SAWA UNIVERSITY

امراض الدم الكورس الأول

Introduction of hematology

جامعـــــــة ســـــــــاوة الاهلية — Sawa University

كليـــــة التقنيـــات الصحيـة والطبيـة — College of health and medical techniques

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الجانب النظري

...محاضرة رقم 1

Theoretical

Lecture No.

……1..

تدريسي المادة : د وضاح علي حسين

CONTENTS OF THIS TEMPLATE

- Definition
- Importance of hematology
- General functions of blood
- Composition of blood
- RBC morphology
- Leucocyte types and characters
- Thrombocyte
-

Hematology

* Branch of medicine concerning the study of composition , function and disease of blood and blood forming organs such as BM spleen and lymph node .

It include study of the etiology, diagnosis , treatment , and prevention of blood diseases

* The word "heme" comes from the Greek word for blood

Why hematology is important

Hematology is the specialty responsible for the diagnosis and management of

a wide range of benign and malignant disorders of

Red blood cells

White blood cells

Platelets

Proteins involved in bleeding and clotting

Blood vessels

bone marrow

Lymph nodes

Spleen

The role of the hematologist

Hematologists work very closely with other health professionals including GPs, pharmacists and specialist nurses, advising colleagues in hospital and primary care.

Hematologists perform a wide range of laboratory tests to produce and interpret results assisting clinicians in their diagnosis and treatment of disease whilst supporting hospital departments including A&E, intensive care, operating theatres, special care baby units and oncology

.

Hematologist play an important role to fined out the cause of blood born disease by providing the required laboratory results

Hematologist help the patient to get better treatment by providing the accurate test results to the physician

deals with routine determination of total numbers of cells in circulation , hb concentration and differential count of leukocyte

Stained blood smear help in detecting morphological abnormalities of various cells in seen peripheral blood circulation

For example, hematologists are the pathologists who receive blood samples from GP surgeries and check them for abnormalities.

They look at blood film and, if they suspect leukemia, can assess the patient, explain concerns, perform a bone marrow biopsy and examine and interpret the samples.

The diagnosis can be done within a few hours, since in some cases treatment must be started immediately.

Some hematologists are involved in transfusion medicine, ensuring that adequate stocks of safe blood are available when needed for blood transfusions.

They confirm which donated blood is the right match for the patient’s blood group.

Hematology tests

Blood tests provide valuable information for diagnosing hematological and non-hematological diseases and disorders such as anemia , leukemia , sickle cell anemia, hemophilia and several infection

A complete blood count (CBC) is one of the most common blood tests employed in disease diagnosis.

The hematological parameters measured in a CBC include the number of white and red blood cells, platelet count, hematocrit red blood cell volume, hemoglobin concentration, differential white blood count, and various other red blood cell indices

* Key investigation with CBC , blood film examination and examination of BM

**Properties of blood

1. Color:

Blood is red in color. Arterial blood is bright red because of more O2 and venous blood is purple red because of more CO2.

2. Volume

The average volume of blood in a normal adult is 5 L.

In newborn baby it is 450 ml.

It increases during growth and reaches 5 L at the time of puberty.

In females, it is slightly less and is about 4.5 L.

It is about 8% of the body weight in a normal young healthy adult weighing about 70 kg.

**

3. Reaction and pH:

Blood is slightly alkaline and its pH in normal conditions is 7.4.

PH maintained By the action of

1 . Excretion of H ions or OH- by the kidneys by the action of buffer system (carbonate phosphate protein)

2. excretion of co2 by the lung

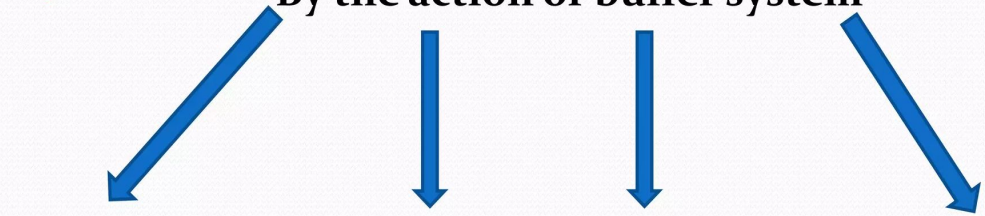
4. Viscosity:

Blood is five times more viscous than water. It is mainly due to red blood cells and plasma protein

pH of blood

pH is maintained by :

- **The excretion of carbon dioxide by the lungs**
- **The excretion of H^+ or OH^- by the kidneys.**
- **By the action of buffer system**



- **Carbonate**
- **Phosphate**
- **Protein**
- **Haemoglobin**

(HA $\longleftrightarrow$ $H^+ + A^-$)

**Function of blood

Main function of blood is transport

1. Respiratory function

Oxygen and carbon dioxide transport between tissue and lung

2. Transport of nutritional substances for all cells

(glucose, amino acid , fatty acid , vitamins ketone bodies)

3. Transport of final products of metabolism from tissue to the kidney where from they excreted with urine (urea , uric acid , bilirubin and creatinine)

*

4. Transport Hormones which are secreted by ductless (endocrine) glands are released directly into the blood. The blood transports these hormones to their target organs/tissues.

5. Blood also transports enzymes

6. Homeostatic function

Maintenance of water content and acid base balance and pH of blood

In acidosis and alkalosis the respiratory system and kidneys help blood to restore blood pH to normal

7 . Maintenance of body temperature

As a result of a re distribution of blood volume between skin and the internal organ at high and low temperature of external environment

**

8. Osmotic function

plasma contain proteins mainly albumen which regulates osmotic pressure 25 mmHg

8. Blood coagulation and preventing blood loss

Clotting proteins (fibrinogen) and platelets prevent blood loss when blood vessel is injured

**

9. Protective function against infection

WBCs , antibodies and complement proteins

plasma protein called antibodies or immunoglobulin these Abs specifically bind with foreign substances called Antigen could be viruses , bacteria or other foreign particles

**Composition of blood

Blood is composed Of

A- blood cells 45%

Suspended in liquid pale yellow

B- plasma 55%

**Blood Composition

Spinning tube of blood yields three layers

- **Plasma on top (~55%)**
- **Erythrocytes on bottom Hematocrit (~45%)**
- **WBCs and platelets in Buffy coat (< 1%)**

Hematocrit

- **Percent of blood volume that is RBCs**
- **47% ± 5% for males; 42% ± 5% for females**

