

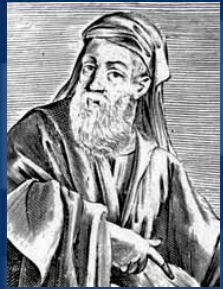


# The Full Blood Count

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Paediatric Oncology and Haematology

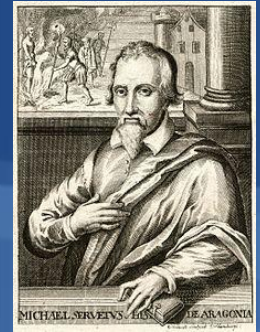


# History

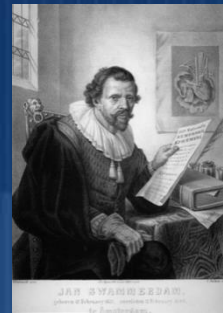


- Empedocles in the 5<sup>th</sup> century BC
  - Vasculature contains Blood, Phlegm, Black bile and Yellow Bile.

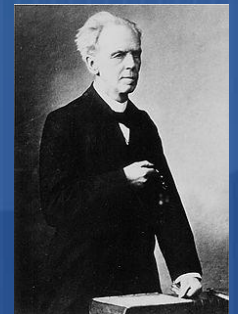
- Michael Servetus in 1550 described the Lesser and systemic circulation



- Jan Swammerdam observed Red Corpuscles in the mid 17<sup>th</sup> century



- Ernst Christian Neumann demonstrated the origin of red blood cells in 1868



- The Full Blood Cell Count (FBC) is the most commonly performed tests in health care.
- Circulate through the heart, arteries, and veins carrying nourishment, hormones, vitamins, antibodies, heat, and oxygen to the body's tissues.
- All blood cells originate from a common stem cell
- Diagnostic information about the hematologic and other body systems,
  - prognosis,
  - response to treatment,
  - and recovery.



## FULL BLOOD COUNT

=> Haemoglobin		13.0	11.1-14.1	g/dl
=> Red Cell Count		4.82	3.90-5.10	$10^{12}/l$
=> Haematocrit		37.2	30.0-38.0	%
=> MCV		77.2	72.0-84.0	fl
=> MCH		27.0	25.0-29.0	pg
=> MCHC		34.9	31.0-36.0	g/dl
=> RDW		14.0	10.0-14.0	%
=> White Cell Count		11.25	6.00-16.00	$10^9/l$
=> Neutrophils		36.3		%
=> Neutrophils Abs	#	4.09	1.00-7.00	$10^9/l$
	Delta: 2.58 on 10/04/17-1517			
=> Lymphocytes		53.0		%
=> Lymphocytes Abs		5.96	3.50-11.00	$10^9/l$
=> Monocytes		8.1		%
=> Monocytes Abs		0.91	0.20-1.00	$10^9/l$
=> Eosinophils		2.5		%
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FULL BLOOD COUNT

=> Haemoglobin

13.0

11.1-14.1

g/dl

=> White Cell Count

11.25

6.00-16.00

$10^9/l$

=> Platelet Count

371

137-373

$10^9/l$



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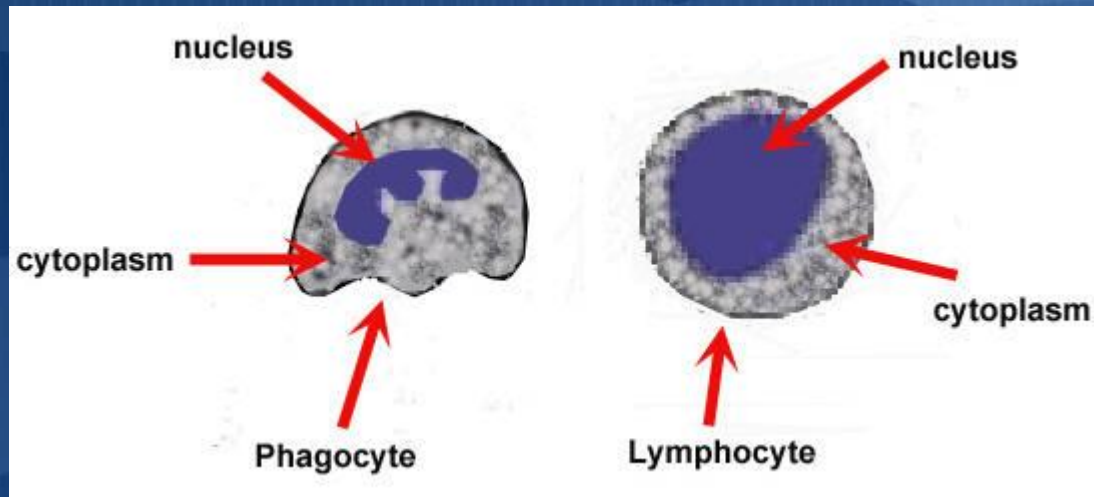
# White Cell Count

- The WBC is nonspecific, yet sensitive.
- Is a valuable indicator that something is wrong somewhere.

