



THE BASICS OF BLOOD

- This section will familiarize **YOU**, the service professional, with the basic physiological functions and properties of blood and the various tests performed on blood in the clinical laboratory.

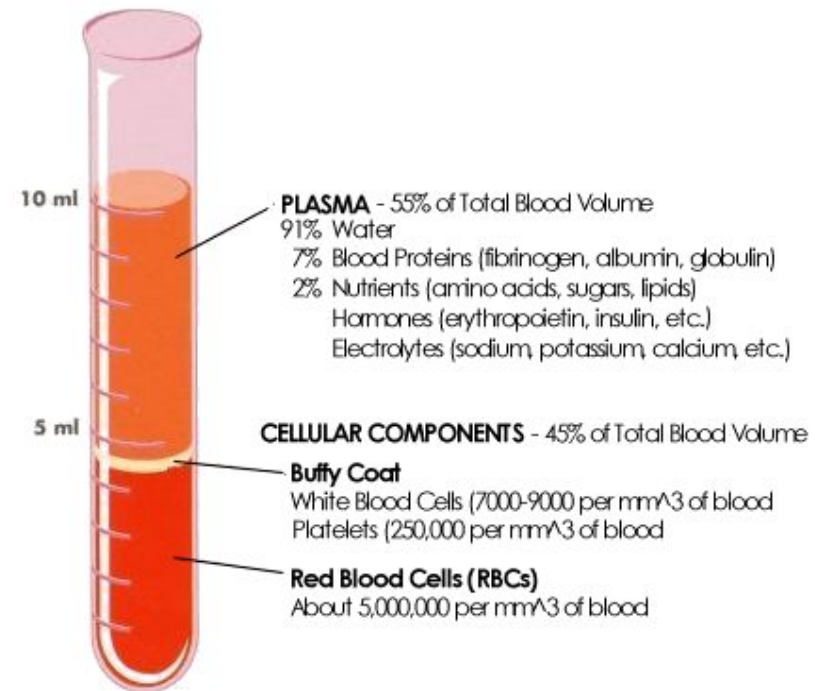


Upon completion of this section, you will be able to:

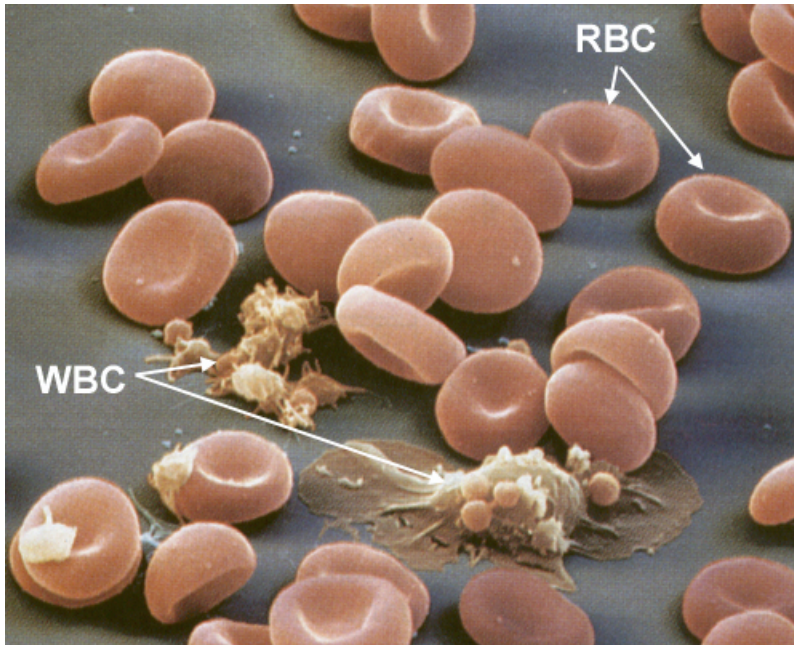
- ▶ Describe the basic functions and physical properties of red blood cells.
- ▶ Describe how hemoglobin is measured.
- ▶ Describe the basic function of white blood cells.
- ▶ Identify the five types of white blood cells.
- ▶ State the purpose of White Blood Cell Differential Analysis.
- ▶ Describe the basic function and physical properties of thrombocytes.
- ▶ Identify and calculate the Red Blood Cell Indices.

