
بسم الله الرحمن الرحيم

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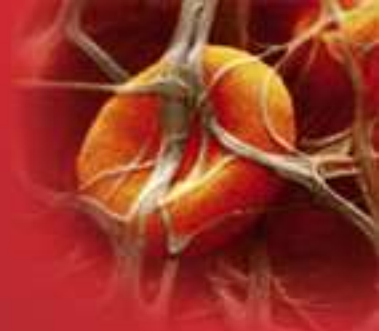
"قالوا سبحانك لا علم لنا إلا ما علمتنا إنك أنت العليم الحكيم"

صدق الله العظيم



4 – Control of erythropoiesis (Iron Absorbtion & metabolism)

Objectives;

Intended learning outcomes (ILOs)

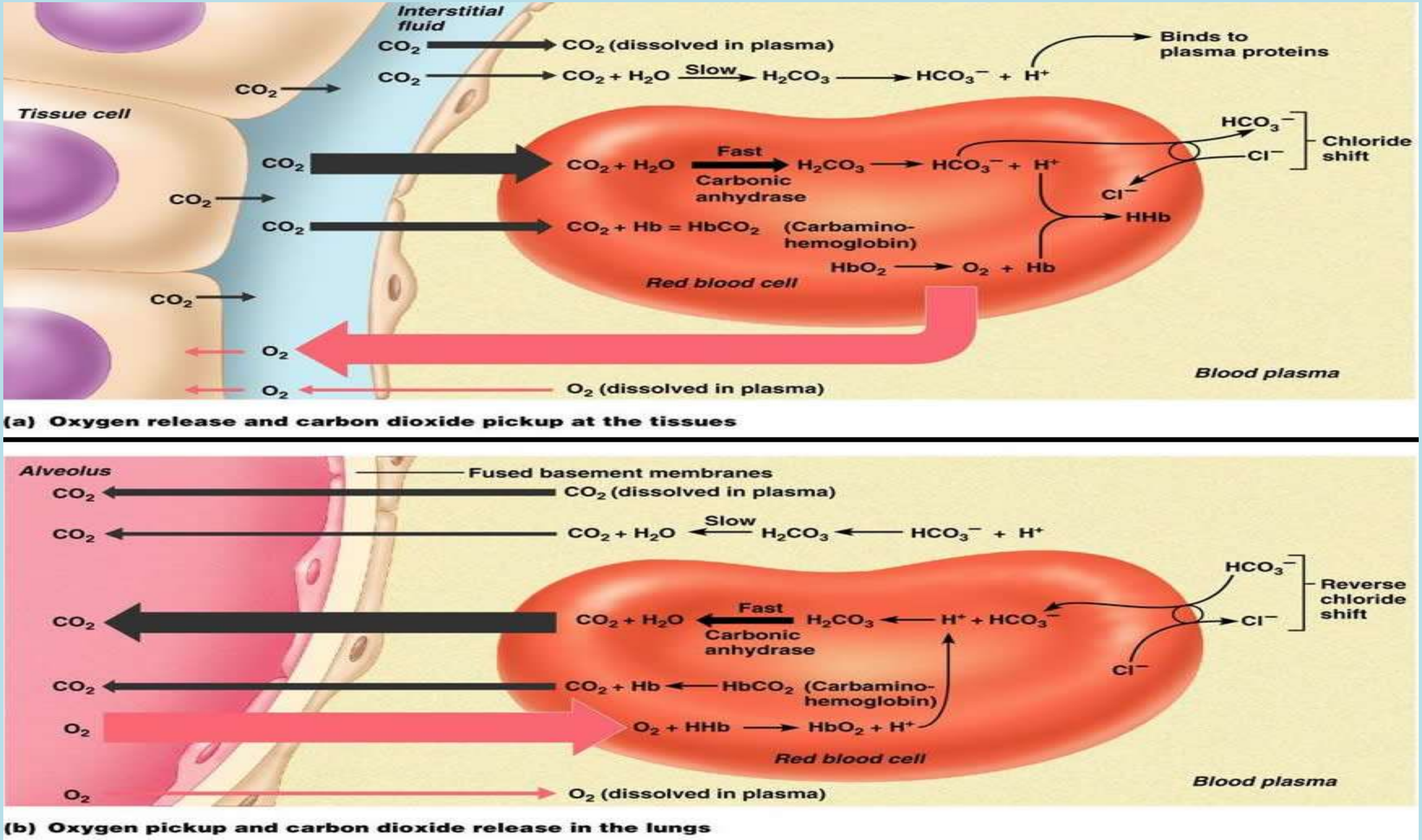
After reviewing the PowerPoint presentation and the associated learning resources, the student should be able to:

- **Describe the importance of iron in the process of erythropoiesis & hemoglobin synthesis.**
- **Discuss the mechanism of iron absorption.**
- **Define anemia**
- **Classify anemia and explain its assessment**
- **Describe the physiological consequences and clinical picture of anemia**
- **Recognize the different types and causes of anemia**
- **Know how to differentiate between the different types and causes of anemia**
- **Know the blood indices, their normal values and how to calculate them**
- **Define polycythemia**
- **Classify polycythemia**
- **Describe the physiological consequences of polycythemia**

Chemical Reactions of HB

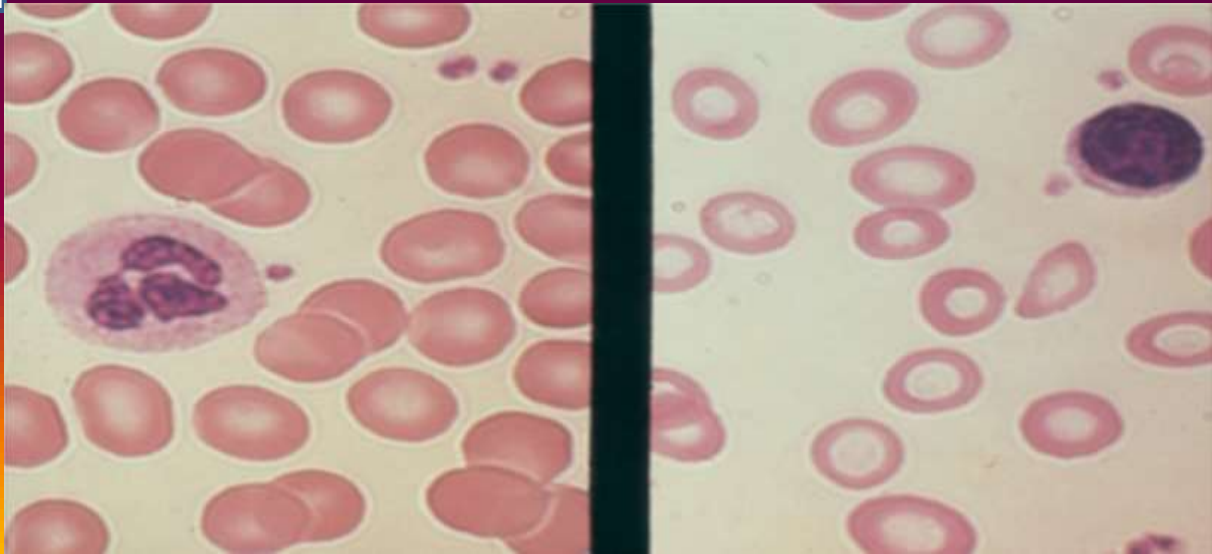
- Oxygenation …. Oxyhemoglobin. **(Normal)**
- Oxidation ……… Methemoglobin. **(Abnormal)**
- Co2………………. CarbminoHemoglobin. **(Normal)**
- Co………………… Carboxyhemoglobin. **(Abnormal)**

Carbon Dioxide transport



Iron

Origin	Animal and plan sources (meat, liver, fruits, vegetables).
Storage	In the liver in the form of ferritin.
Causes of Deficiency	1 – Blood loss (the most important cause). 2 – Dietary deficiency. 3 – Defective absorption. 4 – Defective storage (liver diseases).
Absorption	Mainly in the duoedunum.
Blood film	Microcytic anemia.



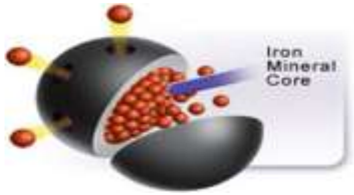
Mechanism of iron absorption

Forms of iron

Hemoglobin: 65%

Myoglobin: 4%

Ferritin (The storage form): 30%



Intracellular oxidative enzymes: 1%

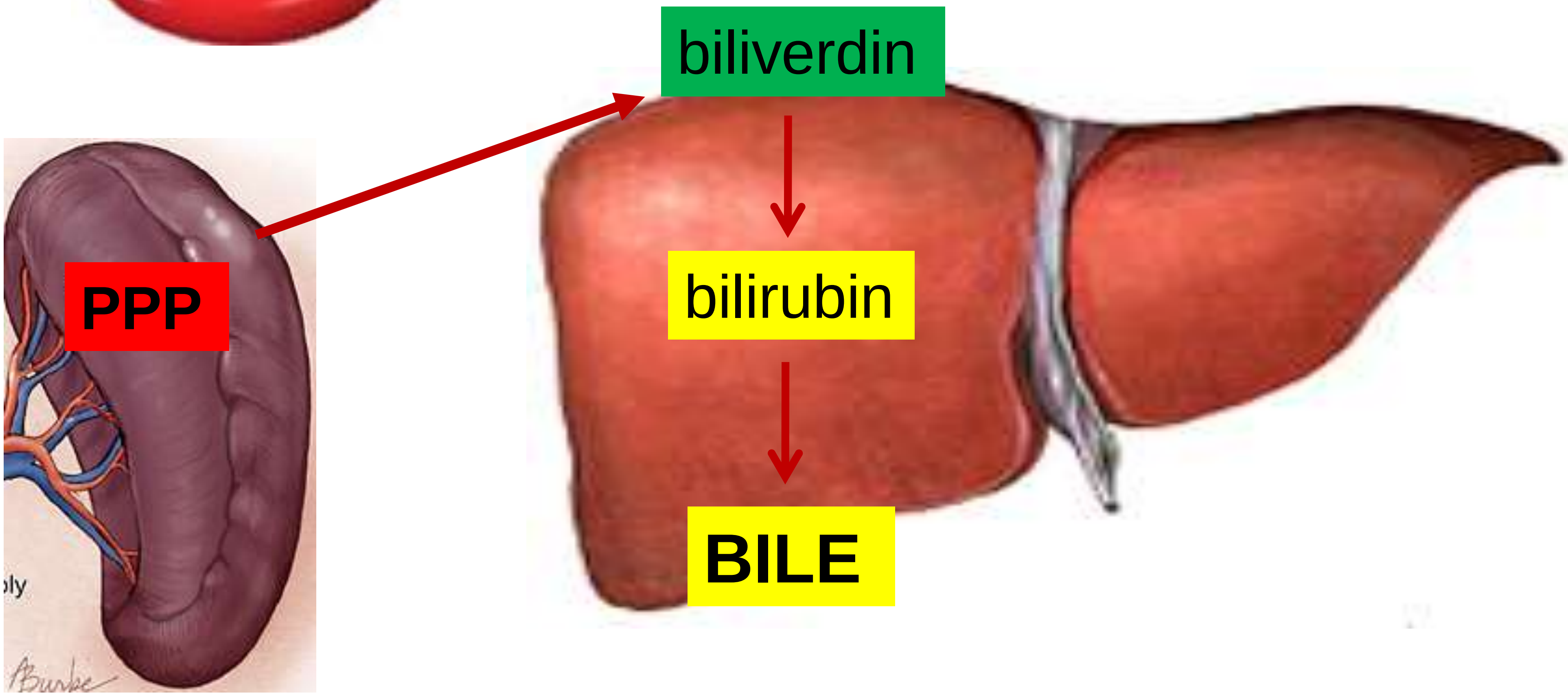
Steps of iron absorption

Iron must be absorbed in the ferrous (reduced of Fe^{++}) state.
Conversion from the ferric (oxidized state or Fe^{+++}) is helped by the presence of gastric HCL & Ascorbic acid (vitamin C) in the diet.
Rate of absorption is determined by the rate of iron loss from the body.
And is regulated by the hepatic protein (Hepcidin).
Then Iron is transported in the bloodstream carried on the carrier protein: Transferrin.
To be transferred to the functions or storage sites.