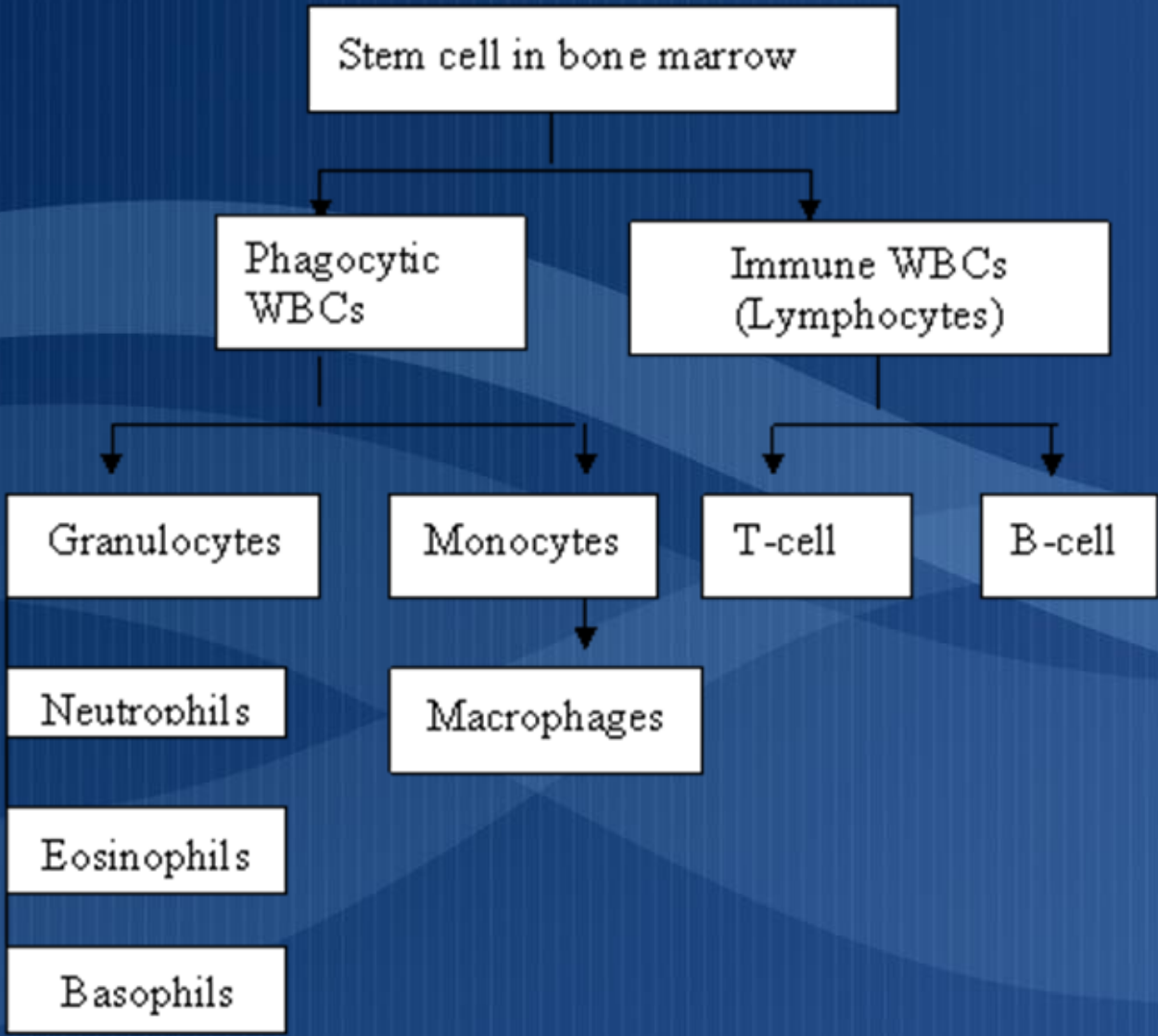


# White Cell Count

- Protect the body from invasion by foreign substances such as bacteria, fungi and viruses.
- Phagocytic WBCs and the immune WBCs.

