

HEMATOLOGY

I- Blood picture

(Complete blood count)

By

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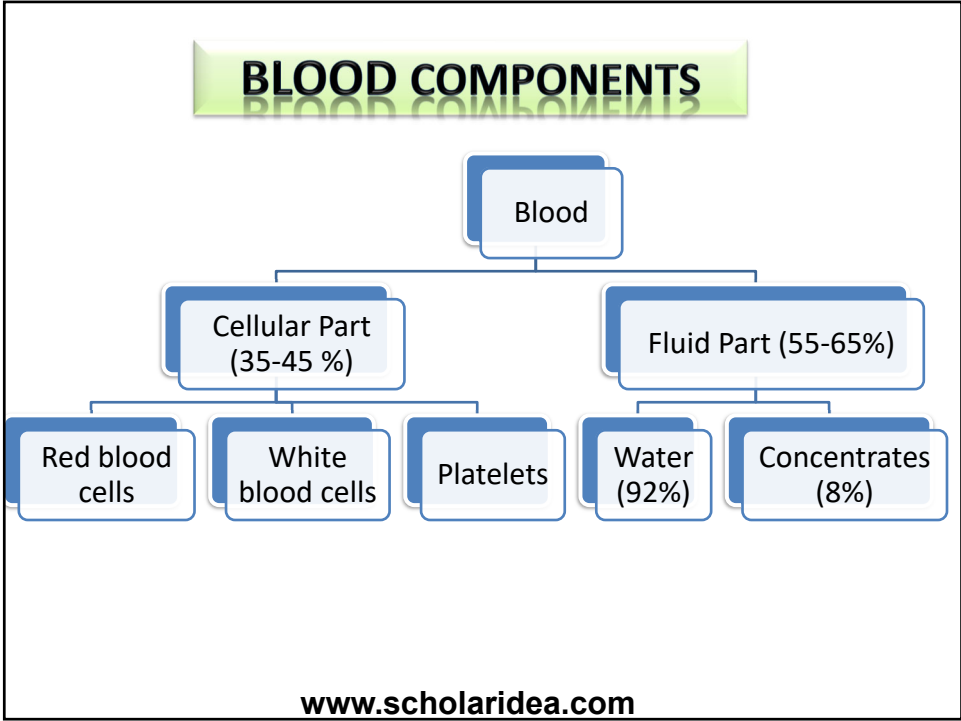
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Hematology may be defined as the scientific study of the structure and function of the blood in health and disease. Hematology therefore is a laboratory science in which we quantitatively and qualitatively observe the different components of blood in order to diagnose a great variety of diseases.

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Blood Picture
Complete Blood Count (CBC)
Hemogram

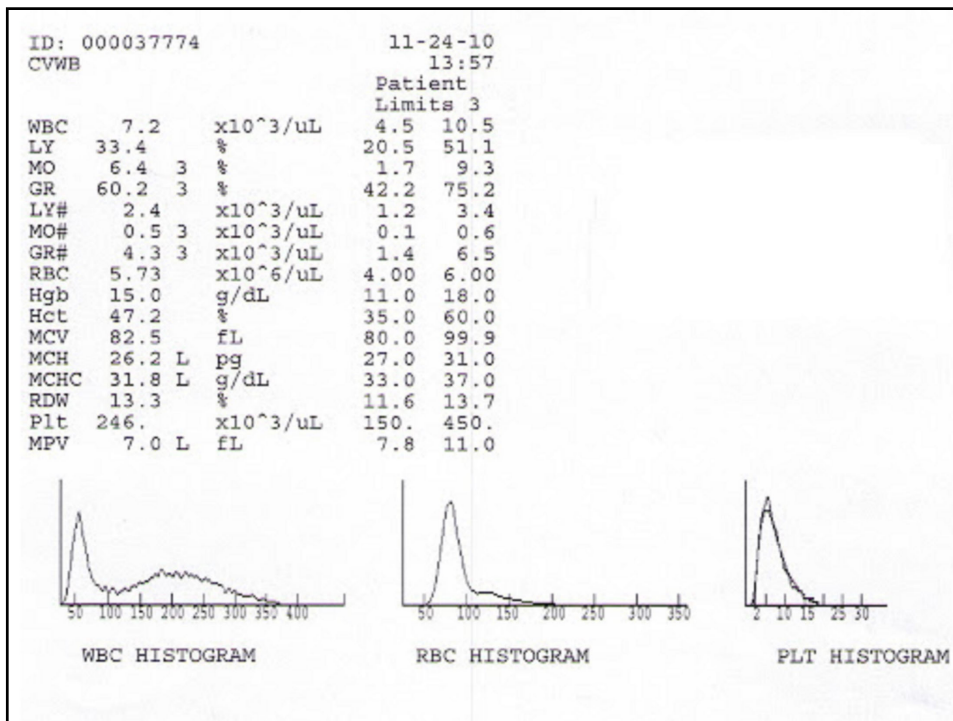
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Component	Your Value	Standard Range	Units	Flag
White Blood Cell Count	5.4	4.0 - 11.0	K/uL	
Red Blood Cell Count	5.20	4.40 - 6.00	M/uL	
Hemoglobin	16.0	13.5 - 18.0	g/dL	
Hematocrit	47.2	40.0 - 52.0	%	
MCV	91	80 - 100	fL	
MCH	30.8	27.0 - 33.0	pg	
MCHC	33.9	31.0 - 36.0	g/dL	
RDW	12.7	<16.4 -	%	
Platelet Count	149	150 - 400	K/uL	L
Differential Type	Automated			
Neutrophil %	56	49.0 - 74.0	%	
Lymphocyte %	23	26.0 - 46.0	%	L
Monocyte %	13	2.0 - 12.0	%	H
Eosinophil %	7	0.0 - 5.0	%	H
Basophil %	1	0.0 - 2.0	%	
Abs. Neutrophil	3.1	2.0 - 8.0	K/uL	
Abs. Lymphocyte	1.2	1.0 - 5.1	K/uL	
Abs. Monocyte	0.7	0.0 - 0.8	K/uL	
Abs. Eosinophil	0.4	0.0 - 0.5	K/uL	
Abs. Basophil	0.0	0.0 - 0.2	K/uL	

