

Plasma Proteins

Plasma Proteins :

Serum Electrophoretic Pattern — Normal & Abnormal

(All points grounded in the retrieved text)

Normal Pattern

- Serum proteins separate into **5 major fractions** on agar electrophoresis:
Albumin ? ?1 ? ?2 ? ? ? ?
(Albumin has the **maximum mobility**, ?-globulins have **minimum mobility**)
 - **Gamma globulins** contain **immunoglobulins** (antibodies).
?1 mainly contains ?1-antitrypsin.
?2 mainly contains ?2-macroglobulin.
? contains **LDL**.
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Abnormal Electrophoretic Patterns

- **Chronic infections:** smooth, wide-based ?-globulin increase.
 - **Multiple myeloma:** sharp **M-spike** due to monoclonal immunoglobulins.
 - **Plasma (instead of serum):** **Fibrinogen** forms a prominent band in ? region (may mimic M-band).
 - **Primary immune deficiency:** reduced ?-globulin fraction.
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- **Nephrotic syndrome:** massive loss of small proteins ? **prominent ?2 band** (macroglobulin retained).
 - **Cirrhosis:** low albumin, wide ? band; **?-? bridging**.
 - **CLL:** reduced ?-globulins.
 - **?1-antitrypsin deficiency:** thin or missing ?1 band.
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Albumin

(Grounded in PDF lines)

- Major plasma protein; synthesized in liver.
 - Single polypeptide chain; molecular weight ~69,000 Da.
 - Present in **CSF and interstitial fluid** because it can leave circulation.
 - **Half-life:** ~20 days; liver synthesizes ~12 g/day (25% of hepatic protein synthesis).
 - Important functions:
 - Maintains **oncotic pressure**
 - Transports numerous substances (fatty acids, bilirubin, drugs, Ca^{2+} , hormones).
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Transport Proteins (Carrier Proteins)

(Based on Table 28.1)

Major Transport Proteins & Their Functions

- **Albumin:** transports fatty acids, bilirubin, calcium, drugs like aspirin, sulphonamides.
 - **Prealbumin (Transthyretin):** transports steroid hormones, thyroxine, retinol.
Short half-life (1 day).
 - **Retinol Binding Protein (RBP):** transports vitamin A; indicator of protein turnover.
 - **Thyroxine Binding Globulin (TBG):** transports T3, T4.
 - **Transcortin (CBG):** transports cortisol and corticosterone; increased in pregnancy.
 - **Haptoglobin:** binds free hemoglobin; low in hemolysis; acute phase protein.
 - **Transferrin:** transports iron; prevents iron loss.
 - **Hemopexin:** binds free heme; prevents iron loss.
 - **HDL / LDL:** lipoprotein carriers for cholesterol & lipids.
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Polymorphism

(Grounded in PDF)

- A protein shows **different phenotypes in a population**; only one form seen in each person.
- Seen in:
 - **Haptoglobin** (Hp1-1, Hp2-1, Hp2-2)

- **Transferrin**
- **Ceruloplasmin**
- **α1-Antitrypsin**
- **Immunoglobulins**
- Useful for **genetic and anthropological studies**.

Acute Phase Proteins

- Levels increase **50–1000 fold** during **inflammation, infection, trauma, neoplasia**.
- Synthesized mainly by the **liver** under cytokine stimulation (IL-6, IL-1, TNF-α).
- Rise early in inflammation and fall early during recovery.

Major Acute Phase Proteins

- **C-Reactive Protein (CRP)**
 - **Ceruloplasmin**
 - **Haptoglobin**
 - **Fibrinogen**
 - **α1-Antitrypsin**
 - **Complement proteins**
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C-Reactive Protein (CRP)

- Named for its reaction with **C-polysaccharide** of pneumococci.
- A **α₂-globulin**, molecular weight **115–140 kDa**.
- Synthesized in the **liver**.
- Activates **complement** and enhances **phagocytosis**.
- Rises rapidly and falls rapidly (faster response than ESR).
- High-sensitivity CRP correlates with **coronary artery disease risk**.

Ceruloplasmin

- A **blue-colored α₂-globulin** containing **6–8 copper atoms** per molecule.
- Molecular weight ~160 kDa.
- Synthesized mainly in the **liver**; copper incorporated during intracellular processing.
- Plasma **half-life: 4–5 days**.

