HLS

MODIFIED NO. 1

PHYSIOLOGY

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Introduction: Red Blood Cells, Anemia and Polycythemia

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UNIT VI

Chapter 33

Color code
Slides
Doctor
Additional info
Important

☞ Learning Objectives

- Identify blood components (formed elements), their main characteristics and functions.
- Understand genesis of blood cells (hematopoiesis)
- Describe regulation red blood cells production
- Identify requirements for erythropoiesis
- Describe red blood cells cycle
- Define abnormalities of red blood cells

Functions of Blood

- **Transport** Mediated through RBCs Or the fluid(plasma)

O2, CO2, nutrients, wastes (carry the wastes that are eliminated from the cells to kidney ,liver , lungs)**,**

hormones (regulatory substances)

Blood is part of extracellular compartment
- Extracellular = blood + interstitial fluid
- Intracellular (60%) > extracellular (40%)

- **Regulation**

pH , temp , Blood pressure , volume, Osmotic pressure

- **Protection**

Clot in case of hemorrhage and the vessels were cut some components of the blood will help coagulate the blood thus preserving the blood

immune cells protect us from invasion by pathogens from the external environment (wbc , complement system, immunoglobulins)

Proteins carry certain ions and cations from being free and interacting with cells changing the structure and function

pH (is mediated through: bicarbonate HCO^{3-} (VERY IMPORTANT FOR PH), different electrolytes and proteins),(a very narrow window of pH is allowed within our bodies)

temp (blood mainly consists of water and due to its physical properties (high specific heat) it can help regulate the temperature and blood flow

↑ in Temp. → vasodilate the vessels to release heat / ↓ in Temp. → constrict the vessels to conserve heat

Note proteins and cells work optimally in a certain range of temperature, any increase or decrease in temperature can lead to abnormal function and even death

Blood pressure , volume (blood volume determines blood pressure)

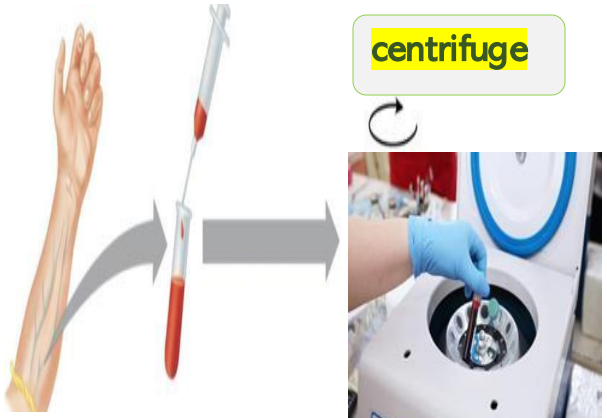
Osmotic pressure: related to proteins (Oncotic pressure) and electrolytes in blood → control the net movement of fluid between compartments thus determining the volume.

Consuming a salty meal or receiving IV fluids with high sodium chloride (NaCl) levels will result in: - Fluid moving from the interstitial space into the bloodstream, increasing the electrolytes concentration of the interstitial fluid

—>This leads to fluid shifting from inside the cells to the interstitial space

raising both extracellular volume and blood volume.

Exchange (nutrients and gases) in capillaries beds is facilitated by oncotic pressure



centrifuge

Lowest density

Plasma (55%)

Clear straw yellowish liquid

In middle

Buffy coat, composed of white blood cells and platelets

Red blood cells (45%)

Highest density

Packed red blood cell volume (in red)

(a) Appearance of centrifuged blood

Figure 19.01a Tortora - PAP 12/e
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Hematocrit (Hct) is a measure of the proportion of red blood cells (RBCs) volume in a person's blood

Whole blood 8%

Other fluids and tissues 92%

BODY WEIGHT

Blood plasma 55%

Formed elements 45%

VOLUME

Proteins 7%

Albumins 54%

Globulins 38%

Fibrinogen 7%

All others 1%

Water 91.5%

Mostly water

Mostly NaCl

Electrolytes

Nutrients

Gases

Hormones

Regulatory substances

Other solutes 1.5%

Waste products

Ammonia, uric acid CO_2 , Urea Creatinine

PLASMA (weight)

SOLUTES

Platelets 150,000–400,000

1%

White blood cells 5,000–10,000

Red blood cells 4.8–5.4 million

99%

Mostly RBC

FORMED ELEMENTS (number per μL)