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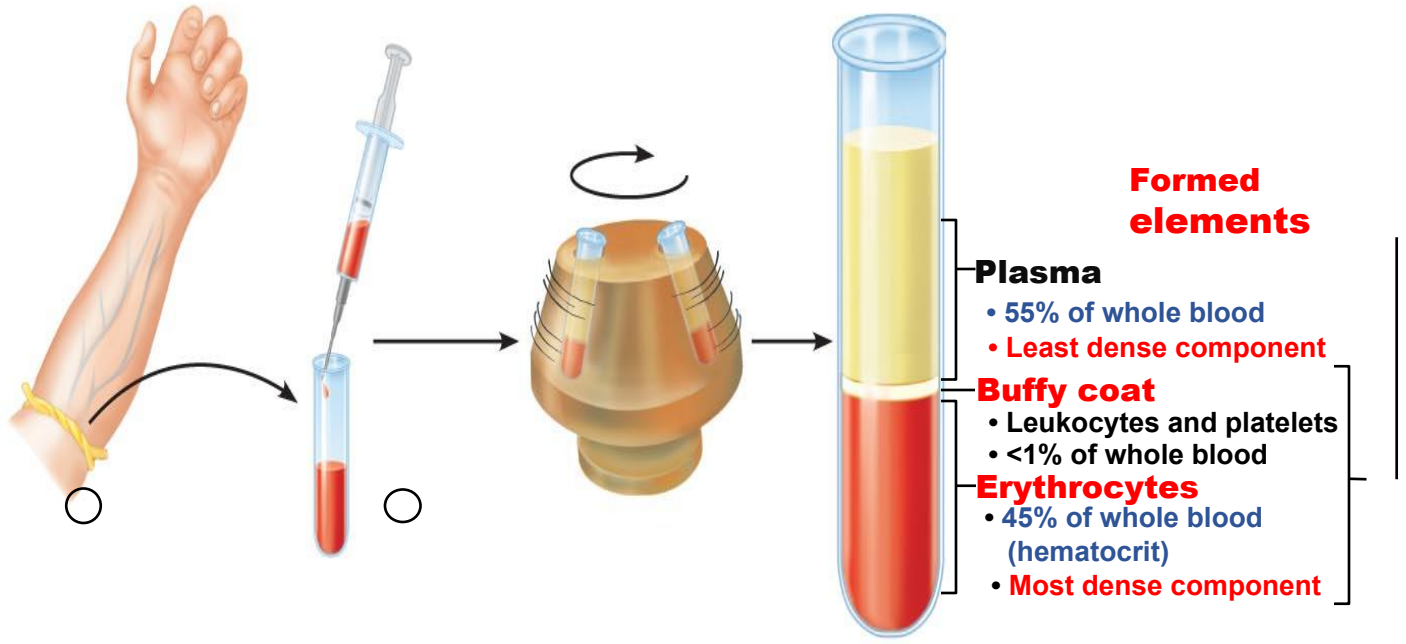
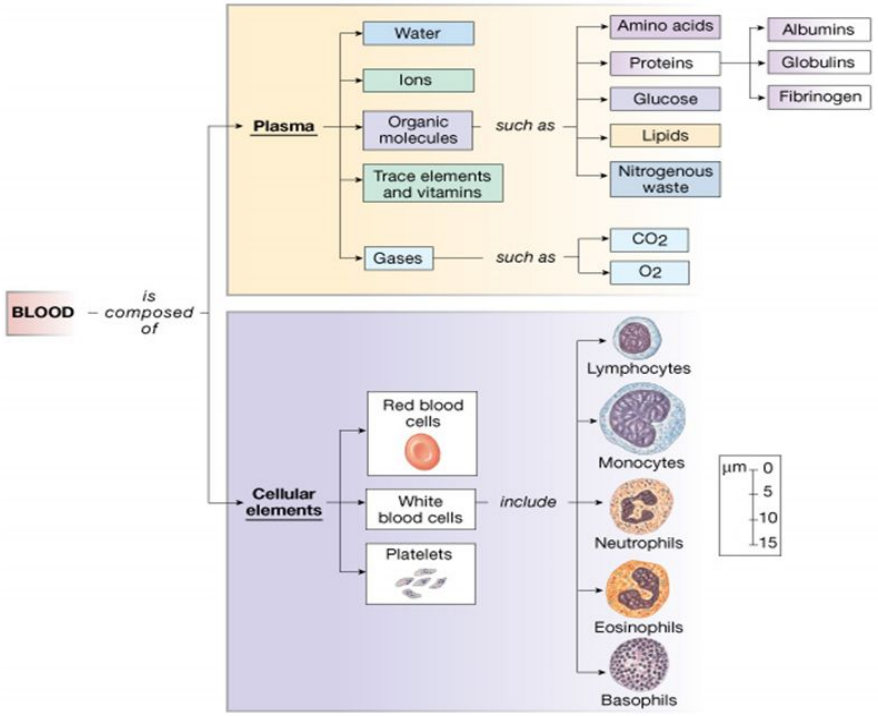


Withdraw blood and place in tube.

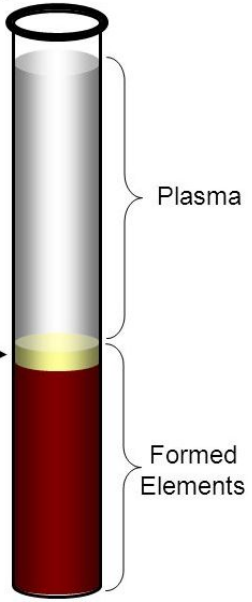
Centrifuge the blood sample.


BLOOD
is composed of
Plasma
Water
Ions
Organic molecules
such as
Amino acids
Proteins
Albumins
Globulins
Fibrinogen
Glucose
Lipids
Nitrogenous waste
Trace elements and vitamins
Gases
such as
CO_2
O_2
Cellular elements
Red blood cells
White blood cells
Platelets
include
Lymphocytes
Monocytes
Neutrophils
Eosinophils
Basophils
µm
0
5
10
15

**

The Composition of Blood

- Whole blood can be *fractionated* into:
  - *Plasma* (liquid component)
    - Approximately 55% of blood volume
  - *Formed elements* (cellular components)
    - Red blood cells (RBCs)
    - White blood cells (WBCs)
    - Platelets (thrombocytes)
    - Approximately 45% of blood volume
      - Slight differences between males and females



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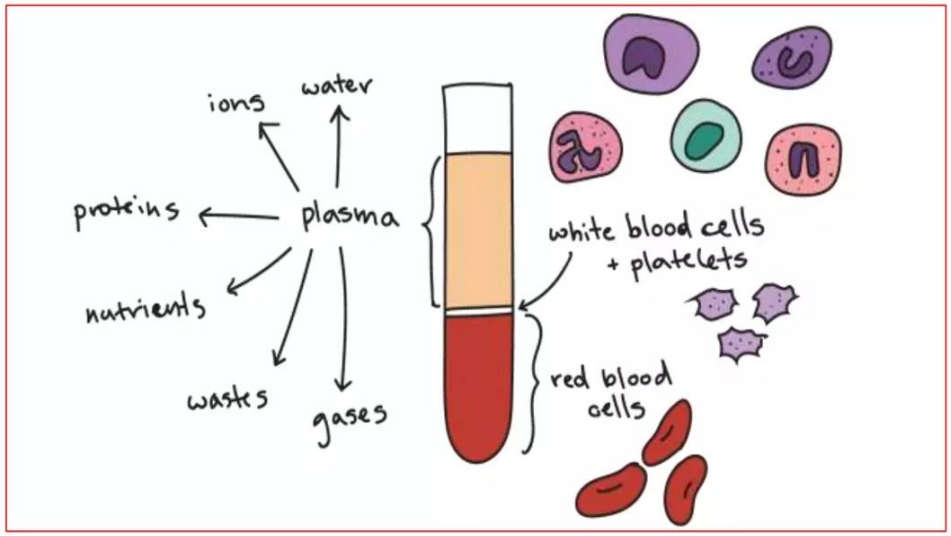
Components of Blood