Functions

- Acts as **ferroxidase** (oxidizes Fe^{2+} to Fe^{3+} for transferrin binding).
- Major **antioxidant** in plasma.
- Carries **90% of plasma copper** (rest loosely bound to albumin).

Decreased Levels

- **Wilson's disease**
- Malnutrition
- Nephrotic syndrome
- Cirrhosis

Increased Levels

- Active hepatitis
- Biliary cirrhosis
- Pregnancy
- Estrogen therapy
- Obstructive biliary disease
- Inflammatory states and malignancy

Alpha-1-Antitrypsin (A1AT)

- Major component of the **α1-globulin** fraction.
- A **protease inhibitor**, especially against **neutrophil elastase**.

Electrophoresis Finding

- In A1AT deficiency ? **thin or absent ?1 band**.

Clinical Importance

- Deficiency causes:
 - **Early-onset emphysema/COPD** (due to unchecked elastase activity).
 - **Cholestatic liver disease/cirrhosis** (due to A1AT accumulation in hepatocytes).
- It is also an **acute phase protein**, so levels may rise in inflammation.

Alpha-2-Macroglobulin (A2M)

- A major protein component of the **?2-globulin** fraction.
- Very **large molecular weight (~725 kDa)**, hence **cannot pass the glomerular filter** easily.

Functions

- Acts as a **pan-protease inhibitor**: inhibits *trypsin*, *chymotrypsin*, *plasmin*, *kallikrein*.
- Binds and inactivates proteases by trapping them inside its structure.
- Transports **cytokines and growth factors**.
- Helps in **immune modulation** and **inflammation control**.

In Electrophoresis

- Produces a **prominent ?2 band** because of large size.
- In **nephrotic syndrome**, smaller proteins are lost in urine, but A2M is retained ?
?2 band becomes markedly increased.

Clinical Significance

- **Increased** in:
 - Nephrotic syndrome (classic)
 - Diabetes mellitus
 - Hyperestrogenic states (pregnancy, estrogen therapy)
- **Decreased** in:
 - Acute pancreatitis
 - Severe liver disease

Negative Acute Phase Proteins

*(Proteins whose levels **decrease** during inflammation)*

During inflammation, the liver shifts toward synthesis of **positive acute phase proteins**, causing a **drop** in the synthesis of certain normal plasma proteins. These are called **negative acute phase proteins**.

Major Negative Acute Phase Proteins

1. Albumin

- Falls because liver prioritizes acute phase proteins.
- Also decreases due to increased capillary leakage.

2. Prealbumin (Transthyretin)

- Sensitive indicator of **nutritional status**.
- Drops rapidly in inflammation.

3. Transferrin

- Decreases because iron sequestration reduces iron transport.
- Helps reduce availability of iron to pathogens.

4. Retinol Binding Protein (RBP)

- Decreases in inflammation and malnutrition.

5. Apolipoproteins (A-I, A-II)

- Mild decrease.

Clinical Utility

- Helps differentiate **acute inflammation** from chronic states.
- Low albumin + high CRP indicates **acute phase response**.
- Prealbumin & transferrin reductions help monitor **malnutrition** vs **inflammation**.

Clotting Factors (Coagulation Factors)

There are **13 factors**, mostly made in the **liver**. Many require **vitamin K** for synthesis (II, VII, IX, X).

List of Clotting Factors

1. **Factor I** – Fibrinogen
2. **Factor II** – Prothrombin
3. **Factor III** – Tissue factor (Thromboplastin)
4. **Factor IV** – Calcium (Ca^{2+})
5. **Factor V** – Proaccelerin
6. **Factor VII** – Proconvertin
7. **Factor VIII** – Antihemophilic factor A
8. **Factor IX** – Christmas factor / AHF B
9. **Factor X** – Stuart–Prower factor
10. **Factor XI** – Plasma thromboplastin antecedent
11. **Factor XII** – Hageman factor
12. **Factor XIII** – Fibrin-stabilizing factor

Coagulation Pathways

- **Intrinsic pathway:** XII → XI → IX → VIII

- **Extrinsic pathway:** Tissue factor (III) + VII
- Both converge on **common pathway:** X ? V ? Prothrombin ? Thrombin ? Fibrinogen ? Fibrin ? XIII (crosslinking)

Vitamin K–dependent factors

- II, VII, IX, X + Protein C & Protein S

Anticoagulants

Substances that **prevent clot formation** in vitro or in vivo.

