HEMATOPOIETIC & LYMPHATIC SYSTEM

SUBJECT : ANATOMY

LEC NO. : 1

DONE BY : ALI ABUGHAZLEH

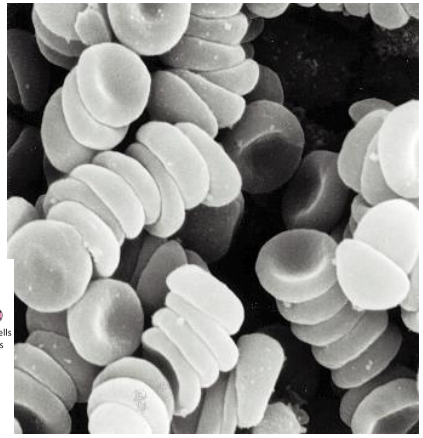
وقل رب زدني علماً

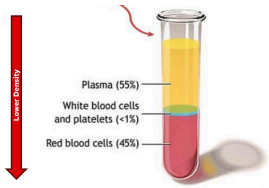
BLOOD

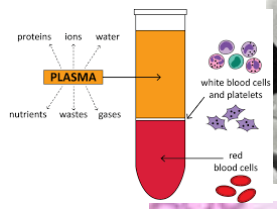
~ HISTOLOGY ~

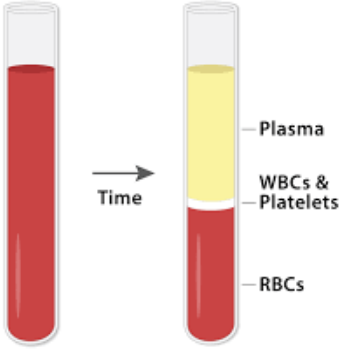
- It is the red fluid which fills the heart and the blood vessels
- Consists of formed elements and plasma
- Formed elements are: Erythrocytes, Leukocytes, Lymphocytes, Monocytes, and Platelets
- Hematocrit
- Buffy coat
- Functions of the blood :

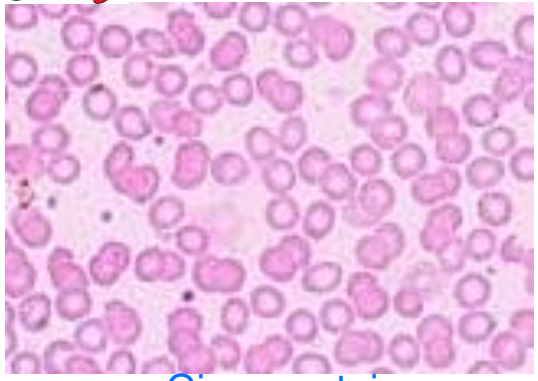
Rouleaux











Giemsa stain

Transportation: Blood carries oxygen from the lungs to cells throughout the body and transports carbon dioxide, a waste product of metabolism, from cells to the lungs for exhalation **and it acts like a** vehicle for transport of endocrine gland hormones toward the site Of actions

It contains a regulatory proteins that are important in metabolism

Temperature regulation: Blood helps regulate body temperature

HB consider an major factor for regulations of buffering system of the body

Composition of Plasma

- **It is an aqueous solution that contains**

  7% plasma proteins (albumin, Globulins, immunoglobulins, Lipoproteins, Coagulation factors, and some regulatory proteins)

  0.9% inorganic substances

  2% organic substances

Composition of Plasma

Plasma is composed of :

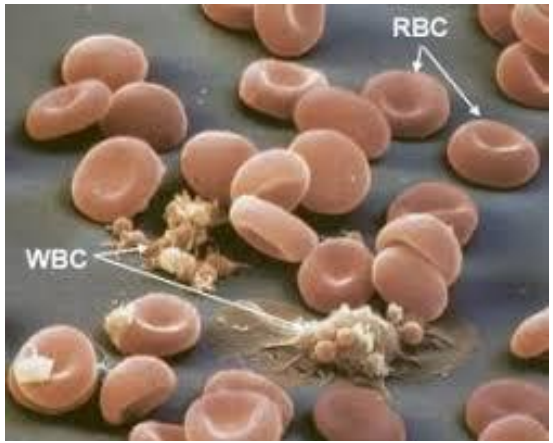
1. **Water: 92%**
2. **Organic substances: Plasma proteins, Lipids, glucose, amino acids, vitamins, enzymes, and waste products.**
3. **Inorganic constituents: (Na^+, Cl^-,HCO_3^-).**
4. **Blood gases: O_2, CO_2 and N_2.**

Count of RBCs

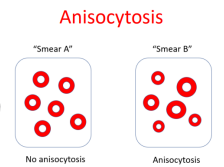
Adult Males: 4.5–6 million/mm3.

