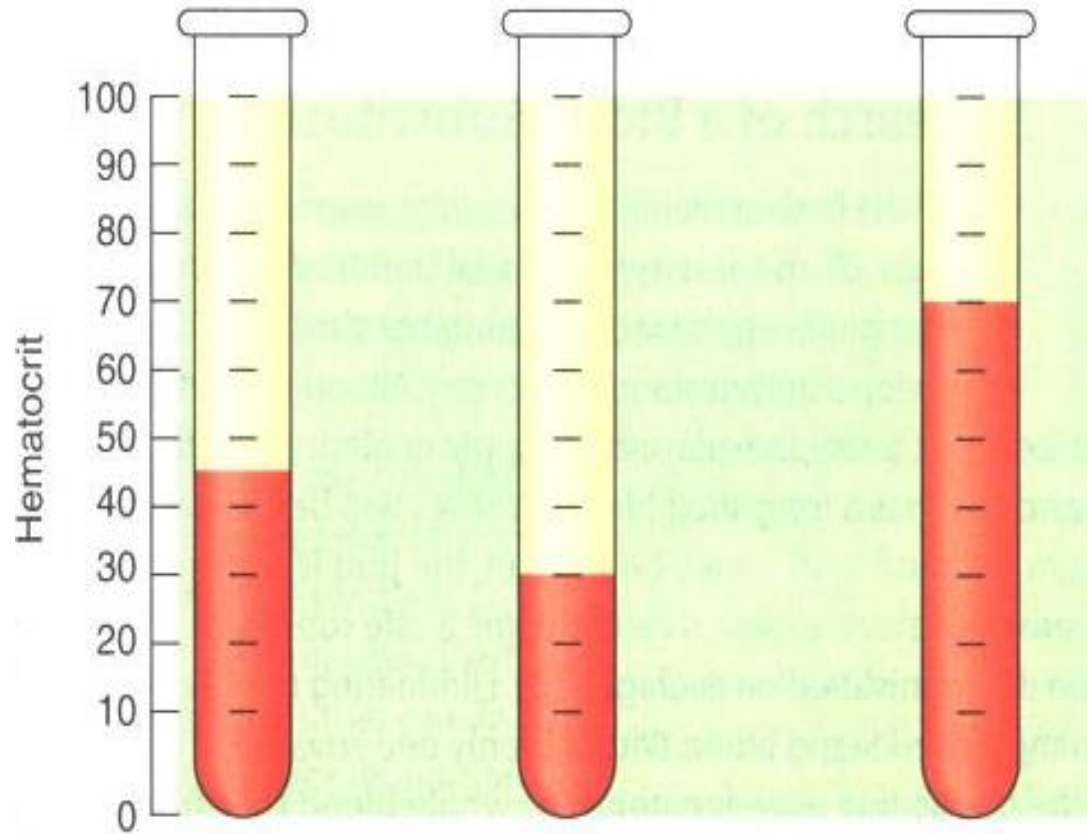
(structure, synthesis, function & diseases associated)