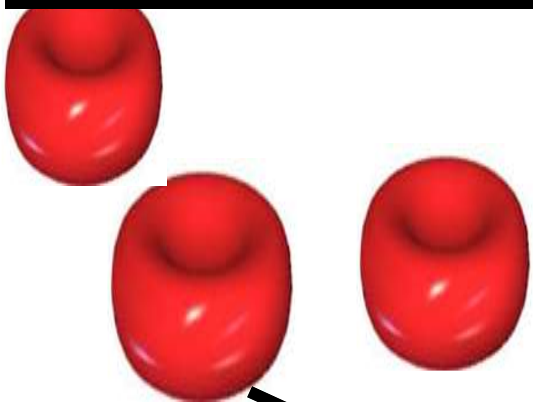
RBC Life Cycle & fate

- RBCs live only 120 days (cells need to be continually replaced)
- Cells rupture during passage into tight capillaries due to loss of membrane flexibility.
- Repair is not possible due to lack of organelles
- damaged cells are removed by macrophages in the spleen and liver
- Breakdown products (Iron & vitamins) are recycled
- Hemoglobin is released then converted into biliverdin.
- Biliverdin is then converted to bilirubin.
- Bilirubin is secreted by liver into bile.

RBCs Fate



Excessive destruction → Hemolytic Jaundice



Anemia and Polycythemia

Anemia is decrease in RBC mass as determined by Hct or Hb values below reference level.

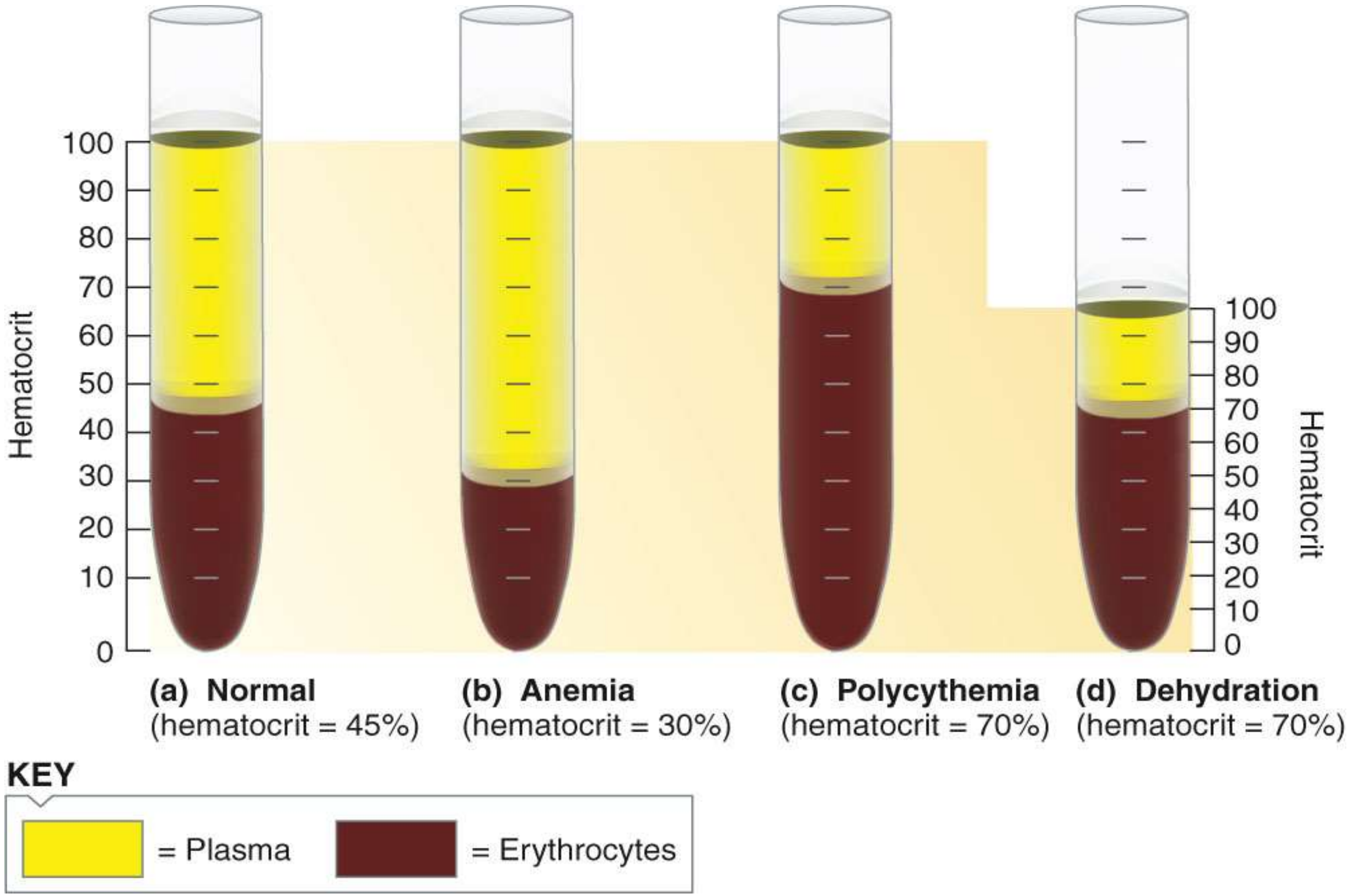
The major causes of anaemia are:

↓ Production or ↑ Loss

1. **Decreased RBC production**
2. **Increased RBC destruction**
3. **RBC Loss without RBC destruction**

Polycythaemia is increase in RBC mass as determined by Hct or Hb values above reference level for age and gender

Hct under various conditions



Clinical Picture of Anemia

Symptoms

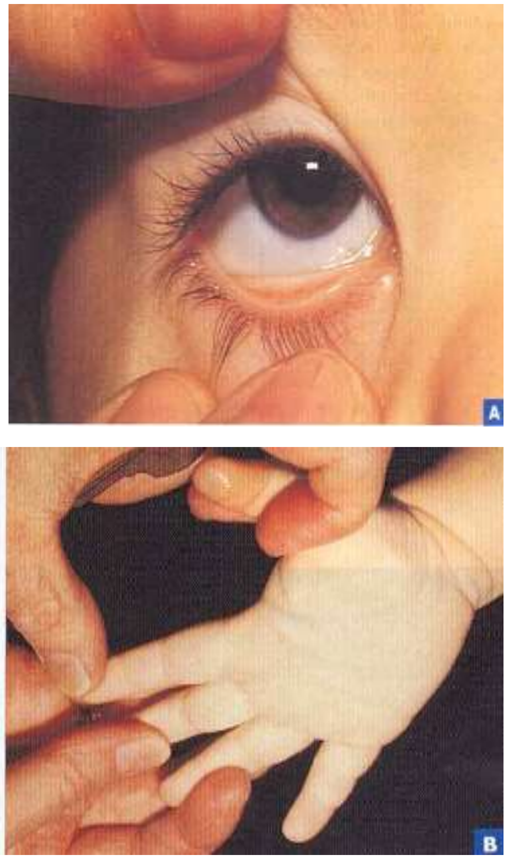
- **fatigue, cold intolerance, pallor, tachycardia and tachypnea.**
  - **oxygen-carrying capacity of blood is reduced**

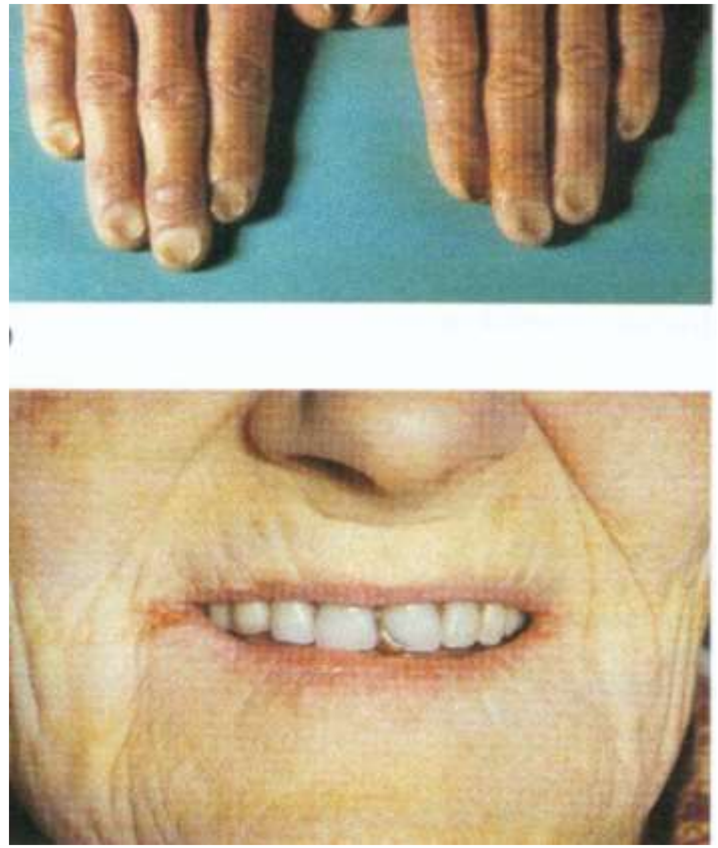
    - lack of O_2 for ATP and heat production

Signs

- ❑ **Pallor: an abnormal loss of skin or mucous membrane color.**
- ❑ **Koilonychia: is when the nail curves upwards (becomes spoon-shaped)**
- ❑ **Angular stomatitis: deep cracks and splits form at the corners of the mouth**
- ❑ **Tachycardia and tachypnea: due to compensatory sympathetic stimulation.**

