3 – Anemia and polycythemia


بسم الله الرحمن الرحيم

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

صدق الله العظيم

Objectives;

Intended learning outcomes (ILOs)

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

- 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

Anemia and Polycythemia

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

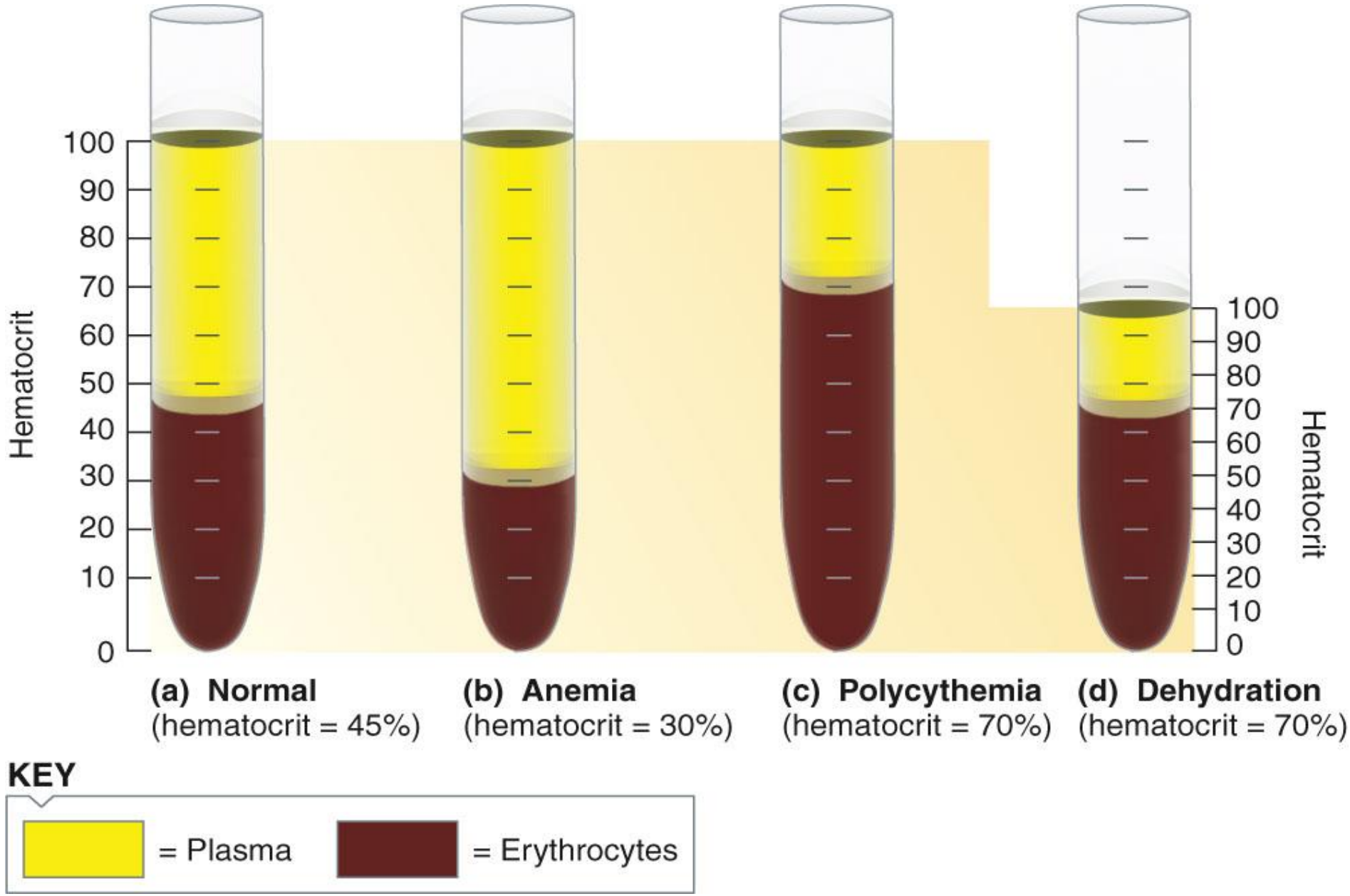
The major causes of anaemia are:

