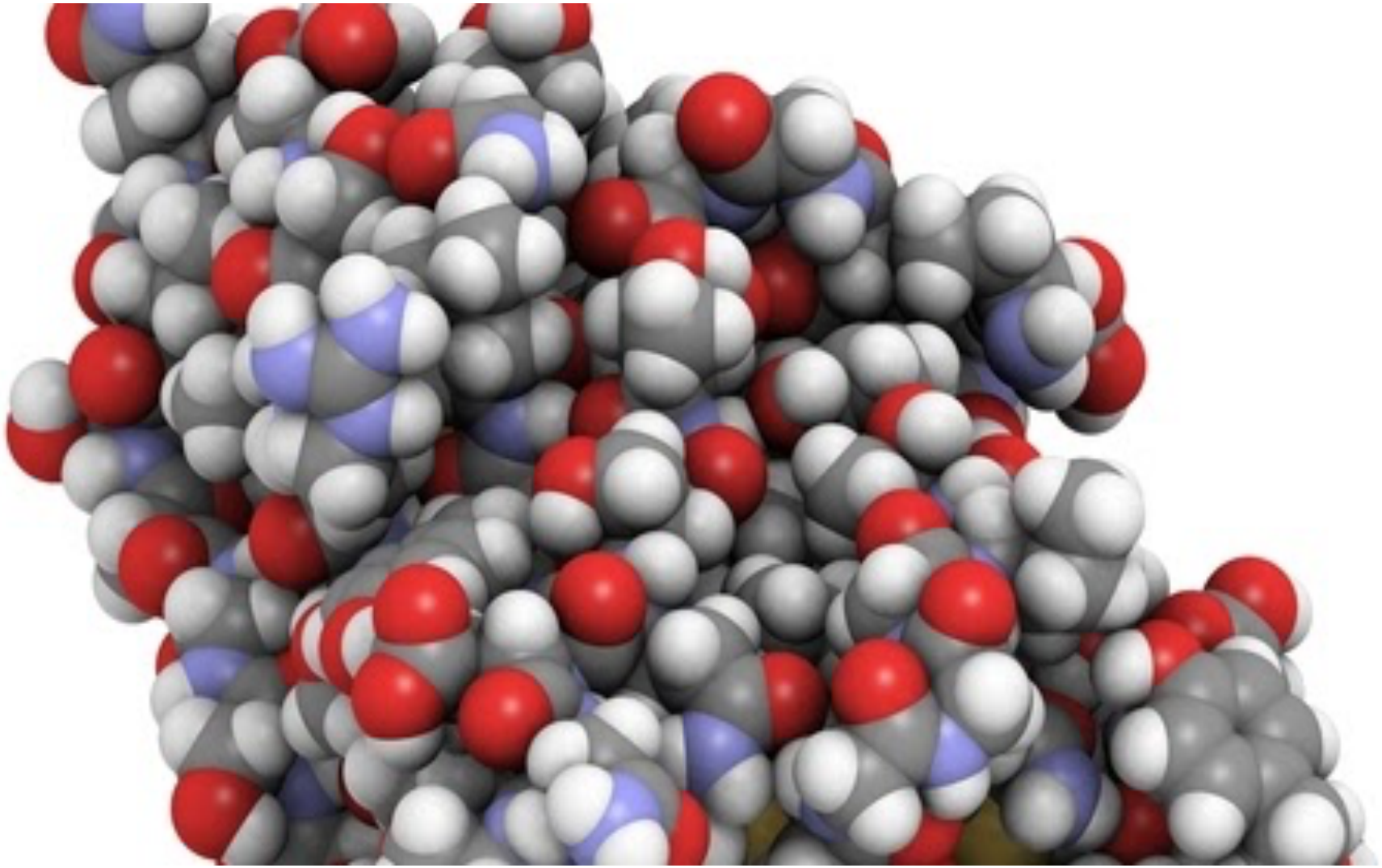
Plasma proteins



BYJU'S The Learning App

PRIMARY STRUCTURE

SECONDARY STRUCTURE

α- helices β- sheets

TERTIARY STRUCTURE

β- sheets

α -helices

QUATERNARY STRUCTURE

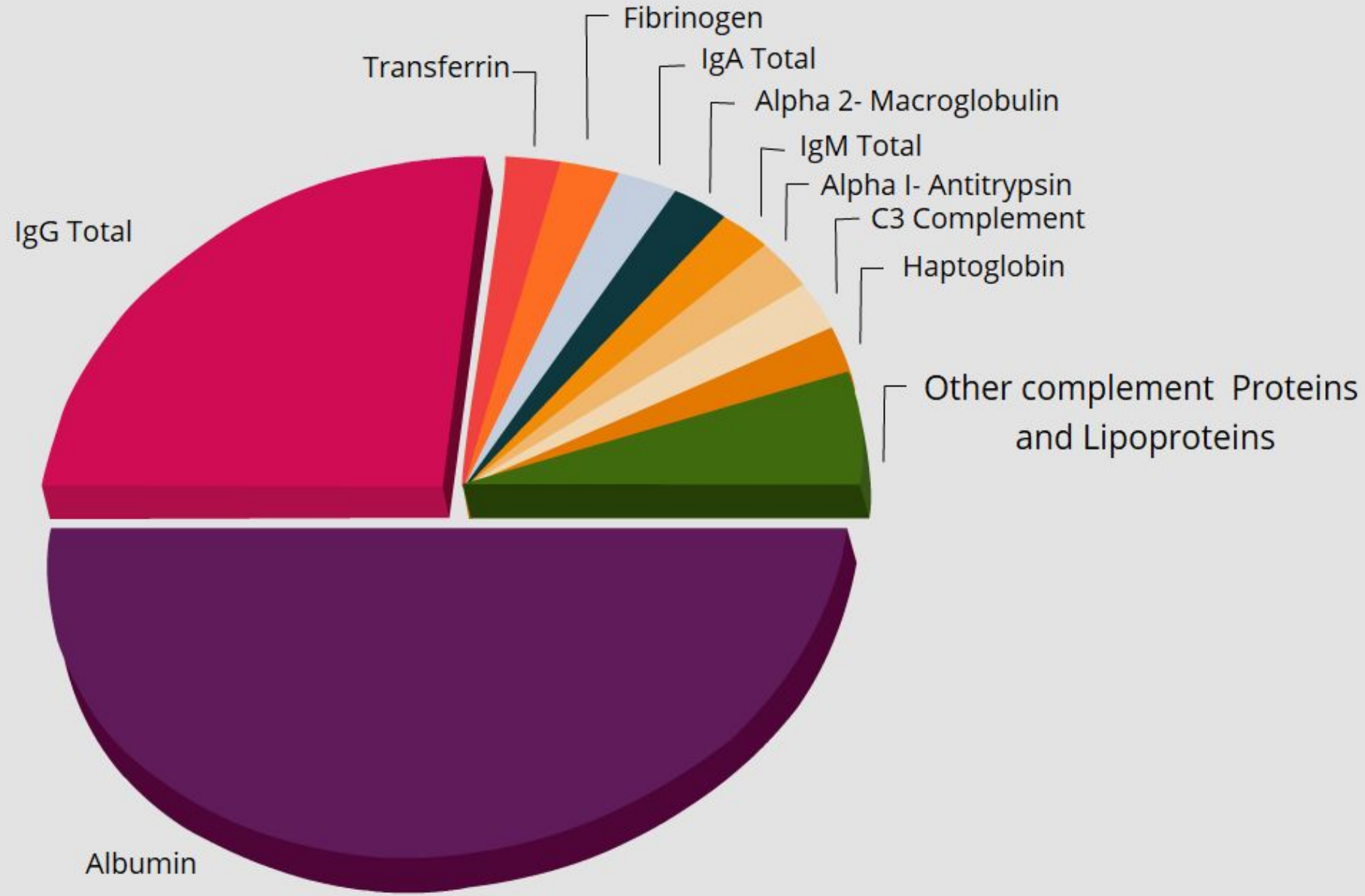
Causes of increase of plasmatic proteins	Causes of reduction of plasmatic proteins
Dehydration	Relative increase of circulating water
Wrong phlebotomy	Excessive loss (kidney, intestine)
Paraproteins	Decreased synthesis (serious liver diseases, food deficit)
Chronic disease	By dilution during infusion (rare)

Plasma proteins 1

- Include proteins of blood plasma and proteins of interstitial fluid
- Almost all are glycoproteins
- Some groups of proteins are classified separately (enzymes, proteohormones)
- Total protein more than 300 proteins

Plasma proteins 2

- **Concentration 65 – 80 g/l;**
  - of this 35 – 50 g/l is **albumin**
  - 20 – 35 g/l are **serum globulins** (transport protein, reactants of acute phase, globulins)
- **Biosynthesis**:
  - liver (most), lymphocytes (immunoglobulins), enterocytes
- **Degradation**:
  - hepatocytes, mononuclear phagocytic system (complexes of antigen-antibody, hemoglobin-haptoglobin)


Fibrinogen
Transferrin
IgA Total
Alpha 2- Macroglobulin
IgM Total
Alpha I- Antitrypsin
C3 Complement
Haptoglobin
IgG Total
Other complement Proteins and Lipoproteins
Albumin

Functions of plasma proteins 1

- Osmotic regulation:
  - Plasma **proteins** **helps to maintain a normal blood volume** and a **normal water content in the interstitial fluid and the tissues**.
  - Albumin content is most important **in** **regulation of colloidal osmotic or oncotic pressure**.
  - Decrease in albumin level results in loss of water from blood and its entry into interstitial fluids causing **edema**.
- Catalytic function (enzymes):
  - Lipases for removal of lipids from the blood

Functions of plasma proteins 2

- Transport of substances :
  - albumin – fatty acids, bilirubin, calcium, drugs
  - transferrin – iron
  - cerulplasmin – copper
  - transcortin – cortisol, cortikosteron
  - lipoproteins – lipids
  - haptoglobin – free hemoglobin
  - thyroxin binding globulin – thyroxin
  - retinol binding protein - retinol