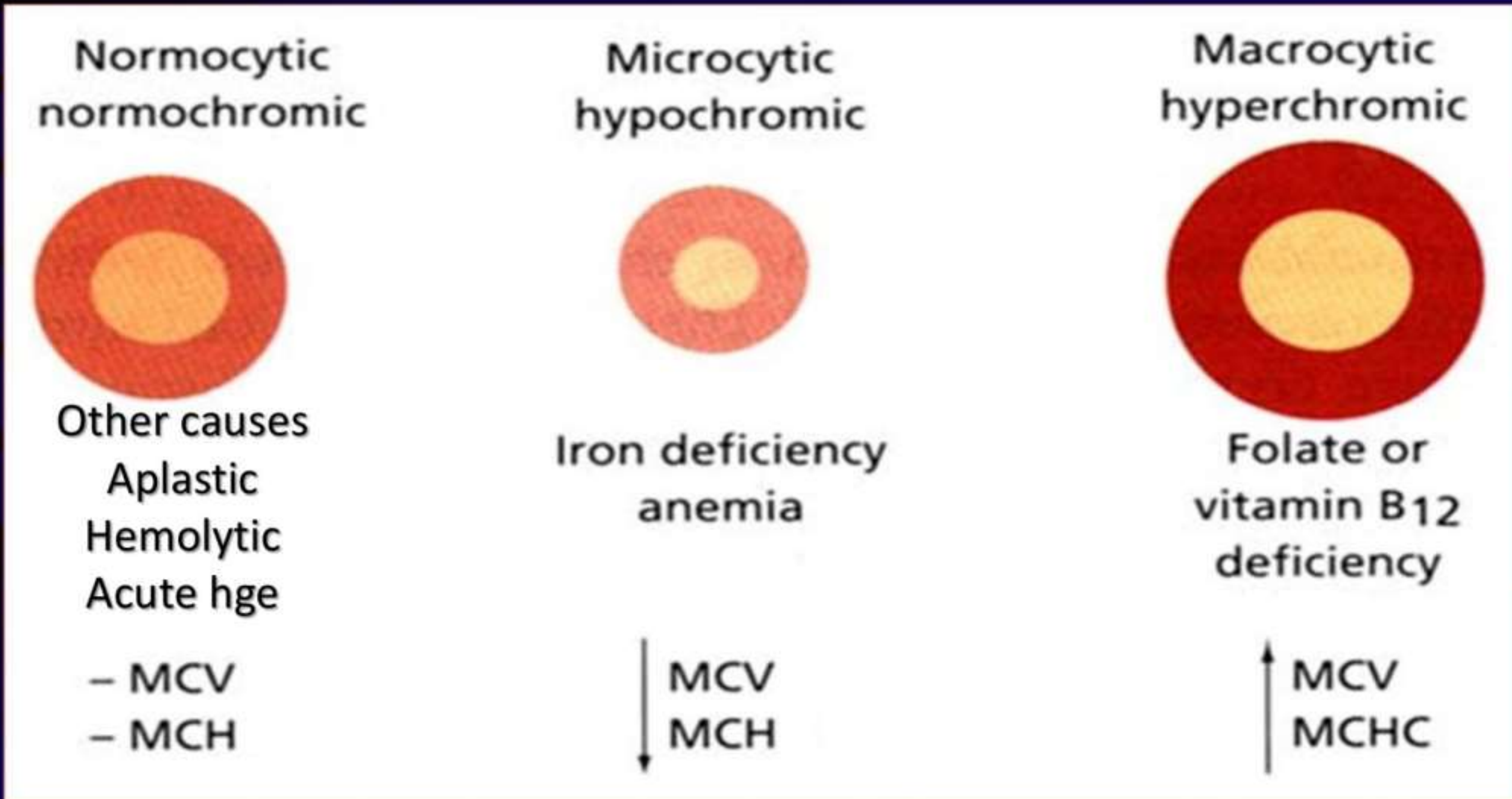
Clinical Picture of Anemia





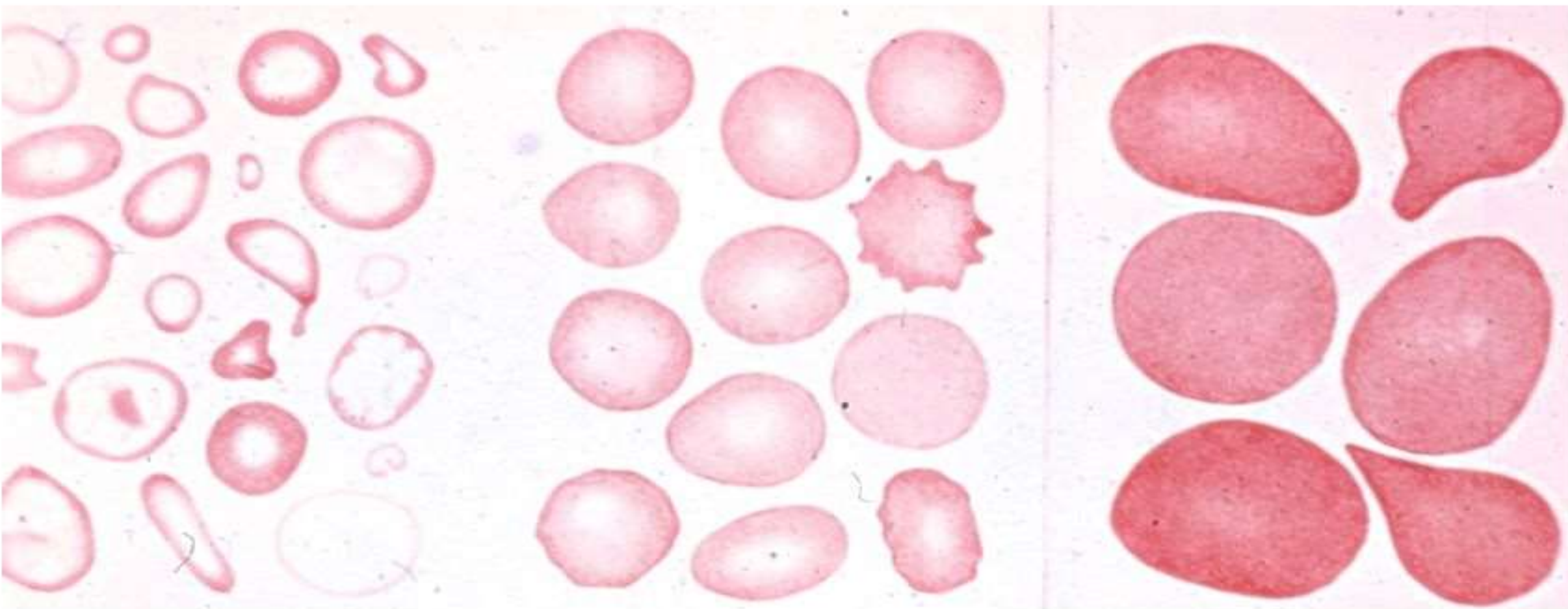
Causes of anemia

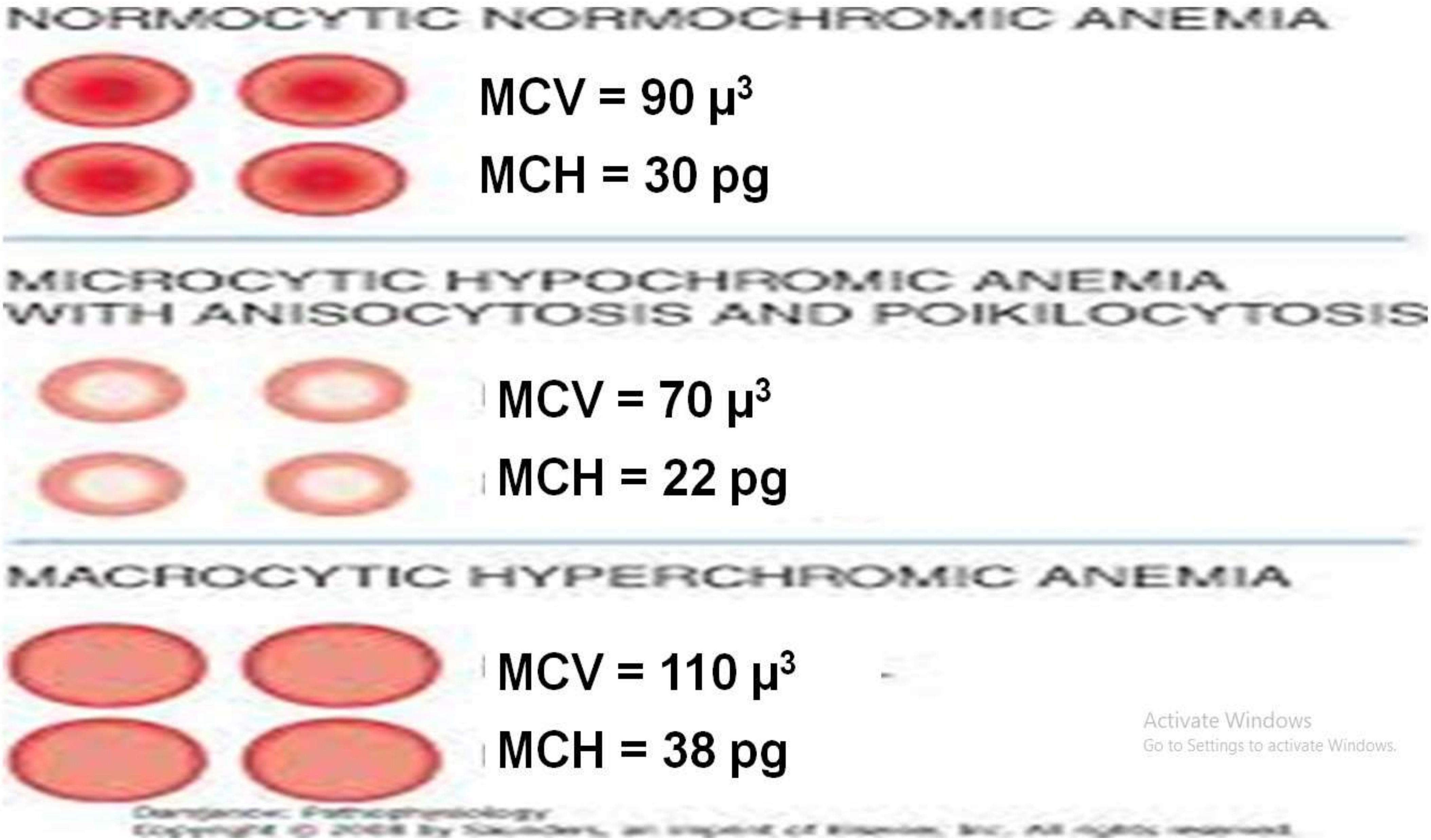
RBC loss without RBC Destruction	Decreased RBC Production	Increased RBC Destruction over Production (Hemolytic Anemias)
– Hemorrhage Due to trauma Due to disorders: e.g.cancer, ulcers – Menstrual flow – Gynecological disorders –Peptic ulcer - Parasitism Hookworms	Iron Deficiency anemia –Folic acid or vitamin B12 deficiency. – Aplastic anemia –Renal disease (lack of erythropoietin production)	– Intrinsic Abnormalities Hereditary Spherocytosis Thalassemia Sickle Cell Anemia G6PD deficiency – Extrinsic Abnormalities Infections Malaria Mycoplasma



Normocytic normochromic
Microcytic hypochromic
Macrocytic hyperchromic
Other causes
Aplastic
Hemolytic
Acute hge
Iron deficiency anemia
Folate or vitamin B12 deficiency
– MCV
– MCH
↓ MCV
MCH
↑ MCV
MCHC

Hypochromic/Microcytic Normochromic/Normocytic Macrocytic(/Normochromic)




NORMOCYTIC NORMOCHROMIC ANEMIA
MCV = 90 µ3
MCH = 30 pg
MICROCYTIC HYPOCHROMIC ANEMIA WITH ANISOCYTOSIS AND POIKILOCYTOSIS
MCV = 70 µ3
MCH = 22 pg
MACROCYTIC HYPERCHROMIC ANEMIA
MCV = 110 µ3
MCH = 38 pg

Haematological indices

Mean corpuscular Hb concentration (MCHC):

The average concentration of hemoglobin in the RBCs expressed as (gm/dl).

$$= \frac{Hb \times 100}{Hct}$$

- Normal value: 32- 35 g/dl of RBCs

Indices		Males	Females
Hematocrit (Hct) (%)		47	42
Red blood cells (RBC) (10^6/L)		5.4	4.8
Hemoglobin (Hb) (g/dL); dL = 100 milliliters		16	14
Mean corpuscular volume (MCV) (fL) [a]	$= \frac{Hct \times 10}{RBC\ (10^6/\mu L)}$	90 - 95	90 - 95
Mean corpuscular hemoglobin (MCH) (pg)	$= \frac{Hb \times 10}{RBC\ (10^6/\mu L)}$	29	29
Mean corpuscular hemoglobin concentration (MCHC) (g/dL of cells) [b]	$= \frac{Hb \times 100}{Hct}$	34	34

[a] Cells with MCVs > 95 fL are called macrocytes; cells with MCVs < 80 fL are called microcytes.

[b] Cells with MCHs < 25 g/dL are called hypochromic.

Type of Anemia	Hb content	RBCs count	PCV (HCT value)	MCV	MCH
Microcytic hypochromic	↓	↓	↓	↓	↓
Normocytic Normochromic	↓	↓	↓	**Normal**	**Normal**
Macrocytic hyperchromic	↓	↓	↓	↑	↑

How to differentiate between aplastic and hemolytic anemias?

Basic Evaluation of Anemia

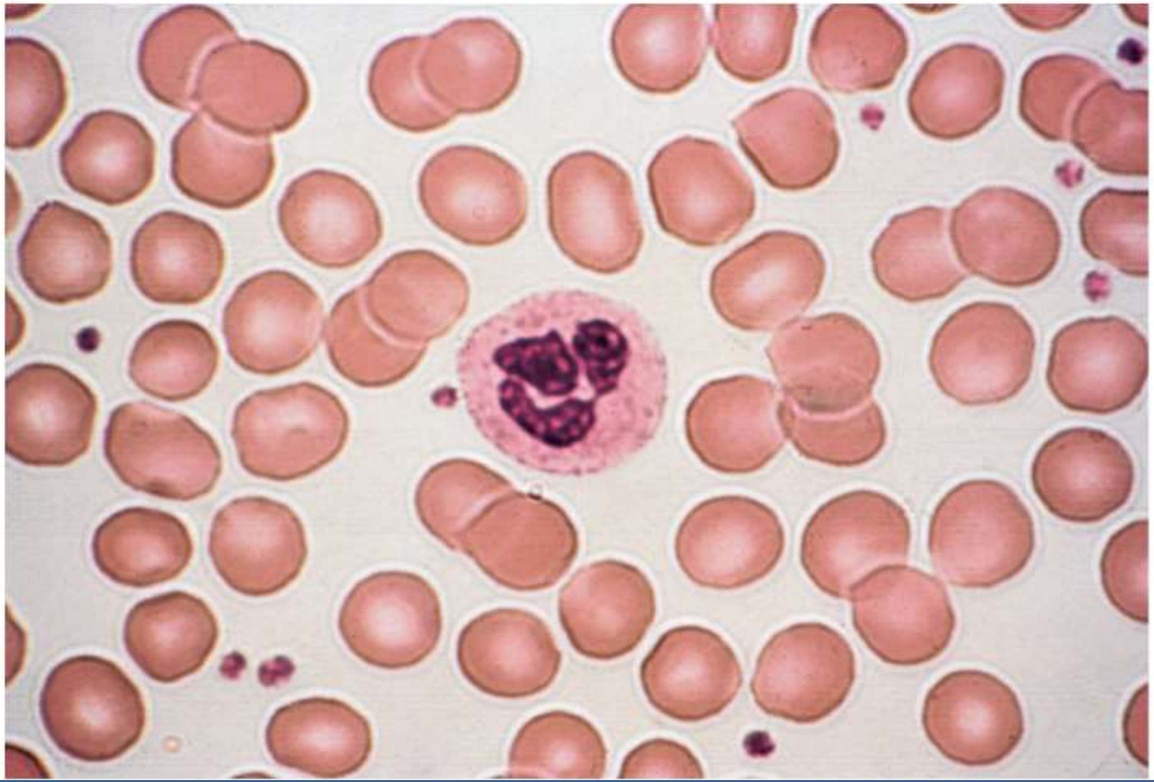
- Review of blood count, blood smear and RBC indices (MCV, MCH, MCHC)

MCV is the most accurate method of measuring red blood cells and most useful in classification of anaemia as microcytic, normocytic or macrocytic.

