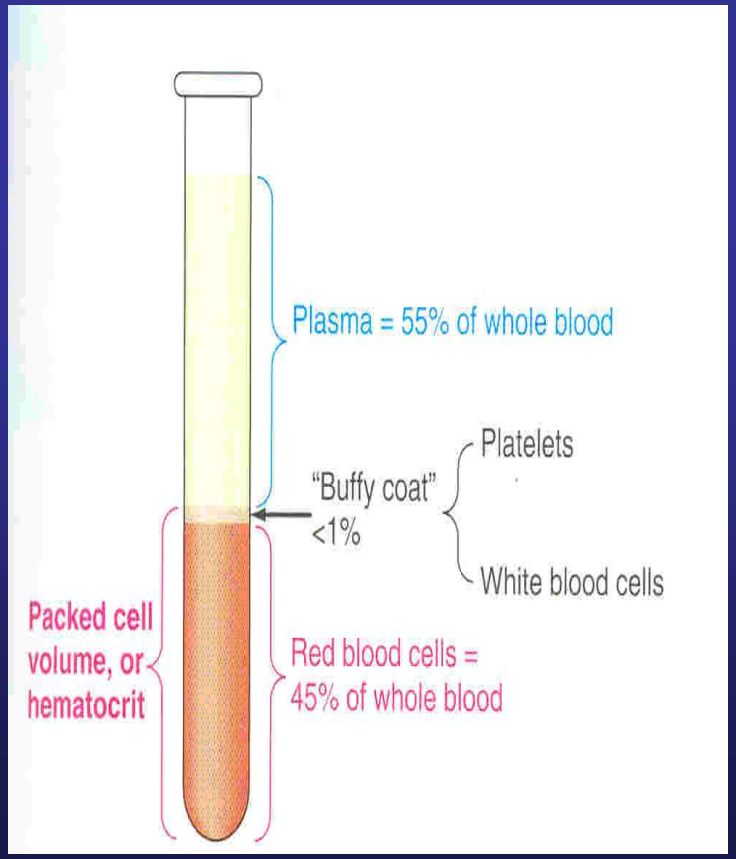
BLOOD

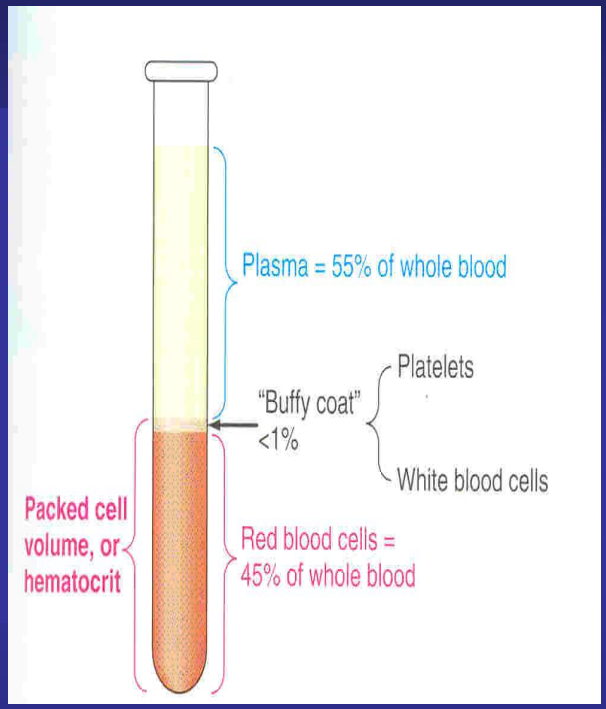
Blood

- The average blood volume of adults is about 7% of body weight (5-5.5 L).

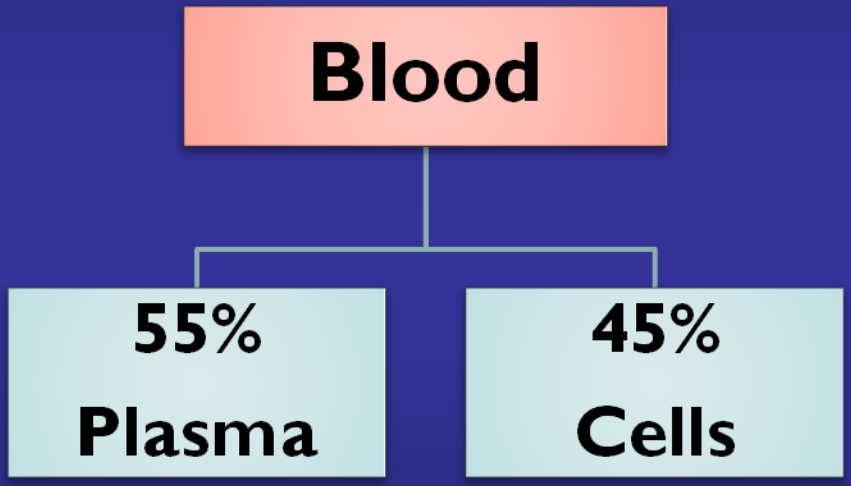


Blood Composition

1. Cellular components
   - Red Blood Cells
   - White Blood Cells
   - Platelets
2. Plasma
   - Consist of:
     - Water: 98%
     - Ions: Na, K, HCO3, PO4 ..etc
     - Plasma proteins (Albumin, globulin, Fibrinogen)
   - Same ionic composition as interstitial fluid