- four main components
- Plasma- 55%
- red blood cells-40-45%
- white blood cells –less than 1%
- Platelets- less than 1 %



Liquid compartment (Plasma)

Plasma contain

1- water 90 – 92 %

2- plasma protein 7 % and include albumen , globulin , fibrinogen and prothrombin

3- in organic salt 0.9% include NaCL and $NaHCO_3$

4- organic material like urea creatinine and cholesterol

5 - monosaccharide mainly glucose , amino acid fatty acid , glycerol and vitamins

6- hormones and enzyme

Table 17.1 Composition c

Table 17.1 Composition of Plasma

CONSTITUENT	DESCRIPTION AND IMPORTANCE
Water	90% of plasma volume; dissolving and suspending medium for solutes of blood; absorbs heat
Solutes	
Electrolytes	Most abundant solutes by number; cations include sodium, potassium, calcium, magnesium; anions include chloride, phosphate, sulfate, and bicarbonate; help to maintain plasma osmotic pressure and normal blood pH
Plasma proteins	8% (by weight) of plasma; all contribute to osmotic pressure and maintain water balance in blood and tissues; all have other functions (transport, enzymatic, etc.) as well
▪ Albumin	60% of plasma proteins; produced by liver; main contributor to osmotic pressure
▪ Globulins	36% of plasma proteins
alpha, beta	Produced by liver; most are transport proteins that bind to lipids, metal ions, and fat-soluble vitamins

Table 17.1 Composition of Plasma (2 of 2)

Table 17.1 Composition of Plasma

CONSTITUENT	DESCRIPTION AND IMPORTANCE
gamma	Antibodies released by plasma cells during immune response
▪ Fibrinogen	4% of plasma proteins; produced by liver; forms fibrin threads of blood clot
Nonprotein nitrogenous substances	By-products of cellular metabolism, such as urea, uric acid, creatinine, and ammonium salts
Nutrients (organic)	Materials absorbed from digestive tract and transported for use throughout body; include glucose and other simple carbohydrates, amino acids (protein digestion products), fatty acids, glycerol and triglycerides (fat digestion products), cholesterol, and vitamins
Respiratory gases	Oxygen and carbon dioxide; oxygen mostly bound to hemoglobin inside RBCs; carbon dioxide transported dissolved as bicarbonate ion or CO_2, or bound to hemoglobin in RBCs
Hormones	Steroid and thyroid hormones carried by plasma proteins

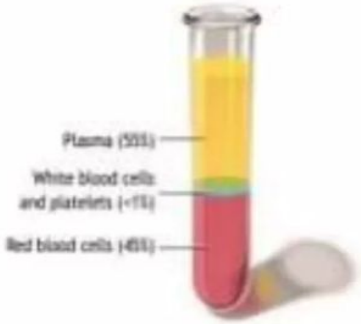
2. Plasma vs. serum

•**Plasma** is the liquid, cell-free part of blood, that has been **treated with anti-coagulants.**

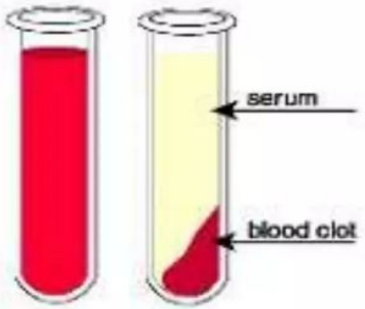
Serum is the liquid part of blood **AFTER coagulation**, therfore devoid of clotting factors as fibrinogen.

Anticoagulated

Clotted



•serum= plasma - fibrinogen



Cellular Elements

Only leukocytes are complete cells

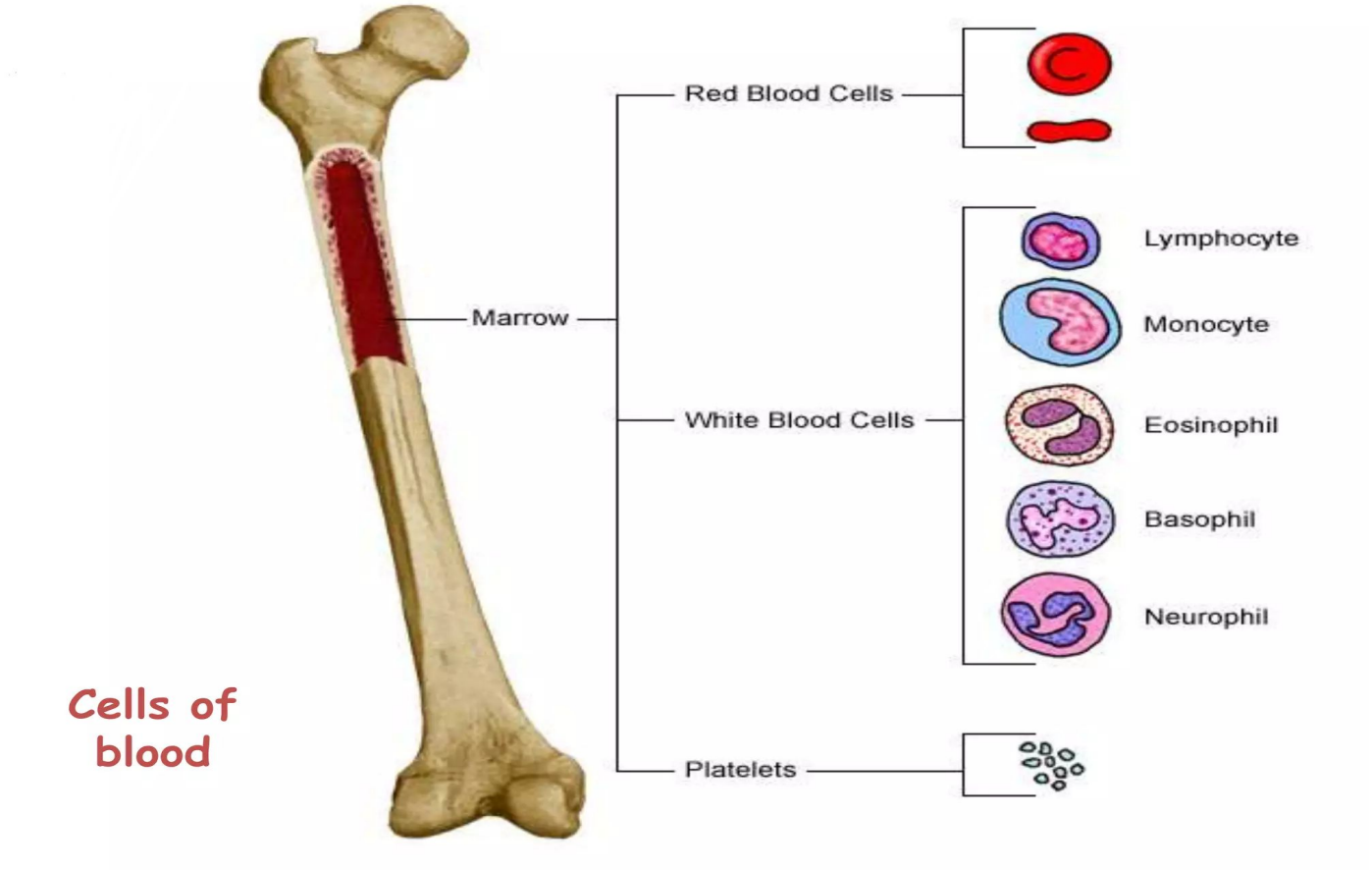
RBCs have no nuclei or other organelles

Platelets are cell fragments

Most formed elements survive in bloodstream only few days

Most blood cells originate in bone marrow and do not divide

*Composition of blood (cellular compartment)