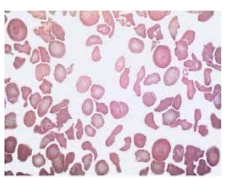
Adult Females: 4–5.5 millions/mm3.

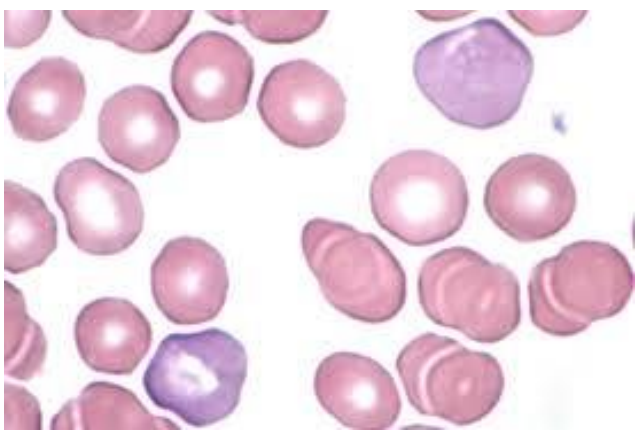
Erythrocytes



- Anucleated cell packed with O_2 - carrying HB
- It is a biconcave disc 7.5 µm in diameter, 2.6 µm at the periphery, 0.75 µm at the center.
- Microcyte- diameter <6 µm
- Macrocyte- diameter > 9µm
- Anisocytosis-variation in size
- Poikilocytosis- variation in shape
- Anemia- decrease number of RBCs
- Polycaethemia- increase the number of RBCs







They are biconcave shape (anucleated) . They are thick on the periphery ,thin in the middle. They provide a larger surface area for gas exchange and smaller volume which is the best .

Polycaethemia : overproduction of RBC , but they are associated with anemia because increases the production of RBCs make blood more viscous. Which lead to decrease the speed of delivery of oxygen to the tissue (amount of O2 reaching the tissue is very low)

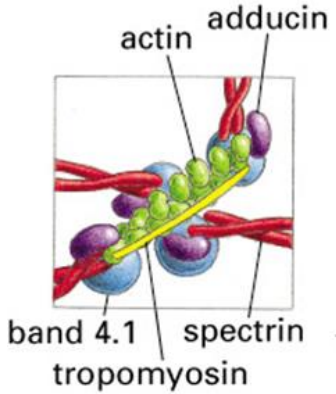
The biconcave shape has the following advantage has a large surface area and **enhances cell flexibility allowing erythrocytes to be squeezed into tiny capillaries without rupture**

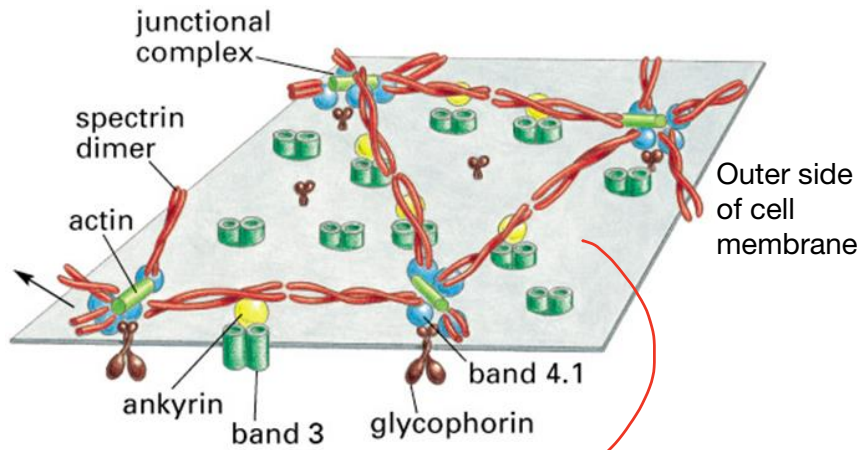
Erythrocytes Cont.,

- **Erythrocyte is flexible which permits adaptation to irregular and narrow diameters of capillaries**
- **Surrounded by a plasmalemma** الجدار البلازمي **and supported by proteins which determine the shape of RBC.**
- **Spectrin links several membrane proteins with cytoskeletal elements**

Main protein share in the formation of cytoskeleton of RBCs

The chain of spectrin are attached to the different proteins in Different site of plasma membrane