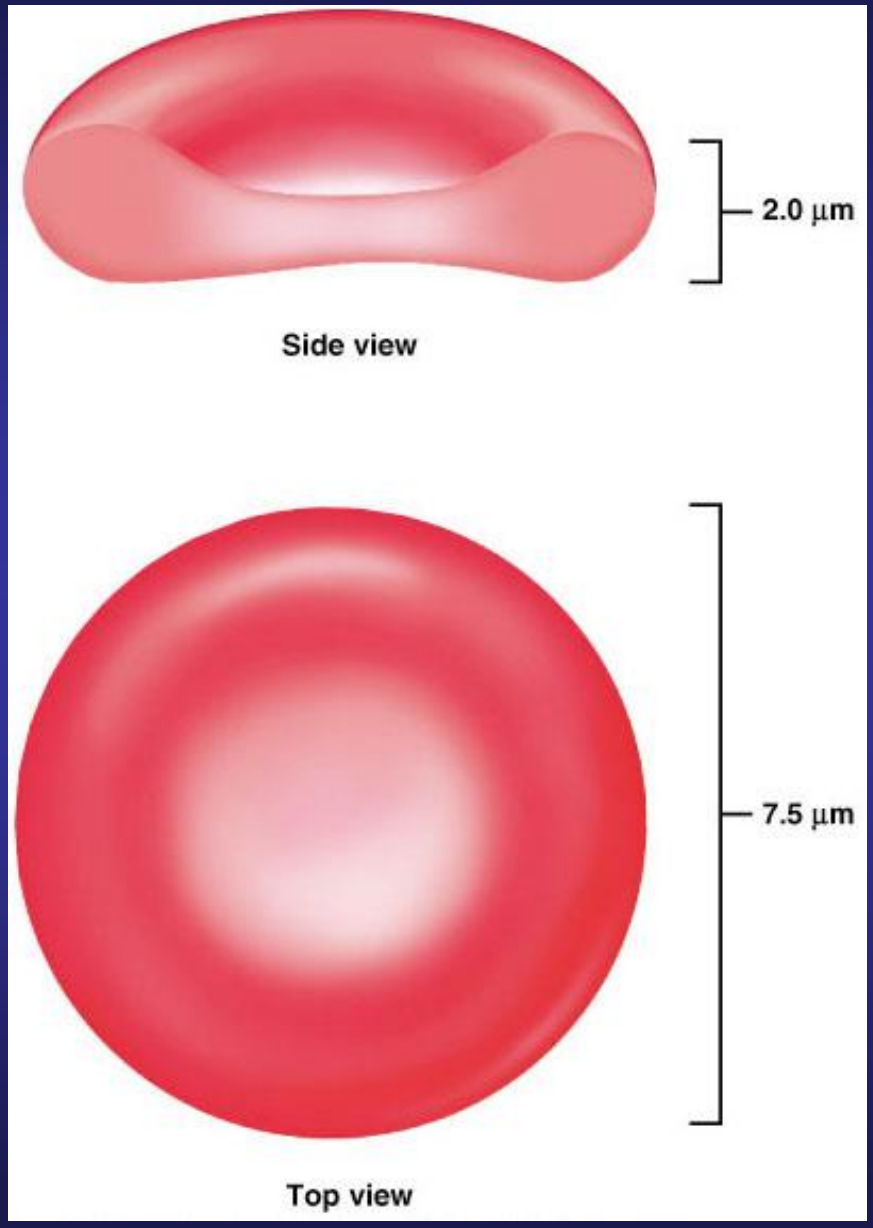


Blood

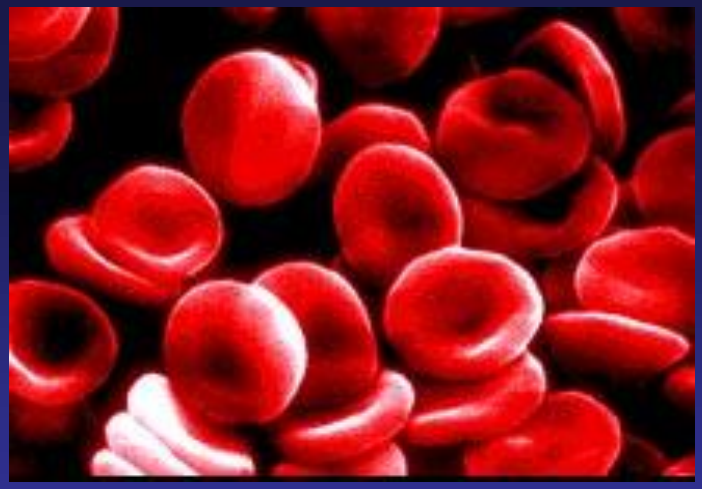


Red blood cell (RBC) Erythrocytes

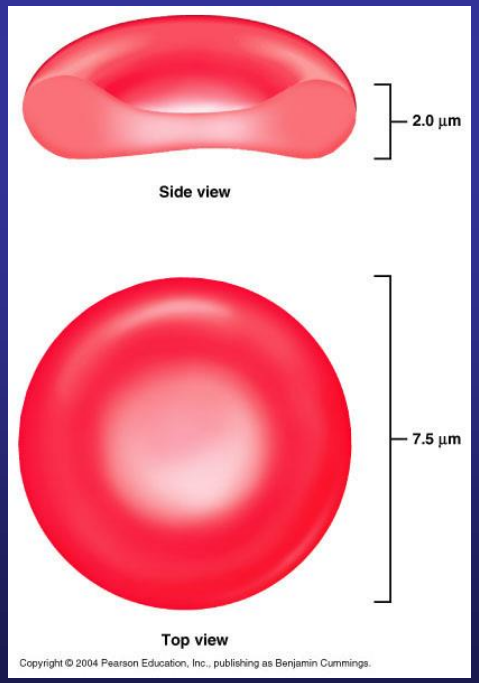
Erythrocytes (RBCs)



Red blood cells cont…



- Structure
  - Flat biconcave disc
  - Non-nucleate
  - Dimensions:
  - Contain a red pigment haemoglobin
  - RBC membrane is elastic so it is flexible (can easily pass through the capillaries).



Red Blood Cells *cont.*

- RBC Count:
  - In males 4.8-6.5 million cells/mm3
  - In females 3.8-5.8 million cells/mm3

  (In Different textbooks there are different values but they are nearly similar).
- Life span 120 days

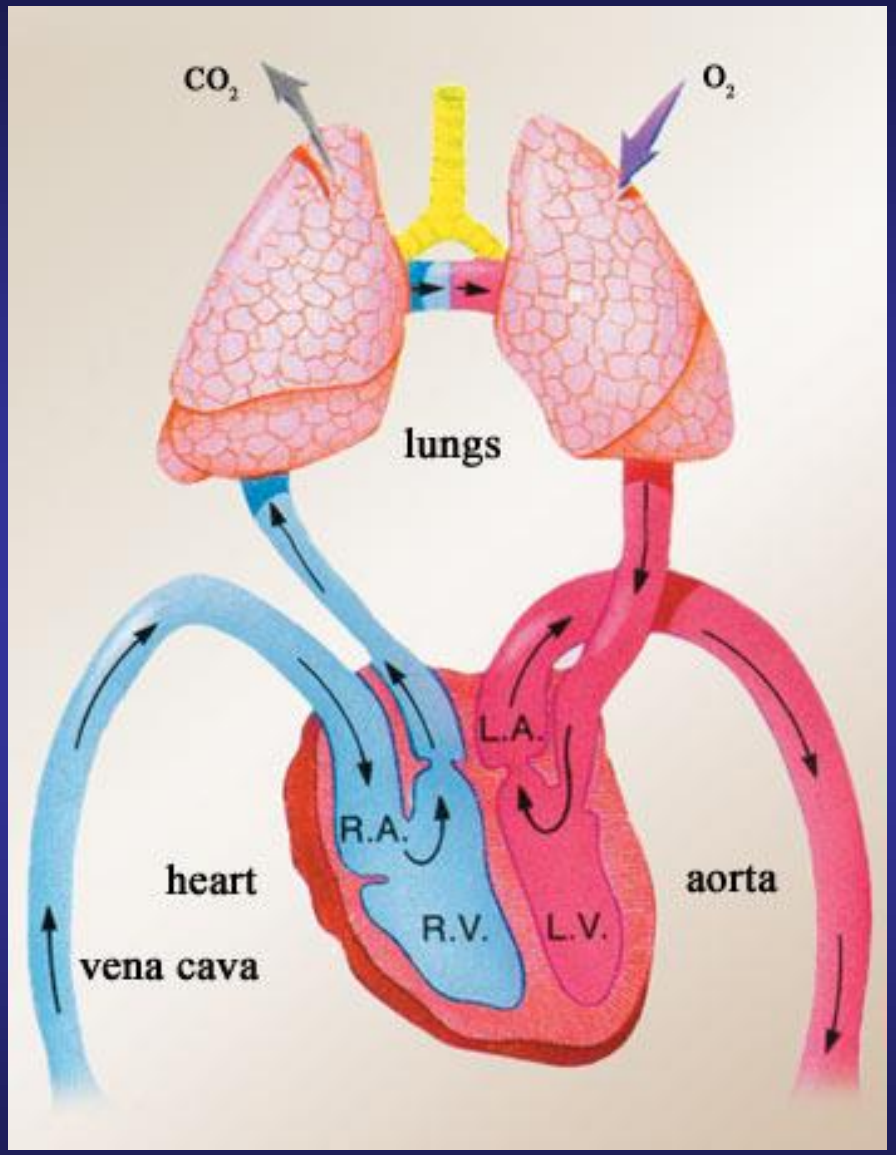
Red Blood cells *cont.*

- Functions
  - Carry Haemoglobin
  - Transport of Oxygen
  - Transport of Carbon Dioxide
  - Buffer (pH ↓ regulation)
- Metabolism
  - Metabolically active cells uses glucose for energy

Red blood cells cont...