THE BASICS OF BLOOD

- ▶ The total blood volume in an adult is **5 to 6 liters** (7-8% of total body weight).
- ▶ Made up of 45% cellular elements and 55% plasma.
 - Plasma is made up of 90% water and 10% nutrients (proteins, carbohydrates and vitamins).
 - The cellular elements are RBCs, WBCs, and Plts.



Erythrocytes (Red Blood Cells/RBCs):



- ▶ *Primary carriers of oxygen.*
- ▶ *45% of the whole blood volume.*
- ▶ *Contain hemoglobin and transport blood gases.*
- ▶ *Also referred to as erythrocytes (erythro meaning red; cyte meaning cell).*
- ▶ *Generally 6 - 8 microns in diameter.*
- ▶ *Manufacture hemoglobin (hemo meaning blood; globin meaning protein).*



Hemoglobin (Hgb/Hb): Iron-protein compound in RBCs that gives blood its red color and transports oxygen, carbon dioxide, and nitric oxide.

- ▶ *The RBC membrane serves as a retaining barrier for the Hgb, but is permeable to oxygen and carbon dioxide molecules which pass freely through it.*
 - *When saturated with oxygen, it's called **oxyhemoglobin**.*
- ▶ *After releasing oxygen to the body tissues, Hgb reverses its function and picks up carbon dioxide for transport to the lungs, where it is expired.*
 - *When saturated with carbon dioxide, it's known as **carboxyhemoglobin***
- ▶ *Hgb is contained entirely in the RBCs, accounting for about 35% of their weight.*
- ▶ *A deficiency of Hgb, caused by a lack of iron in the body, leads to anemia.*



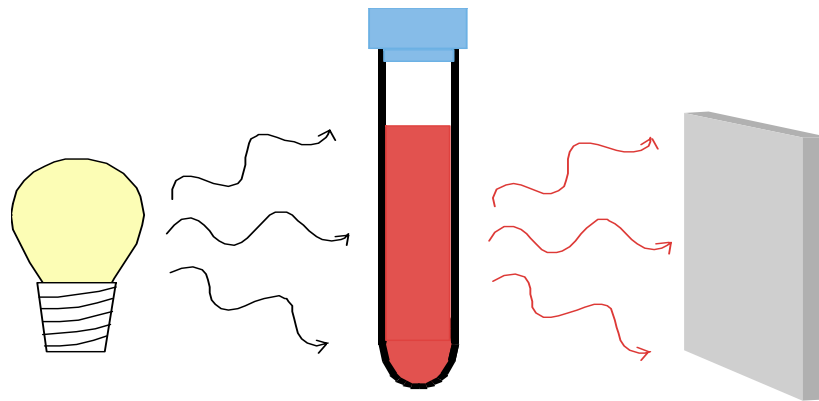
Measurement of Hemoglobin

- When a specified volume of RBCs is exposed to a lysing agent, the Hgb inside the RBCs is released.
 - The resulting intensity of the color of the sample can then be measured **spectrophotometrically**.
 - By comparing a patient's lysed blood solution with standard solutions, a value for Hgb can be calculated.



Spectrophotometry

- Also referred to as Absorption Spectroscopy.
- The design of the photometer involves a light source, a sample holder and a photocell.
 - Connected to each are the appropriate electrical or mechanical systems to control the light intensity, and the conversion of energy received at the photocell into a voltage fluctuation.





Spectrophotometry

- Based on the Beer-Lambert Law which states the correlation between the absorbance (A), the path length traversed (d), and the concentration of the absorbent substance (c).

$$A = k * c * d$$

- Concentration “c” is stated in mol/l and the path length “d” in cm.
- The relative spectral absorption coefficient “k” is a substance-specific function of the wavelength.



RBC Count

- Normally expressed as millions of cells per μL of whole blood.
- The normal RBC range for males is 4.5 to 6.5 million cells/ μL of whole blood; for females it's 4.2 to 5.4 million cells/ μL .