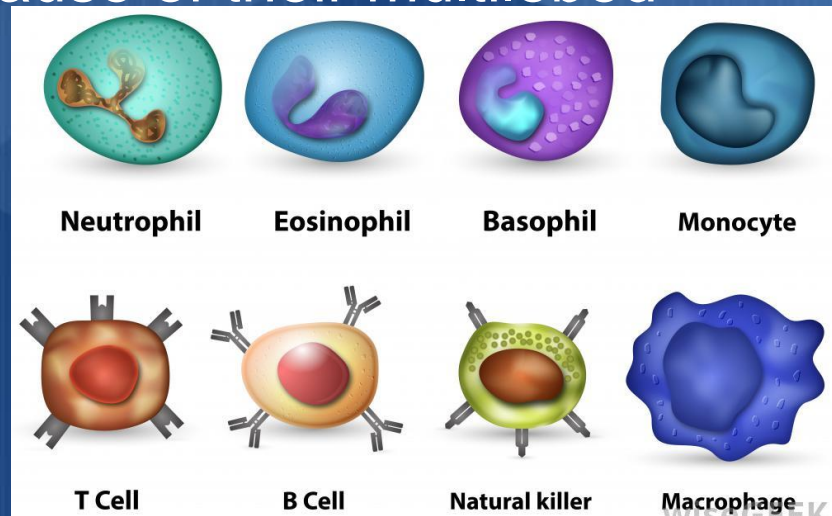






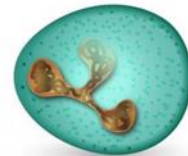
# White Cell Count

- The phagocytic cells
  - granulocytes and
  - monocytes.
- They are also called polymorphonuclear leukocytes (polys) because of their multilobed nucleus.

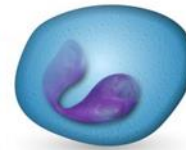


# White Cell Count

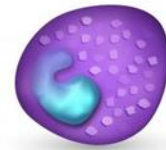
- The three types of granulocytes are
  - neutrophils,
  - eosinophils and
  - basophils.
- Monocytes, along with lymphocytes, are considered mononuclear leukocytes, contain extremely small granules.



**Neutrophil**



**Eosinophil**



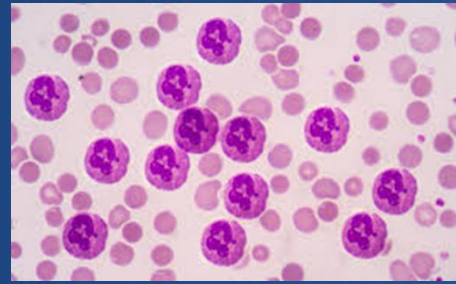
**Basophil**



**Monocyte**



# Neutrophils

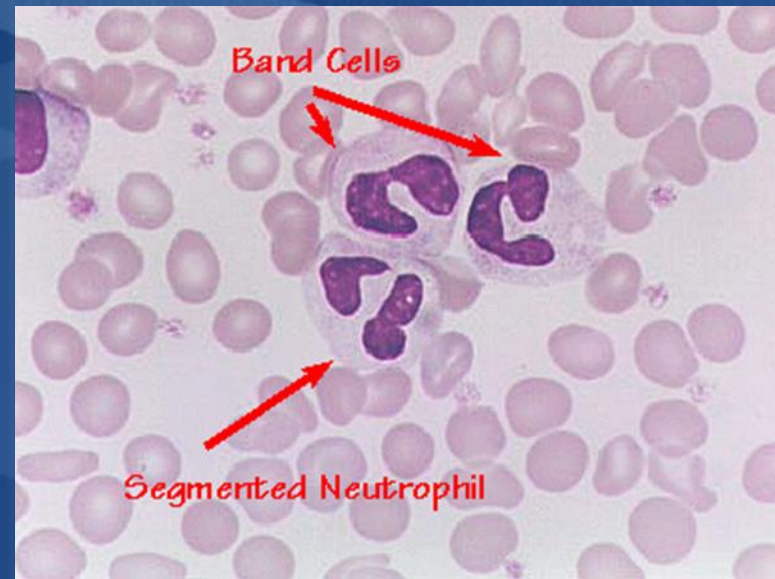


- Neutrophils are the first to arrive at an area of inflammation.
- Clear the area of cellular debris through phagocytosis.
- The most populous of the circulating white cells;
- Most short-lived in circulation.
  - Circulate for about eight hours proceeding to the tissues where they live for about 4 days.
- Produced as a response to acute body stress,
  - infection, infarction, trauma, emotional distress, or other noxious stimuli.
- Phagocyte usually kill themselves in the act of doing in, the bad guys.