↓ 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

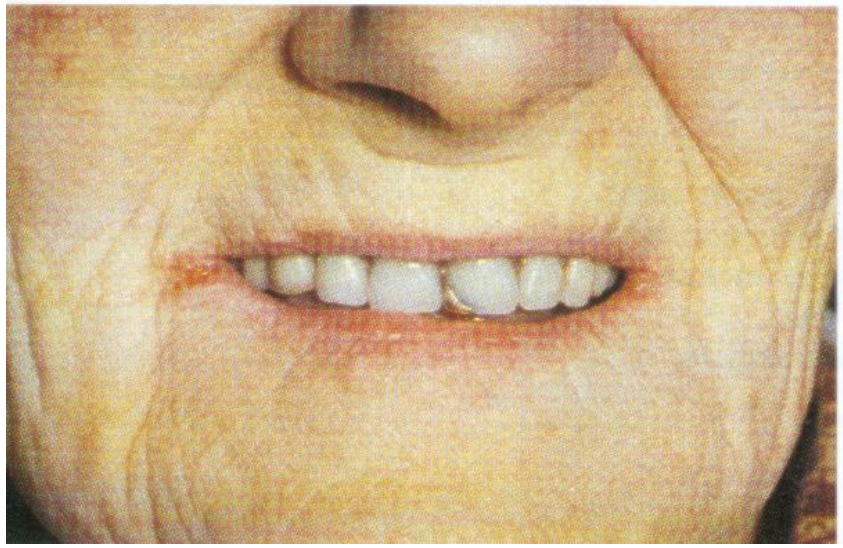
Symptoms

- **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.**

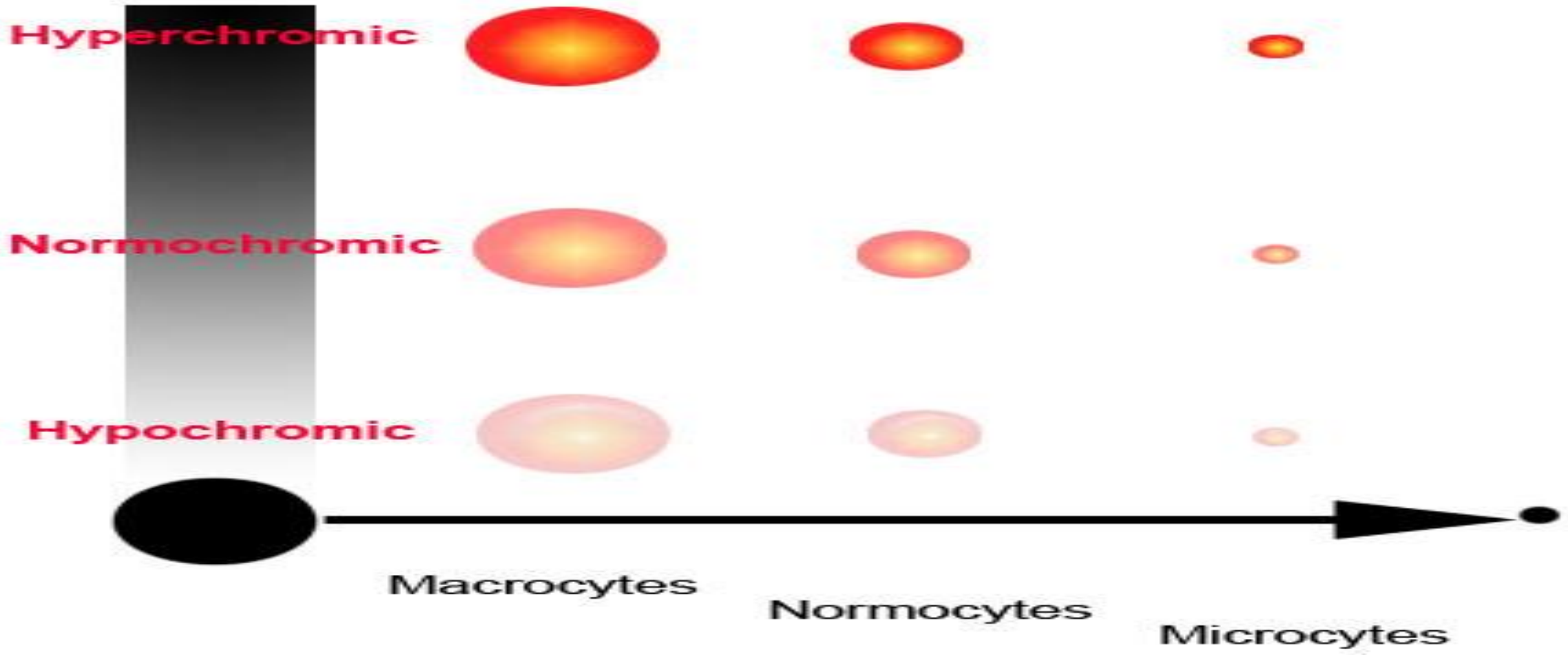