Blood

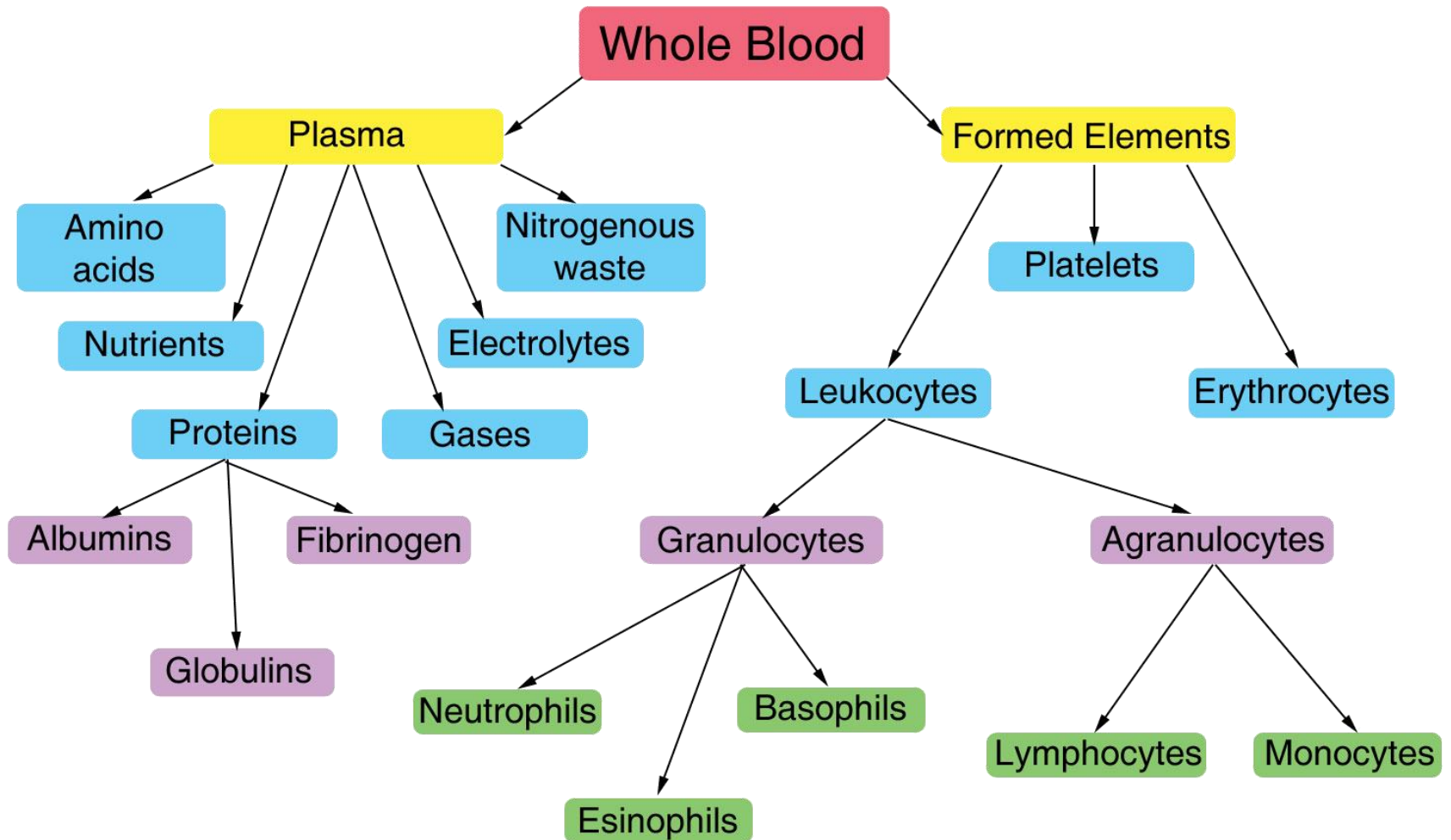


Blood: plasma vs. hematocrit

- Hematocrit or packed cell volume (Adult male: 47 %, Adult females: 42 %)