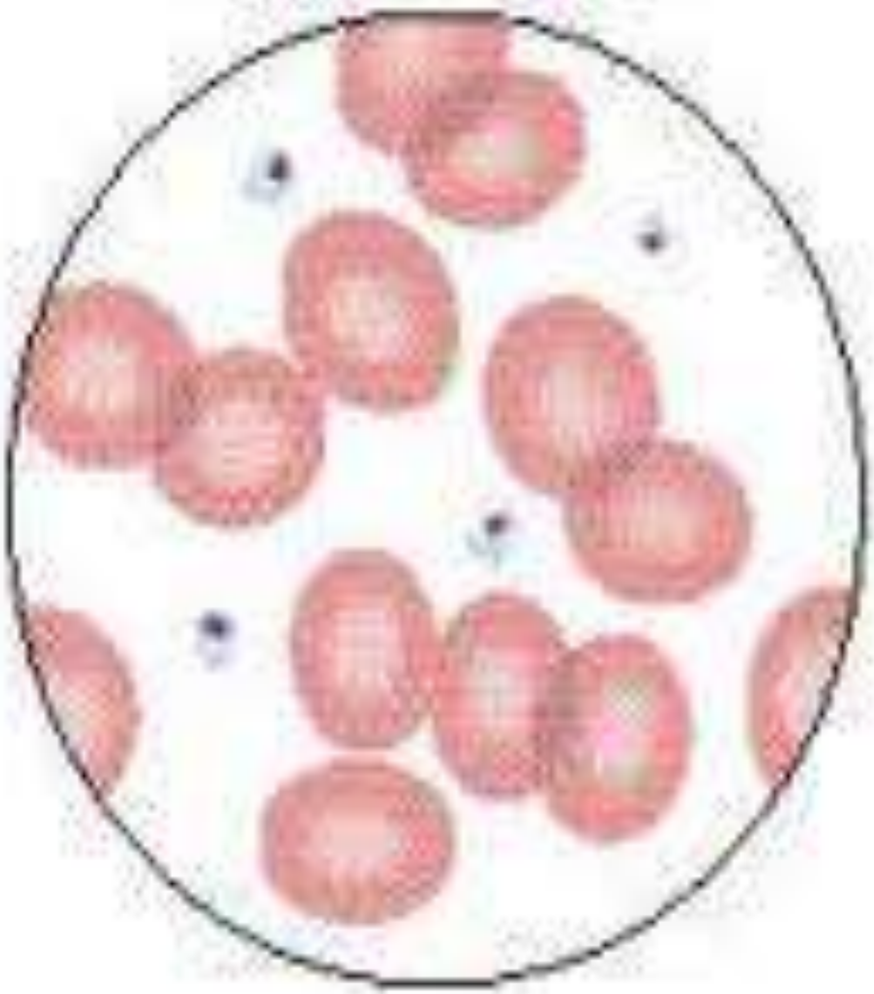
- Reticulocyte index

= reticulocyte count (%) x [observed haematocrit / normal haematocrit] *ie* normalized for hematocrit

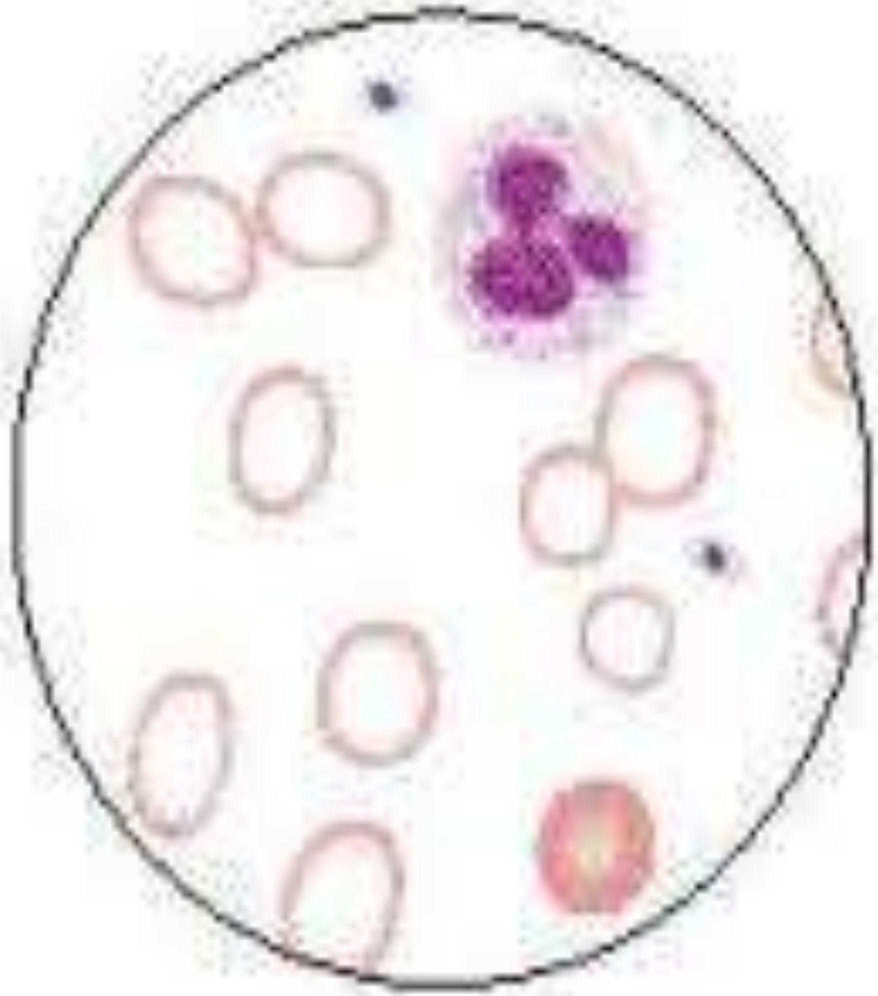
  - Reticulocyte index > 2% indicates excessive RBC destruction or loss (Hemolytic anemia)
  - Reticulocyte index < 2% indicates decreased production (Aplastic anemia)



