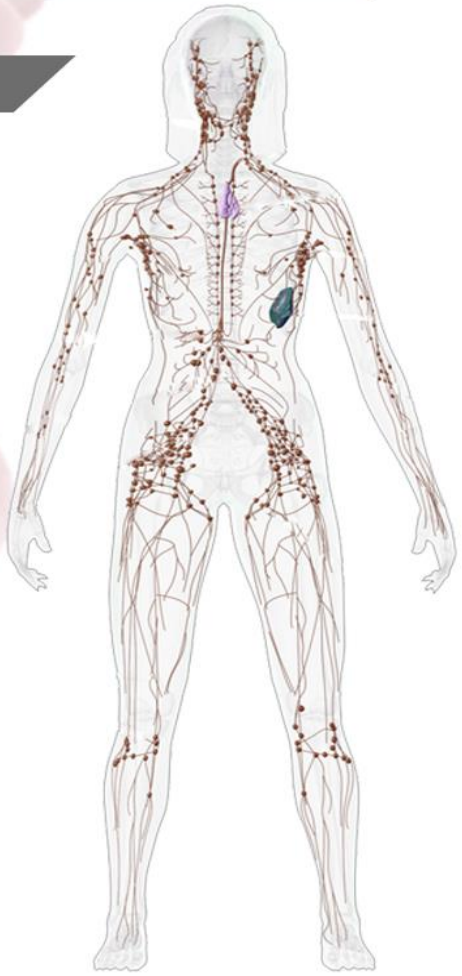
Sheet 1

Hematology and Lymphatic system

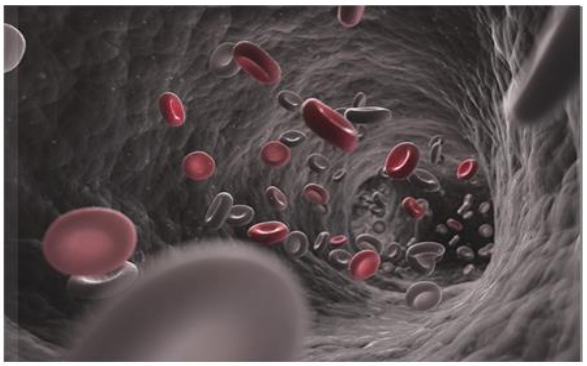
Subject | Physiology



Done by | Tala Saleh

Corrected by | ...

Doctor | Saleem Kh.



Introduction

- Blood is a body fluid and a specialized connective tissue, it performs many important functions within the body, including:

  1- Transportation of CO_2, O_2, nutrients, hormones, enzymes, etc.
  2- Removal of waste products.
  3- Regulation of body temperature and body fluids.
  4- Immunological functions through immunoglobulins.

Blood composition:

- In the average 70-Kg man, the total body water is **45L** (about 65% of the bodyweight), **5L** of these fluids are **blood**.

<table>
<tr><td rowspan="5">5L of blood</td><td rowspan="2">Plasma 55%</td><td colspan="2">Water 90%</td></tr>
<tr><td>Solids 10%</td><td>Plasma proteins (having the highest percentage 6-8%).
Electrolyte (<1%).
Gases (CO_2, O_2, N_2).
Nutrients (glucose, amino acids, etc.).
Waste products (urea, creatinine, uric acid, bilirubin).</td></tr>
<tr><td rowspan="3">Cells 45%
(also called 'formed elements'; as they are formed after centrifuging the blood)</td><td colspan="2">Erythrocytes.</td></tr>
<tr><td colspan="2">Leukocytes (Neutrophils, eosinophils, basophils, lymphocytes and monocytes).</td></tr>
<tr><td colspan="2">Thrombocytes (platelets).</td></tr>
</table>

- Used **volume units** when counting blood cells are:

  Microlitre (µL) = Millimetre cubed (mm^3) // Millilitres (mL) // Litres (L).

- **Normal** erythrocytes (RBCs) counts are: *'memorize'*

  In males: about 5 million cells per µL (4.3 - 5.9).
  In females: about 4.5 million cells per µL (3.5 - 5.5).