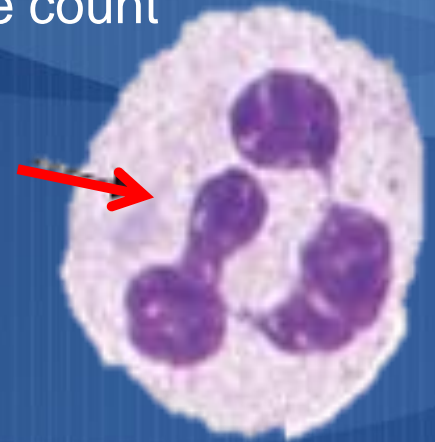
# Neutrophils

- Neutrophils consist of band neutrophils and segmented neutrophils, the latter being the most mature type.
- **In stress situations, the body reacts quickly by releasing the neutrophils before they have reached maturity. When this increase in band cells is found, it is known as a shift to the left.**
- The term left to right shift means that the cells have more than the usual number of nuclear segments.
- In the case of Liver disease, pernicious anemia, megaloblastic anemia and Down's syndrome.



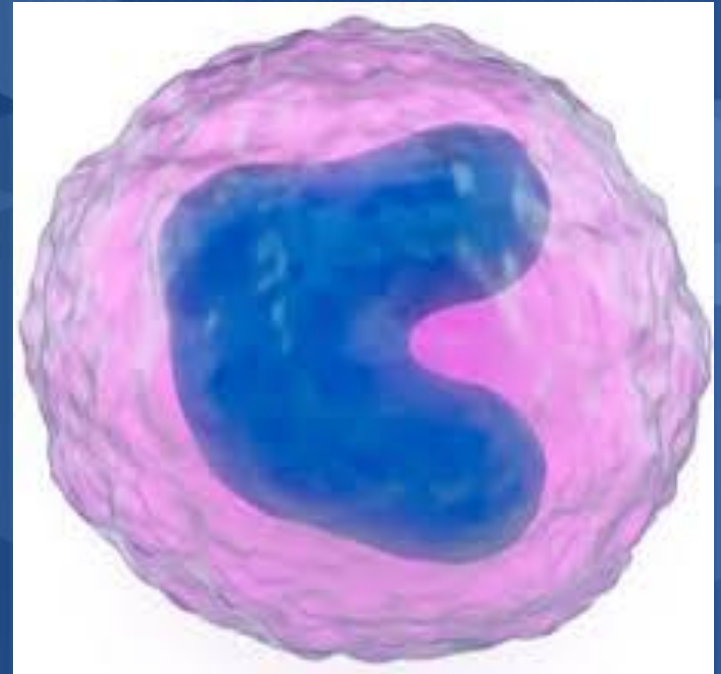
# Neutrophils

- Döhle bodies, which consist of aggregates of ribosomes and endoplasmic reticulum.
- Obesity and cigarette smoking are associated with an increased neutrophil count. It is estimated that for each pack per day of cigarettes smoked, the granulocyte count may be expected to rise by 1000/ul



# Monocytes

- Monocytes which live months or even years
- Not phagocytic cells.
- Monocytes and neutrophils share the same stem cell.



# Monocytes

- Monocytes mature into macrophages, which are phagocytic cells.
- They are produced by the marrow, circulate for five to eight days, and then enter the tissues where they are mysteriously transformed into histiocytes.
- Histiocytes process foreign antigens and present them to the immunocompetent lymphocytes.
- Mycobacteria can live in histiocytes (following phagocytosis) for years.





# Eosinophils



- Play an important role in the defence against parasitic infections.
- They also phagocytize cell debris, in the later stages of inflammation.
- They are also active in allergic reactions.
- The hallmark of the eosinophil is the presence of bright orange, large, refractile granules
- The life span of eosinophils in the peripheral blood is about the same as that of neutrophils.
- Following a classic acute phase reaction, as the granulocyte count in the peripheral blood drops, the eosinophil count temporarily rises.