Hemoglobin

- *The normal hemoglobin range for a male is 14 to 18 g/dl; for a female, it is 12 to 16 g/dl.*
- *The Hgb value is three times the RBC.*
 - *Thus, a patient with an RBC of 4.0 million cells/uL would be expected to have a Hgb of about 12.0 g/dl.*
 - ***3 times normal RBC = Hgb value (g/dl)***



Hematocrit

- ▶ *The Hct is expressed as a percentage.*
- ▶ *Normal Hct range for males is 42% to 52%; for females it is 37% to 47%.*
- ▶ *Hct is normally about three times the Hgb.*
 - *Thus a patient with a Hgb of 12.0 g/dl would be expected to have a Hct of about 36%.*
- ▶ ***3 times normal Hgb Value = Hct Value (%)***



Leukocytes (White Blood Cells/WBCs):

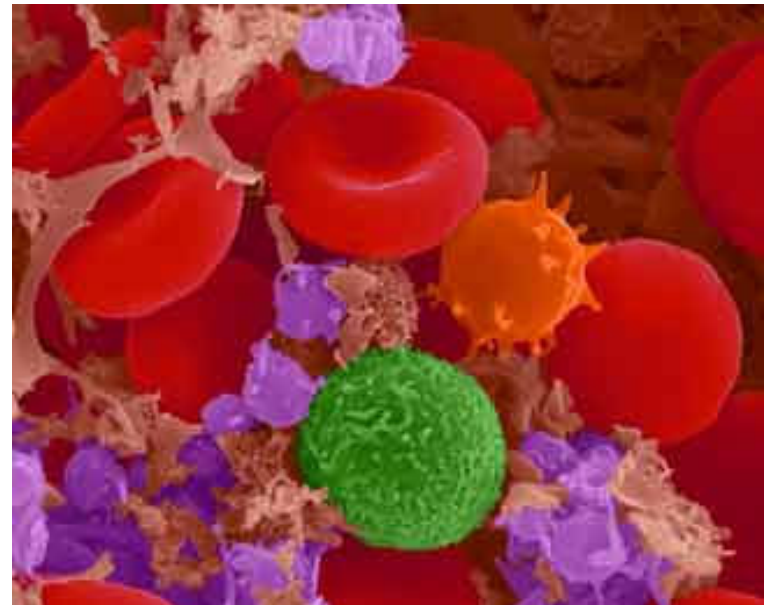
- *The primary defense mechanism against invading bacteria, viruses, fungi, and parasites.*
- *Identify an invading organism as foreign, attach to it, and then destroy it.*
- *Also produce antibodies which are released into the blood to target and attach to foreign organisms to weaken and destroy it.*



Leukocytes (White Blood Cells/WBCs):

- *There are several types of WBCs which make up less than 1% of the whole blood volume:*

- *-Neutrophils*
- *-Eosinophils*
- *-Basophils*
- *-Lymphocytes*
- *-Monocytes*





Leukocytes (White Blood Cells/WBCs):

- ▶ *Normally, for every one WBC there are 1000 RBCs and 20 platelets.*
- ▶ *Normal range for a WBC is 4,000 to 12,000 cells/uL.*
 - *Neutrophils (50 to 75%)*
 - *Lymphocytes (20 to 45%)*
 - *Monocytes (3 to 11%)*
 - *Eosinophils (1 to 3%)*
 - *Basophils (0 to 1%).*
- ▶ ***Every 1 WBC = 1000 RBCs and 20 Plts***