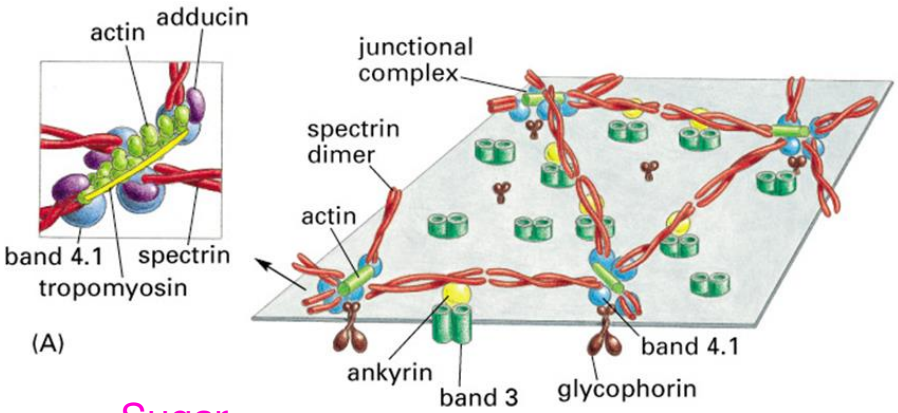
All these components are proteins and shares in formation of the cytoskeleton of RBCs

Red Blood Cell Membrane Skeleton

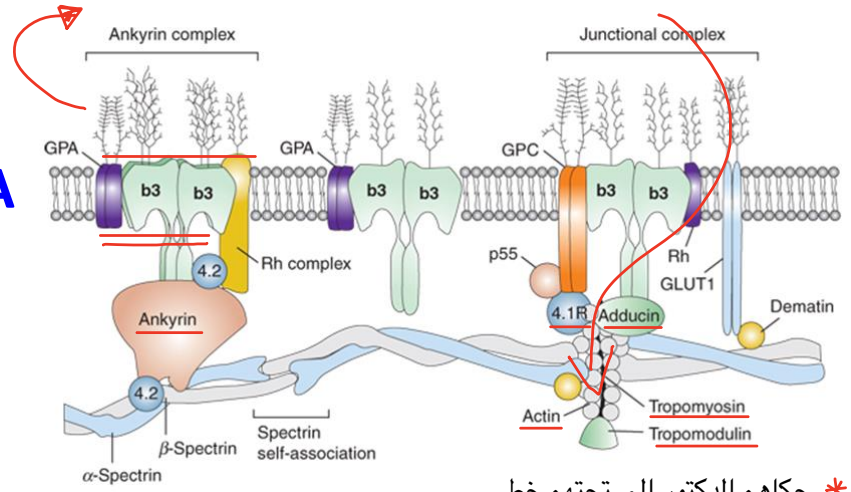
Integral proteins

- **Glycophorin A and Band 3** act as ion channels and anion transport
- **Ankyrin, Adducin, and Band 4.1** anchor **spectrin** to **glycophorin C** and **band 3 proteins**
- **Spectrin** forms a lattice (شبكة) and bound to **actin filaments**
- **Glygocylated** domains of **Glycophorin A** and **Band 3** includes **antigenic** sites for **ABO** blood typing

بعض هذه السكريات تستخدم لمعرفة زمرة الدم



Sugar



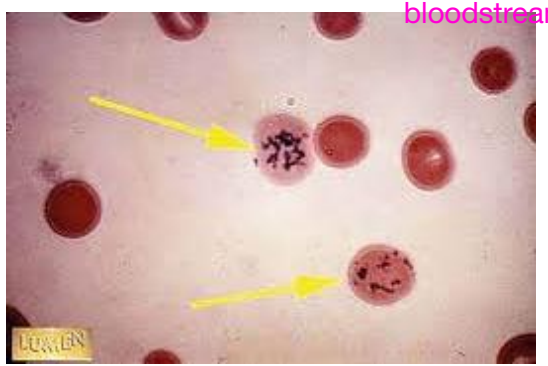
* حكاهم الدكتور الي تحتهم خط

Erythrocytes Cont.,

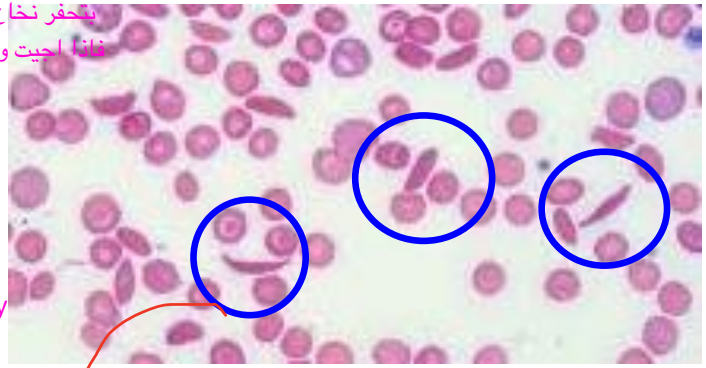
Reticulocytes are immature red blood cells (RBCs) produced in the bone marrow and released into the blood stream .