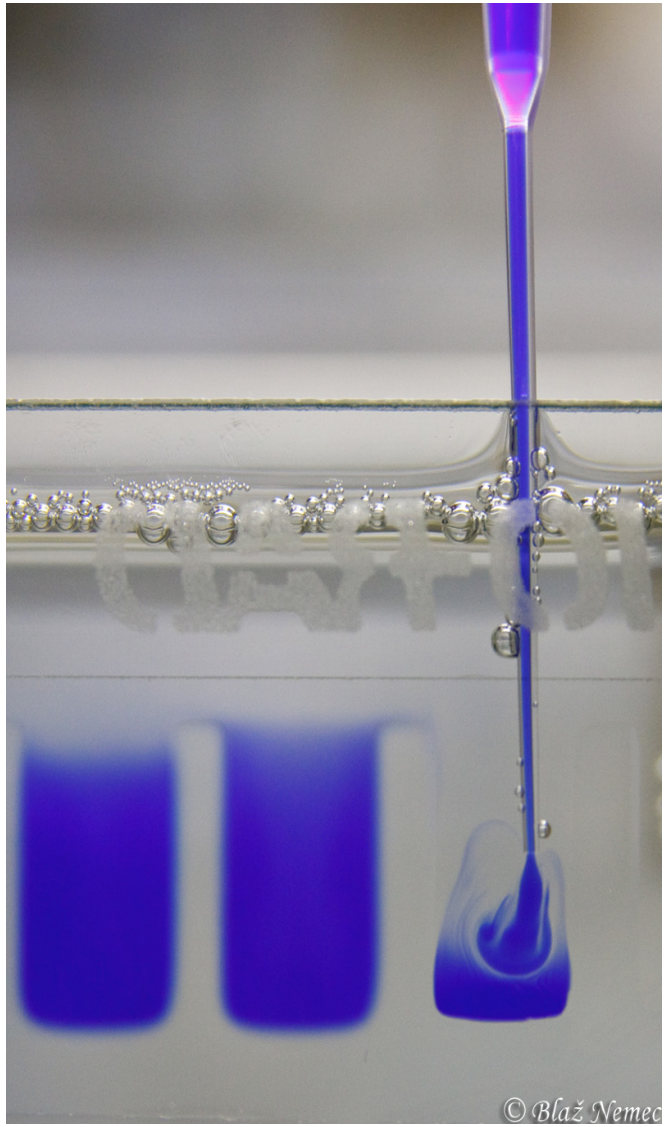
Functions of plasma proteins 3

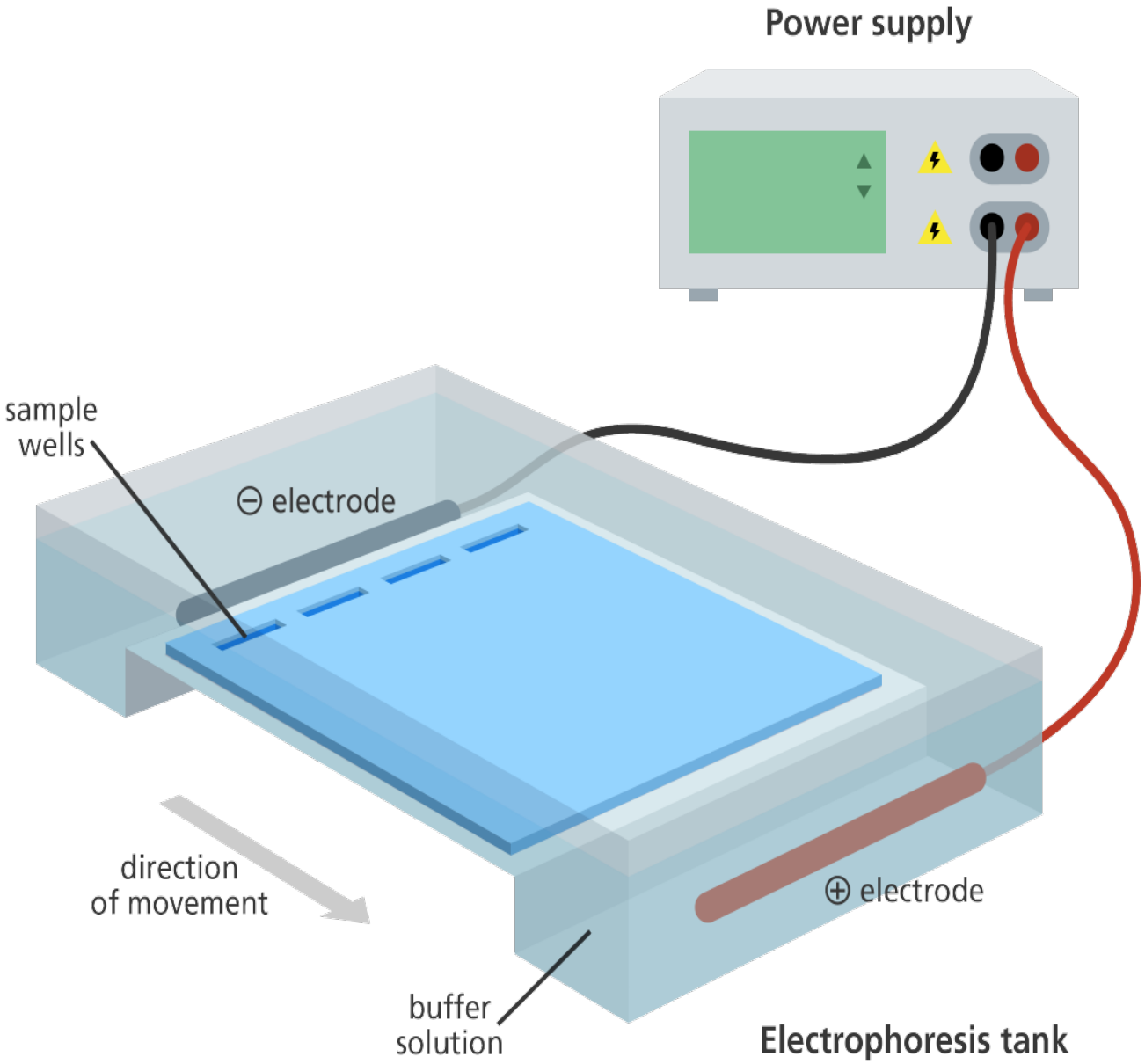
- Blood clotting:
  - Many factors are involved in clotting mechanism and prevent loss of excessive amount of blood; e.g. clotting factors IX, VIII, thrombin, fibrinogen etc.
  - An excess of deficiency leads to a disease
- Anticoagulant activity (thrombolysis):
  - Plasmin breaks down thrombin and dissolves the clot
- Buffering capacity:
  - Proteins in plasma help to maintain acid-base balance