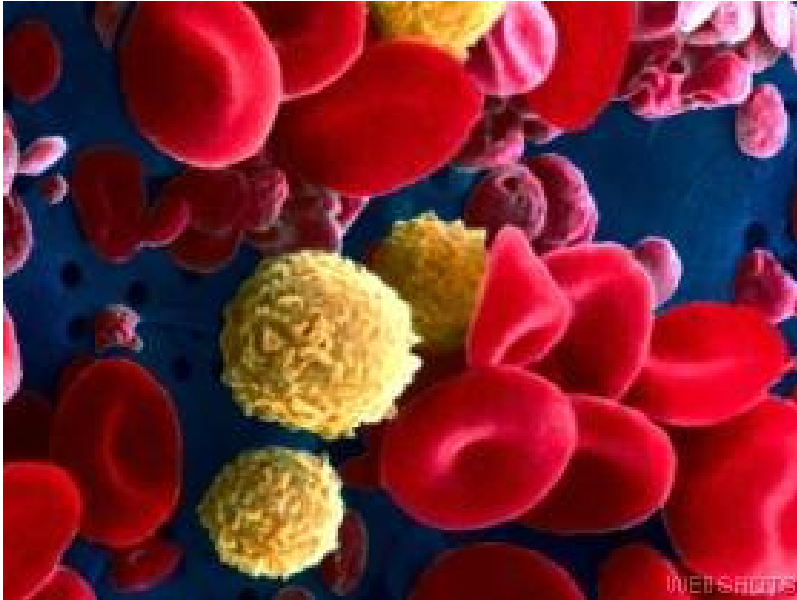


WBC Differential Analysis

- *One of the fundamental analyses of hematology.*
- *A diagnostic tool that can act as a pointer to aid the physician in the diagnosis and/or monitoring of a multitude of diseases.*
 - *Neutrophils commonly increase with bacterial infections.*
 - *Lymphocytes commonly increase with viral infections.*
 - *Monocytes commonly increase with tuberculosis.*
 - *Eosinophils commonly increase with allergic reactions, parasitic infections and in the later stages of inflammation.*
 - *Basophils also commonly increase with allergic reactions.*

Thrombocytes (Platelets/Plts):

- ▶ Platelets, also referred to as thrombocytes (thrombo meaning clot; cyte meaning cell) are the smallest cellular component of blood; about 2 to 4 microns in diameter.



Thrombocytes (Platelets/Plts):



- Circulate inactivated until they come into contact with a damaged blood vessel at which point they form a clump adhering to each other and to the blood vessel wall.
- They secrete chemicals that alter a blood-borne protein called fibrinogen that forms a mesh of fibers at the damaged site.
- A clot forms when Plts and red and white blood cells become trapped in the fibers.
- The normal range for a Plt count is 150,000 - 400,000 Plts/ μ L.



CALCULATED RBC INDICES

- *Indices refer to calculated values that describe certain RBC properties such as size, shape and color.*
- *There are three indices:*
 - *Mean Corpuscular Volume (MCV)*
 - *Mean Corpuscular Hemoglobin (MCH)*
 - *Mean Corpuscular Hemoglobin Concentration (MCHC).*



CALCULATED RBC INDICES

- *Mean Corpuscular Volume:*

- *The average volume (size) of a RBC.*

$$(Hct / RBC) * 10 = MCV$$

or

$$(.44 / 5,000,000) * 10 = 88 \text{ fL}$$

- *The normal range for males is 90 fL +/- 9 (femto- is 10^{-15}); for females it is 87 fL +/- 7.*



CALCULATED RBC INDICES

• Mean Corpuscular Hemoglobin:

- The average weight of Hgb in a RBC.*

$$(Hgb / RBC) * 10 = MCH$$

or

$$(15 / 5,000,000) * 10 = 30 \text{ pg}$$

- The normal range for both males and females is 27 to 31 pg (pico- is 10^{-12}).*



CALCULATED RBC INDICES

• Mean Corpuscular Hemoglobin Content:

- The average concentration of Hgb in the RBCs.*

$$(Hgb / Hct) * 100 = MCHC$$

or

$$(15 / .44) * 100 = 34\%$$

- The normal range for both males and females is 33% to 37%.*



SUMMARY

• **We have:**

- Described the basic functions and physical properties of red blood cells.
 - Primary carriers of oxygen.
 - Make up 45% of the whole blood volume.
 - Generally 6 to 8 microns in diameter.
 - Contain hemoglobin and transport blood gases.
- Described how hemoglobin is measured.
- Described the basic function of white blood cells.
 - Primary defense mechanism against invading bacteria, viruses, fungi and parasites.



SUMMARY

We have:

- Identified the five types of white blood cells.
 - Neutrophils
 - Lymphocytes
 - Monocytes
 - Eosinophils
 - Basophils
- Stated the purpose of White Blood Cell Differential Analysis.
 - Acts as a pointer to aid in the diagnosis and/or monitoring of the disease.
- Described the basic function and physical properties of thrombocytes.
 - Smallest cellular component of blood; 2 to 4 microns in diameter.
 - Aid in the clotting process.



SUMMARY

• **We have:**

- Identified and calculated the Red Blood Cell Indices.
 - MCV
 - MCH
 - MCHC