Neutrophils 60–70%

Lymphocytes 20–25%

Monocytes 3–8%

Eosinophils 2–4%

Basophils 0.5–1.0%

WHITE BLOOD CELLS

(b) Components of blood

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THE FIGURE ABOVE IS IMPORTANT DO NOT SKIP

When a blood sample is taken and centrifuged in the laboratory, it separates into layers based on density.
The bottom layer, known as packed red blood cells (RBCs), contains the most dense components.
Above this is a clear, pale yellow liquid called plasma.
In between these two layers is a narrow white band known as the buffy coat, which consists of white blood cells (WBCs) and platelets. This layer is less dense than RBCs but more dense than plasma, although it occupies a smaller volume.
The formed elements of blood include RBCs, WBCs, and platelets, with RBCs making up the majority. Plasma, which constitutes about 55% of blood volume, is acellular (no cells) and primarily composed of water (91.5%) and solutes such as gases, proteins(7% , largest solute in the plasma, most of them are proteins only present in the blood such as albumin (major protein in the blood contributes to the osmotic pressure of the blood) , fibrinogen , globulins) , electrolytes (mostly NaCl)
The volume percentage of red blood cells is approximately 45%, a measurement known as hematocrit (Hct).
Overall, blood accounts for about 8% of total body fluids.

- 45% of formed elements (cells or fragments of cells): The majority of formed elements are red blood cells (RBCs), making up 99% of the formed elements, while white blood cells (WBCs) and platelets constitute 1% of the formed elements.
- Normal RBC count is approximately 4.8 - 5.4 million per microliter, and it varies between males and females (higher in males) due to factors like hormones, other factors also affect the count such as hypoxia etc.
- Normal WBC count is approximately 5000 - 10000 per microliter.
- Normal platelet count is approximately 150000 - 400000 per microliter.
- The most abundant WBCs are neutrophils (60-70% of WBCs), followed by lymphocytes (25%), monocytes (3-8%), eosinophils (2-4%), and the least abundant are basophils (0.5-1%). Each type has specific functions, and their numbers can change based on conditions such as infections and allergies.

Blood physical characteristics: (mimics water, as water is the solvent of blood.)

- 38 C (about one degree higher than oral or rectal temperature).
- Viscous sticky (more viscous than water)
- alkaline pH 7.35-7.45 (narrow range)
- Color depends on O2 (bright-dark) red
- 20% of ECF, 8% by weight
- 8%*the weight = volume/weight of the blood
- Blood volume: 5-6 L males, 4-5 L females / Body size

The variation in blood volume is closely related to body size.

- Hormonal regulation: RAAS, ANP,ADH (by regulating water volume, we can regulate blood volume).

• Slightly alkaline pH (7.35-7.45): If the pH decreases → acidosis, and if it increases → alkalosis. The body tries to correct the pH to normal through various mechanisms, including blood (which contains proteins that act as buffers), the lungs, and the kidneys.

Hormonal regulation: The volume of blood is highly regulated by various mechanisms because it is directly related to blood pressure.

- Decreased blood pressure is dangerous as it can lead to brain hypoxia and coma.
- 1)RAAS (Renin-Angiotensin-Aldosterone System): This system controls the levels of Na+, which affects water reabsorption or excretion in the kidneys.
- 2)ANP (Atrial Natriuretic Peptide): Natriuretic means it increases Na+ excretion, thus reducing blood pressure (it acts as a natural antihypertensive).
- Remember: Water always follows solutes.
- 3)ADH (Anti-Diuretic Hormone) or Vasopressin: Anti-diuretic means it decreases diuresis, conserving water in cases of low blood pressure or dehydration.

Question

There are different types of blood sampling tubes. Depending on the test you are going to perform in the lab, there is a suitable tube for each test.

Are all blood sampling tubes the same? And procedures?