Functions of plasma proteins 4

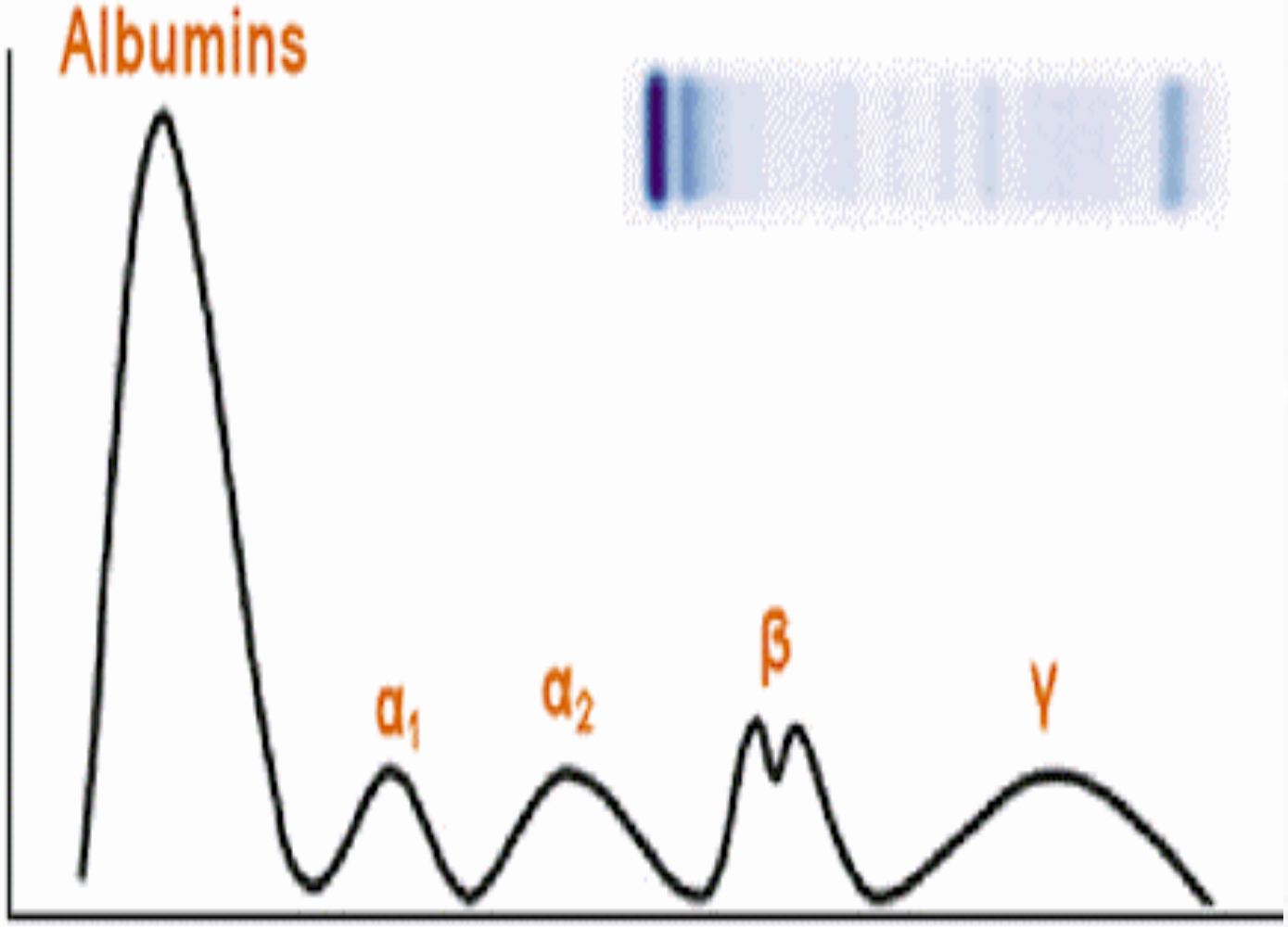
- Protective function:
  - Immunoglobulins combine with foreign antigens and remove them.
  - Complement system removes cellular antigens.
  - Enzyme inhibitors remove enzymes by forming complexes with them. For example α_1-antitrypsin combines with elastase, trypsin and protects the hydrolytic damage of tissues such as lungs.
  - Some proteins increase during acute phase