Blood: plasma vs. cells

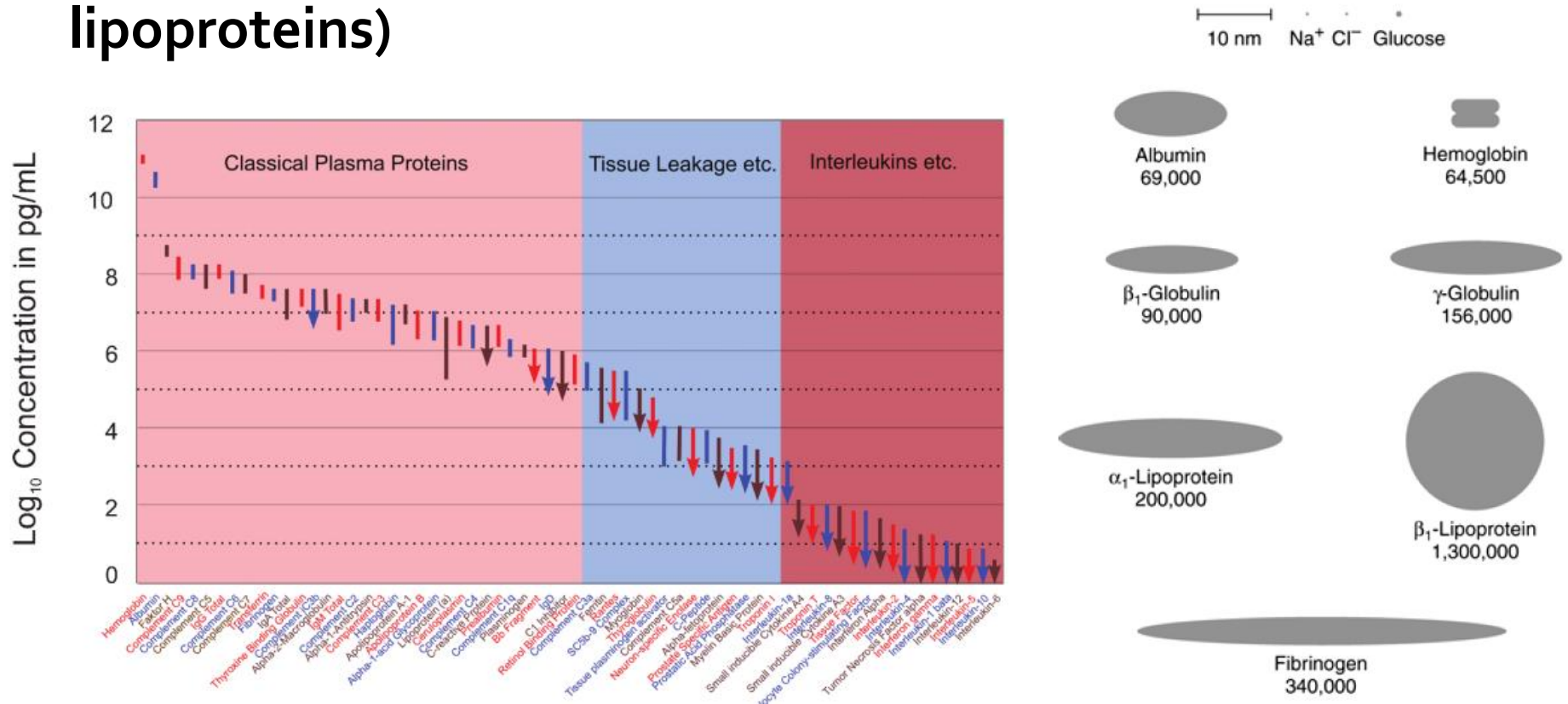


Plasma

- Is the liquid medium in which blood cells are suspended
- Composition:
 - Water (92%)
 - Solids (8%)
- Organic:
 - Plasma proteins: Albumin, Globulins & Fibrinogen
 - Non-protein nitrogenous compounds: urea, free amino acids, uric acid, creatinine, creatine & NH_3
 - Lipids: Cholesterol, TG, phospholipids, free fatty acids
 - Carbohydrates: Glucose, fructose, pentoses
 - Other substances as: Ketone bodies, bile pigments, vitamins, enzymes & hormones
- Inorganic: Na^+ , K^+ , Ca^{2+} , Mg^{2+} , Cl^- , HCO_3^- , HPO_4^{2-} , SO_4^{2-}