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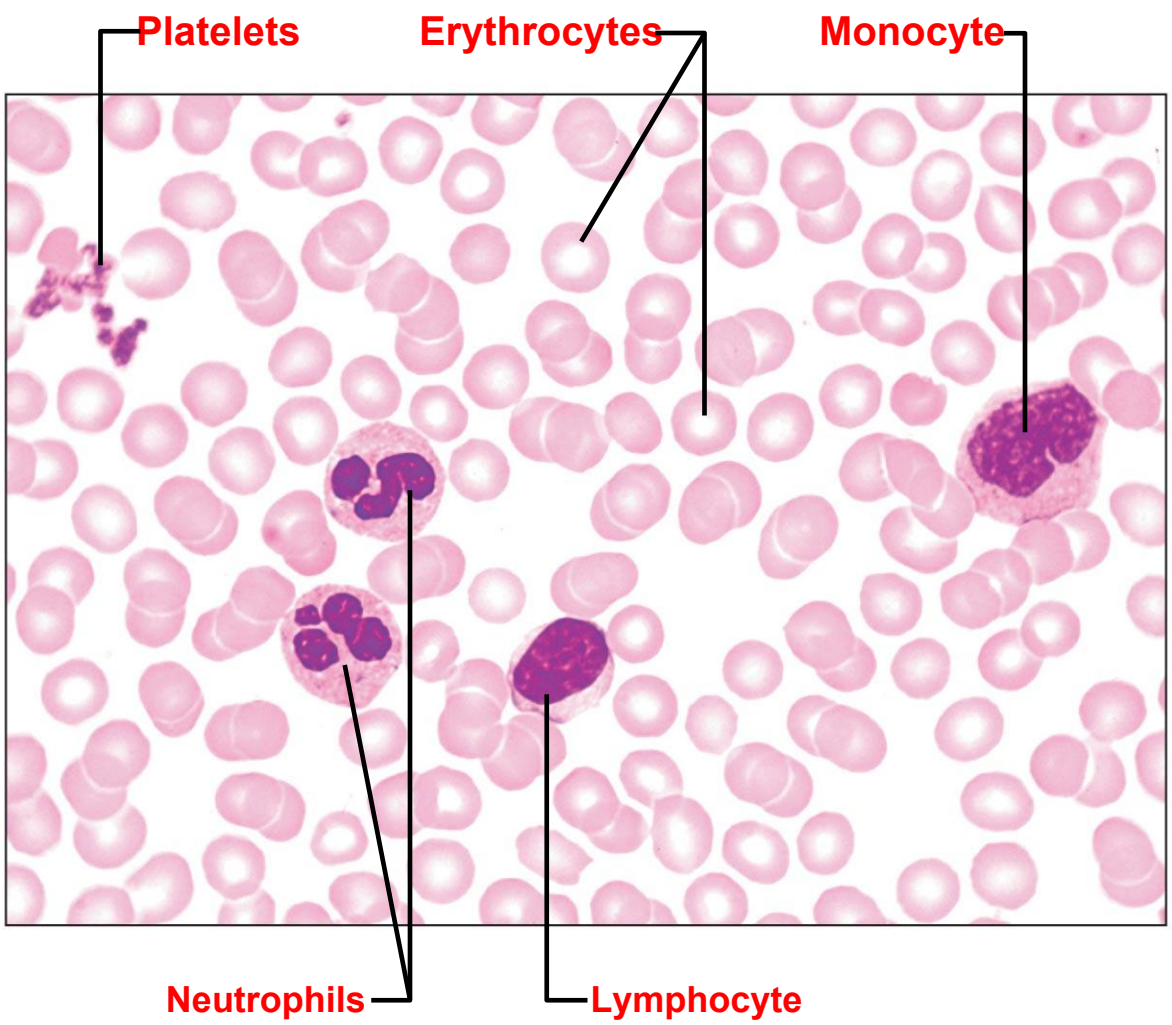
* *Figure 17.2 Photomicrograph



Red blood cell *

Erythrocytes or RBCs

Most abundant cell in the blood

(4 million – 6 million per microliter of blood)

formed in the bone marrow

mature forms do NOT have a nucleus

shaped as biconcave disks

6-8 micrometer in diameter

life span of about 120 days

Hemoglobin (iron protein) carry oxygen from the lung and carbon dioxide bind to the rbc and is taken to the lung

RBC carry blood group antigen ABO and RH factor

*

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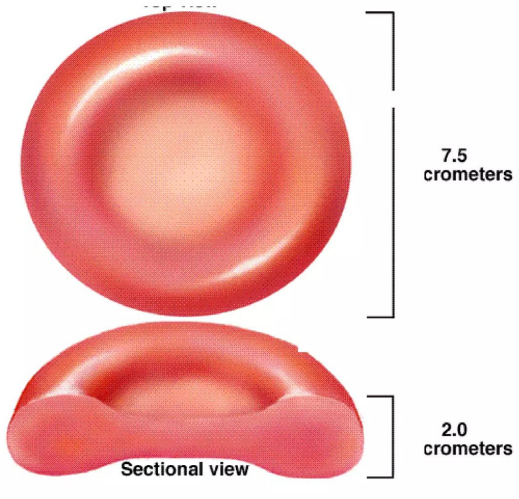
Erythrocytes (Red Blood Cells, RBCs)



Structure:

-Primary cell content is *hemoglobin*, the protein that binds oxygen and carbon dioxide.

- no nucleus nor mitochondria

Red Blood Cells
(Erythrocytes)

Red blood cells (RBCs) are the **non-nucleated,** disc shaped, biconcave formed elements in blood.

Normal Value: 4 to 5.5 milliom/mm^3 blood.