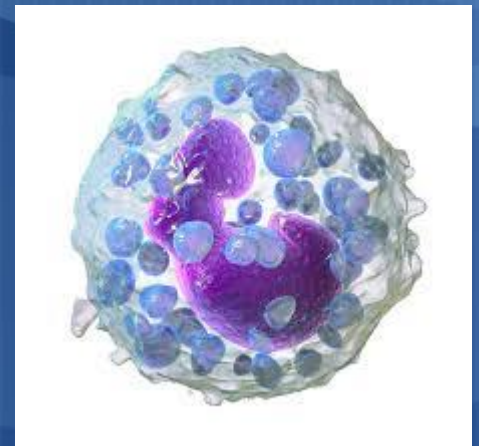
# Eosinophils

- Eosinophils are capable of amoeboid motion
- Since they are often seen at the site of
  - invasive parasitic infestations
  - allergic responses
  - chronic allergic conditions
- Allergic Response
  - inactivate slow reacting substance of anaphylaxis (SRS-A)
  - neutralize histamine
  - inhibit mast cell degranulation.



# Basophils

- Least numerous
- Very large, deep purple cytoplasmic granules which overlie, as well as flank, the nucleus. Eosinophil granules, by contrast, only flank the nucleus but do not overlie it.
- The basophil and the mast cell are the blood and tissue versions



# Basophils

## Allergic Response

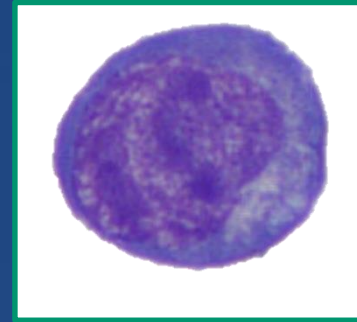
- Basophils release histamine, bradykinin, and serotonin when activated by injury or infection.
- These substances are important to the inflammatory process since they increase capillary permeability and thus increase the blood flow.
- The mast cell is the essential effector of immediate (Type 1) hypersensitivity reactions

## Clotting

- In addition, the granules on the surface of basophils secrete the natural anticoagulating agent
- This provides some balance to the clotting and coagulation pathways.



# Lymphocytes

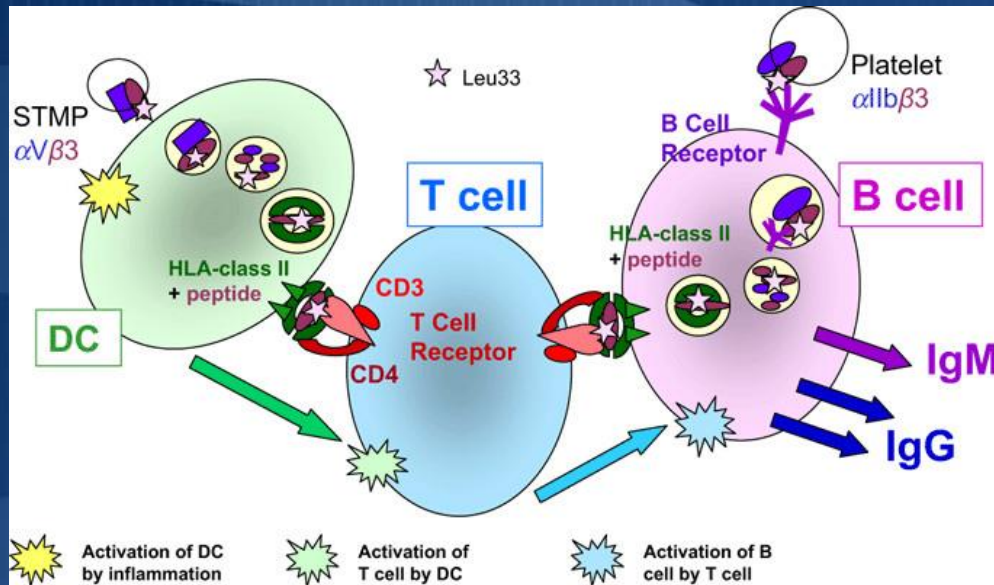


- The neutrophils and monocytes are the brutes, the lymphocytes are the brains
- **T lymphocytes, or T cells, and the B lymphocytes or B cells, mature in lymphoid tissue and migrate between the blood and lymph system.**
  - can move back and forth between the vessels and the extravascular tissues,
  - are capable of reverting to blast-like cells, and
  - when so transformed, can multiply as the immunologic need arises
- After neutrophils, lymphocytes are the most numerous of the circulating leukocytes.
- Azurophilic cells (i.e., T-cells that have a surface receptor for the IgG Fc region) or natural killer (NK) null-cells.
- Lifespan of days or years, depending on their type.



# Lymphocytes

- They play an integral part in the antibody response to antigens.



- X-linked, severe combined immune deficiency.