Clinical Picture of Anemia



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

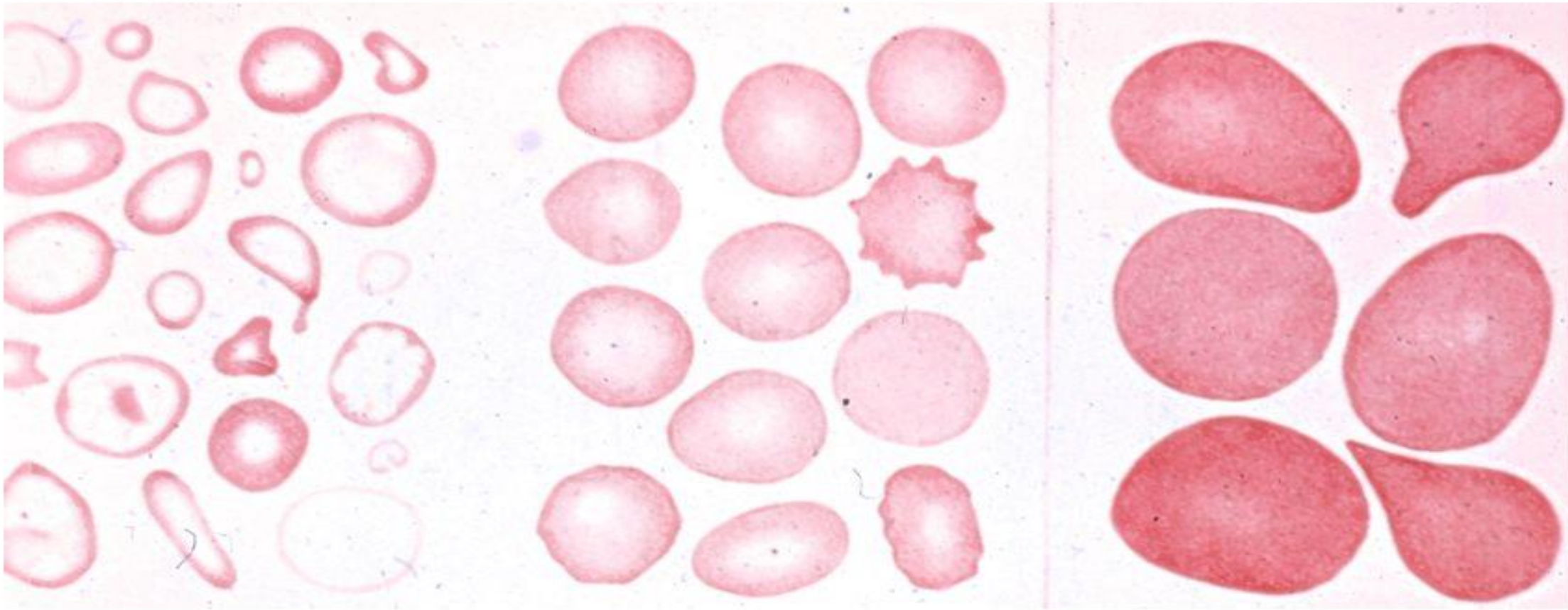
Types of anemia



Hypochromic/Microcytic

Normochromic/Normocytic

Macrocytic(/Normochromic)