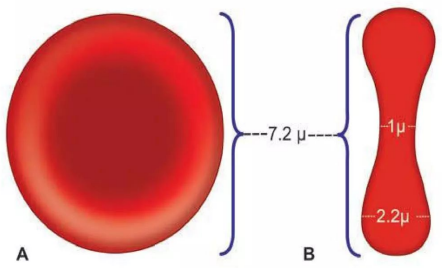
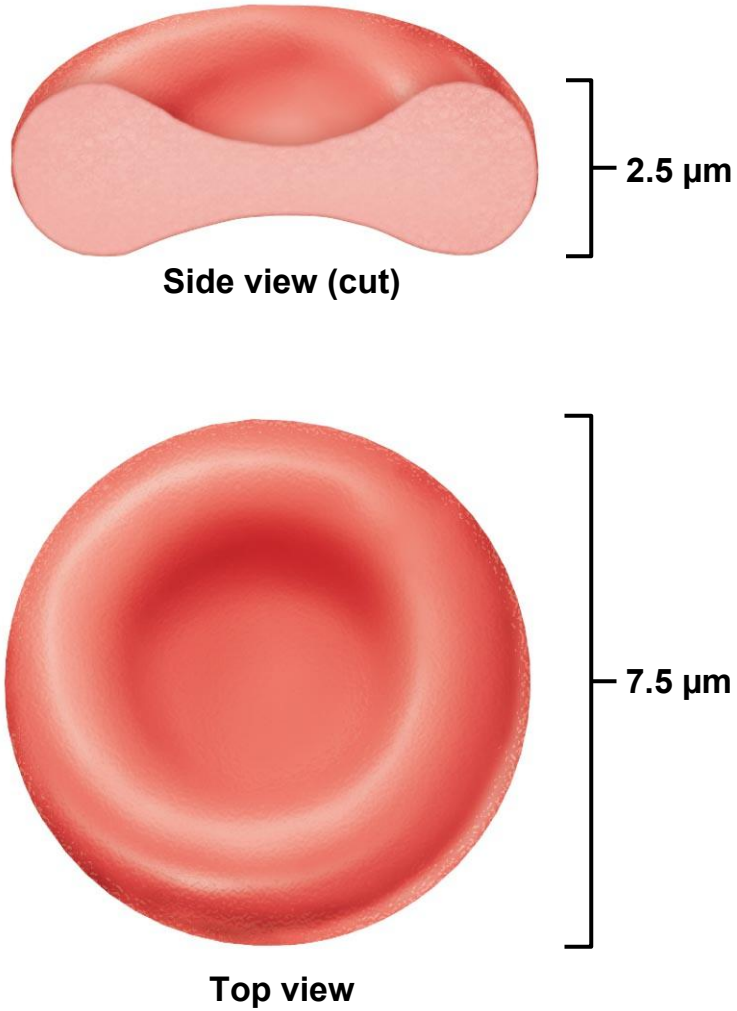
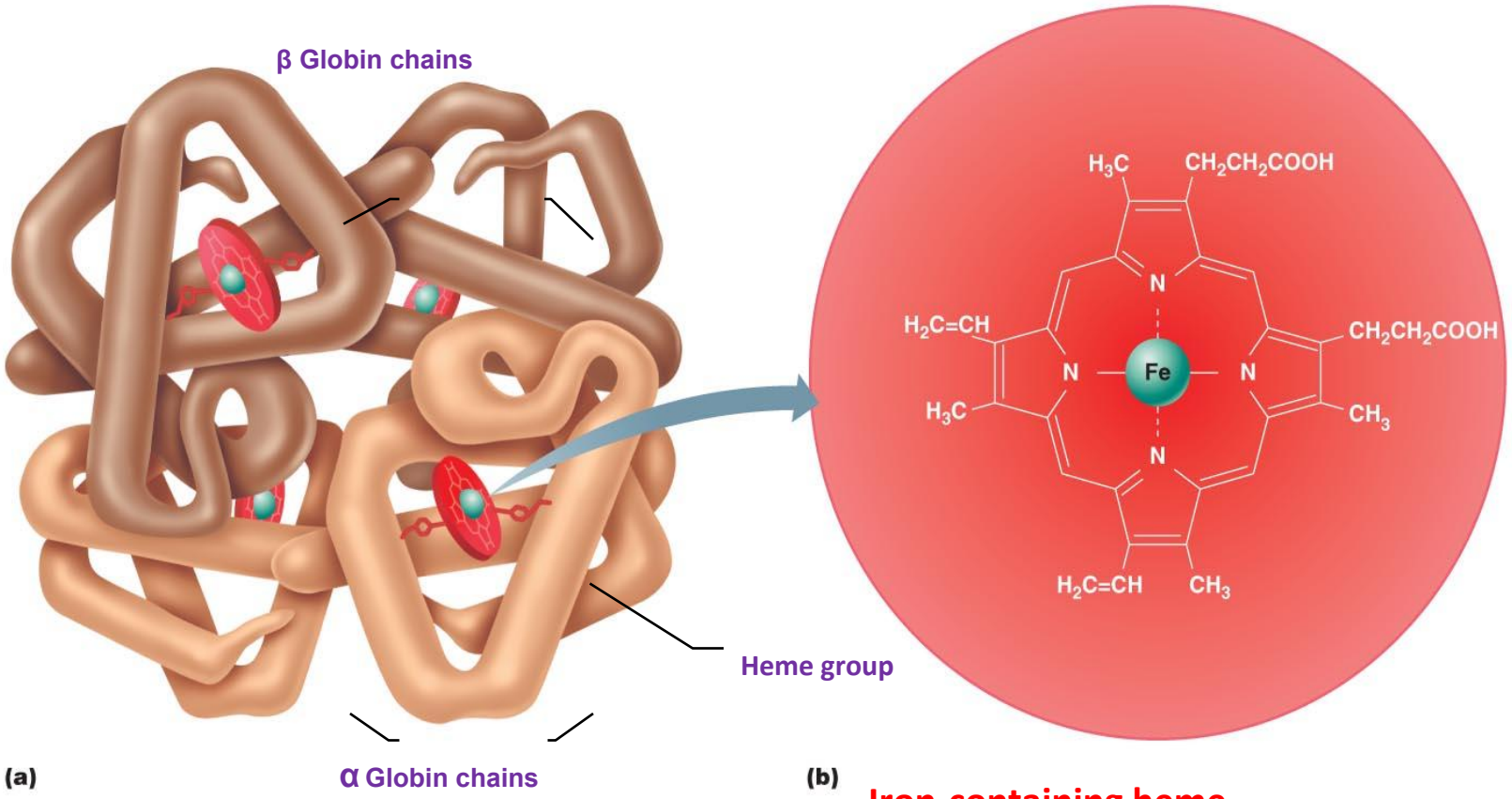


Figure 17.3 Structure of erythrocytes (red blood cells).



Structure



Hemoglobin consists of 4 globin (two alpha and two beta polypeptide chains) and four heme groups.

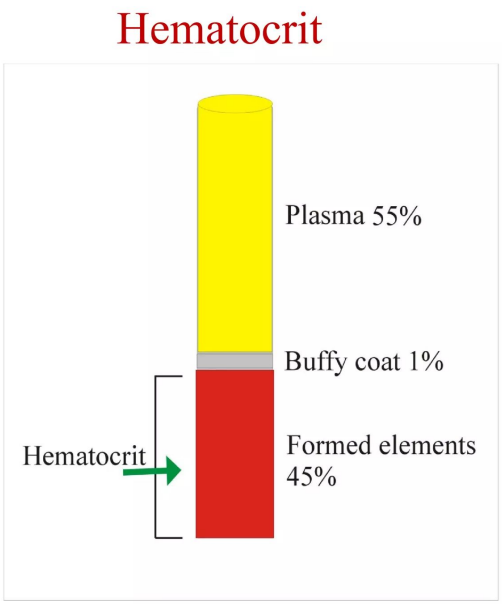
Iron-containing heme pigment.