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# Red Blood Cells

- life span of 80-120 days
- substances necessary for creation of erythrocytes,
  - metals (iron, cobalt, manganese),
  - vitamins (B12, B6, C, E, folate, riboflavin, pantothenic acid, thiamine),
  - amino acids.
- Regulatory substances necessary for normal erythropoiesis include
  - erythropoietin,
  - thyroid hormones and
  - androgens.





# Erythrocyte count

- If the number of RBCs is decreased at least 10% below normal, the condition is known as anaemia
- Reticulocytes are normally released into the bloodstream at the same rate at which old RBCs are destroyed, about 1% of the total RBC component per day

## Drugs that increase the RBC

gentamicin  
methyldopa.  
androgens

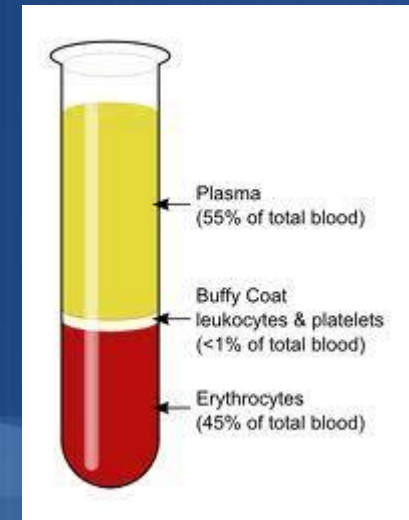
## Drugs that decrease the RBC

ampicillin,  
chloramphenicol,  
indomethacin,  
isoniazid,  
Phenobarbital,  
phenytoin,  
rifampin,  
tetracyclines,  
vitamin A



# Haematocrit

- Hematocrit (Hct) is a measure of the total volume of the erythrocytes relative to the total volume of whole blood in a sample
- A drop of 3% in Hct equals approximately one unit of blood loss
- The Hct reflects the interplay of three variables:
  - fluid volume
  - RBC count
  - RBC size
- Hyperglycemic macrocytosis,
  - If one pours glucose into our conceptual test tube, simulating diabetic hyperglycemia, the red sediment will swell up, thus raising the Hct even though the fluid volume and RBC count is unchanged.



# Haemoglobin



- Vehicle for the transport of oxygen and carbon dioxide.
- Composed of two portions.
  - heme portion contains iron and the red pigment popyrin, and the
  - globin portion is composed of amino acids that form a single protein called globin.
- determines the oxygen carrying capacity of the blood.
- In normal, hydration status the Haemoglobin is approximately one third of the Hct value.



# RBC Indices

- MCH
- Mean corpuscular volume (MCV)
- Red Cell Distribution Width (RDW)
- Mean corpuscular Hb (MCH)
- Mean corpuscular Hb concentration (MCHC)



# MCH

- MCH measures how much (weight) Hb there is in the RBC
- $MCH = (Hb \text{ [in g/dL]} \times 10 \div (RBC \text{ count [in millions}/\mu\text{L]})$