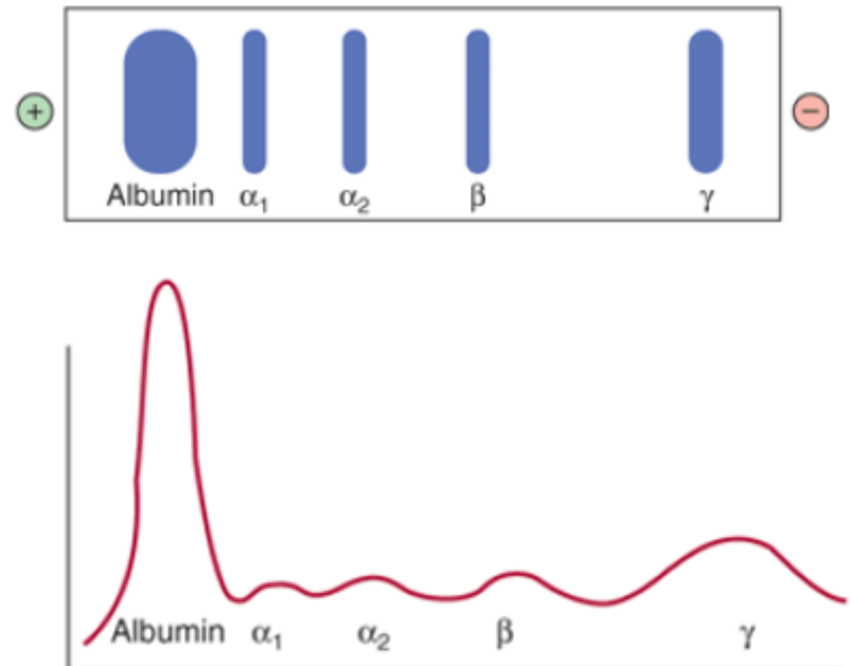
Plasma proteins are a mixture

- More than 500 plasma proteins have been identified
- Normal range 6-8 g/dl (the major of the solids)
- Simple & conjugated proteins (glycoproteins & lipoproteins)



The separation of plasma proteins

- Salting-out (ammonium sulfate): fibrinogen, albumin, and globulins
- Electrophoresis (most common): serum (defibrinated plasma), five bands (albumin, α_1 , α_2 , β , and γ)

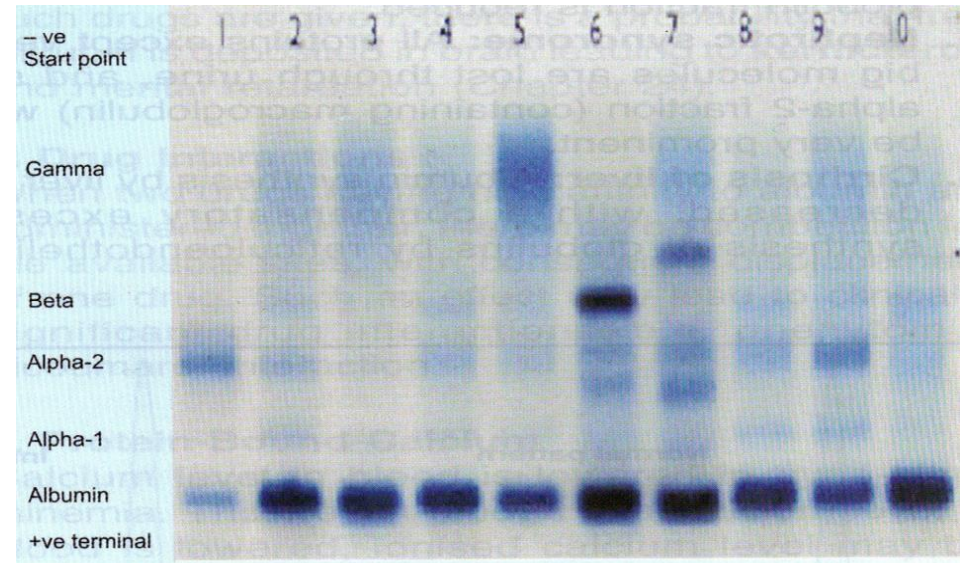


NORMAL VALUES:

| Name | Absolute values (g/l) | Relative values (%) |
|-----------------------|-----------------------|----------------------|
| Albumins | 35 – 55 | 50 – 60 |
| α_1 -globulins | 2 – 4 | 4.2 – 7.2 5 % |
| α_2 -globulins | 5 – 9 | 6.8 – 12 9 % |
| β -globulins | 6 – 11 | 9.3 – 15 12 % |
| γ -globulins | 7 – 17 | 13 – 23 18 % |

Electrophoresis of plasma proteins

- Albumin is smaller than globulin, and slightly negatively charged
- Globulins (3 bands):
- α band:
 - ✓ α_1 region consists mostly of α_1 -antitrypsin
 - ✓ α_2 region is mostly haptoglobin, α_2 -macroglobulin, & ceruloplasmin
- β band: transferrin, LDL, complement system proteins
- γ band: immunoglobulins