* Leukocytes white blood cells

The name "white blood cell" derives from the physical appearance of a blood sample after centrifugation.

White cells are found in the *buffy coat*, a thin, typically white layer of nucleated cells between the sediment red blood cells and the plasma.

*Composition of blood



**White blood cells

Leukocytes or WBCs

Largest sized blood cells

numbers in the blood (4,500 -11,000 per microliter)

Formed in the bone marrow and some in the lymph glands

primary cells of the immune system

contain nuclei the shape depends on type of cell

certain WBC produce antibodies (B lymphocyte)

Life span from 24 hours to several years

Size is 8 – 20 micrometer in diameter

*

***Leukocytes are grouped into two major categories Granulocytes and a granulocytes

(presence and absence of microscopic granules in their cytoplasm when stained with Giemsa or Leishman stains).

1. **Granulocytes**

contain specialized membrane bound **cytoplasmic granules include neutrophil , eosinophils, basophil**

distinguished from one another by the morphology of their nucleus, their size, and how their granules stain

2. A granulocytes

lack obvious granules

include lymphocytes and monocytes

****

PERIPHERAL SMEAR STAINING

What stains are routinely used for staining peripheral smear

Romanowsky stains are routinely used.

These stains contain the combinations of acidic and basic dyes that produces distinction between staining of cell and staining of granules differentially

eosinophilic granules by acidic components of dye

basophilic granules has affinity for basic component of dye

Granules in neutrophils are stained by Azure complexes

What are the different types of Romanowsky stains

Leishman's stain

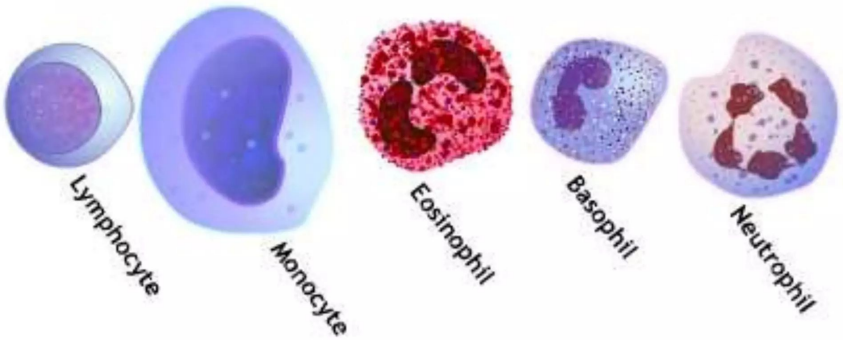
Wright's stain

Giemsa's stain

Jenner's stain

Field's stain

***Types of white blood cells (leukocyte)



**Quantity of leukocytes

Segmented neutrophil - 47 % -- 72%

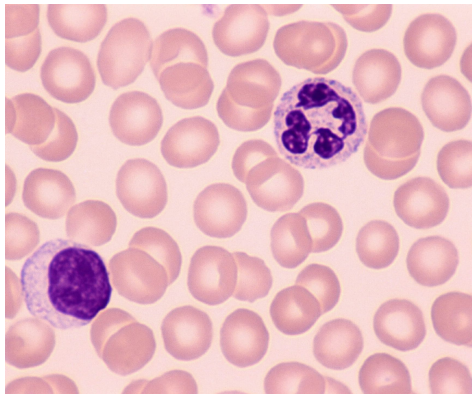
Lymphocytes are - 18 % -- 37%

Monocyte -- 3 % – 11 %

Basophil -- 0 – 1 %

Eosinophils -- 0,5% -- 5 %

**Granulocyte



Neutrophil

size 12- 15 mic

life span 4 – 8 hours

phagocytosis and killing bacteria

Multi-lobed nuclei typically consisting of 3 to 5 segments joined by thin strands,

They are called neutrophils because their granules show up most clearly with **stains that are chemically neutral (neither acidic nor basic)** The granules are numerous but quite fine and normally appear light pink .

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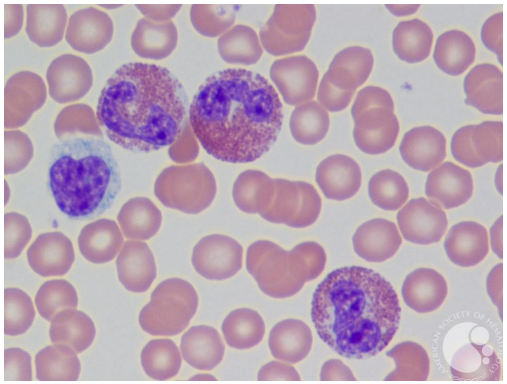

** Eosinophil

size 12- 16 mic

Life span 4 -8 hours

Killing parasite and regulate mast cells

Response to inflammation and allergic disease like bronchial asthma

bi-lobed nucleus

large cytoplasmic specific granules that are eosinophilic with acidic stain , staining red

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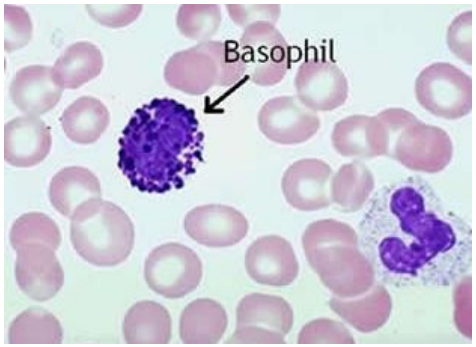
**Basophil

Size 8 - 10 micr

life span 4 – 8 hours

mediate inflammatory response



S-shaped nuclei

cytoplasmic specific granules (0.5 µm) in diameter that stain blue to purple

The granules of basophils stain best with basic (alkaline) stains that pick up a dark blue stain