# MCH

- **Hypochromic anaemia**  
iron deficiency  
chronic blood loss  
thalassemia

## **Normochromic anaemia**

acute blood loss  
renal or bone marrow failure  
hypometabolic states

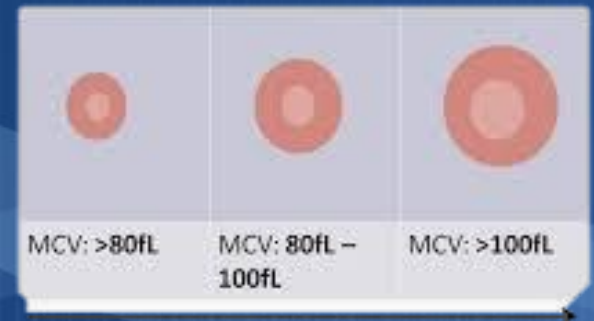
## **Hyperchromic anaemias**

alcoholism,  
folic acid  
B12 deficits,  
oestrogen administration



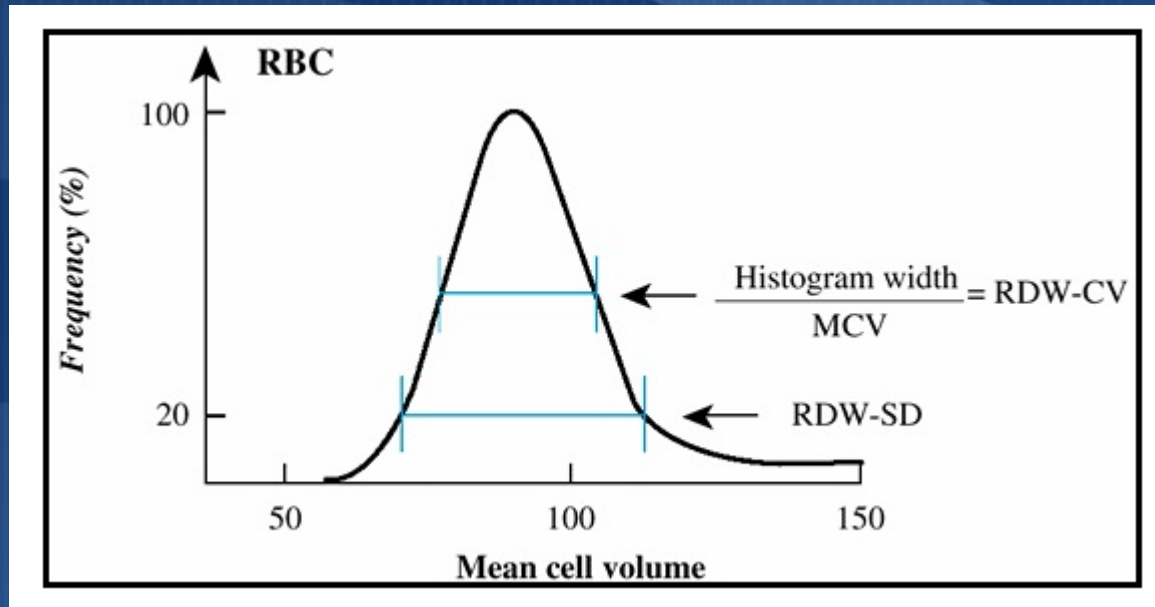
# Mean corpuscular volume (MCV)

- The MCV is the mean volume of all the erythrocytes counted
  - $MCV = Hct \div RBC \text{ count}$
- Microcytic, Macrocytic, and Normocytic.
- Mentzer index
  - $MCV / RBC =$
  - If more than 13, predicts an iron deficiency;
  - if less than 13, the prediction is toward beta-thalassemia minor.



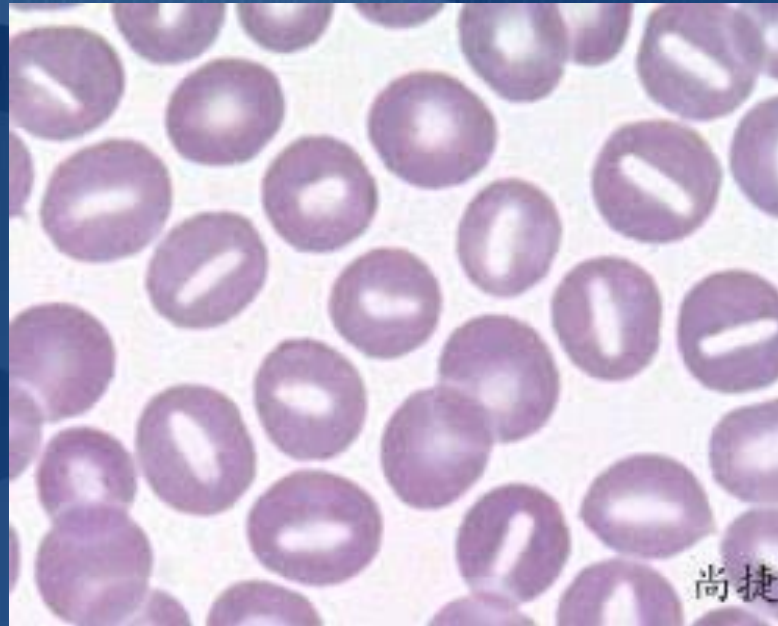
# Red Cell Distribution Width – RDW

- Mathematically expressing magnitude of dispersion of a population about a mean
- Describes the variance in the actual size of all the red cells