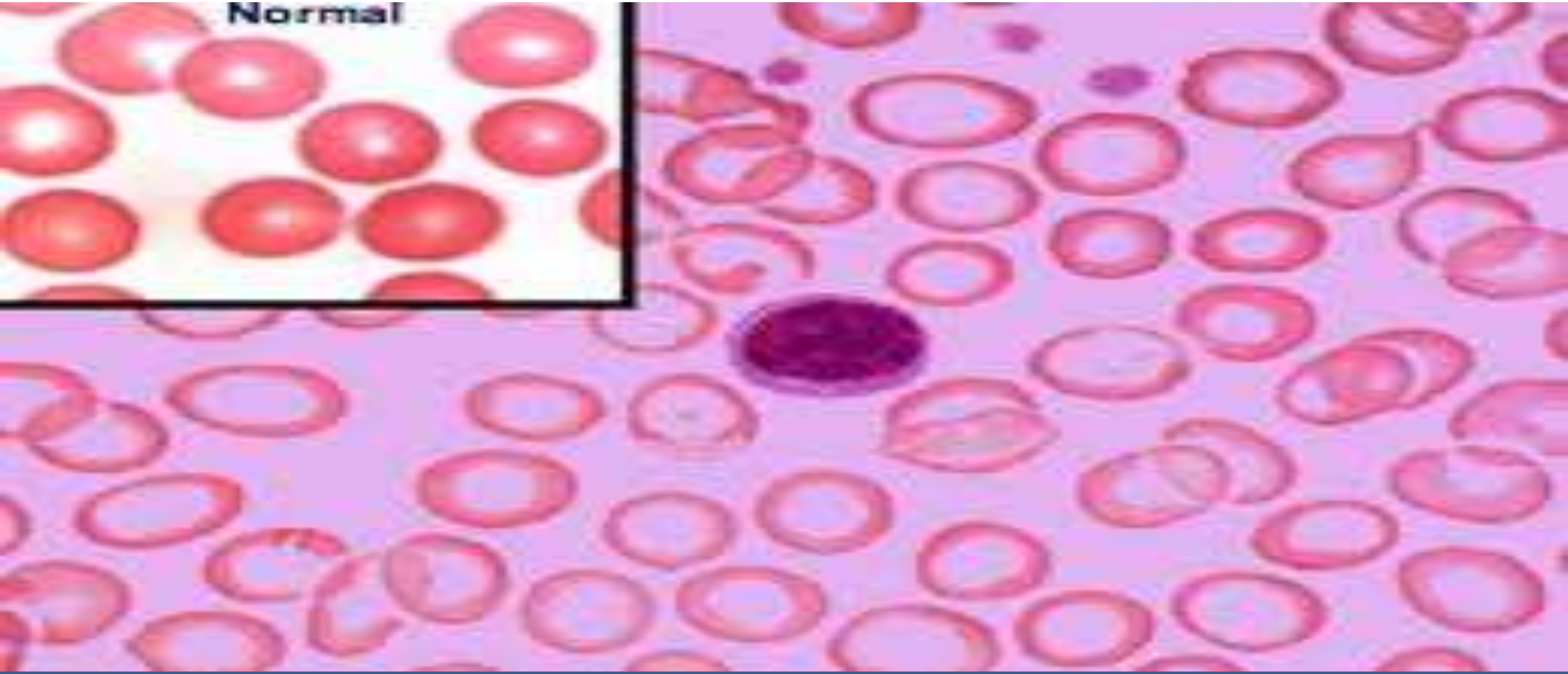
Normocytic normochromic



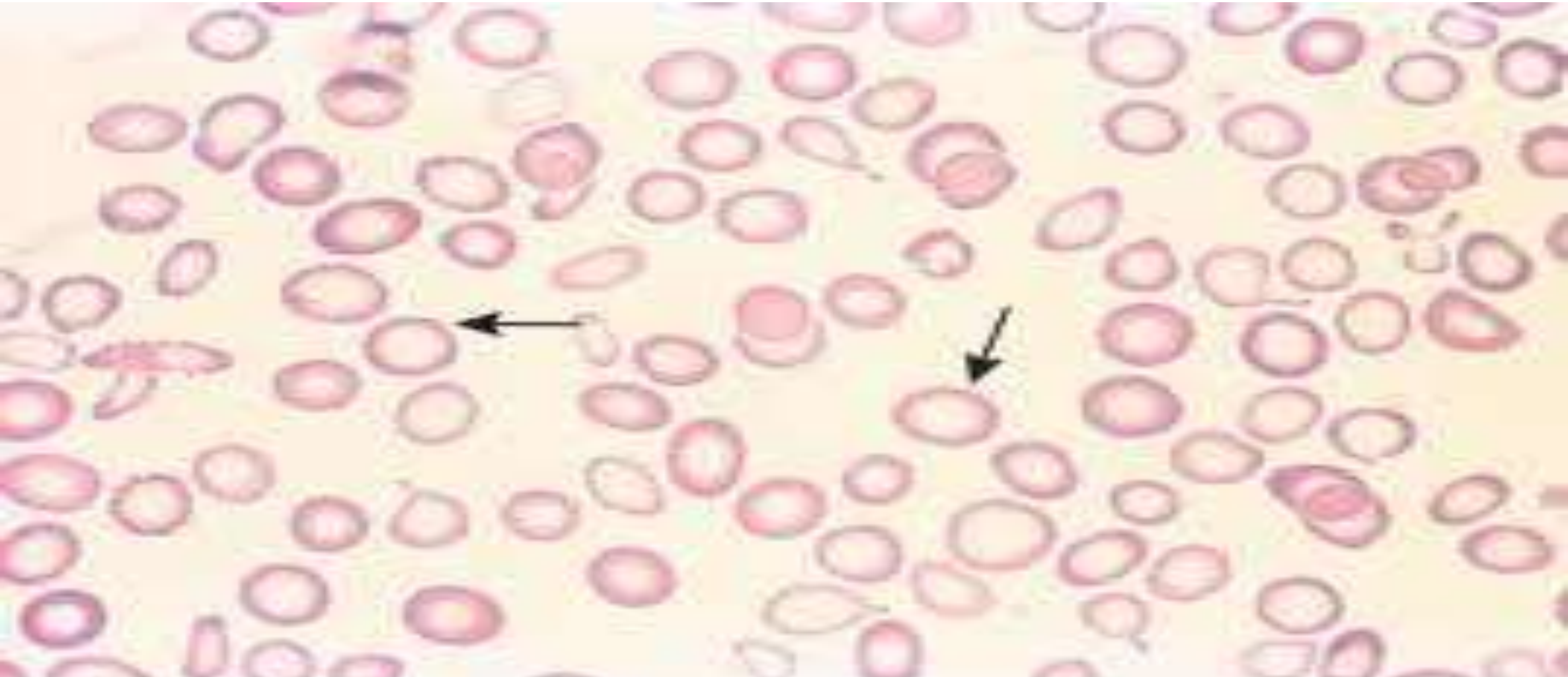
Normal Peripheral Blood Smear



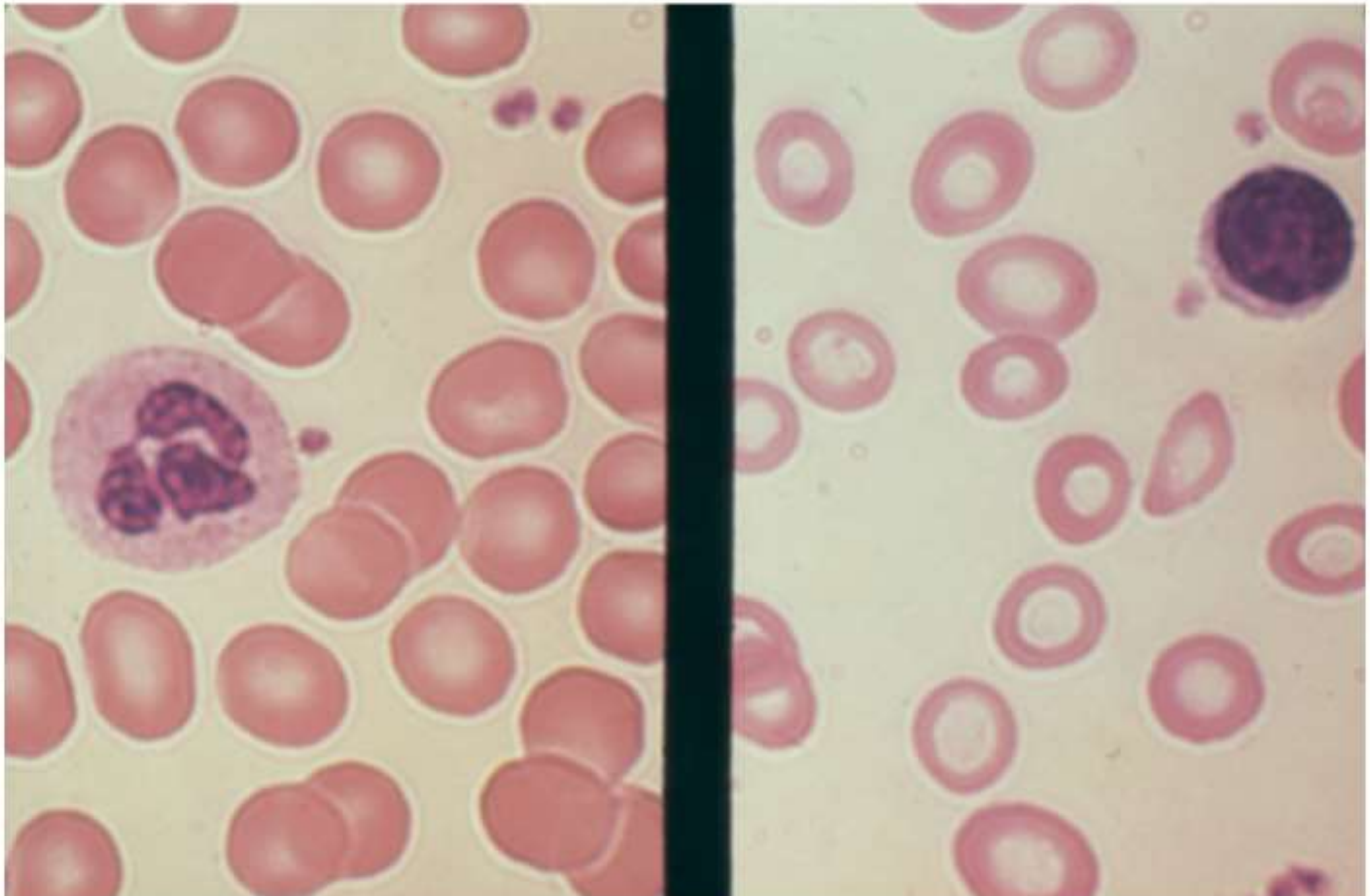
Microcytic, Hypochromic Anemia



Microcytic hypochromic anemia = Iron deficiency



Microocytic hypochromic anemia = Iron deficiency



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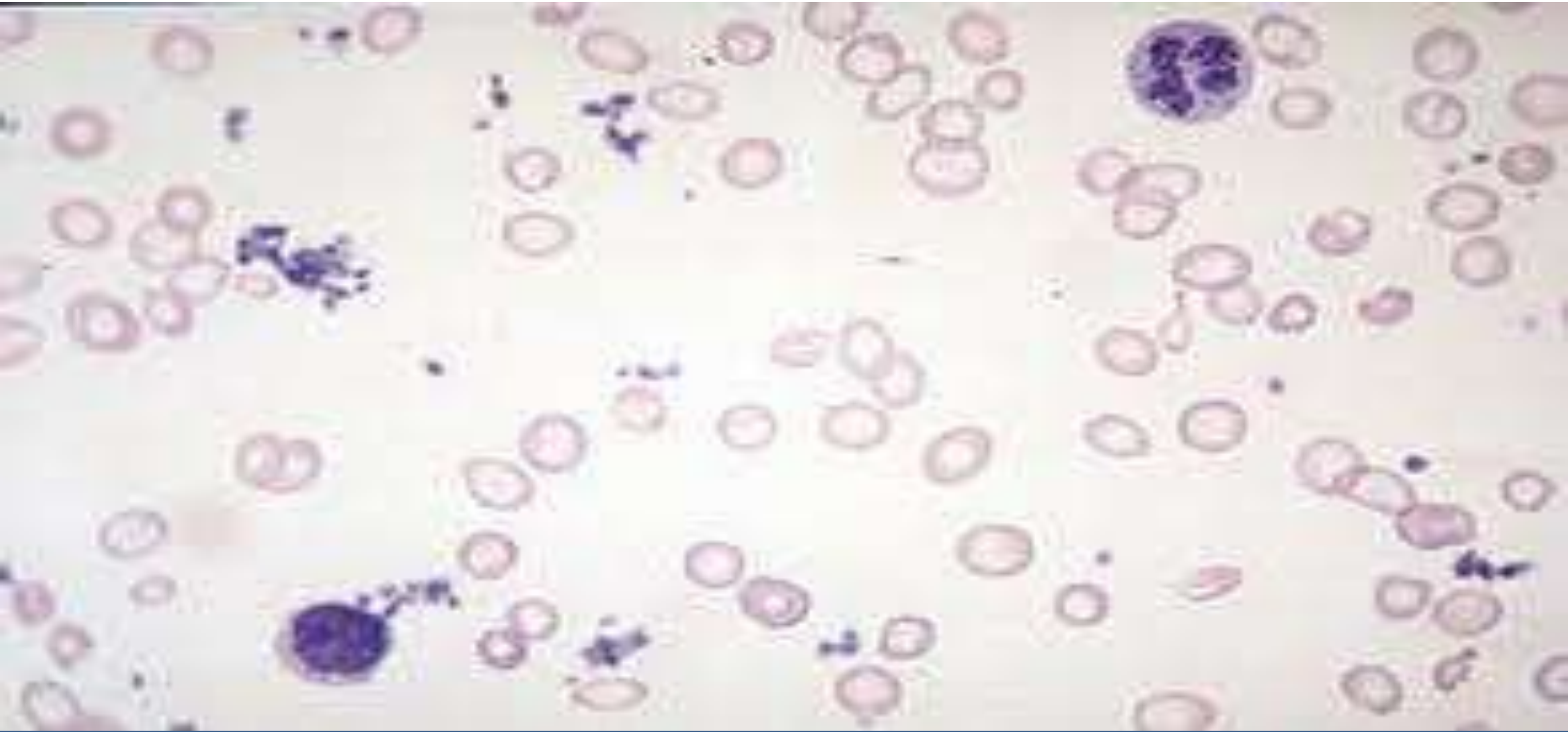