Natural Anticoagulants

1. Heparin

- Enhances **antithrombin III** ? inactivates IIa (thrombin), Xa, IXa.

2. Antithrombin III

- Inhibits thrombin and factors IXa, Xa, XIa, XIIa.

3. Protein C

- Vitamin K–dependent; activated by thrombin–thrombomodulin complex.

4. Protein S

- Cofactor for Protein C.

5. TFPI (Tissue factor pathway inhibitor)

- Inhibits tissue factor–VIIa complex.

Clinical Anticoagulants

1. Heparin

- Immediate effect.
- Monitored by **aPTT**.

2. Warfarin

- Inhibits vitamin K recycling.
- Affects II, VII, IX, X.
- Monitored by **PT/INR**.

3. Direct Oral Anticoagulants (DOACs)

- Dabigatran (IIa inhibitor), Rivaroxaban/Apixaban (Xa inhibitors).

In Vitro Anticoagulants

- **EDTA** – binds calcium
 - **Citrate** – binds calcium (used in coagulation studies)
 - **Oxalate** – precipitates calcium
 - **Heparin** – used for arterial blood gas samples
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Fibrinolysis

Process that **breaks down fibrin clots**.

Key Components

- **Plasminogen** – inactive precursor
- **Plasmin** – active fibrinolytic enzyme
- Converts fibrin into **Fibrin Degradation Products (FDPs)**, including **D-dimer**.

Activation of Plasminogen

1. **tPA (tissue plasminogen activator)** – endothelial origin
2. **Urokinase**
3. **Factor XIIa**

Inhibitors of Fibrinolysis

- **α₂-antiplasmin** – inhibits plasmin
- **PAI-1** – inhibits tPA and urokinase

Clinical Use

- Elevated **D-dimer** ? DIC, thrombosis, pulmonary embolism.
- **Thrombolytic drugs:**
 - Streptokinase

- Alteplase (tPA)
- Tenecteplase (TNK)

Hemophilia

Hemophilia A

- **Deficiency of Factor VIII.**
- **Most common** inherited coagulation disorder.
- X-linked recessive.
- Prolonged **aPTT**, normal PT & platelet count.
- Clinical:
 - Hemarthrosis
 - Deep muscle bleeds
 - Prolonged bleeding after injury

Hemophilia B

- **Deficiency of Factor IX** (Christmas disease).
- X-linked recessive.
- Similar presentation to hemophilia A.

Hemophilia C

- **Factor XI deficiency**, autosomal recessive.
- Mild bleeding tendency.

Diagnosis

- Prolonged **aPTT**
- Mixing test corrects aPTT
- Specific factor assays confirm diagnosis

Treatment

- Factor VIII/IX concentrates
- Desmopressin (DDAVP) for mild Hemophilia A (releases stored Factor VIII & vWF)
- Avoid intramuscular injections & NSAIDs

Important Points to Remember — Plasma Proteins

- Plasma proteins are synthesized mainly in the **liver**, except **immunoglobulins**, which are formed by **plasma cells**.
- Serum electrophoresis shows **5 major bands**:
Albumin ? ?1 ? ?2 ? ? ? ?
- **Albumin** has the **highest mobility** and contributes most to **oncotic pressure**.

- **Gamma globulin** fraction contains **immunoglobulins (IgG, IgA, IgM, IgD, IgE)**.
- **Nephrotic syndrome** shows ↓ albumin, ↓ C_3 , ↓ C_4 , and **marked ↑ C_{199}** (due to ↑2-macroglobulin retention).
- **Cirrhosis** shows **↑-↑ bridging** due to increased IgA.
- **Multiple myeloma** shows a sharp **M-band** in γ region.
- **Albumin** transports fatty acids, bilirubin, Ca^{2+} , drugs; low albumin occurs in liver disease, nephrotic syndrome, malnutrition.
- **Prealbumin (transthyretin)** is a sensitive marker of **protein-energy malnutrition**.
- **Transferrin** is a negative acute phase protein; ↓ in iron deficiency anemia.
- **Haptoglobin** decreases in **hemolysis** due to binding hemoglobin.
- **Ceruloplasmin** contains **6–8 copper atoms**; low in **Wilson's disease**.
- **C-Reactive Protein (CRP)** rises rapidly in inflammation; **high-sensitivity CRP** predicts coronary artery disease risk.
- **Alpha-1-antitrypsin (A1AT)** is a protease inhibitor; deficiency causes **early-onset emphysema**.
- **Alpha-2-macroglobulin** is massively increased in **nephrotic syndrome** (cannot be filtered due to large size).
- **Negative acute phase proteins:** albumin, prealbumin, transferrin, RBP.
- **Clotting factors:** II, VII, IX, X are **vitamin K-dependent**.