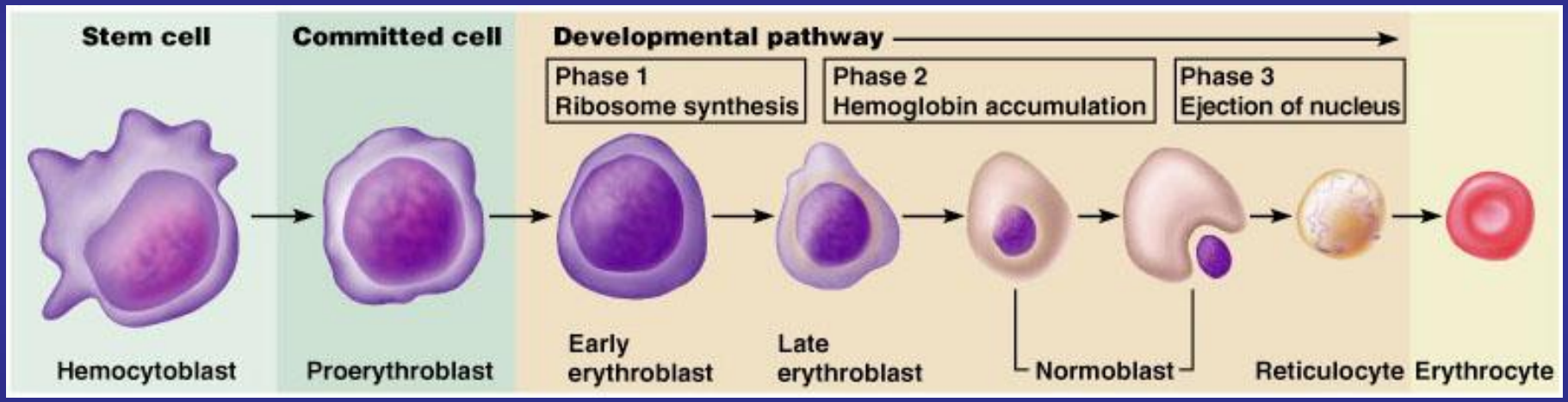
- Function:

Transport oxygen from lungs to tissues and carbon dioxide from tissues to lungs (because they contain hemoglobin)



Erythropoiesis:

The process of Production of Erythrocytes.