Tubes: there are a lot of procedures to withdrawal blood sample from patients (from veins, arteries or capillaries):

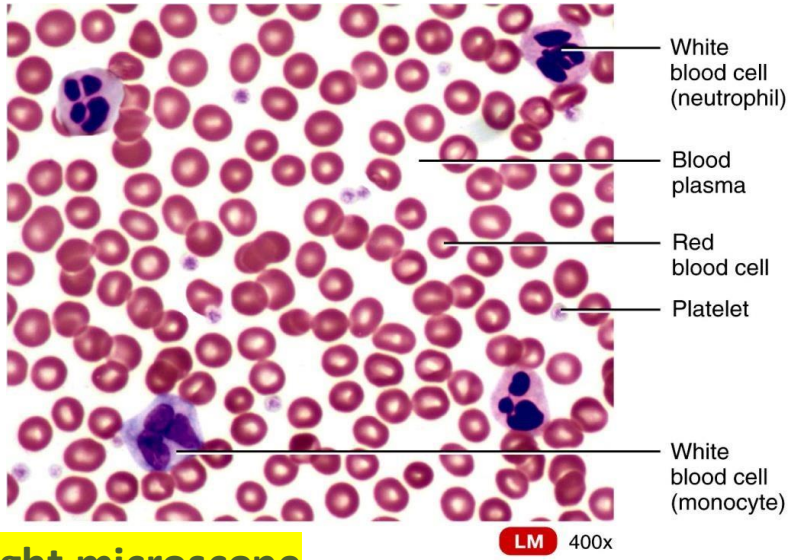
VEINS ARE SUPERFICIAL TO ARTERIES

Venipuncture (the most common and the easiest) It has the properties of venous blood,

Finger or heel stick , arterial stick.

While the red blood cell count is similar in veins and arteries, the concentrations of gases differ significantly between the two. To accurately measure oxygen saturation, it's essential to obtain a sample from an artery through an arterial stick.

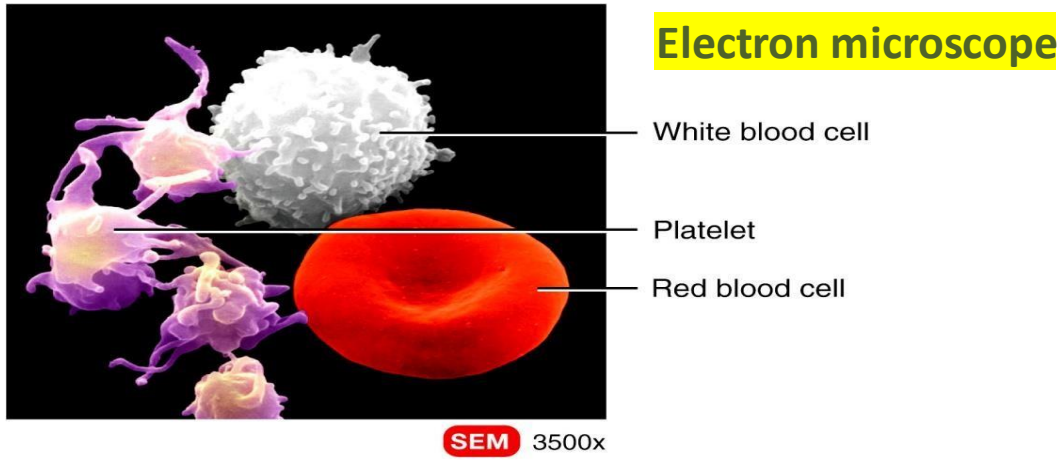
Formed Elements of Blood



Light microscope (b)

- The majority of cells are RBCs (red donut shaped cells), also we have large multi lobular cell (WBCs) and their colours range between blue and red, also we also have fragments that appear like dead cells (platelets).

Blood : a liquid connective tissue , Extracellular matrix is plasma, cells are suspended in the plasma



Electron microscope

(a)

RBCs have biconcave disc appearance under electron microscope, the physiological relevance of biconcave structure is to increase the surface area, and is formed because the RBCs lack nucleus.

Interstitial fluid: part of ECF renewed by blood

Interstitial fluid is a part of extracellular fluid (ECF) that is continuously renewed and modified by blood. It provides the environment through which cells acquire nutrients and eliminate waste products. All body cells are suspended in this interstitial fluid, which actively interacts with the bloodstream to facilitate these essential processes.

يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ ۚ وَاللَّهُ بِمَا تَعْمَلُونَ خَبِيرٌ

Additional sources

1. **Blood function** (https://youtu.be/64dKdBeHnes?si=zhCh8317DEZ2COJf)
2. **Blood components** https://youtu.be/j2-BGTmuZjU?si=cv3qycFsugx-uqg_

امسح الرمز و شاركنا بأفكارك لتحسين أدائنا !!