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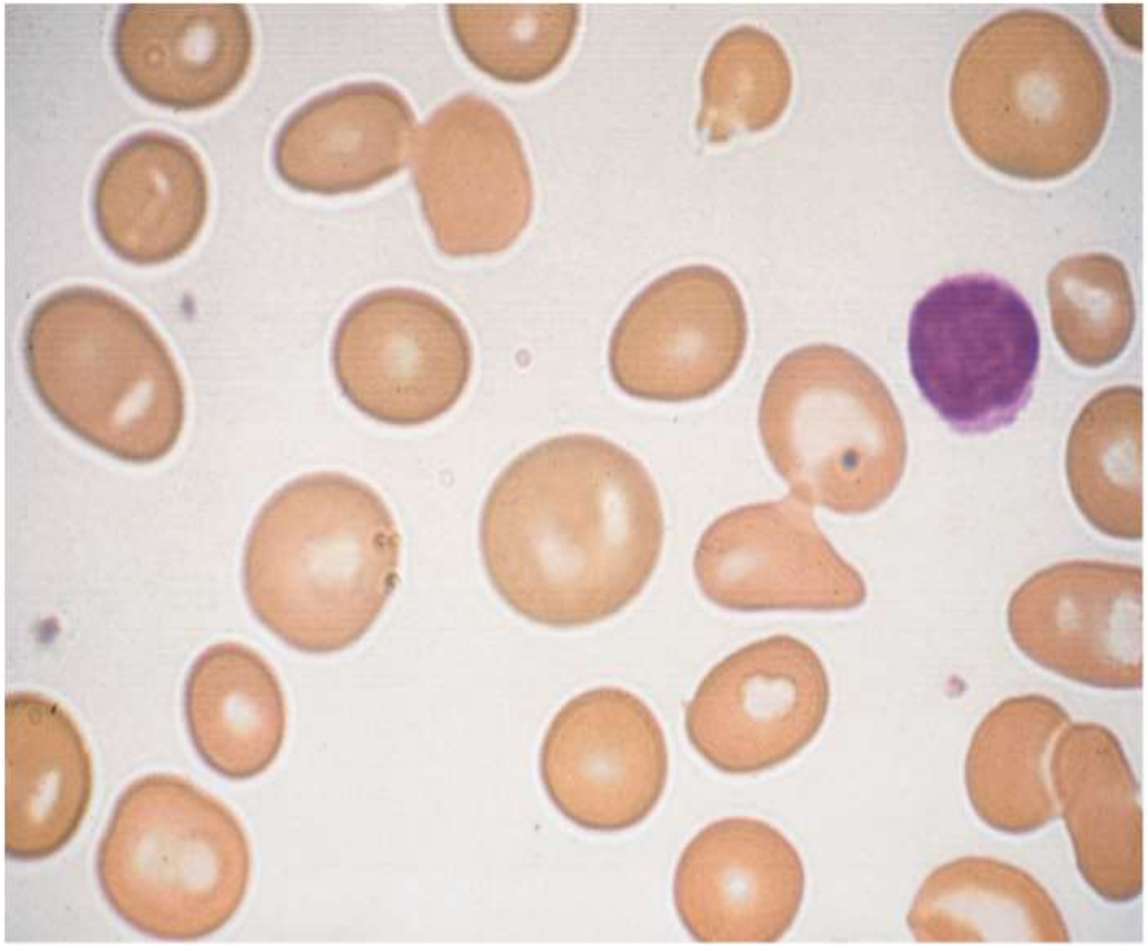
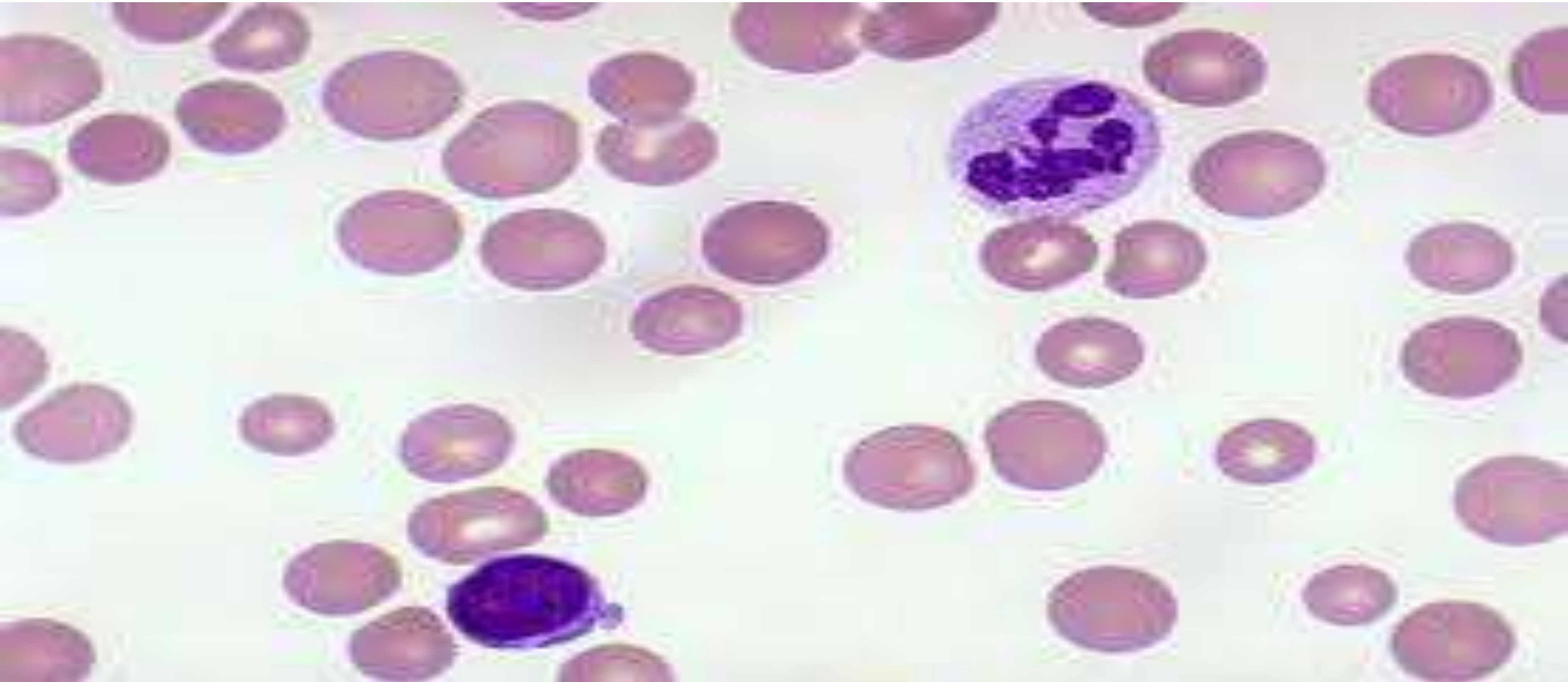


Macrocytic anemia = vitamin B12 or Folic acid deficiency



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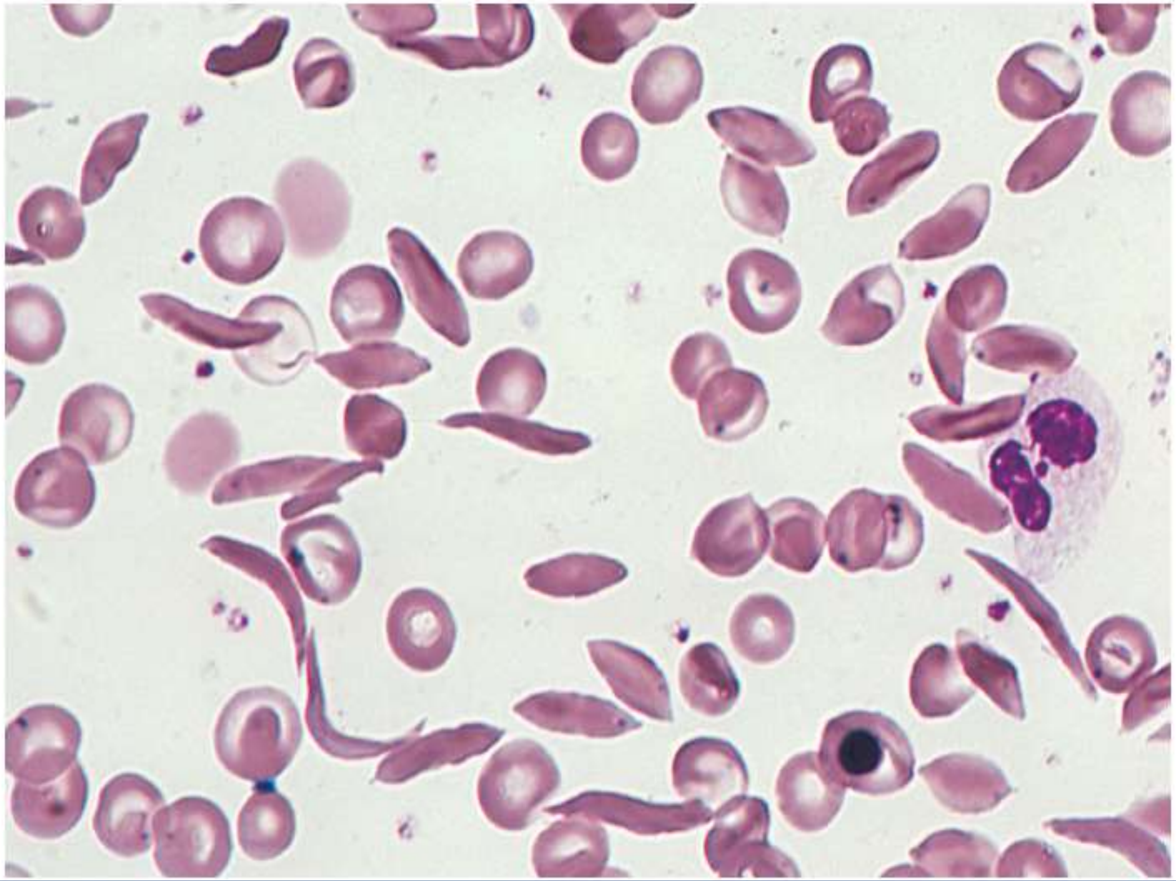
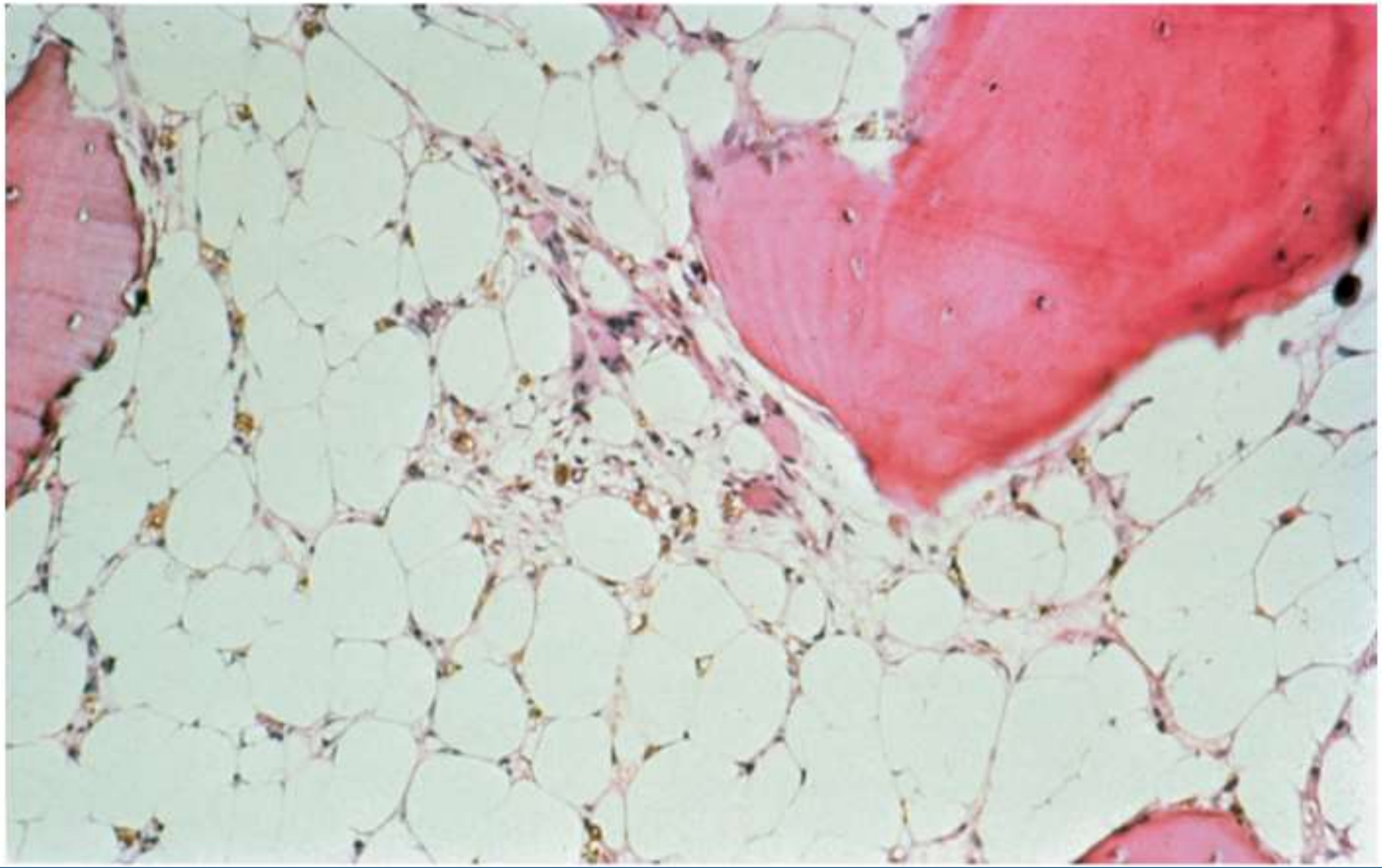
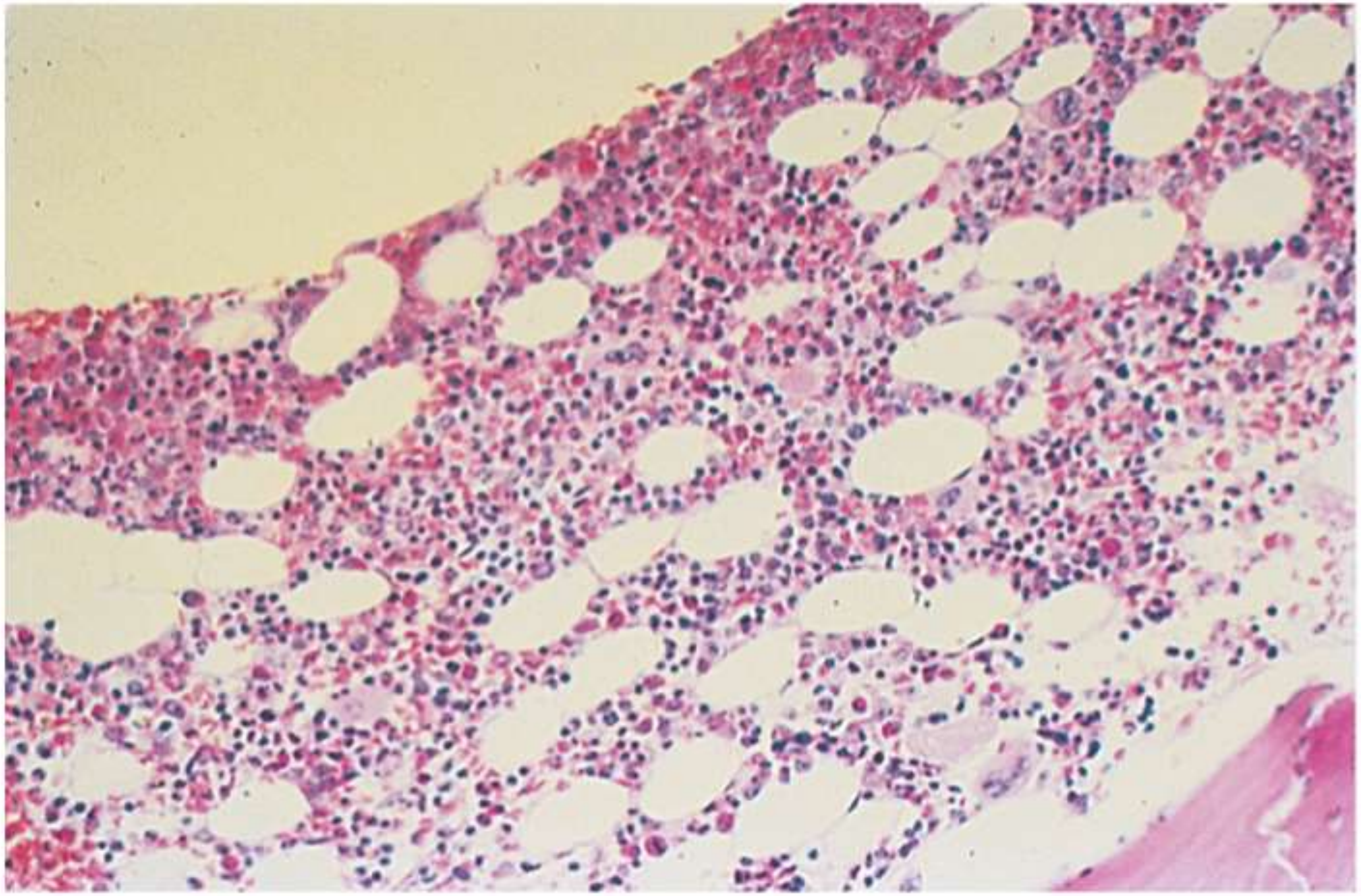
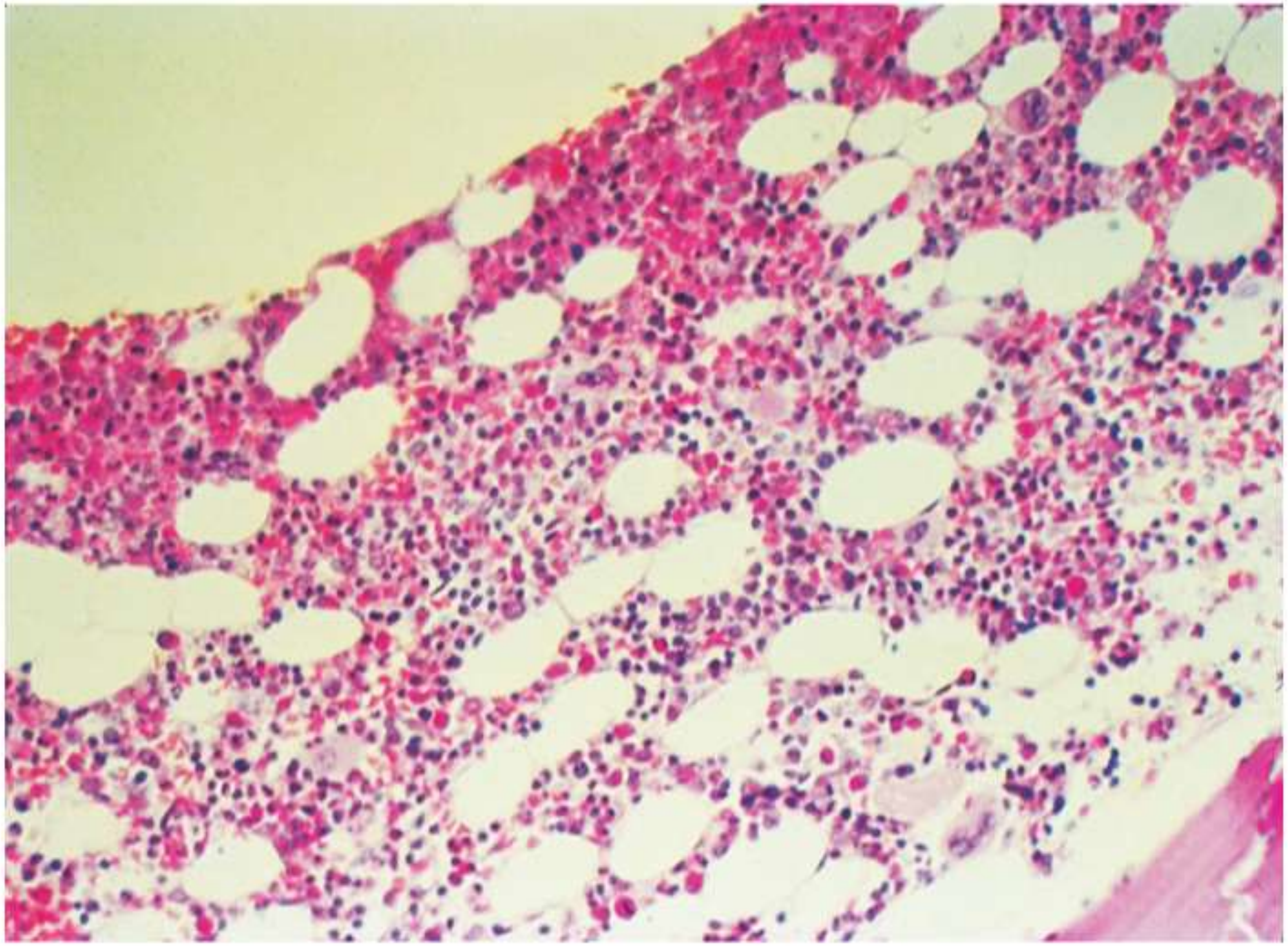