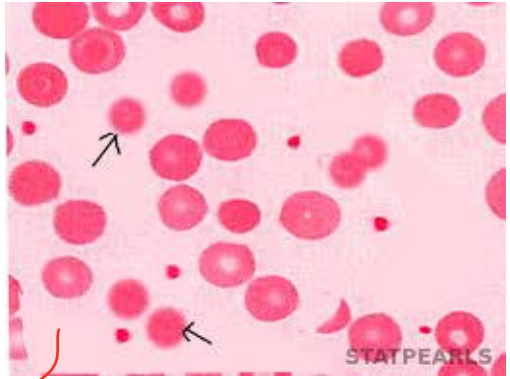
Reticulocytes are slightly immature red blood cells. A reticulocyte count is a blood test that measures the amount of these cells in the blood. In the presence of some anemias, the body increases production of red blood cells (RBCs), and sends these cells into the bloodstream before they are mature.

- **Hb constitutes 33% of RBC which accounts for acidophilia**
- **Reticulocytes**
- **Sickle Cell Anemia**
- **Hereditary spherocytosis**



الجسم بنتج الجسم عدد معين من الخلايا الحمراء وفجأه فقد الشخص كمية كبيرة من الدم
يحفز نخاع العظم من اجل تعويض الفاقد مرة واحدة بالتالي عدد خلايا الدم غير الناضجة سيزداد
فانا اجيت وفحصت عين دم لشخص ما وكان عدد ال reticulocytes كبير جدا اي اكبر من النسبة
الطبيعية ١٠٪ اذن نخاع العظم نشط فنبحث عن الاسباب احد الاسباب هو النزيف





HbA is the adult hemoglobin, which is the main form of hemoglobin in humans, while the HbF is a predominant form of hemoglobin in the developing fetus. HbF has high affinity for O2 .

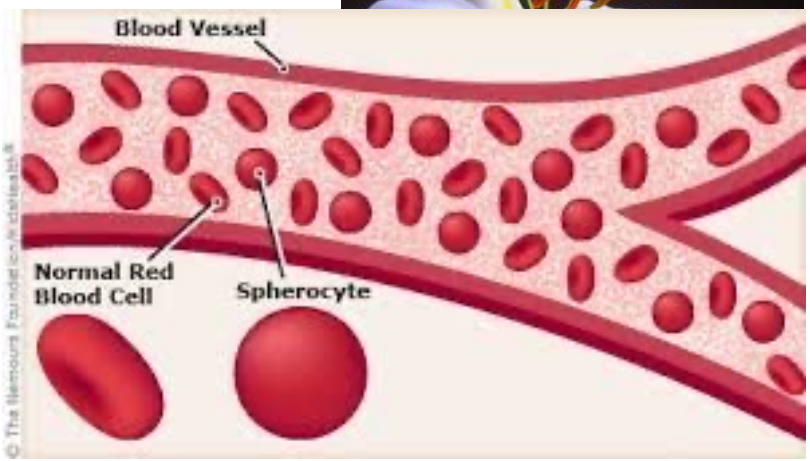
Hemoglobin S is an abnormal form of hemoglobin that causes the red cells to become rigid, and sickle shaped. This is commonly called sickle cell anemia .

Spectrin deficiency associated with hereditary spherocytosis
the RBCs become weak and lysis in short time lead to **haemolytic anaemia**

يشكل الهيموغلوبين ثلث خليه الدم الحمراء وهو الذي يعطيها اللون الاحمر
عمر خلايا الدم الحمراء هو ١٢٠ يوم

اخر خطوة من اجل تصبح خليه الدم الحمراء ناضجة وتنطلق الى السيتوبلازم هي ان تفقد النواة والعضيات المختلفة

يبلغ نسبة الخلايا الحمراء الناضجة حوالي ٩٠٪ والباقي حوالي ١٠٪ من خلايا الدم الحمراء من المتحمل ان تغادر مكان التصنيع وقد بقي بداخلها بعض العضيات لكن الامر لا يطول بحيث بعد وقت قصير حوالي يوم واحد تختفي هذه العضيات وتصبح الخليه ناضجة بالكامل



On the bloode stream they are inactive and immotile to become active they must leave the bloode stream and change the shape to amebia ,have a short life span . يبلغ عدد خلايا الدم البيضاء ما يقارب ١١٠٠٠ خليه تقريبا

Leukocytes

- Leave blood to become functionally active
- Divide into granulocytes and agranulocytes depending on the density of distribution of granules
- They are spherical in plasma and become motile and amoebic in tissues
- Granulocytes possess Azurophilic granules (Lysosomes) and specific granules that stain specifically with neutral, basic, and acidic stains
- They are terminally differentiated cells with a short life span (a few days)
- RER and Golgi are poorly developed
- Most white blood cells undergo apoptosis

Azurophilic (nonspecific) granules are lysosomes found in the cytoplasm of all five kinds of white blood cells. They're named for their property of staining with blue or violet dyes (azur = blue; philic = loving).