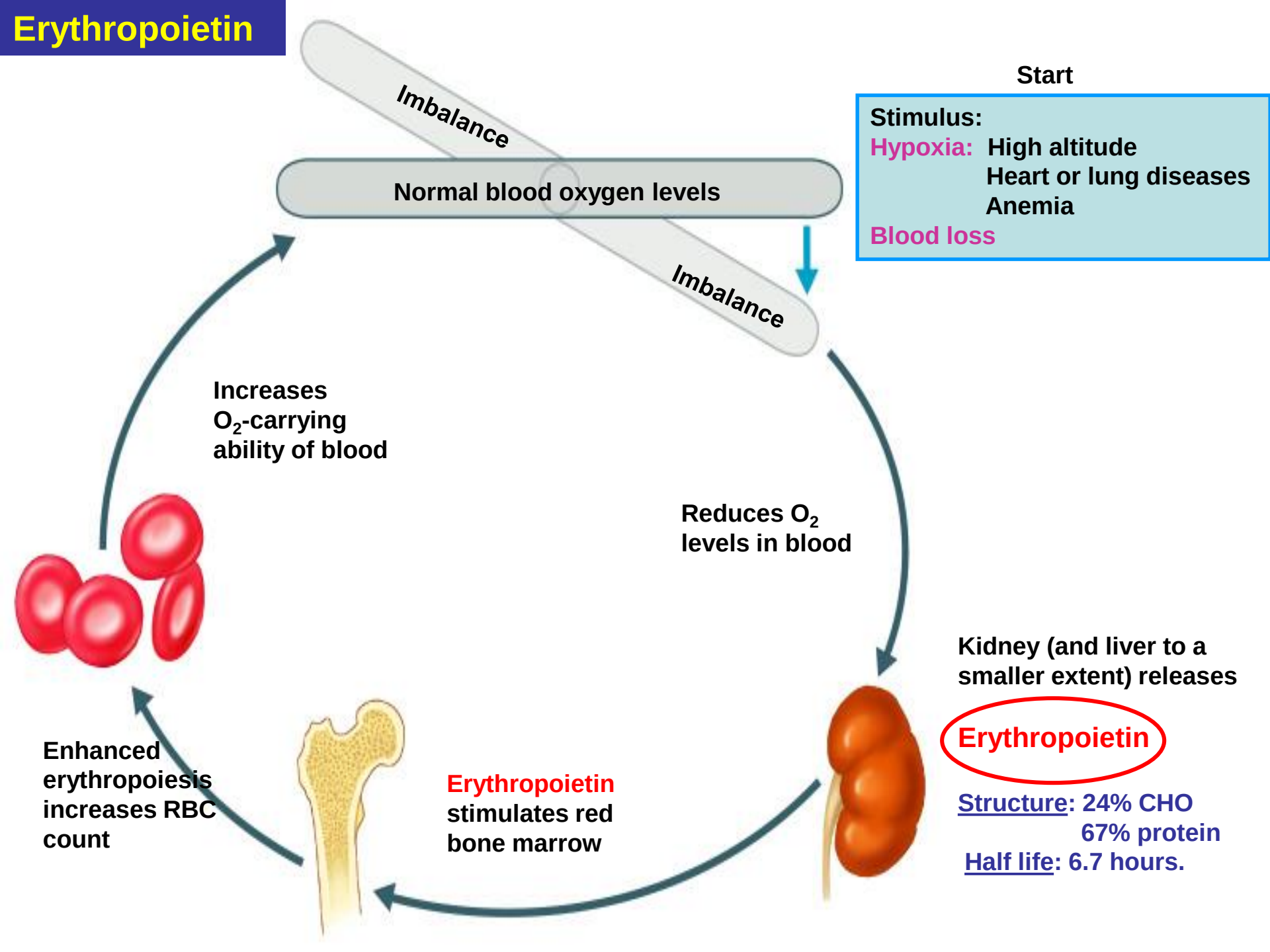


- Hemocytoblasts give rise to all formed elements

Features of the maturation process of RBC

1. Reduction in size
2. Disappearance of the nucleus
3. Acquisition of haemoglobin

Erythropoietin



Control of Erythropoiesis

- Erythropoiesis is stimulated by *erythropoietin* hormone

  Stimulated by:

- Hypoxia (low oxygen)
  - Anaemia
  - Hemorrhage
  - High altitude
  - Lung disease
  - Heart failure

Erythropoiesis:

- **Nutritional requirements of RBC production:**

1. Amino acids

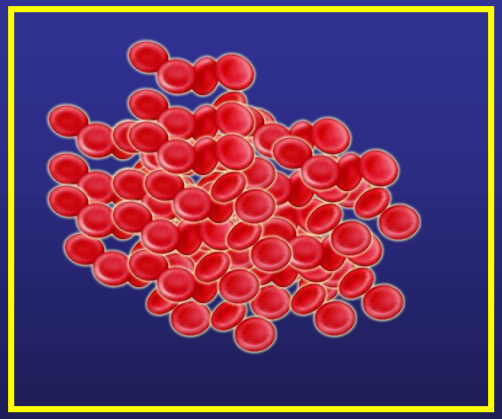
2. Iron.

3. Vitamins (Vit: B12, folic acid, Vit: C)

4. Trace elements (Copper, cobalt, zinc)

Haemoglobin

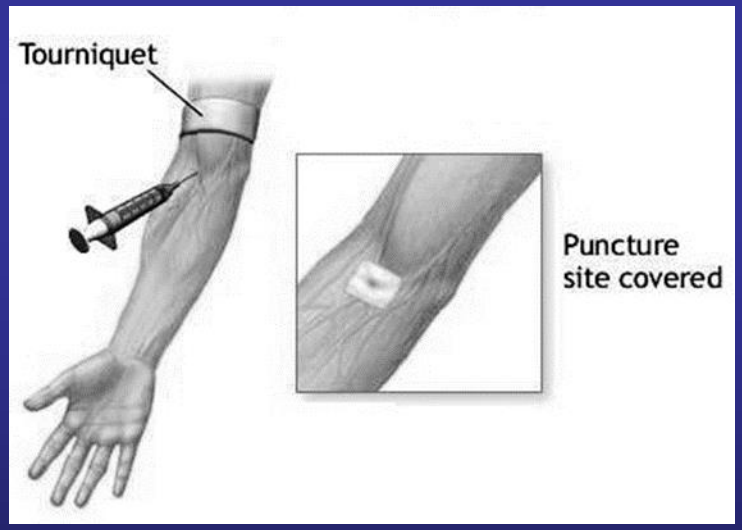
- **Haemoglobin is the protein molecule in red blood cells that carries oxygen from the lungs to body's tissues and returns carbon dioxide from the tissues to the lungs.**
- **It is red pigment present in RBCs and gives red blood cells their colour.**
- **280 million molecules / cell**



Hemoglobin cont…

- Male: 13-18 g/dl
- Female: 11.5 -16.5 g/dl
- Anemia:
  - Decrease number of RBC
  - Decrease Hb
  - Symptoms: Tired, Fatigue, short of breath,
  - Signs: pallor, tachycardia