Proteins move in an electric field according to their charge and size

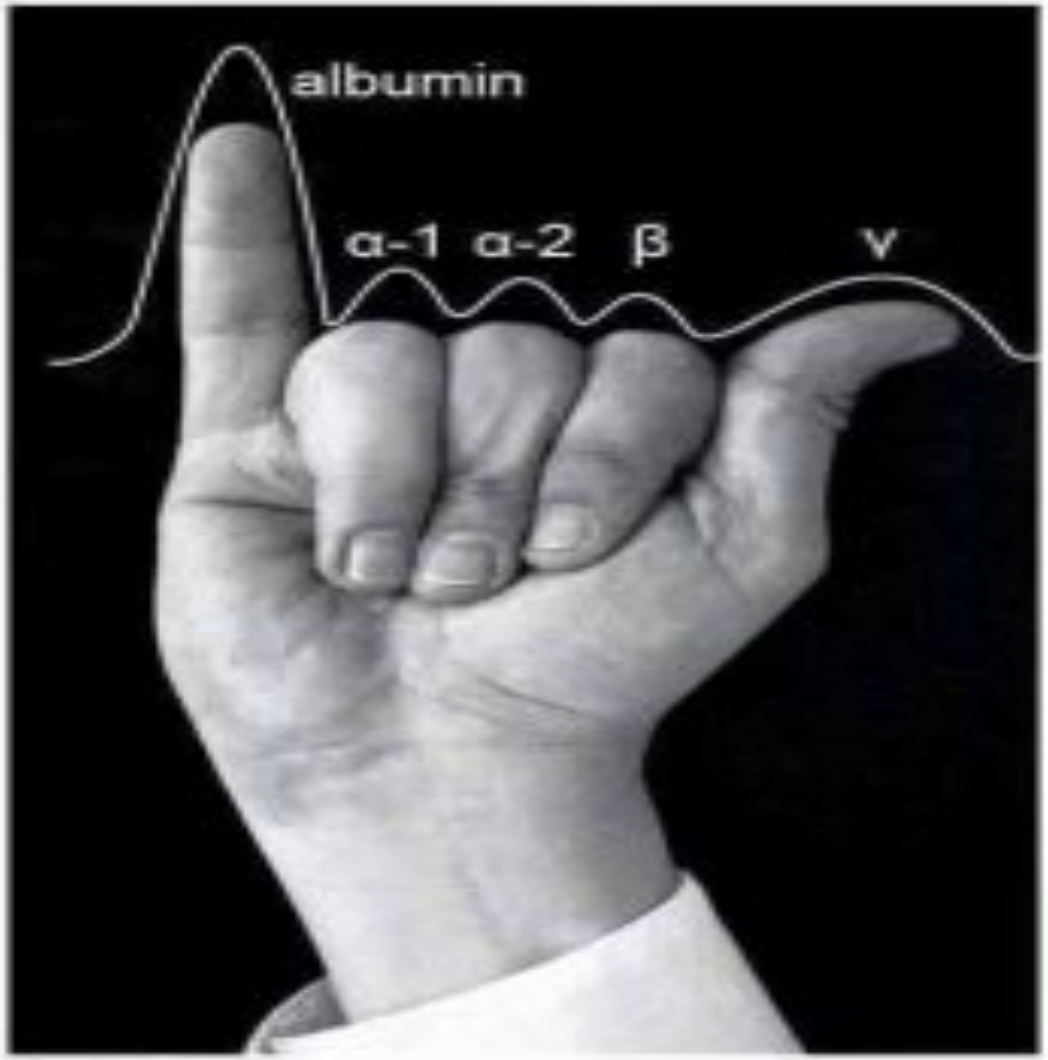




Normal electrophoretic graph and Blood Proteins



Easy way to remember serum protein electrophoresis



Fractions	Rel. amount (%)	c (g/l)
Albumins: albumin	52 – 58	34 – 50
α_1-globulins: thyroxin-binding globulin, transcortin, α_1-acid glycoprotein, α_1-antitrypsin, α_1-lipoprotein (HDL), α_1-fetoprotein	2,4 – 4,4	2-4
α_2-globulins: haptoglobin, macroglobulin, ceruloplasmin	6,1 – 10,1	5 – 9
β-globulins: transferrin, hemopexin, lipoprotein (LDL), fibrinogen, C-reactive protein, C3 and C4 components of the complement system	8,5 – 14,5	6 – 11
γ-globulins: IgG, IgM, IgA, IgD, IgE	10 – 21	8 – 15

Acute phase reactants (APRs)

- **Their levels change during acute inflammatory response**

- **Cause conditions where there is:**
  - **-the destruction of cells**
  - **-the reversible cell damage and subsequent repair**
  - **-the metabolic activation of certain cells (immune cells)**

- **Concentration changes in:**
  - **-infection**
  - **-surgery**
  - **-injury**
  - **-cancer**

Types of APRs:

-C-reactive protein: ~1000-fold increase!

-α_1-antitrypsin

-fibrinogen

-haptoglobin (HP)

-C3, C4

-serum amyloid A (SAA

C-reactive protein (CRP)

- Belongs to β_2-globulin, the levels of which rise in response to inflammation
- Acute-phase reactant
- Plasma concentration levels of CRP **rapidly increase within 2 hours** of acute insult, reaching a **peak at 48 hours** (bacterial, viral, fungal infection, rheumatic diseases, malignity, tissue necrosis)

Fibrinogen

- **Glycoprotein, belongs to β_2-globulins (Mr 340 000)**
- **Concentration in plasma - 1.5 – 4.5 g/l**
- **Component of the coagulation cascade – fibrin precursor**
- **Acute-phase reactant ⇒ ↑ acute inflammation**

Haptoglobin (Hp)

- α_2- globulin, tetramer $\alpha_2\beta_2$ chains
- Exists in 3 polymorphic forms
- Functions:
  - **binds free hemoglobin** and **delivers it to the reticuloendothelial cells**

Ceruloplasmin

- In plasma: 300 mg/l

- Functions:
  - **carries 90% of copper in plasma** (**copper – cofactor for a variety of enzymes**)

    1 molecule binds 6 atoms of copper

    binds copper more tightly than albumin that carries other 10% of plasma copper $\Rightarrow$ albumin may be more important in copper transport (donates copper to tissues more readily)

Transferrin

- Transferrin is a β-globulin
- **It binds free iron in serum**
- Normally it is about one third saturated with iron
- Transferrin levels are **decreased in**:
  - *liver disease (e.g. cirrhosis)*
  - *Chronic infections*
  - *Nephrosis*
  - *Congenitalatransferrinaemia*
- **Increased serum** transferrin levels occur during increased transferrin synthesis caused as a result of iron deficiency anemia