Leukocytes

Divided into:

- **Granulocytes containing specific granules**
- **Agranulocytes containing no specific granules**
- **Granulocytes include:** hematoxylin-eosin,

  Neutrophils ما بتوخذ الصبغة

  Eosinophils بتوخذ اللون الاحمر

  Basophils بتوخذ اللون الازرق

- **Agrnulocytes include:**

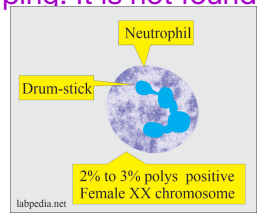
  Lymphocytes small lymphocytes have large spherical nuclei with condensed chromatin. The nucleus is surrounded by a thin pale blue rim of minimal amount of cytoplasm.

  Monocytes

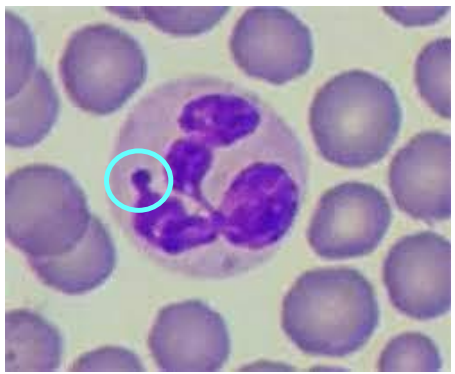
Usually the dimensions of the WBCs, as seen on blood smears, are reported to fall between 12 and 14 μm,

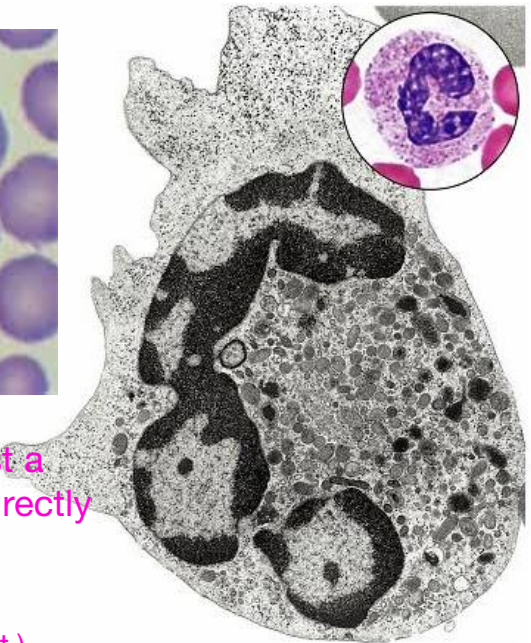
Neutrophils

The drumstick is the drum-shaped nuclear appendage seen in 2% to 3% of the neutrophils in females, indicating 2 X chromosomes. This can be confirmed by karyotyping. It is not found in males.



- Constitute 60-70% of leukocytes in blood
- They live 4-6 hours in blood and 1-4 days in tissue
- Nucleus with 2-5 lobes
- In females, inactive X chromosome may appear on one lobe as drumstick extension





Azurophilic granules:

- Large dense granules with many enzymes and proteases
- They secrete:

Myeloperoxidase (hypochlorite) microbicidal activity against a wide range of organisms directly

Lysozyme Digest the cell wall of bacteria

Defensins Disrupt and weaken the cell membrane and become inactive (easy to digest)

Neutrophils Cont.,

Specific granules

- Small and less dense
- Stain faintly pink
- Contain many ECM components degrading enzymes
- Secrete many chemokines that attract other leukocytes and cytokines
- Secrete lipid mediators

They are best known for their ability to stimulate the migration of cells, most notably white blood cells (leukocytes).

- They kill bacteria by:

O_2^-

H_2O_2

Lactoferrin

Lactoferrin is an iron-binding protein that is released from activated neutrophils at sites of inflammation and has anti-microbial as well as anti-inflammatory properties.

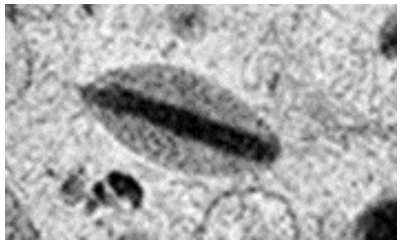
بتمسك بالحديد وبتحرم البكتيريا منه بالتالي بتعطل عمله