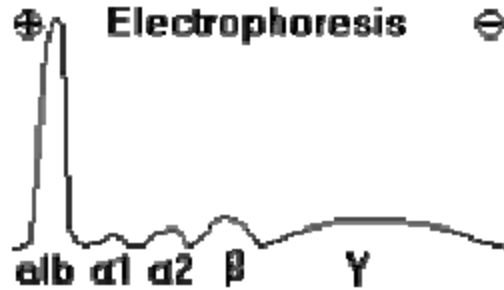


Synthesis of plasma proteins

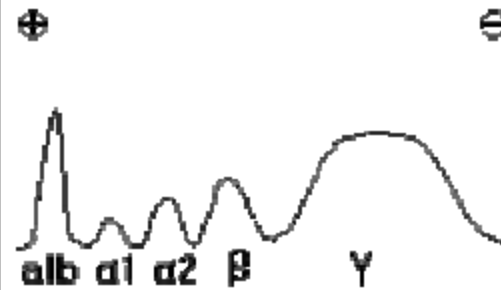
- Mostly liver (albumin, globulins), γ -globulins (plasma cells; lymph nodes, bone marrow, spleen)
- Most plasma proteins are synthesized as preproteins (signal peptide)
- Various posttranslational modifications (proteolysis, glycosylation, phosphorylation, etc.)
- Transit times (30 min to several hours)
- Most plasma proteins are Glycoproteins (N- or O-linked). Albumin is the major exception

ELECTROPHORESIS ASPECTS IN SEVERAL TYPES OF DYSPROTEINEMIA

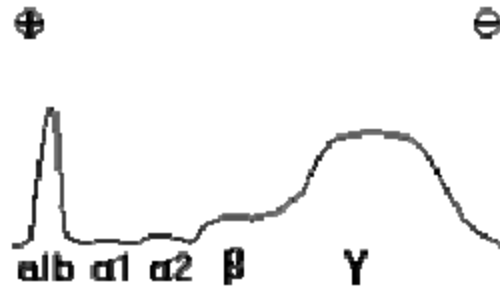
Normal Serum Protein Electrophoresis



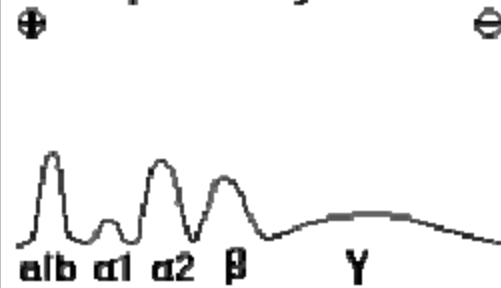
Longstanding Inflammation



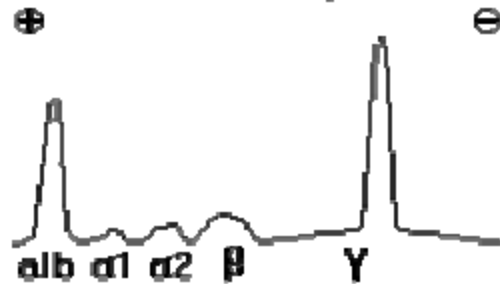
Chronic Liver Failure



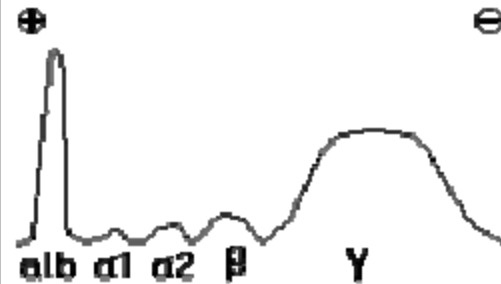
Nephrotic Syndrome



Plasma Cell Myeloma



Polyclonal Gammopathy



Plasma Proteins & Polymorphism

- A mendelian or monogenic trait
- Exists in population in at least two phenotypes, neither is rare
- The ABO blood groups are the best-known examples
- α_1 -antitrypsin, haptoglobin, transferrin, ceruloplasmin, and immunoglobulins
- Electrophoresis or isoelectric focusing