- **Factor VIII deficiency? Hemophilia A**, X-linked recessive.
- **Fibrinolysis** is mediated by **plasmin**, activated by **tPA**, urokinase, streptokinase.
- **D-dimer** increases when fibrin is degraded ? used to detect thrombosis & DIC.

FAQs — Plasma Proteins (Viva-oriented)

1. What are the major fractions seen on serum electrophoresis?

Albumin, α_1 , α_2 , β , γ .

2. Which fraction is largest in normal serum?

Albumin (50–60% of total proteins).

3. What causes α_1 band to disappear?

Alpha-1-antitrypsin deficiency.

4. What causes a marked increase in α_2 band?

Nephrotic syndrome (retention of α_2 -macroglobulin).

5. What is α - β bridging and where is it seen?

Fusion of α and β region; seen in **cirrhosis**.

6. Which condition shows an M-spike on electrophoresis?

Multiple myeloma.

7. Name the major transport proteins in plasma.

Albumin, prealbumin, RBP, TBG, CBG, transferrin, hemopexin.

8. What is the function of haptoglobin?

Binds free hemoglobin; ? in hemolysis.

9. What is the main function of ceruloplasmin?

Copper transport and **ferroxidase** activity ($\text{Fe}^{2+} \rightarrow \text{Fe}^{3+}$).

10. Where is CRP synthesized and when does it rise?

Synthesized in the **liver**; rises in **acute inflammation**.

11. What are negative acute phase proteins?

Proteins that **decrease** during inflammation—albumin, prealbumin, transferrin, RBP.

12. What is the clinical significance of alpha-1-antitrypsin deficiency?

Causes **early-onset emphysema** due to unopposed elastase activity.

13. Why is alpha-2-macroglobulin high in nephrotic syndrome?

Large size prevents filtration ? accumulates in plasma.

14. Which clotting factors are vitamin K-dependent?

II, VII, IX, X, Protein C, Protein S.

15. What activates plasminogen?

tPA, urokinase, streptokinase.

16. What is elevated in active fibrinolysis?

D-dimer.

17. What is the defect in Hemophilia A?

Factor VIII deficiency, X-linked recessive.

18. What happens to prothrombin time in liver disease?

PT becomes prolonged (liver synthesizes most clotting factors).

19. What is the carrier protein for retinol?

Retinol Binding Protein (RBP).

20. Which protein has the role of anti-oxidant and copper carrier?

Ceruloplasmin.

MCQs — Plasma Proteins

1. The major protein fraction seen on serum electrophoresis is:

- A. γ -globulin
- B. α_2 -globulin
- C. Albumin
- D. β -globulin

Answer: C

2. A sharp M-band in the γ region suggests:

- A. Cirrhosis
- B. Nephrotic syndrome
- C. Multiple myeloma
- D. Hemolytic anemia

Answer: C

3. α_2 - μ bridging in electrophoresis is characteristic of:

- A. Acute inflammation
- B. Cirrhosis
- C. Nephrotic syndrome
- D. Primary immune deficiency

Answer: B

4. The α_1 region mainly contains:

- A. Haptoglobin
- B. Ceruloplasmin
- C. Alpha-1-antitrypsin
- D. Fibrinogen

Answer: C

5. In nephrotic syndrome, the fraction that becomes markedly elevated is:

- A. Albumin
- B. α_1
- C. α_2
- D. β

Answer: C

6. Which plasma protein transports the highest proportion of copper?

- A. Albumin
- B. Transferrin
- C. Ceruloplasmin
- D. Hemopexin

Answer: C

7. Low ceruloplasmin levels are seen in:

- A. Wilson's disease
- B. Hemochromatosis

- C. Pregnancy
- D. Estrogen therapy

Answer: A

8. Which protein rises rapidly and falls rapidly during inflammation?

- A. Albumin
- B. CRP
- C. TBG
- D. Transferrin

Answer: B

9. Negative acute phase proteins include:

- A. CRP
- B. Haptoglobin
- C. Albumin
- D. Fibrinogen

Answer: C

10. Alpha-2-macroglobulin is typically increased in:

- A. Liver cirrhosis
- B. Hemolytic anemia
- C. Nephrotic syndrome
- D. Multiple myeloma