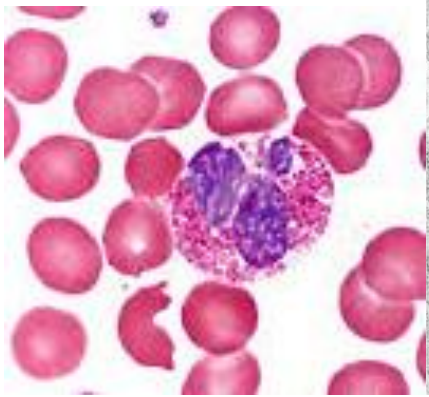
Eosinophils

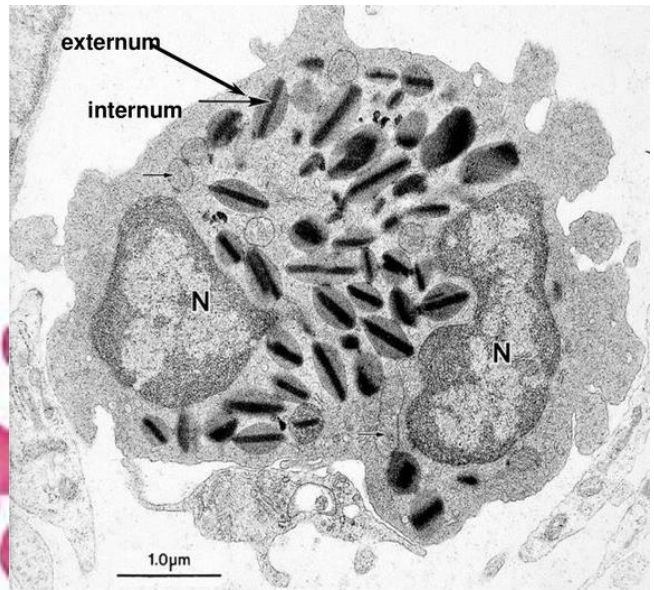
- Constitute 1-4% leukocytes
- Nucleus with 2 lobes
- Contain specific acidophilic granules (200).
  - Internum with major basic protein (Arginine Rich)
  - Externum
- Removal of antigen-antibody complex
- Eosinophilia — Seen on worms Such as helminths infection
- Eosinopenia — Seen on athletics take steroids / androgen

مسؤوله عن اللون الاحمر

The specific granules have a special shape (oval) that not found any where



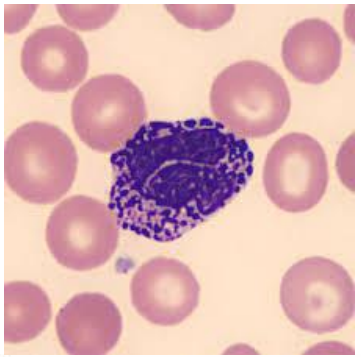




It secrete certain substances which is mediator of inflammation and may **counteract** the effect of substance secreted by basophils

اول خليه تستجيب لقرصة النحل وتفرز محتوياتها
مثل الهيستامين الذي يسبب توسع الشرايين
وتزداد النفاذية والهيبارين مضاد للتخثر وتكون
غالبا الاستجابه موضعيه في بعض الحالات عند
الاشخاص الذين لديهم حساسيه شديدة تتسبب
استجابة ال basophils الشديدة في حدوث
مضاعفات مثل anaphylactic قد تؤدي الى
الوفاه (كأنه قرصته خلية نحل كاملة)

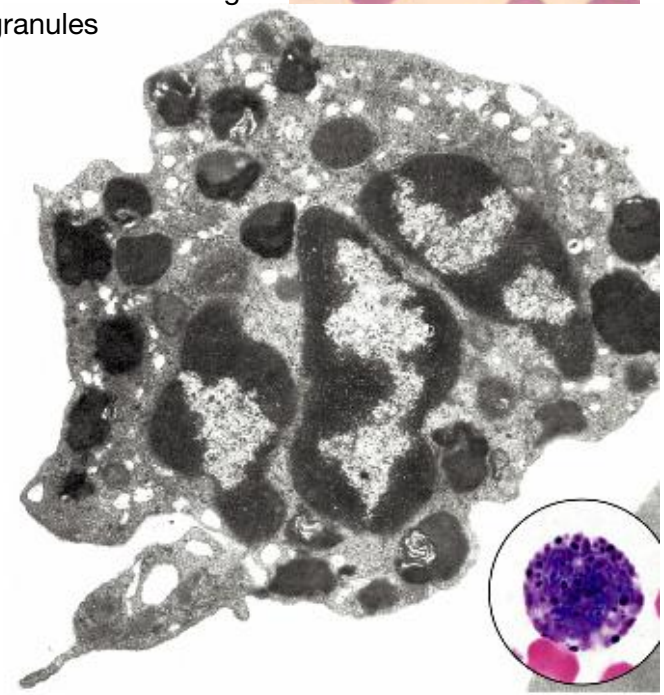
Basophils



- Constitute <1% of leukocytes
- Nucleus with irregular lobes
- Contain specific basophilic granules (0.5 µm)
- Granules are large, fewer in number and irregular in shape
- They stain purple obscuring the nucleus
- Contain histamine, heparin (Metachromasia), other mediators of inflammation (platelet-activating factor, eosinophilic chemotactic factor, and phospholipase A)