Plasma Proteins Half-Lives

- Determined through isotope labeling studies (I^{131})
- Albumin & haptoglobin (20 & 5 days)
- Diseases can affect half-lives (ex. Crohn's disease), albumin may be reduced (1 day)
- Protein-losing gastroenteropathy – (2-15)% - up to 60%

Functions of plasma proteins

General functions

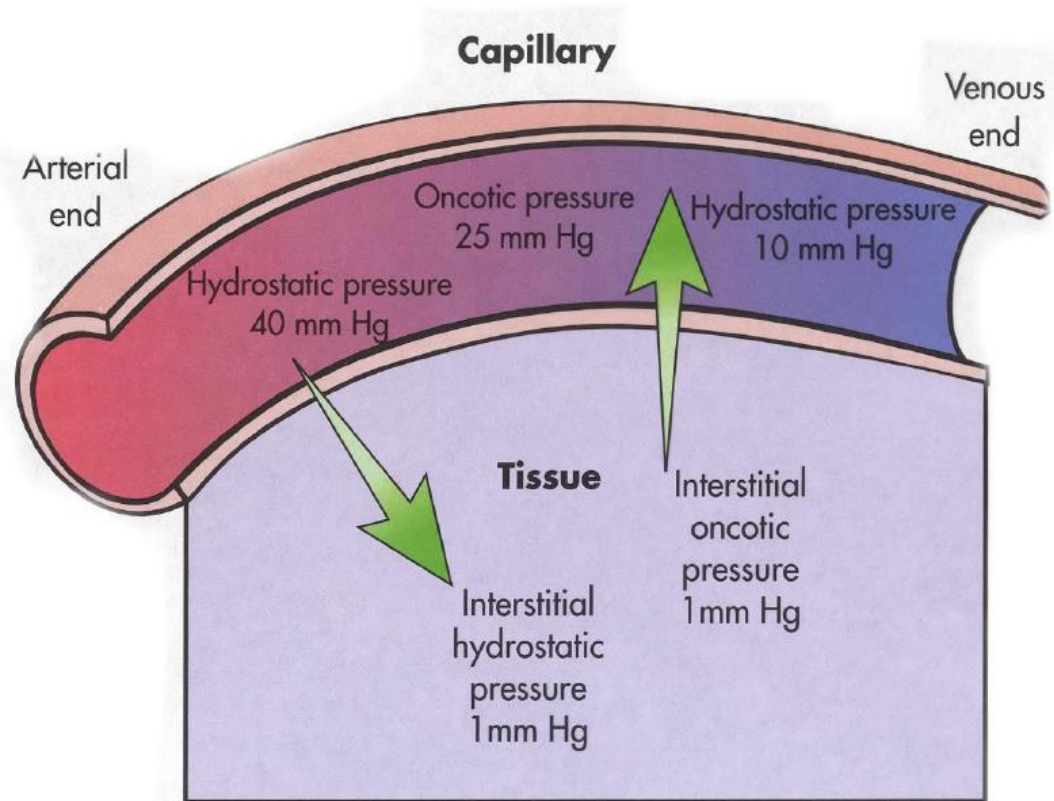
- A nutritive role
- Maintenance of blood pH (amphoteric property)
- Contributes to blood viscosity
- Maintenance of blood osmotic pressure

Specific functions

- Enzymes (e.g. rennin, coagulation factors, lipases)
- Humoral immunity (immunoglobulins)
- Blood coagulation factors
- Hormonal (Erythropoietin)
- Transport proteins (Transferrin, Thyroxin binding globulin, Apolipoprotein)

Starling forces

- ✓ Arterioles, venules vs. tissue hydrostatic pressure (37 & 17 vs. 1 mm Hg)
- ✓ Plasma proteins oncotic pressure is 25 mm Hg
- ✓ Edema can be a result of protein deficiency



Acute-phase proteins

- Levels increase (up to 1000 folds), acute inflammation, tissue damage, chronic inflammation & cancer. C-reactive protein (CRP), α_1 -antitrypsin, haptoglobin, & fibrinogen
- Interleukin-1 (IL-1), main stimulator (gene transcription)
- Nuclear factor kappa-B (NFkB): Exist in an inactive form in cytosol, activated and translocated to nucleus (interleukin-1)
- Negative acute phase proteins: prealbumin, albumin, transferrin