Answer: C

11. Retinol Binding Protein is a transporter of:

- A. Vitamin D
- B. Vitamin A
- C. Thyroxine
- D. Cortisol

Answer: B

12. A thin or absent α_1 band on electrophoresis indicates:

- A. Hypoalbuminemia
- B. α_1 AT deficiency
- C. Wilson's disease
- D. IgA deficiency

Answer: B

13. Which is a vitamin K-dependent protein?

- A. Fibrinogen
- B. Ceruloplasmin
- C. Factor VII
- D. Factor VIII

Answer: C

14. CRP belongs to which fraction in electrophoresis?

- A. Albumin
- B. α_1
- C. β
- D. γ

Answer: C

15. The main ferroxidase in plasma is:

- A. Transferrin
- B. Ceruloplasmin
- C. Hemopexin
- D. Ferritin

Answer: B

16. Haptoglobin decreases in:

- A. Obesity
- B. Hemolysis

- C. Nephrotic syndrome
- D. Hypothyroidism

Answer: B

17. Which of the following increases in pregnancy and estrogen therapy?

- A. α 1-antitrypsin
- B. Transferrin
- C. Ceruloplasmin
- D. Albumin

Answer: C

18. Factor VIII deficiency leads to:

- A. Hemophilia B
- B. Hemophilia A
- C. Hemophilia C
- D. Von Willebrand disease

Answer: B

19. Plasmin breaks down fibrin to produce:

- A. Ferritin
- B. D-dimer
- C. Reticulin
- D. Heme

Answer: B

20. Which transport protein binds cortisol?

- A. CBG (Transcortin)
- B. TBG
- C. Albumin
- D. Hemopexin

Answer: A

Clinical Case–Based Questions — Plasma Proteins

Case 1 — M-band in γ region

A 58-year-old man presents with bone pain and recurrent infections. Serum electrophoresis shows a **sharp M-spike in the γ region**.

Q: What is the most likely diagnosis?

Answer: Multiple myeloma

Explanation: Monoclonal Ig production creates a narrow M-band.

Case 2 — α – γ Bridging

A 45-year-old male with long-standing alcoholism shows **merging of α and γ bands** on electrophoresis.

Q: What condition does this pattern suggest?

Answer: Liver cirrhosis

Explanation: Increased IgA causes α – γ bridging.

Case 3 — Nephrotic pattern

A child presents with pitting edema. Serum electrophoresis shows **high γ 2 band** and **very low albumin**.

Q: What disorder is most likely?

Answer: Nephrotic syndrome

Explanation: Loss of smaller proteins in urine; large γ 2-macroglobulin is retained γ 2 spike.

Case 4 — Thin γ 1 band

A 20-year-old nonsmoker develops early-onset emphysema. Serum electrophoresis shows **absent α_1 band**.

Q: Which protein is deficient?

Answer: Alpha-1-antitrypsin

Explanation: A1AT deficiency ? absent α_1 region.

Case 5 — Low ceruloplasmin

A 14-year-old boy presents with tremors and Kayser–Fleischer rings. Lab reports show **very low ceruloplasmin**.

Q: What is the most likely diagnosis?

Answer: Wilson’s disease

Explanation: Defective copper incorporation ? low ceruloplasmin.

Case 6 — Elevated CRP

A 30-year-old woman develops fever and joint swelling. CRP is markedly elevated but ESR is normal.

Q: What does this imply?

Answer: Very early acute inflammation

Explanation: CRP rises before ESR.

Case 7 — High haptoglobin

A patient recovering from intravascular hemolysis shows increasing haptoglobin levels.

Q: What does low haptoglobin indicate during active hemolysis?

Answer: Binding and clearance of free hemoglobin

Explanation: Haptoglobin decreases because it binds Hb-released in hemolysis.

Case 8 — High transferrin

A 28-year-old woman with fatigue shows **high transferrin** and **low ferritin**.

Q: What condition is most likely?

Answer: Iron deficiency anemia

Explanation: Transferrin increases to capture more iron.

Case 9 — Copper overload signs absent

A pregnant woman shows **high ceruloplasmin**, but no neurologic signs.

Q: What explains this elevated ceruloplasmin?

Answer: Physiological rise during pregnancy

Explanation: Estrogen increases ceruloplasmin synthesis.