MEASUREMENT OF BLOOD CELL COUNTS BY USING COULTER ANALYZER

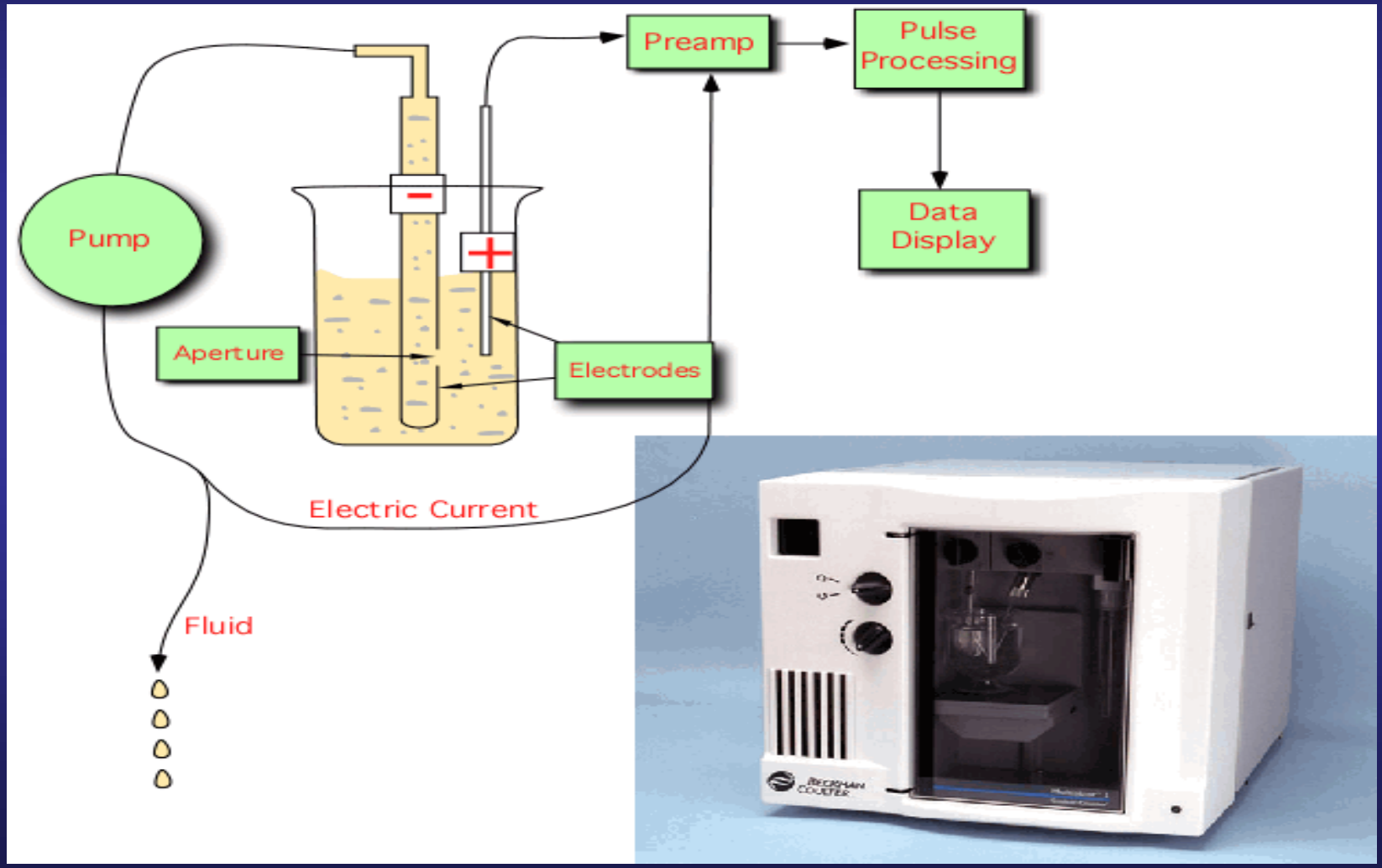


COULTER ANALYZER

Coulter Counter Principle

- It count and measure the size of the cells by **detecting and measuring electrical resistance when a liquid pass through aperture**.
- While passing the aperture, the cells impedes the current and causes a measurable pulse.
- Number of pulses --> number of particles.
- Height of pulses --> volume of particles.