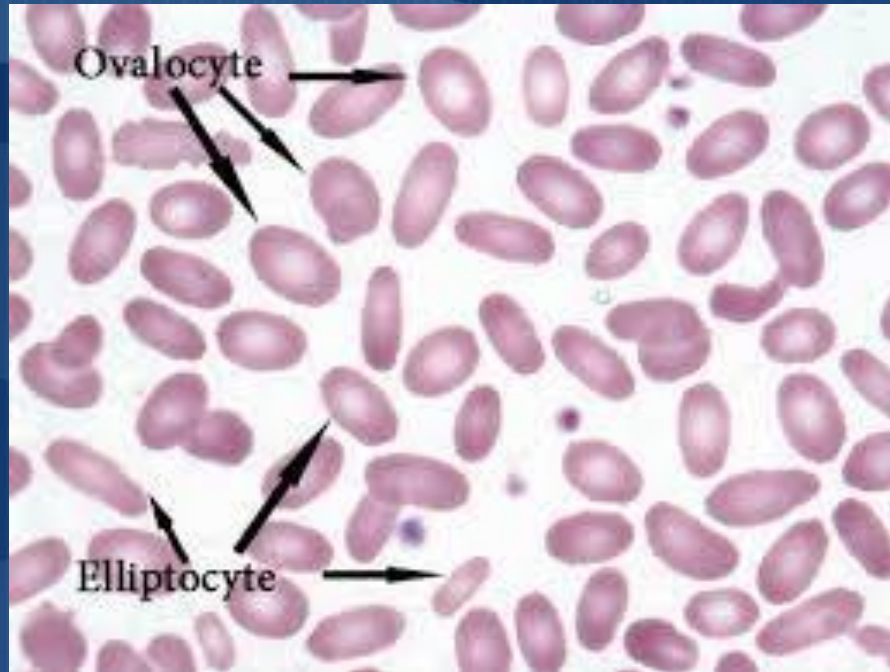
# Stomatocytes



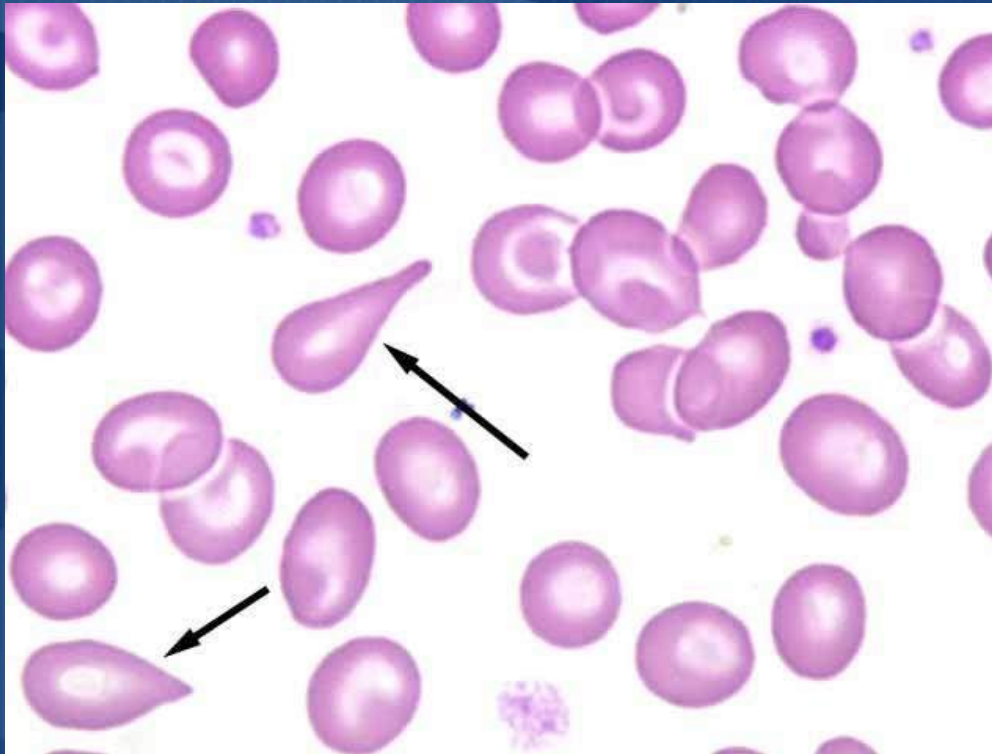
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# Elliptocytes/Ovalocytes



# Dacryocyte (Tear drop cells)



# Schistocyte



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# Platelets

- Platelets (thrombocytes) are the smallest of the formed elements in the blood.
- They are fragments of megakaryocytes which are formed in the bone marrow.
- life span of 8 – 12 days,
- removed from the circulation by the spleen.



# Platelets

## **Platelet counts may be increased in**

- high altitudes
- persistent cold temperatures
- strenuous exercise
- excitement
- with drugs such as epinephrine
- oral contraceptives
- Acute Phase reaction

## **A platelet count may be decreased**

- prior to menstruation
- amphotericin B
- ampicillin
- Aspirin
- Autoimmune disease
- Infection
- Chemotherapy
- Marrow failure



# Any

# “Bloody”

# Questions?