**A granulocyte lymphocyte and monocyte

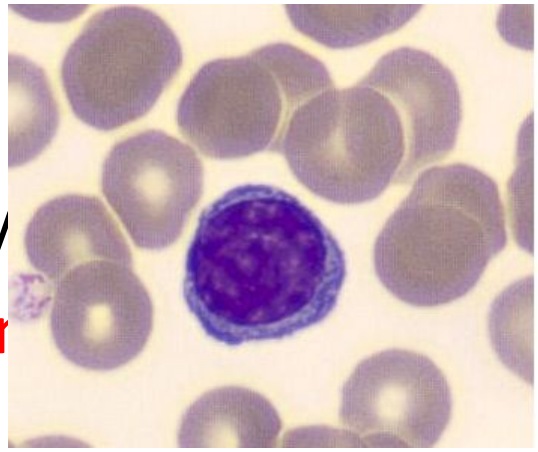
lymphocyte

Size 6-8 micr

Life span day- years

They are key cells in immune sy

spherical nuclei scant cytoplasr



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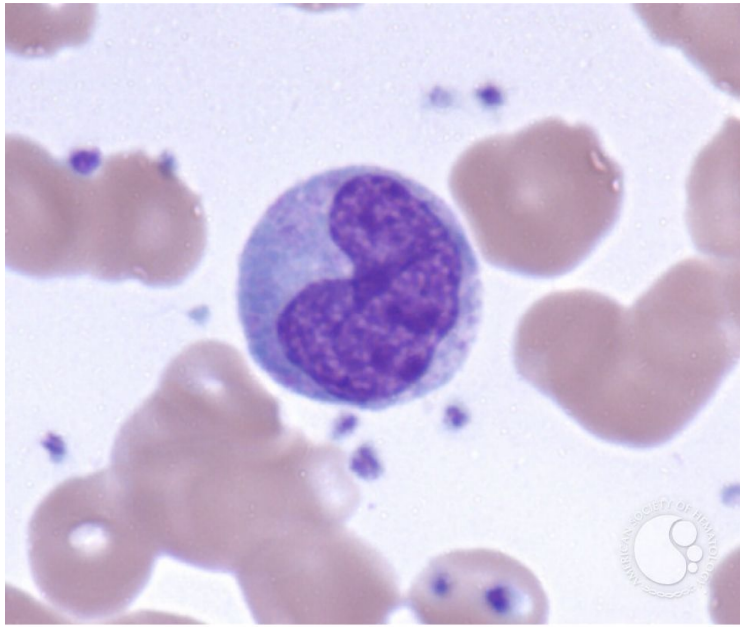
*Monocyte



Size 16- 22 mic

Life span 10 – 20 hours

Precursor to macrophage (histocyte)

Nucleus u shape indented , C- shaped, or kidney-bean" shape

**Thrombocyte or platelets

Thrombocytes

are a component of blood whose function (along with the coagulation factors)

is to react to bleeding from blood vessel injury by clumping, thereby initiating a blood clot

Platelets have no cell nucleus; they are fragments of cytoplasm derived from the megakaryocytes of the bone marrow

Size 2 – 4 mic

Life span 7 -10 days

Shape could be rounded or oval or spiky

150, 000 – 400,000 platelets / cu. Mm . Of blood

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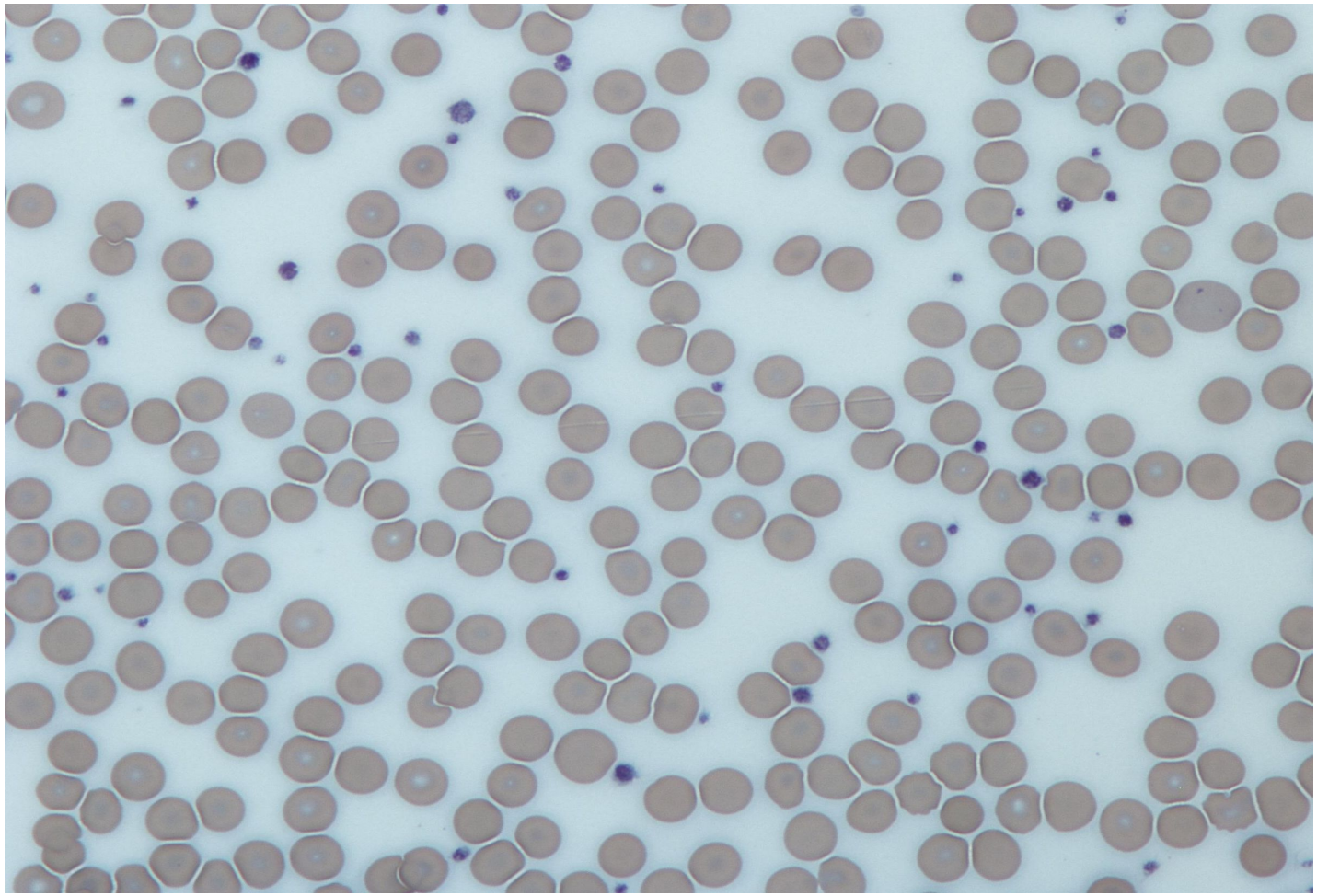