Coulter Counter Principle



Coulter Counter Principle

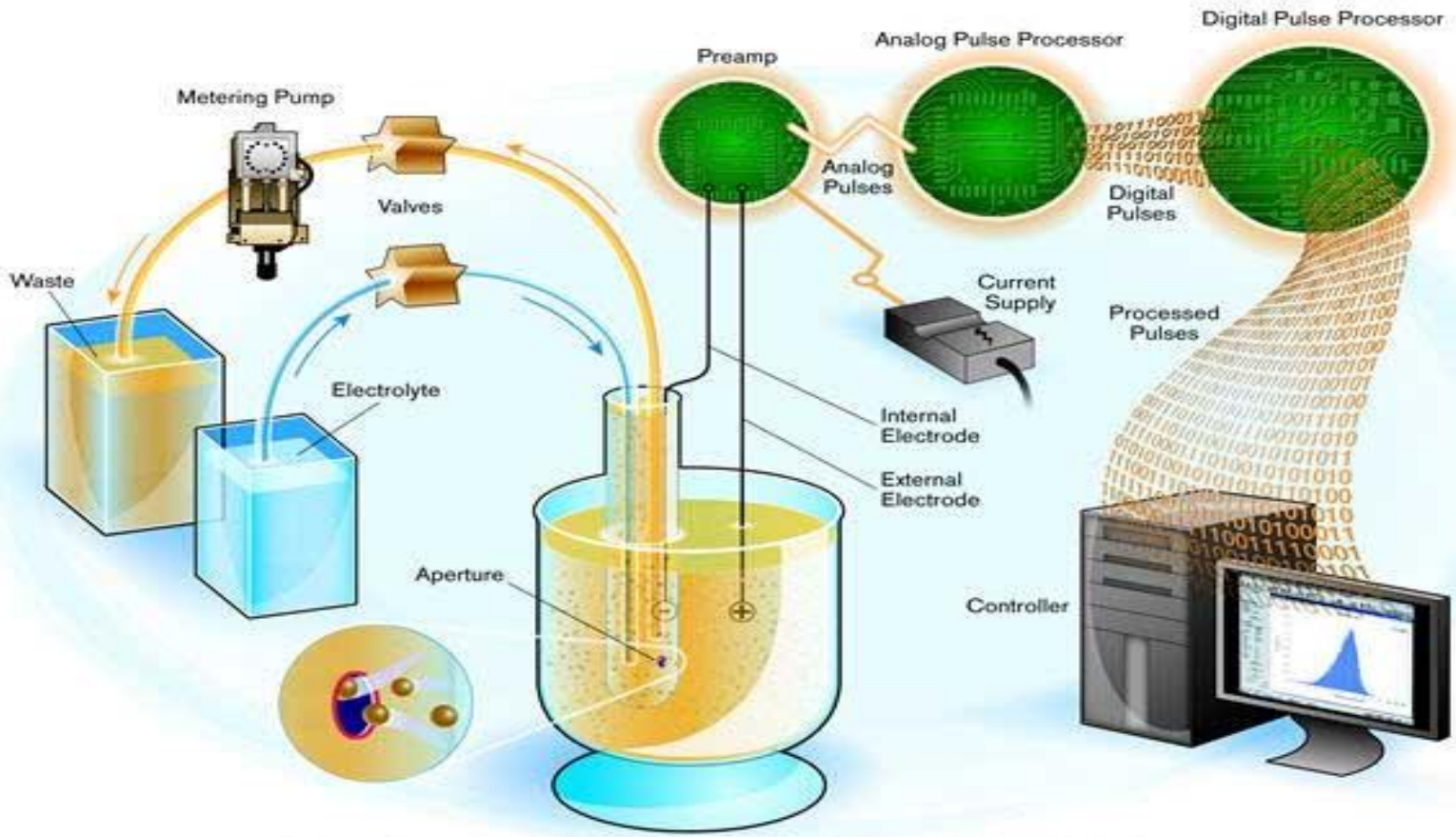


Figure 1. Schematic of a COULTER COUNTER

Normal values

	Male	Female	Average
RBC	4.5-6.5 $x10^6/\mu l$	3.8-5.8 $x10^6/\mu l$	4.7–6.5 $x10^6/\mu l$
WBC	4 – 11 $x10^3$ $/\mu l$	4 – 11 $x10^3$ $/\mu l$	4 – 11 $x10^3$ $/\mu l$
HB	13-18 g/dl	11.5-16.5 g/dl	13 –18 g/dl
Platelet	150-400$x10^3$ $/\mu l$	150-400$x10^3$ $/\mu l$	150-400$x10^3$ $/\mu l$

IMPORTANT TERMINOLOGY

- **POLYCYTHEMIA:** Increased red blood cell count above normal.
- **ANAEMIA:** Reduced ability of blood to carry Oxygen due to either decreased red blood cell count and/or hemoglobin concentration.
- **LEUCOCYTOSIS:** Increased white blood cell count above normal.
- **LEUCOPENIA:** Decreased white blood cell count below normal.
- **THROMBOCYTOSIS:** Increased platelets count above normal.
- **THROMBOCYTOPENIA:** Decreased platelets count below normal.

CALCULATION OF RED BLOOD CELL INDICES

1. MEAN CELL VOLUME (MCV)

- This is the volume of an average red blood cell measured in *femtoliters* (fl).

- $MCV = Packed\ Cell\ Volume\ x\ \frac{10}{RBC\ Count}$

- MCV of a normal person ranges from 78 – 98 fl.

- If MCV is low, it means that red blood cells are small in size and they are called **microcytes.** But if MCV is high, it means that red blood cells are large in size and they are called **macrocytes**.

CALCULATION OF RED BLOOD CELL INDICES

MEAN CELL HEMOGLOBIN (MCH)

- This is the weight of hemoglobin in an average red blood cell measured in picograms (pg).
- $MCH = Hemoglobin\ Concentration\ x\ \frac{10}{RBC\ Count}$
- MCH of a normal person ranges from 27 – 32 pg.
- High value of MCH tell us that red blood cells are **hyperchromic** and low value of MCH will be seen if red blood cells are **hypochromic**.

CALCULATION OF RED BLOOD CELL INDICES

MEAN CELL HEMOGLOBIN CONCENTRATION (MCHC)

- This is the concentration of hemoglobin per 100 ml of red blood cell measured in grams/deciliters (g/dl).
- $MCHC = Hemoglobin\ Concentration\ x \frac{100}{Packed\ Cell\ Volume}$
- MCHC of a normal person ranges from 32 – 36 g/dl.
- Value of MCHC below normal suggests Iron deficiency Anemia.

CALCULATION OF RED BLOOD CELL INDICES

What is the clinical importance of knowing the red blood cell indices?

They help to determine the type of anemia a patient is suffering from.

CALCULATION OF RED BLOOD CELL INDICES

TYPES OF ANEMIA
Hemorrhagic Anemia
Aplastic Anemia
Nutritional Anemias
Hemolytic Anemia

CALCULATION OF RED BLOOD CELL INDICES

An examination of the blood of 2 adult males (A and B) provided the following data:

•	**SUBJECT "A"**	**SUBJECT "B"**
•RBC COUNT	3.6 X 10^6 / mm^3	2.5 X 10^6 / mm^3
•Hb Concentration	7.2 g/dl	8 g/dl
•Packed Cell Volume	25%	25%

(a)Calculate MCV, MCH and MCHC for each of these subjects.