Sickle cell anemia

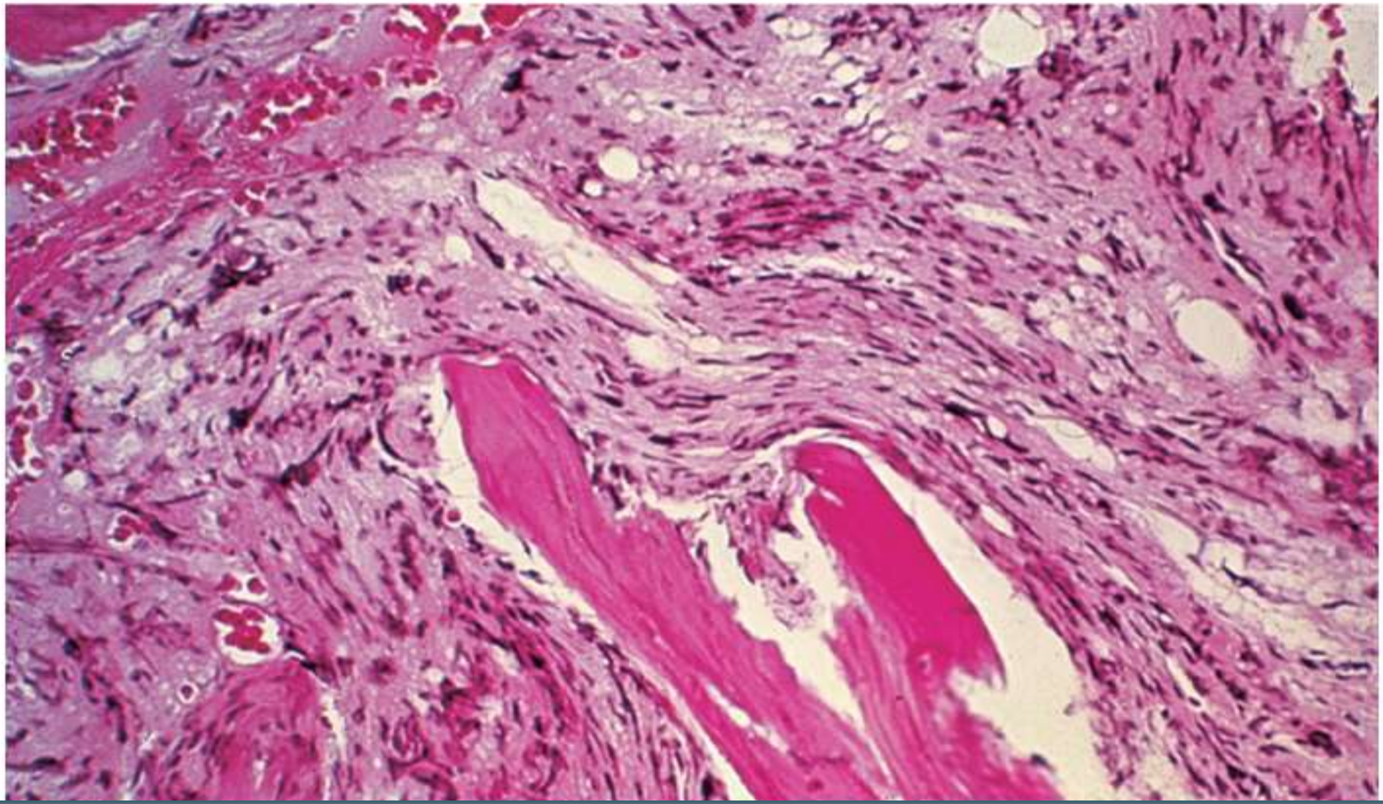


Aplastic anemia = bone marrow disease





wer view of normal adult marrow (H&E stain), showing a mix of fat cells (clear areas) and hematopoietic cells. The percentage of the space that consists of hematopoietic cells is referred to as marrow cel
ds for increased marrow production occur, cellularity may increase to meet the demand. As people age, the marrow cellularity decreases and the marrow fat increases. Patients >70 years old may have a