تغطي

Contain 20 S.P large granules



Most of the WBCs (90%) are made of neutrophils and lymphocytes that play a crucial role in immunity

Lymphocytes

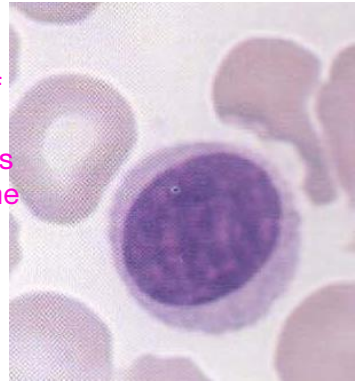
- **Constitute 30% of leukocytes**
- **Round or indented nucleus**
- **Divide into:**

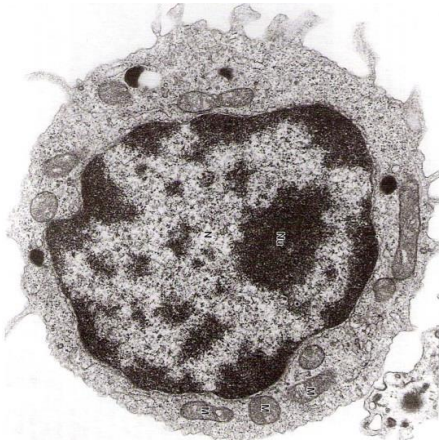
  Small lymphocytes 6-8 µm

  Medium lymphocytes >9 µm

  Large lymphocytes 18 µm

The more prominent type of lymphocytes is small lymphocytes and have the same size of RBCs

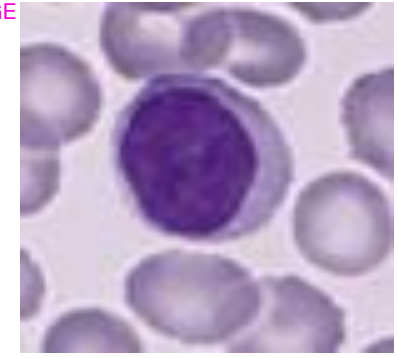


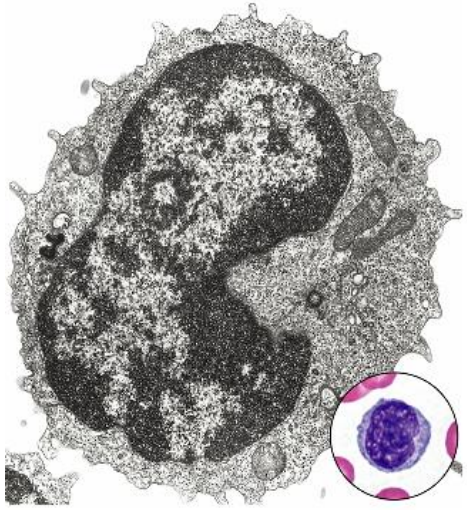


- **They are differentiated by cell surface receptors into:**

  B-lymphocytes

We can identify by the presence of immunoglobulin receptors such as IGE





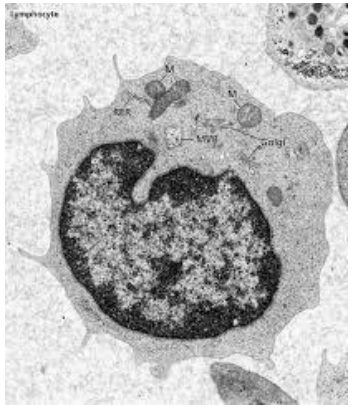
  T-lymphocytes (CD_4, CD_8 , CD_{25})

Helper , killer, regulatory

CD stands for cluster of differentiation.