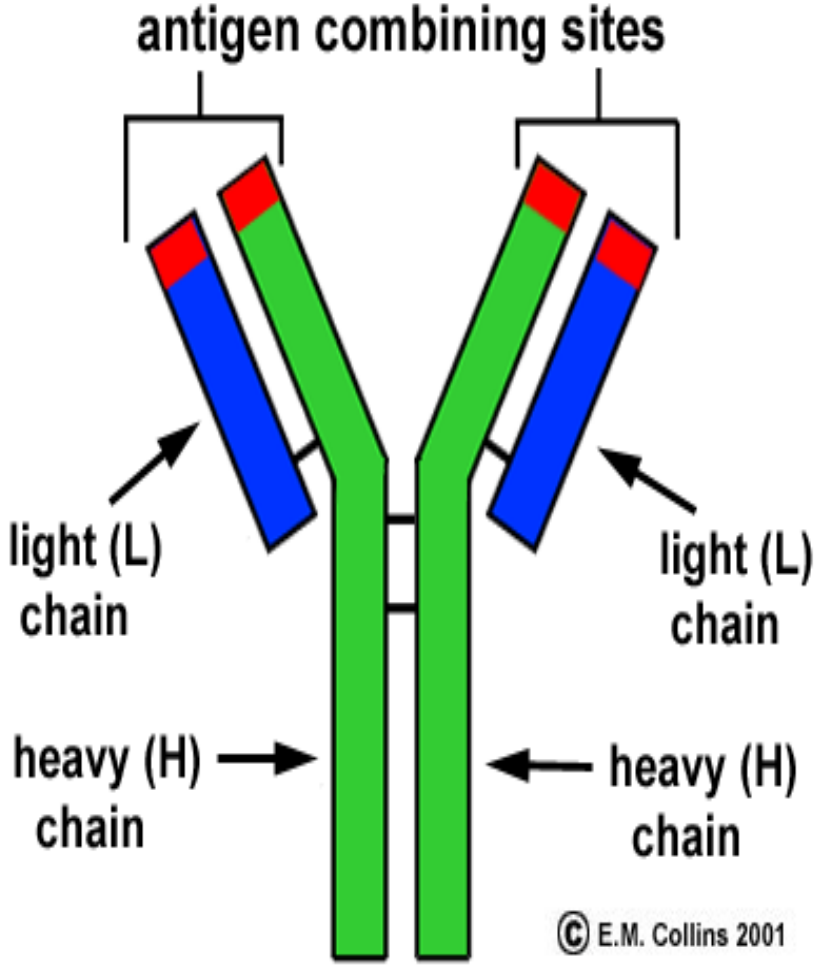
Ferritin

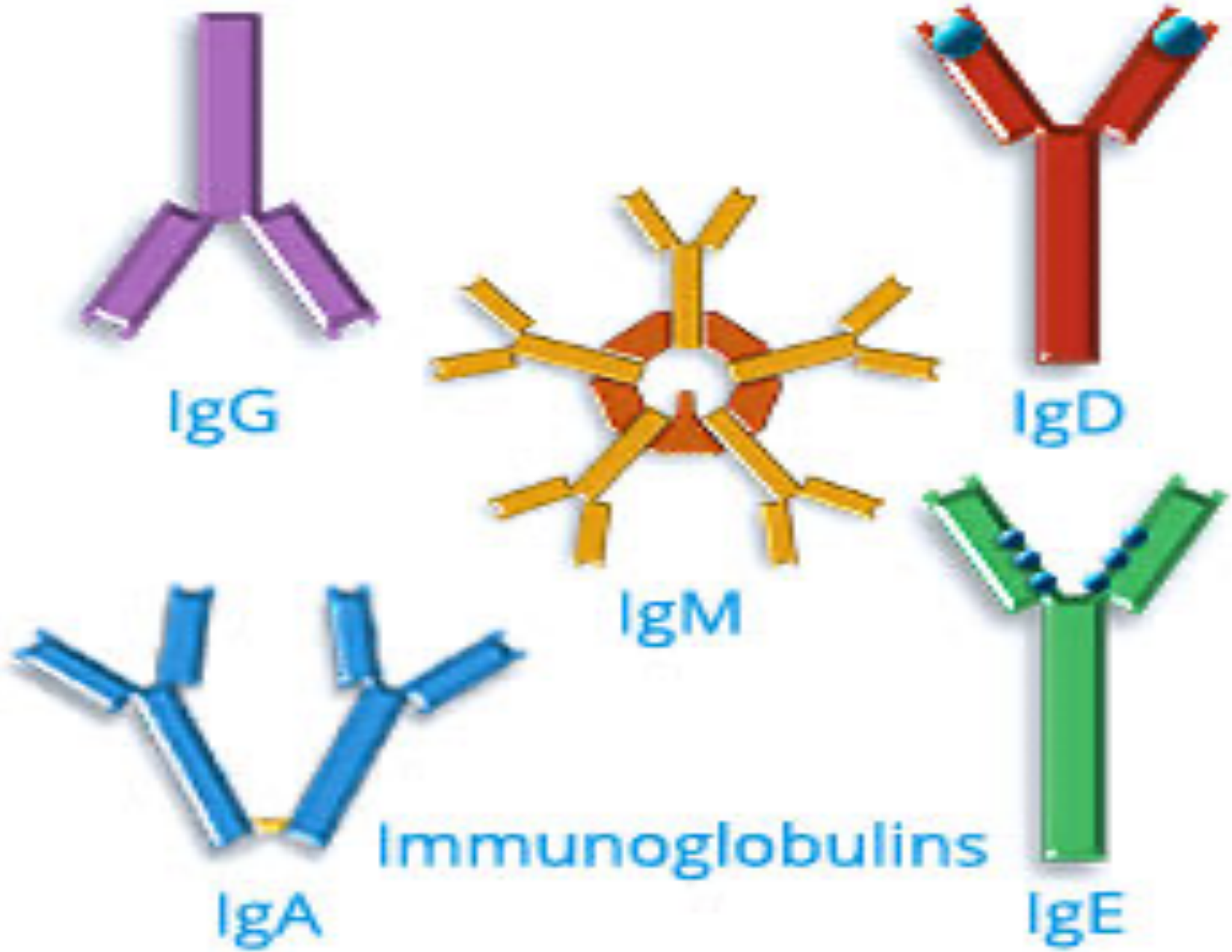
- Intracellular protein; only small portion in plasma
- 24 subunits surround 3000 - 4500 ions of Fe^{3+}
- Function: **stores iron** that **can be called upon for use when needed**
- Primary **hemochromatosis** – genetic disorder characterized by increased absorption of iron from the intestine $\Rightarrow$ accumulated iron damages organs such as the liver, skin, heart, and pancreas. Concentration of ferritin is elevated.

Immunoglobulins

- **Antibodies produced by B cells in response to antigen stimulation of the organism**
- **React specifically with antigenic determinants**

- Structure:
  - consist of a minimum of 4 polypeptide chains - 2 heavy (H) a 2 light (L) linked by disulfide bridges
    - light chains contain constant (C) and variable (V) region




IgG
IgM
IgD
IgA
Immunoglobulins
IgE

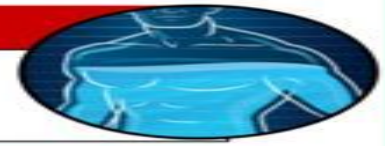
Nursing Mnemonics & Tips

TO REMEMBER IMMUNOGLOBULINS

"GAMED"

G — **IgG**

the most abundant type of antibody, is found in all body fluids and protects against bacterial and viral infections.

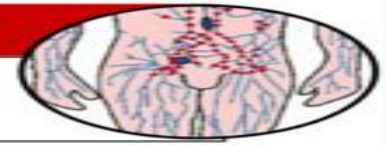


A — **IgA**

is found in high concentrations in the mucous membranes, particularly those lining the respiratory passages and gastrointestinal tract, as well as in saliva and tears.

M — **IgM**

is found mainly in the blood and lymph fluid, is the first antibody to be made by the body to fight a new infection.