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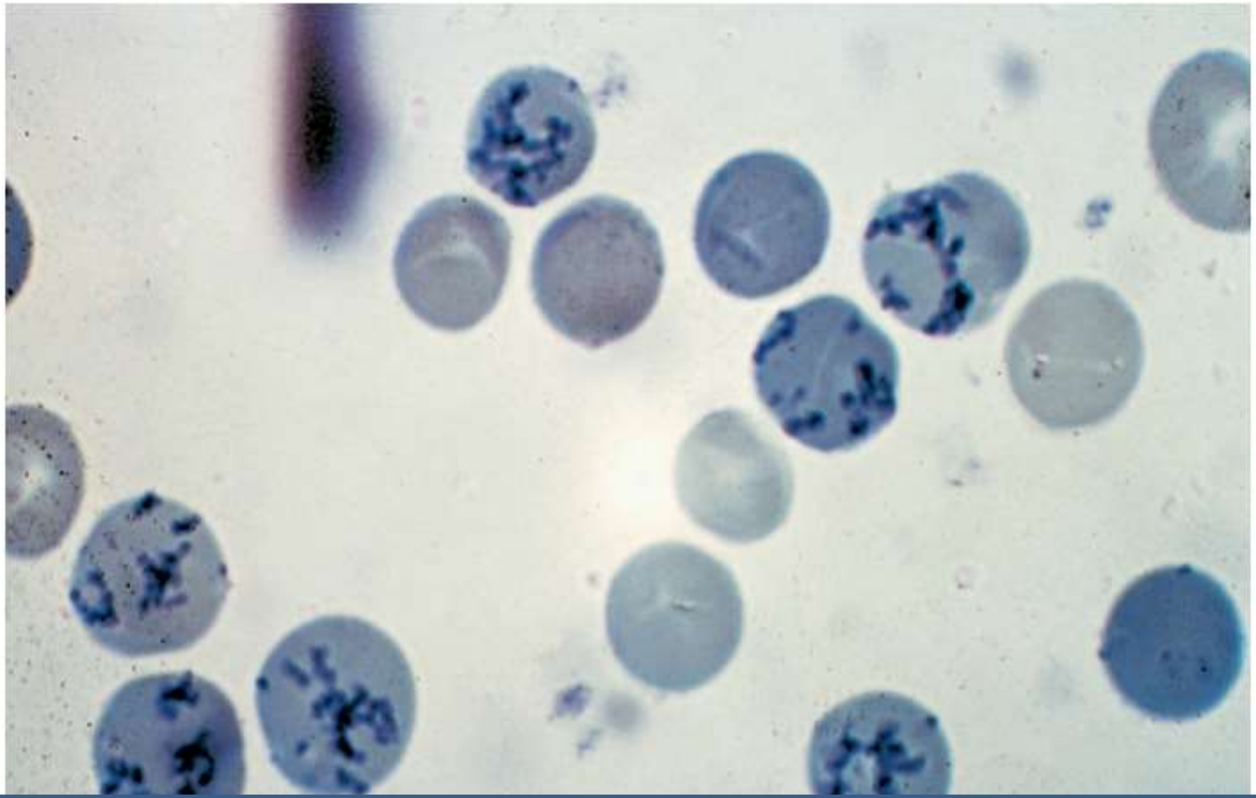
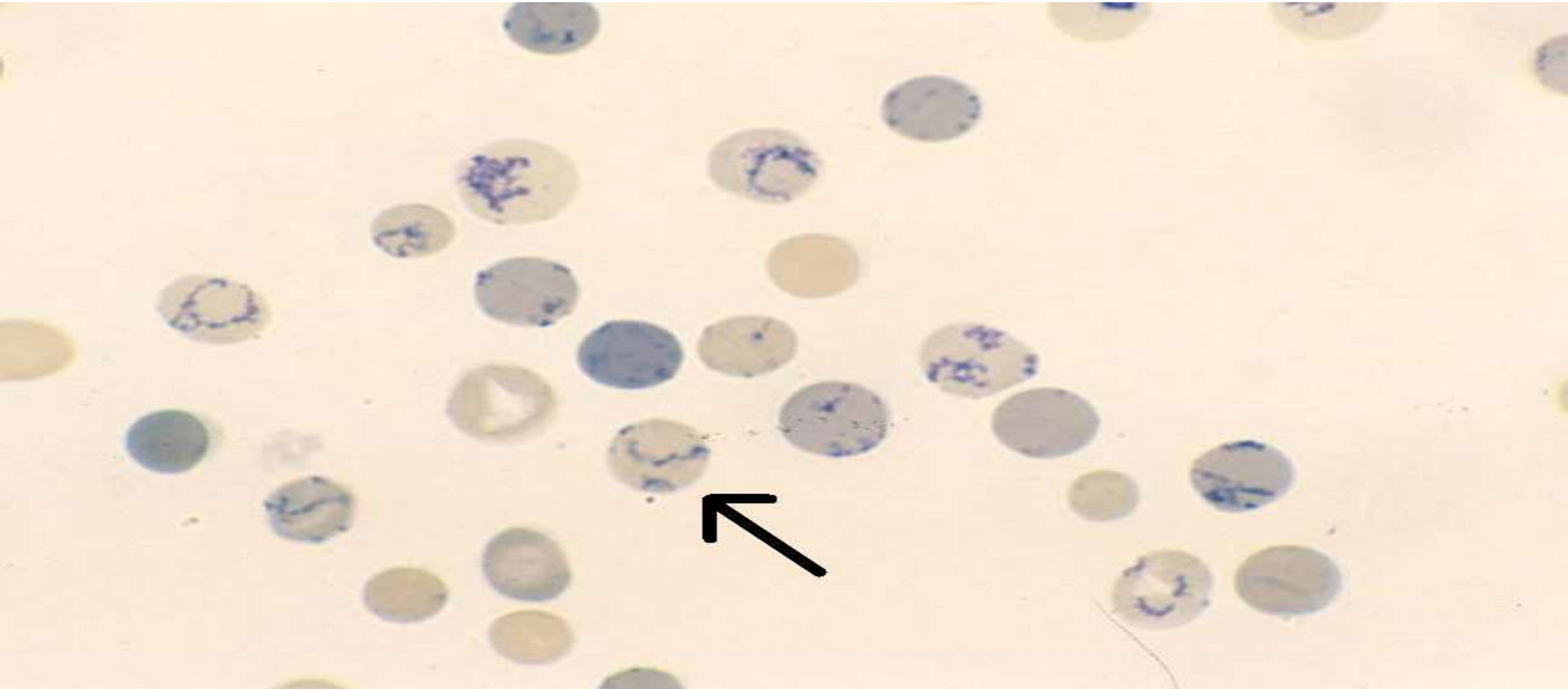


Reticulocytosis = Hemolytic anemia



Reticulocytosis = Hemolytic anemia


Reticulocyte

Polycythemia

Types:

❑ True or absolute

- **Primary (polycythemia rubra vera):**
  uncontrolled RBC production (cancer of the bone marrow)

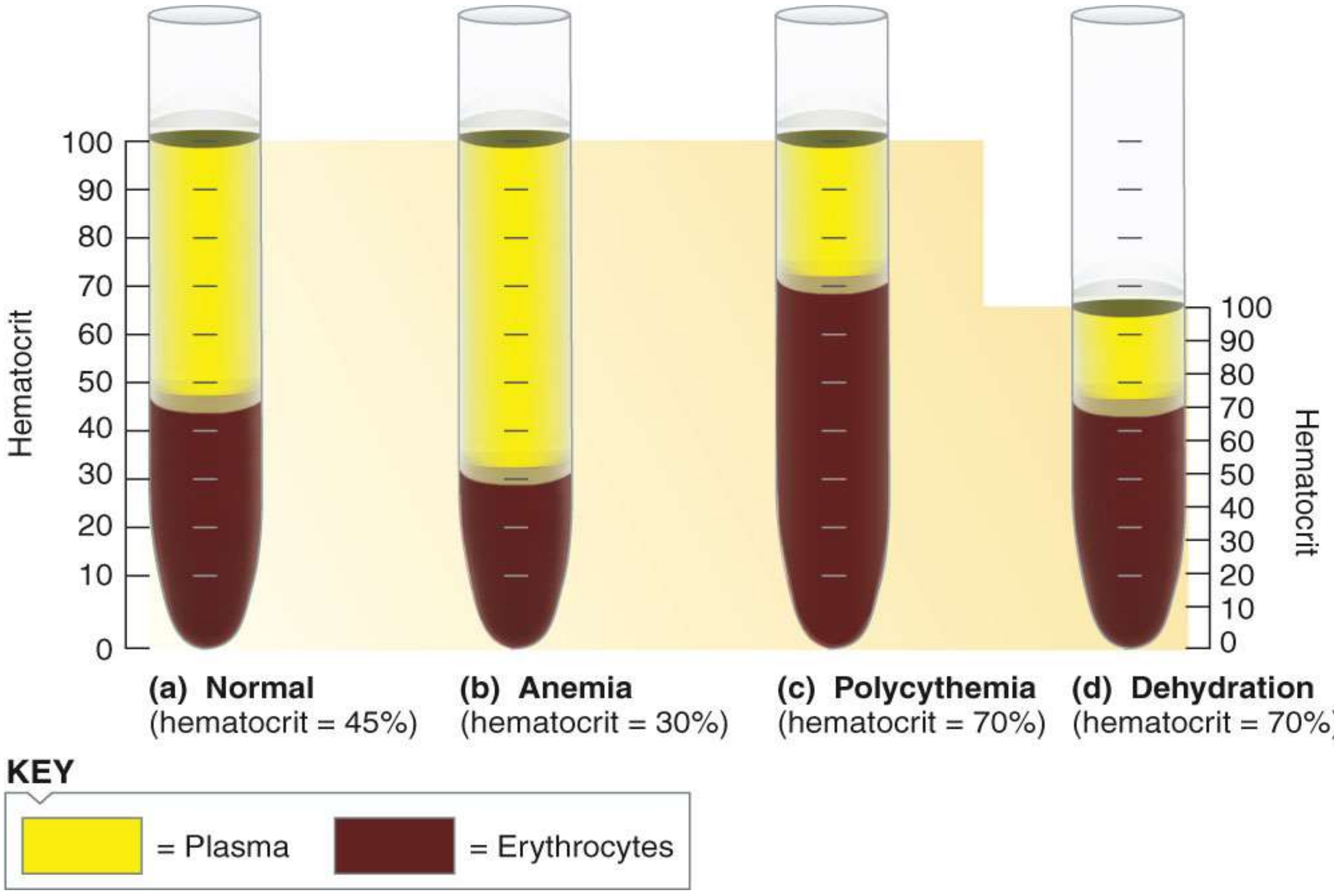
- **Secondary to hypoxia: high altitude, chronic respiratory or cardiac disease**
- **Hypoxia occurs due to the increased release of Erythropoietin.**

❑ Relative

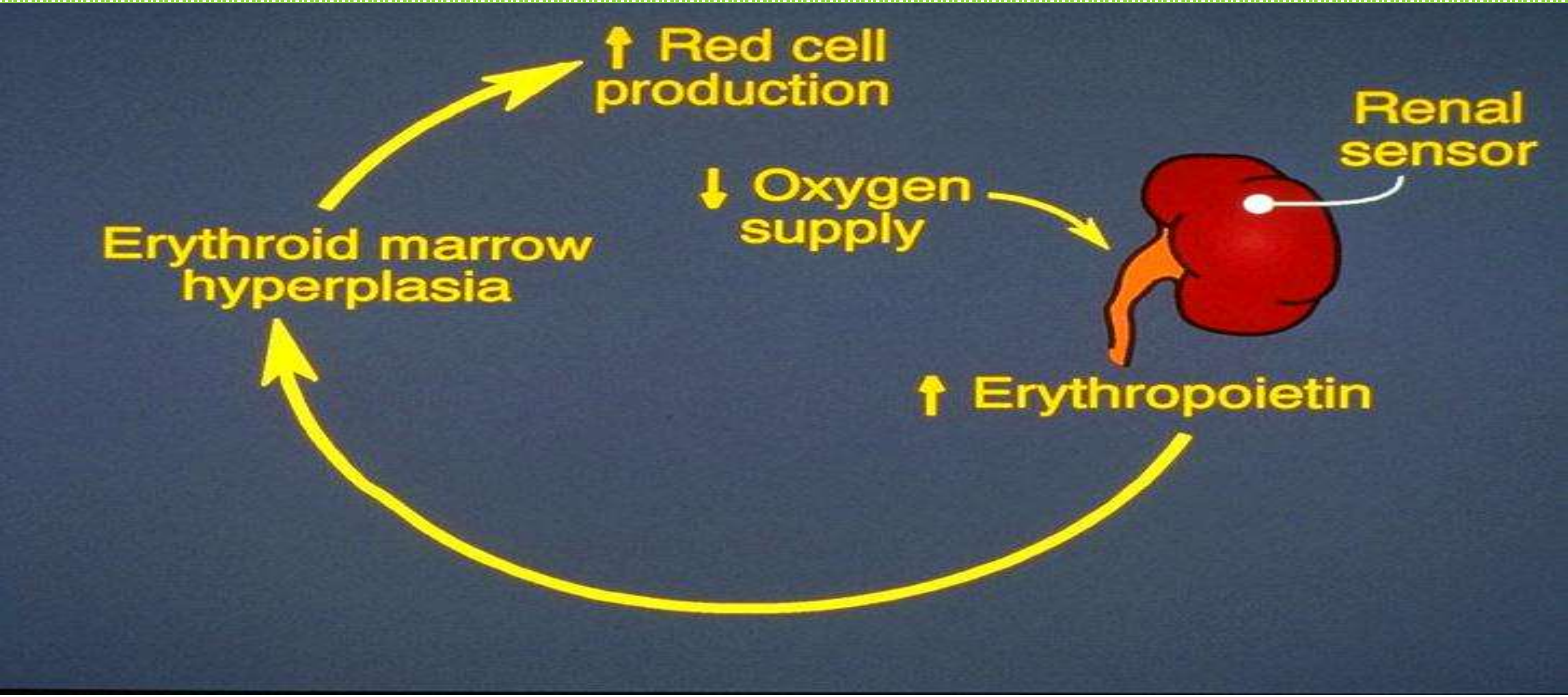
- **Hemoconcentration:**
  - » **loss of body fluid in vomiting, diarrhea, sweating**

Complications of polycythemia: hyperviscosity of the blood

Hct under various conditions



Pathophysiology of Polycythemia



Thank You