  Note how males have **higher** RBCs count than females because of hormones like **androgens** (i.e.: testosterone) which **stimulate RBC synthesis** (erythropoiesis).

Plasma Proteins

(6-8% of blood plasma)

- **Almost** all plasma proteins are produced in the **liver**, thus diseases affecting the liver's function will influence the production of these proteins. There are over 1400 identified plasma proteins, the **main** plasma proteins are:

1- **Albumin** (4.5 g/100 ml), most abundant plasma protein and the main generator of **oncotic pressure**.

2- **Fibrinogens** (0.3 g/100 ml), contributes to plasma **viscosity**.

3- **Globulins** (2.5 g/100 ml). **Alpha** and **beta** globulins are produced by the **liver**, while **gamma** globulins (including Immunoglobins), are produced by **lymphocytes**.

4- **Prothrombins**.

- **Functions** of plasma proteins:

1- **Transportation** (for gases, hormones, nutrients, etc.)

2- **Defense**, through immunoglobulins (produced by lymphocytes).

3- **Blood coagulation**, through fibrinogen and prothrombin.

4- **Reserving body protein.** Even during hypoproteinemia plasma protein may promptly pass out of the circulation to supply body needs for protein.

5- **Viscosity**, mainly due to fibrinogen and globulins.

> ***Note:*** *when we talk about blood, RBCs have the greatest effect on blood viscosity, but when we solely talk about plasma, fibrinogen has the greatest effect.*

6- Maintain exchange of fluids between the capillaries and tissues by the oncotic or colloidal osmotic pressure which is mainly produced by albumins.

> ***Note:*** *Oncotic pressure normal value ranges from 25-28 millimeter mercury (mmHg).*

Complete and incomplete proteins

- Plasma proteins are made of amino acids. Amino acids are either essential, or nonessential.
- **Complete** proteins contain all the **nine** essential amino acids the body requires, whereas **incomplete** proteins are **missing** one or more.
- The most important sources of complete proteins are eggs, chicken and fish.
- Incomplete proteins are provided by **vegetables**. Vegetarians are exposed to develop amino acid deficiency because they don't take complete proteins.

Blood pH

- **Normal blood pH** ranges from **7.35 - 7.45**, the **neutral** point being **7.4**.
- The pH scale of blood is different than that of water, due to having different neutral point, where for water it's 7 whereas blood is 7.4, therefore, **below** 7.4 is **acidic** and **above** 7.4 is **basic**.
- When pH levels are above 8 or below 6.8, the following occurs:

1- Enzymes are **denaturated** and their function is disturbed. The most important enzyme that will be affected is the **sodium-potassium pump** (Na^+ /K^+ ATPase).

2- Affects the **H^+/ K^+** pumps, thus the entry and exit of K^+ are altered and that, in turn, disturbs the internal environment (blood homeostasis).

3- Over or hypo-excitability of the CNS.

Blood Distribution and Volume

- **Blood distribution:**

Veins	**65-75%**
Arteries	**10-15%**
Lungs	**10%**
Capillaries	**5%**
Heart	**5%**

- **Blood volume** varies physiologically due to 8 factors:

1- **Gender**: there is a difference between males and females, as males have a higher blood volume due to hormones (androgens).

2- **Pregnancy**: pregnant women have more plasma and blood volume due to hormonal changes.

3- **Muscular exercise**: it increases blood volume.

4- **Posture**: in the standing position there is a reduction in blood volume of about 15%, in which this 15% "goes" into the interstitial fluid.

5- **Blood pressure**: elevated blood pressure lowers blood volume.

6- **Altitude**: increases blood volume. As we ascend in altitude, less oxygen is taken with each breath; leading to hypoxia thus stimulates RBCs production which in turn increases blood volume.

7- **Excitement**: in which case adrenaline is released increasing the blood volume.

8- **Contraction of the spleen**: as it contains blood, it increases blood volume.

Good Luck