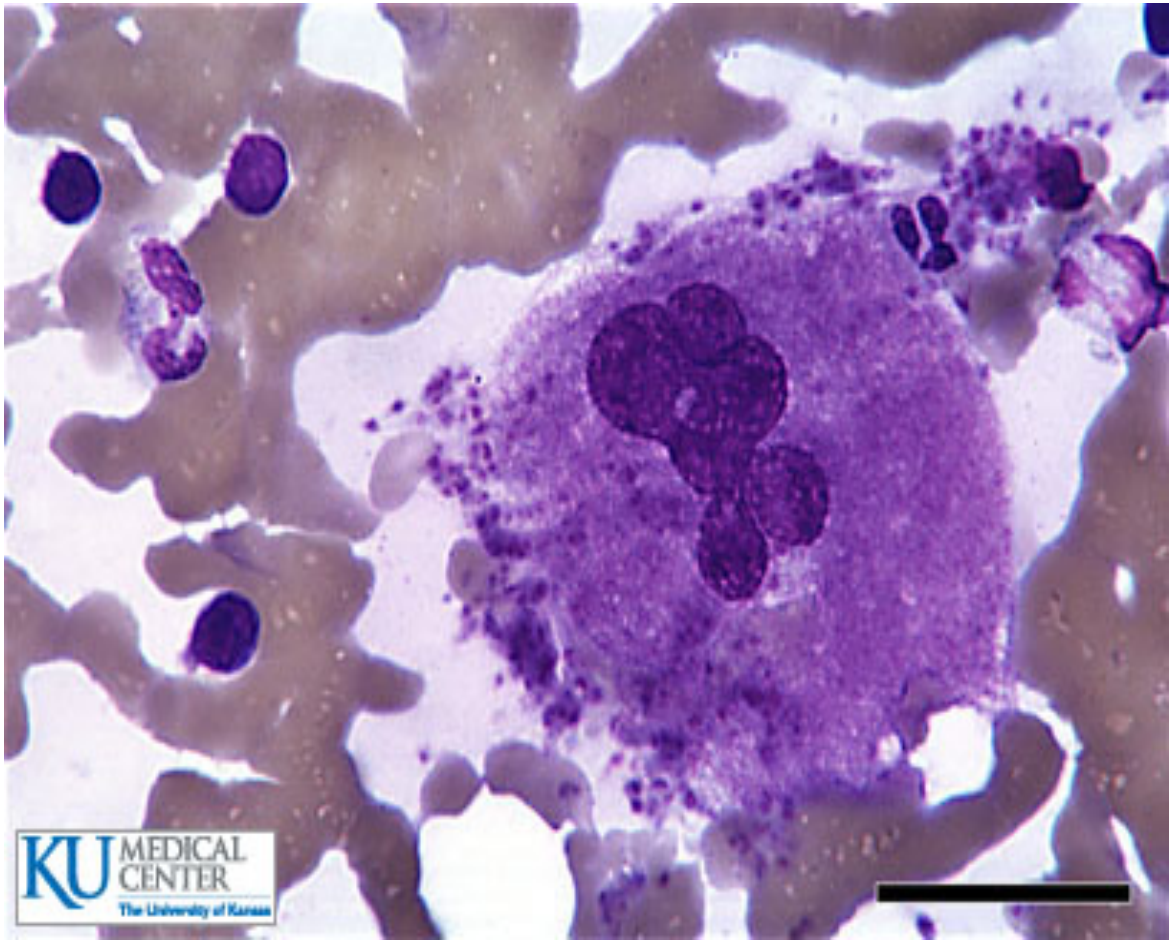
KU MEDICAL CENTER
The University of Kansas

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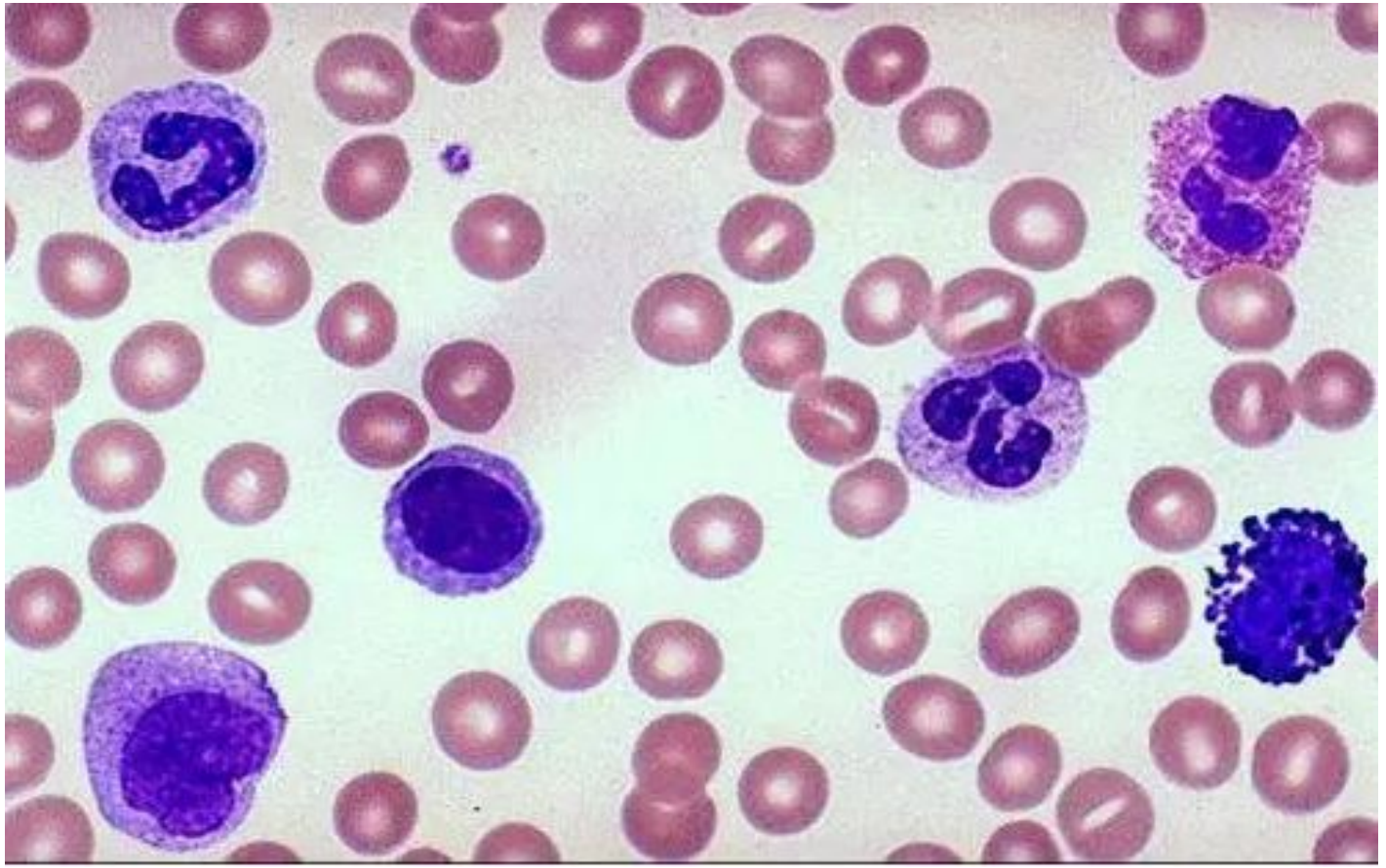
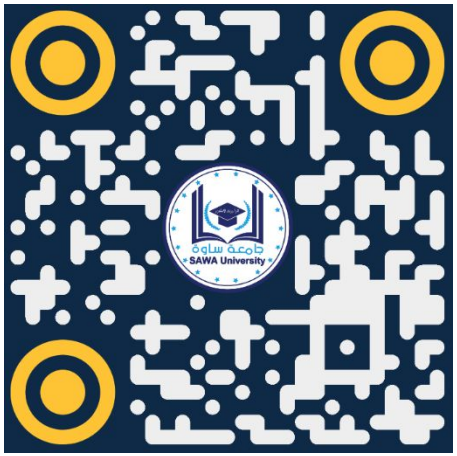


- Enumerate briefly characters of blood
- Describe layers of 5 cc blood in test tube after spinning in centrifuge and percent of each layer
- Describe briefly types and classification of leukocyte in the blood and percentage of each type
- blood have two component cellular and liquid compartment enumerate briefly the liquid component of blood
- Enumerate the types of stain used in staining blood film and base of staining leukocyte granules



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