(b)What are the abnormalities encountered in these men. What are the possible causes of these abnormalities?

CALCULATION OF RED BLOOD CELL INDICES

The solution:

SUBJECT "A"	SUBJECT "B"
MCV = 25 x 10 /3.6 = **69.4 fl** **MCH** = 7.2 x 10 / 3.6 = **20 pg** **MCHC** = 7.2 x 100 / 25 = **28.8 g/dl**	**MCV** = 25 x 10 /2.5 = **100 fl** **MCH** = 8 x 10 / 2.5 = **32 pg** **MCHC** = 8 x 100 / 25 = **32 g/dl**

Subject "A"➔Microcytic hypochromic anemia (Iron deficiency anemia)

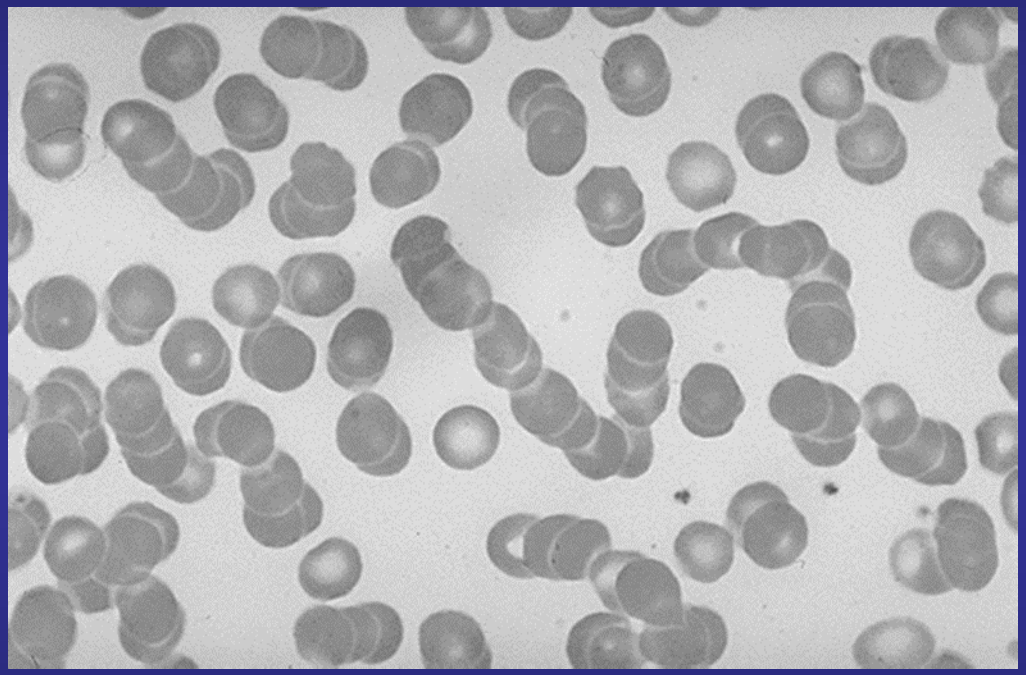
Subject "B" ➔Macrocytic normochromic anemia (Megaloblastic anemia or Pernicious anemia)

Rouleaux formation

What is meant by rouleaux formation?

When red blood cells are stacked together in long chains because of their biconcave disc like surfaces sticking to each other, it is called Rouleaux formation.

Rouleaux formation



ERYTHROCYTE SEDIMENTATION RATE (E.S.R.)

Why does rapid rouleaux formation increase the E.S.R.?

Rouleaux formation becomes rapid when plasma protein concentration is high and because of this E.S.R. also becomes increased.

What is the clinical significance of E.S.R.?

- ESR is a non-specific indicator of presence of a disease.
- ESR is a useful prognostic tool.

ERYTHROCYTE SEDIMENTATION RATE (E.S.R.)

What conditions are associated with an increased E.S.R.?

- Infections
- Connective tissue disorders
- Inflammatory disorders
- Malignancies
- Anemia
- Pregnancy

ERYTHROCYTE SEDIMENTATION RATE (E.S.R.)

- **EQUIPMENT**
- WESTERGREN'S SEDIMENTATION APPARATUS
- ANTICOAGULANT EDTA TUBE
- DISPOSABLE STERILE SYRINGES AND NEEDLES

WESTERGREN'S TUBES

ERYTHROCYTE SEDIMENTATION RATE (E.S.R.)

- **PROCEDURE**

1. Using a sterile syringe, draw 1.6 ml of blood from a suitable vein.
2. Transfer the blood to a test tube containing EDTA to prevent clotting.
3. Fill the Westergren's tube with blood upto the zero mark.
4. Place the tube upright in the stand and leave like this for one hour.
5. Note down the depth of the column of clear plasma at the top of red blood cells in the tube after one hour. This will be E.S.R. reading.

ERYTHROCYTE SEDIMENTATION RATE (E.S.R.)

- Normally the value of E.S.R. ranges from 0mm to 7 mm
- It is slightly higher in females than males. (due to less number of red blood cells)