Case 10 — Elevated α_2 -globulin without edema

A diabetic patient's electrophoresis shows mildly elevated **α_2 -macroglobulin** but normal albumin.

Q: Why may α_2 -macroglobulin be elevated in diabetes?

Answer: Compensatory increase due to glycation & inflammation

Explanation: Chronic hyperglycemia increases A2M synthesis.

Case 11 — Severe malnutrition

A child with severe protein-energy malnutrition has very low **prealbumin** and **RBP**.

Q: Why are these low?

Answer: Short half-life & rapid fall during malnutrition

Explanation: Prealbumin (2 days) and RBP (12 hours) drop quickly.

Case 12 — Prolonged PT/INR

A patient with jaundice has prolonged PT/INR but normal platelet count.

Q: What major plasma proteins are affected in liver failure?

Answer: Clotting factors (II, VII, IX, X)

Explanation: Liver synthesizes vitamin K-dependent factors ? PT prolongs.

Case 13 — D-dimer elevation

A 45-year-old man presents with sudden dyspnea; D-dimer is high.

Q: What does this indicate?

Answer: Active fibrinolysis due to thrombosis/PE

Explanation: Plasmin degrades fibrin → D-dimer formation.

Case 14 — Hemarthrosis in a child

An 8-year-old boy has recurrent joint bleeding. aPTT is prolonged; PT normal.

Q: What is the likely diagnosis?

Answer: Hemophilia A or B

Explanation: Intrinsic pathway factors (VIII or IX) are deficient.

Case 15 — Low albumin, but normal globulins

A 50-year-old patient with chronic liver disease shows very low albumin but normal α -globulins.

Q: Why are gammaglobulins preserved?

Answer: Produced by plasma cells, not the liver

Explanation: Liver failure reduces albumin but immunoglobulins remain.

Viva Voce — Plasma Proteins (Short Q&A)

1. What is the major plasma protein?

Albumin.

2. Where are most plasma proteins synthesized?

Liver.

3. Which plasma proteins are NOT synthesized in the liver?

Immunoglobulins (made by plasma cells).

4. What is the normal albumin level?

3.5–5.0 g/dL.

5. What is the main function of albumin?

Maintains **oncotic pressure** and **transports** many molecules.

6. Which band moves fastest on electrophoresis?

Albumin band.

7. What does α_2 - β bridging indicate?

Liver cirrhosis.

8. What does an M-band represent?

Monoclonal immunoglobulin (multiple myeloma).

9. Which band contains α_1 -antitrypsin?

α_1 -globulin band.

10. Which fraction is markedly increased in nephrotic syndrome?

β_2 -globulin (due to β_2 -macroglobulin).

11. What is the function of haptoglobin?

Binds **free hemoglobin**.

12. Why is haptoglobin low in hemolysis?

It is **consumed** while binding Hb.

13. What is the function of transferrin?

Iron transport.

14. Which transporter carries vitamin A?

Retinol Binding Protein (RBP).

15. What is the major copper-carrying protein?

Ceruloplasmin.

16. What enzyme activity does ceruloplasmin have?

Ferroxidase activity ($\text{Fe}^{2+} \rightarrow \text{Fe}^{3+}$).

17. Low ceruloplasmin is seen in which disease?

Wilson's disease.

18. Which protein rises rapidly in acute inflammation?

C-Reactive Protein (CRP).

19. Name two negative acute phase proteins.

Albumin, Transferrin.

20. Name two vitamin K-dependent factors.

II and VII (also IX, X).

21. Which factor deficiency causes Hemophilia A?

Factor VIII.

22. Which factor deficiency causes Hemophilia B?

Factor IX.

23. What is the role of plasmin?

Breaks down fibrin ? **fibrinolysis.**

24. What test detects fibrin degradation?

D-dimer test.

25. What activates plasminogen physiologically?

tPA (tissue plasminogen activator).

26. What is the main inhibitor of plasmin?

?2-antiplasmin.

27. What happens to PT in liver failure?

PT is **prolonged.**

28. Which plasma protein has the shortest half-life?

RBP (12 hours).

Prealbumin is next (~2 days).

29. What causes absent ?1 band on electrophoresis?

Alpha-1-antitrypsin deficiency.

30. Why is ?2-macroglobulin high in nephrotic syndrome?

Large size ? **cannot be filtered** ? accumulates.