E — **IgE**

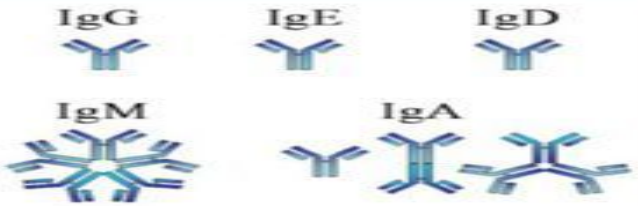
is associated mainly with allergic reactions (when the immune system overreacts to environmental antigens such as pollen or pet dander). It is found in the lungs, skin, and mucous membranes.

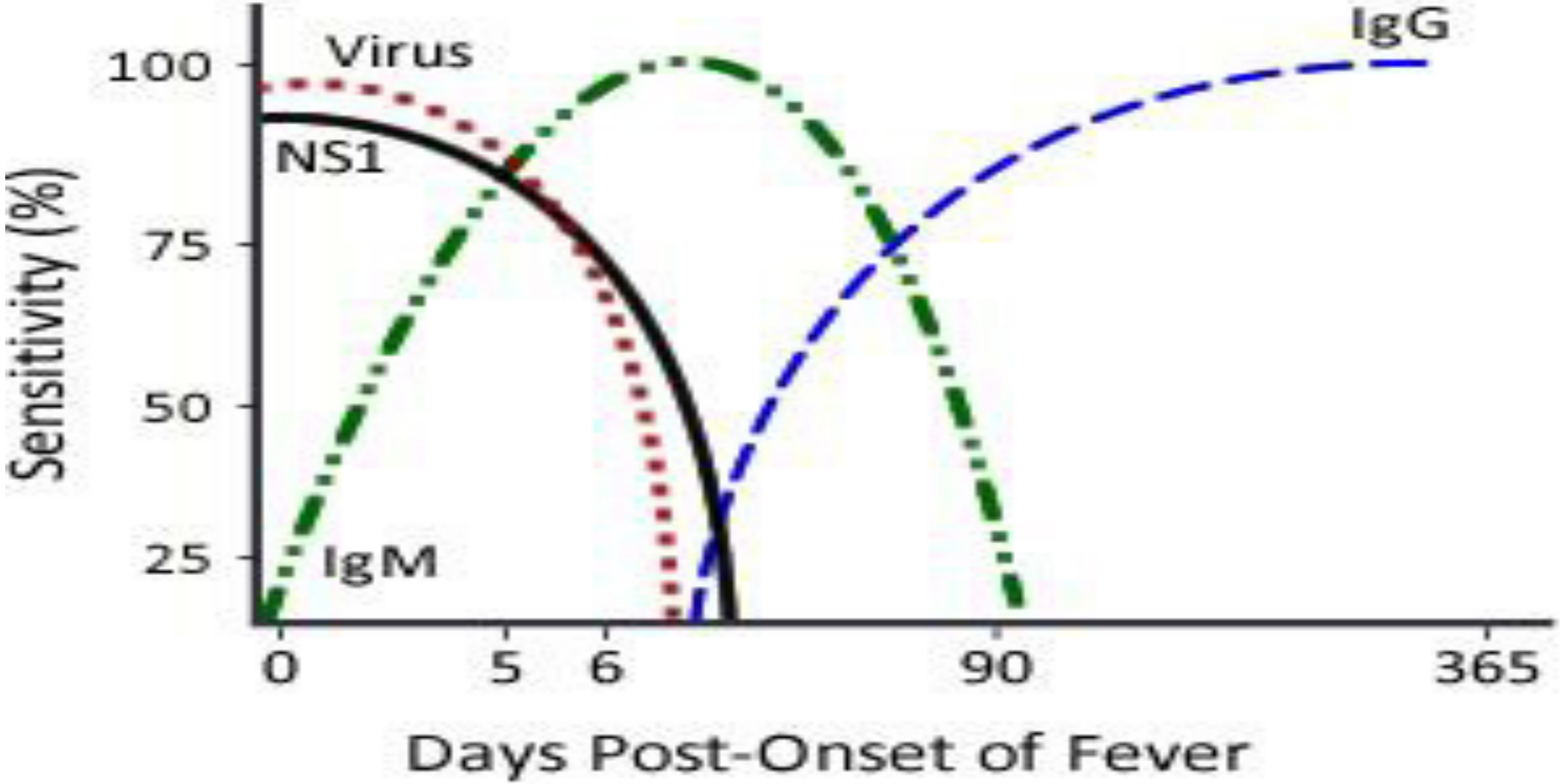
D — **IgD**

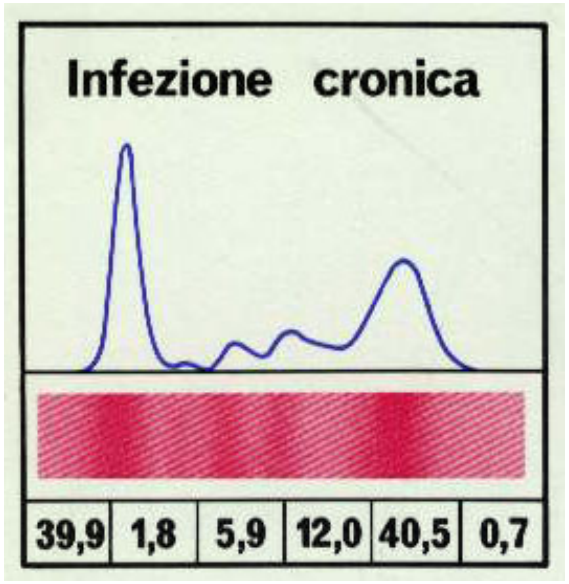
which exists in small amounts in the blood, is the least understood antibody.