Normocytic normochromic

Other causes
Aplastic
Hemolytic
Acute hge

– MCV
– MCH

Microcytic hypochromic

Iron deficiency anemia

↓ MCV
↓ MCH

Macrocytic hyperchromic

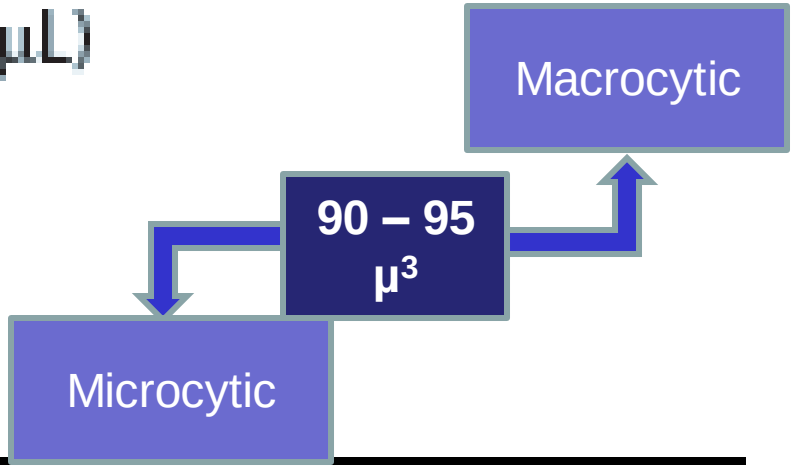
Folate or vitamin B_{12} deficiency

↑ MCV
↑ MCHC

Haematological indices

Mean corpuscular volume (MCV): **The average volume of the red blood cells expressed in femtoliters (fl) or cubic micrometers.**

$$= \frac{Hct \times 10}{RBC\ (10^6/\mu L)}$$



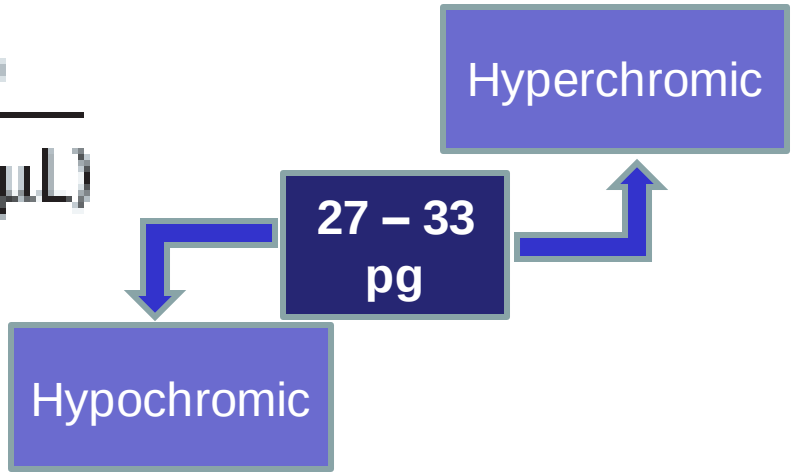
Normal value: 90-95 femtoliters (10^{-15} liters) abbreviated fl.

- ❑ **Macrocytic anemias– larger than normal cells**
- ❑ **Normocytic anemias – cells are normal in volume.**
- ❑ **Microcytic anemias– cells are smaller than normal.**

Mean corpuscular Hb (MCH):

The average amount of hemoglobin inside a RBC expressed in picograms (pg).

$$= \frac{Hb \times 10}{RBC\ (10^6/\mu L)}$$



Normal value: 27-33 pg (10^{-12} gram)

- ❑ **Normochromic**
- ❑ **Hypochromic**
- ❑ **Hyperchromic**

NORMOCYTIC NORMOCHROMIC ANEMIA

MCV = 90 μ^3

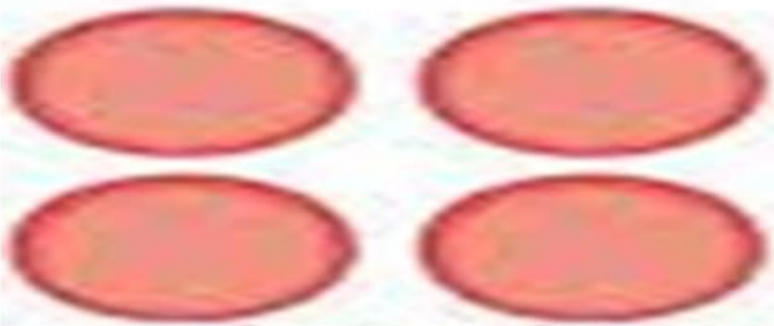
MCH = 30 pg

MICROCYTIC HYPOCHROMIC ANEMIA WITH ANISOCYTOSIS AND POIKILOCYTOSIS

MCV = 70 μ^3

MCH = 22 pg

MACROCYTIC HYPERCHROMIC ANEMIA



MCV = 110 μ^3

MCH = 38 pg

Haematological indices

Mean corpuscular Hb concentration (MCHC):