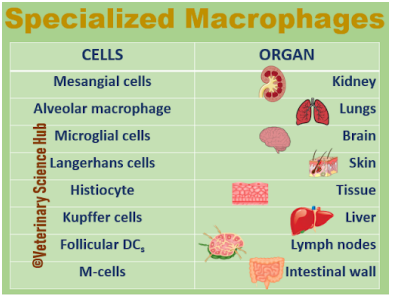
The largest leukocytes in size 18 µm

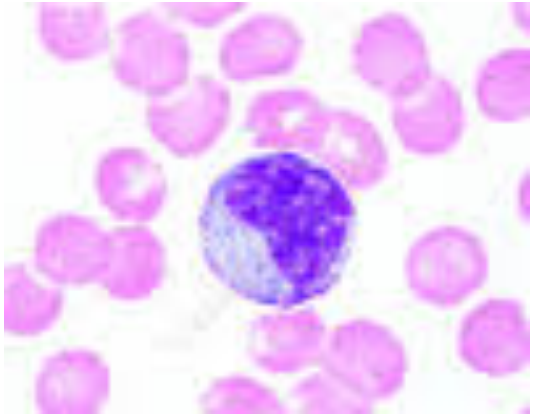
Monocytes

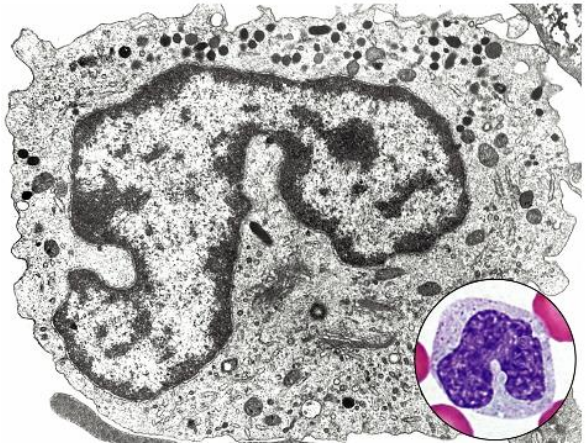


- Constitute 2-8% of leukocytes
- Oval, horse-shoe, or kidney-shaped nucleus
- Differentiate into macrophages in connective tissue
- It is difficult to differentiate between monocyte and large lymphocyte

macrophages take different names according to their tissue location, such as osteoclasts (bone), alveolar macrophages (lung), microglial cells (brain), histiocytes (connective tissue), Kupffer cells (liver), Langerhans cells (LC) (skin),







Megakaryocytes are the hematologic progenitors that give rise to platelets in the bone marrow when associated with endothelial structures.

not a cell it consider as a small

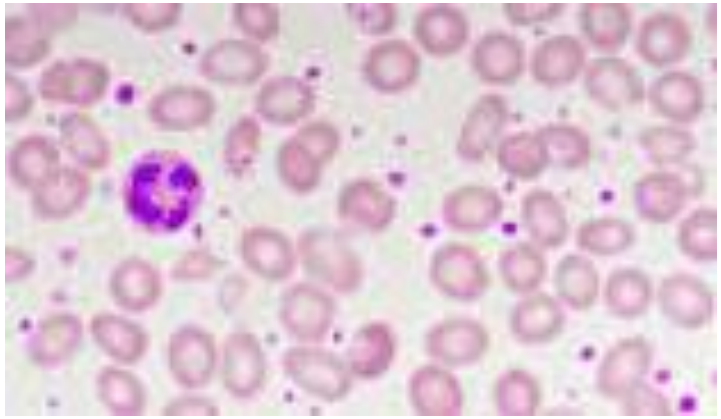
pieces

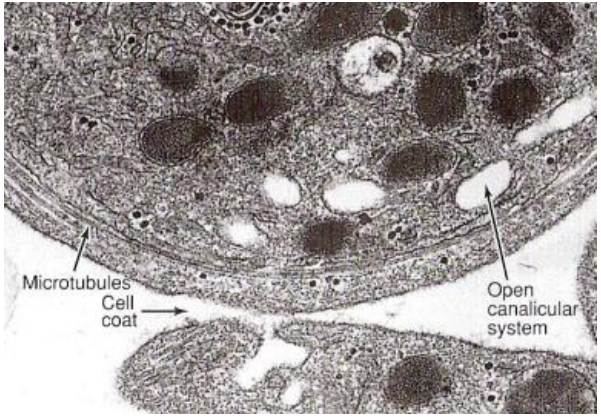
of cytoplasm with organlls that arise from megakaryocyte

زي كانك جايب مقص وبنقص قطع من السيتوبلازم مع شويه عضيات لخلايا كبيرة اسمها ميغاكاريوسايت

Platelets

- A cell fragment 2-4 µm, non-nucleated
- Promote blood clotting and repair small tears in blood vessels
- They are 150,000-400,000/ml
- They live for 10 days
- Each platelet is discoid in shape shaped like a disc like RBCs
- It has a lightly stained peripheral zone called Hyalomere Means transparent شفافة.
- Also has a central dark-stained zone called Granulomere
- Spares Glycocalyx surrounding plasmalemma for adhesion and activation during coagulation





Platelets Cont.,

Hyalomere contains:

On the periphery that Forms the cytoskeleton of platelets

- Marginal bundle of microtubule and microfilaments
- Open canalicular system

Invagination of plasma membrane the pathway for transport of substances like protein or activating substances quickly (short time to go inside platelets)

- Dense tubular system

Part of SER and they are Store calcium

Granulomere contains:

- δ granules: Serotonin, ADP, ATP

For energy

- α granules: fibrinogen, platelet-derived growth factor, platelet specific proteins, platelet factor 4

Important role in clotting

- λ granules: lysosomes

Š granules Smaller in size
average 150-200 nm in diameter
compared to à granules