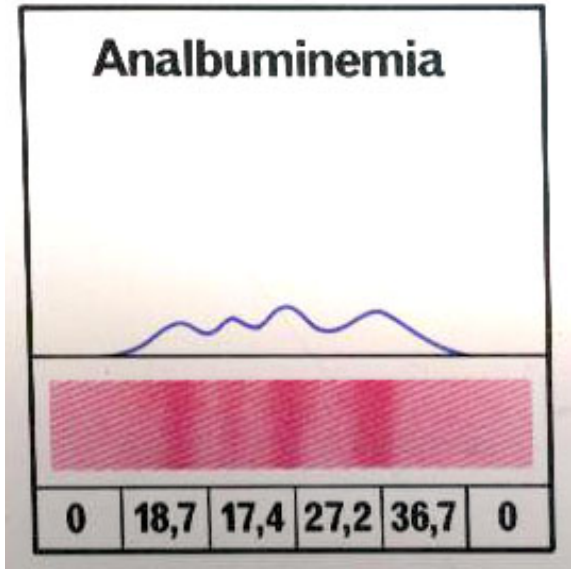
MORE INFORMATION:

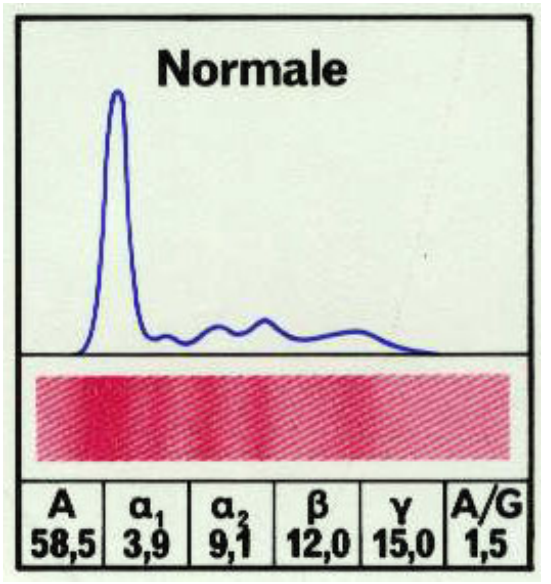
IgA, IgG, and IgM are often measured together. That way, they can give doctors important information about immune system functioning especially relating to infection or autoimmune disease.

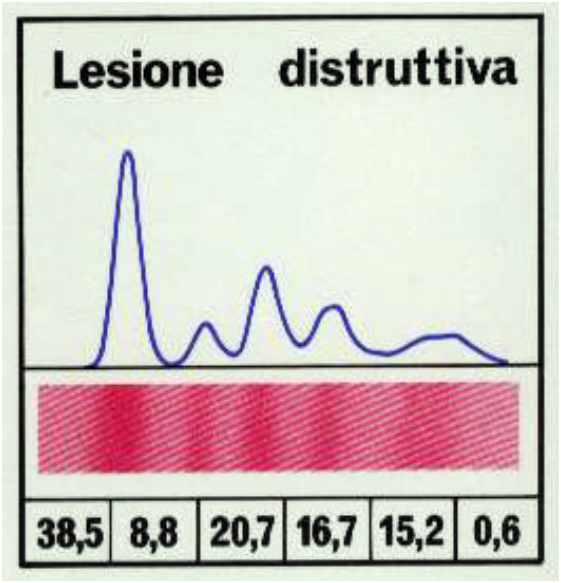


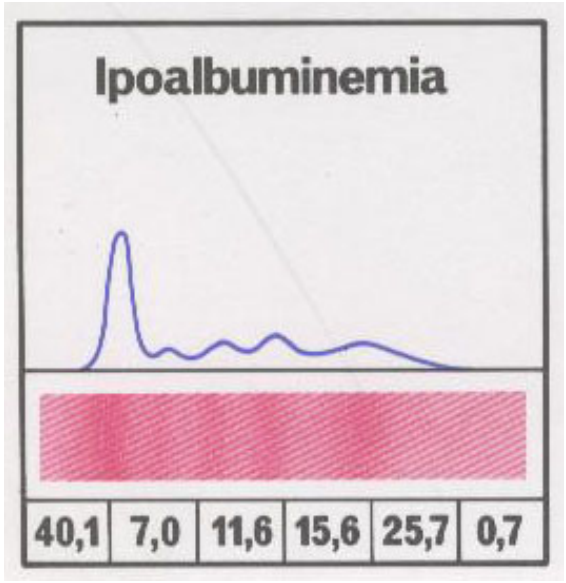

Virus
IgG
NS1
IgM
100
75
50
25
Sensitivity (%)
0
5
6
90
365
Days Post-Onset of Fever

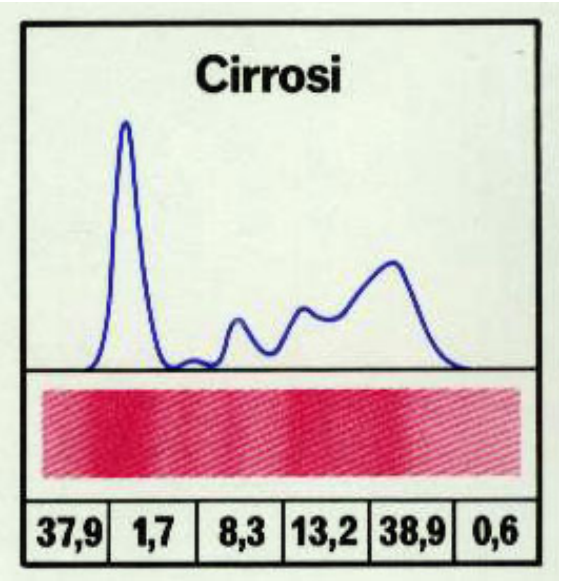

Infezione cronica
39,9 1,8 5,9 12,0 40,5 0,7


Analbuminemia
0 18,7 17,4 27,2 36,7 0


Normale
A 58,5
α1 3,9
α2 9,1
β 12,0
γ 15,0
A/G 1,5


Lesione distruttiva
38,5 8,8 20,7 16,7 15,2 0,6


Ipoalbuminemia
40,1 7,0 11,6 15,6 25,7 0,7


Cirrosi
37,9 1,7 8,3 13,2 38,9 0,6