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

- Normal value: 32- 35 g/dl of RBCs $= \frac{Hb \times 100}{Hct}$

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)**


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**

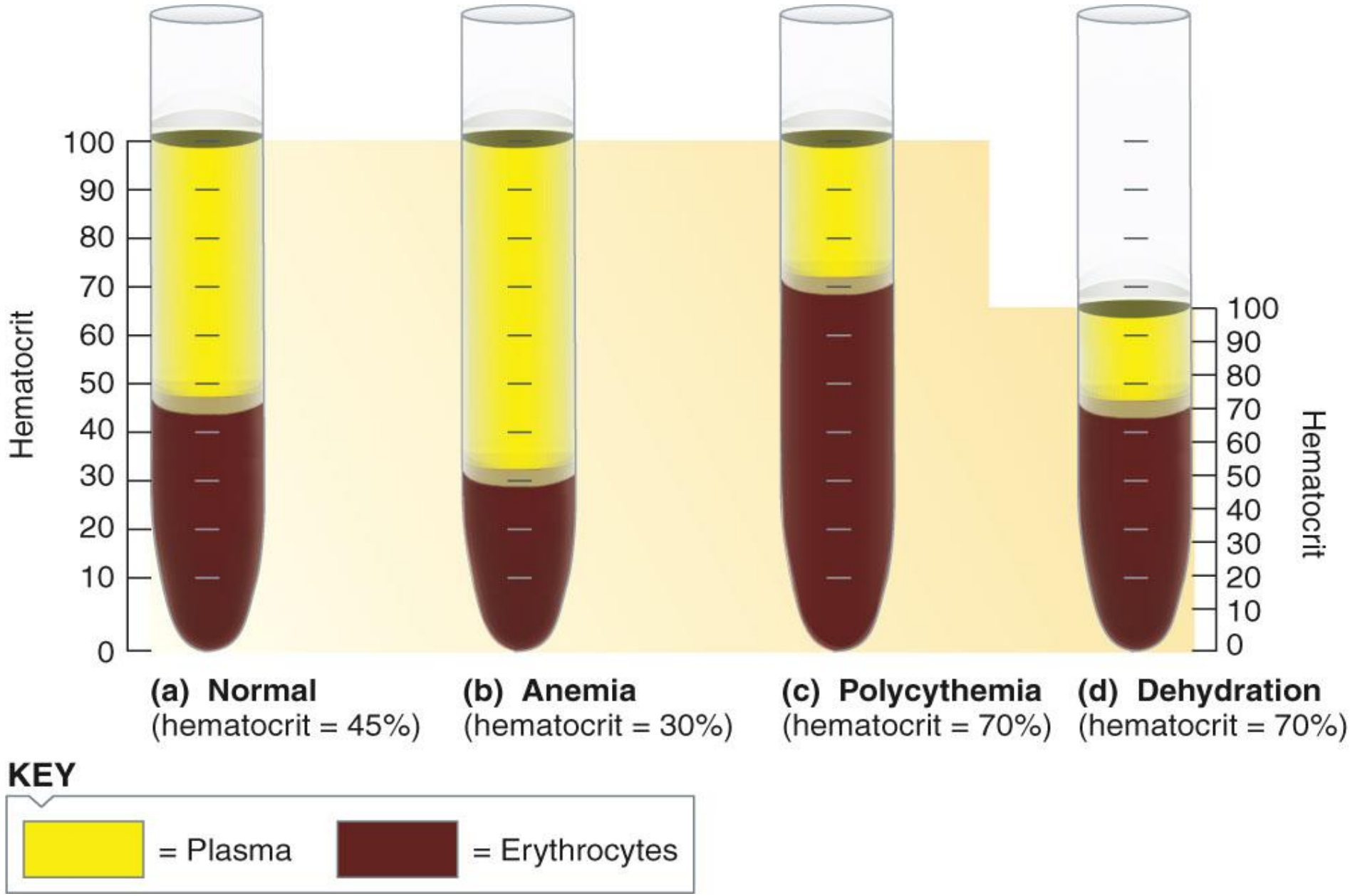
❑Relative

- **Hemoconcentration:**

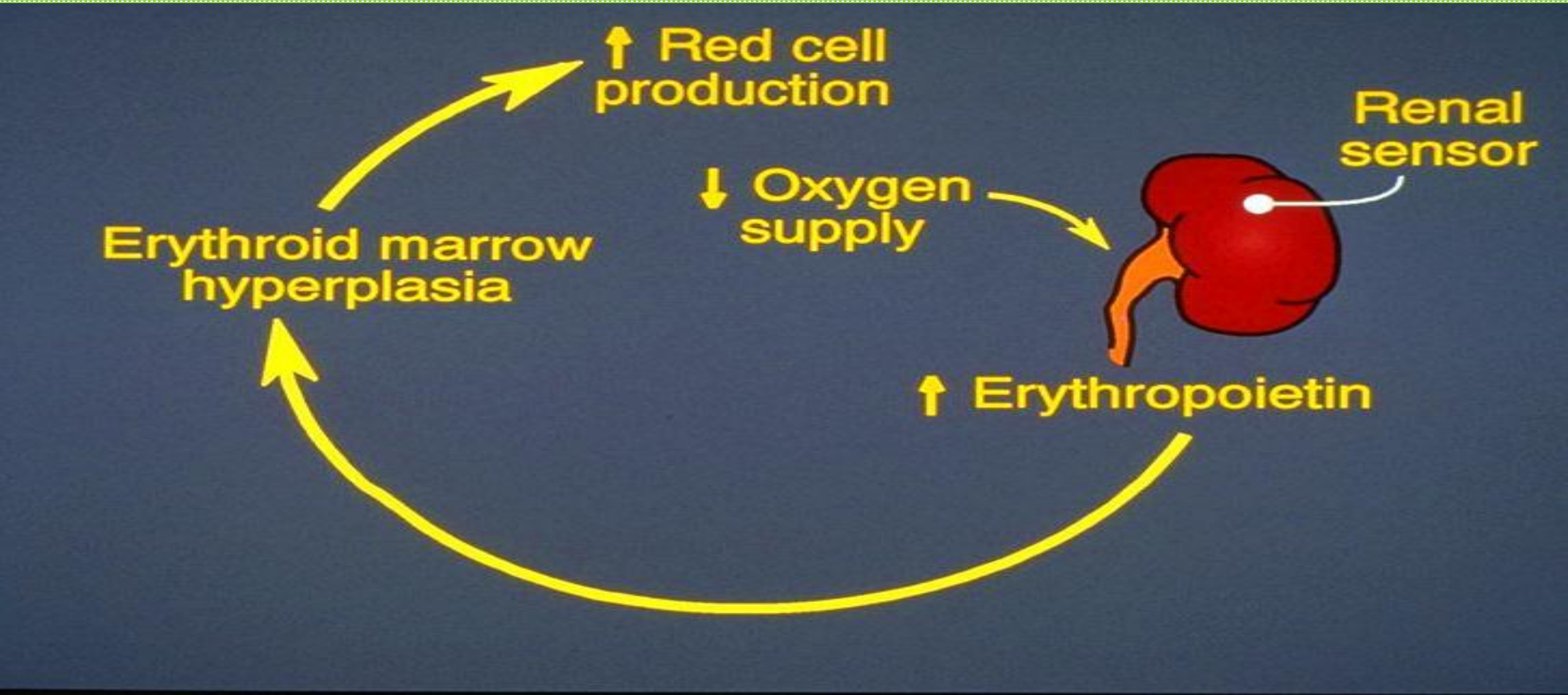
» loss of body fluid in vomiting, diarrhea, sweating

Complications of polycythemia: hyperviscosity of the blood

Hct under various conditions



Pathophysiology of Polycythemia



Thank You