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Evaluation of the red blood cells (RBCs)
Erythrocytes picture

Erythrocytes morphology **RBCs count**

Mean corpuscular values

Packed cell volume

Hemoglobin concentration




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Evaluation of the White blood cells (RBCs)
WBCs picture



Total WBCs count

Differential leucocytes count

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**Evaluation of Platelets (RBCs)
Platelets picture**



**Platelets (Thrombocytes) count
Mean platelet volume (MPV)
Plateletcrit (PCT)
Platelet distribution width (PDW)**

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**Blood Picture
Complete blood count (CBC)**

**RBCs count (/mm³ or T/l)
Hemoglobin concentration (g/dl or g/l)
Packed cell volume (PCV) or Hematocrit (%)
Erythrocytes morphology
Determination of Mean corpuscular values
(MCV, MCH, MCHC)
Total WBCs count (/mm³ or G/l)
Differential leucocytes count
Platelets (Thrombocytes) count (/mm³)**

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Evaluation of the red blood cells (Erythrocyte picture)

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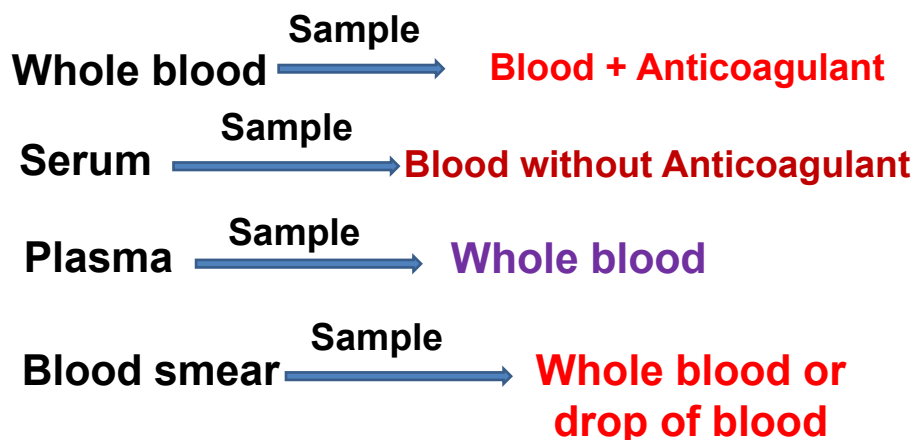
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Test description	Observed value	Unit	Reference range
<i>Erythrocytes</i>			
Total count	4.21	$\times 10^6/\mu\text{L}$	3.8–5.4
Hemoglobin	9.6	g/dL	10.5–14.0
PCV (hematocrit)	30.1	%	32–42
MCV	71.5	fL	72–88
MCH	22.8	pg	24–30
MCHC	31.9	g/dL	32–36
<i>Leucocytes</i>			
Total leucocyte count	11,700	%	4400–11,300
Neutrophils	31	%	45–74
Lymphocytes	66	%	22–50
Basophils	00	%	0–1
Eosinophils	02	%	0–4
Monocytes	01	%	1–8
<i>Platelets</i>			
Total count	840	$\times 10^3/\mu\text{L}$	10–400
MPV	7.7	fL	8–12
¹² PDW	8.8	fL	9–14

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Types of blood samples



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Anticoagulants

Ethylene Diamine Tetra-acetic acid (EDTA)

Dose: 1mg/ml blood

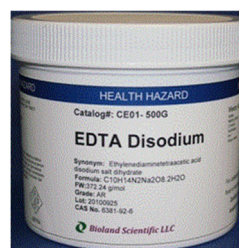
Mode: Binding ionized calcium

Advantages:

- ✓ Hematological analysis.
- ✓ No effect on leukocyte staining affinity.
- ✓ Preserve the blood sample for 24 hours.

Disadvantage

- ❖ Higher concentration of salt withdraws water from red cells and reduces PCV values.



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Haemolysis

It means the breakdown of the RBCs.

- **Using wet needle or syringe.**
- **Collection of the blood sample directly to the bottom of the tube.**
- **Vigorous mixing of the blood sample.**
- **Excessive negative pressure when collecting sample with a syringe will rupture cells and collapse the vein.**
- **Failure to remove the needle from the syringe, when transferring blood from a syringe to a container.**
- **Extreme heat or cold.**

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Clotting of blood samples

It means formation of clots in the whole blood sample.

- **Delay in mixing the blood sample with the anticoagulant.**
- **The amount of the collected blood sample is larger than the concentration of the anticoagulant.**
- **Taking long time in collection of the blood sample.**

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Evaluation of the red blood cells (RBCs) Erythrocytes picture

Determination of RBCs count (/mm³ or T/l)

Determination of Hemoglobin concentration (g/dl)

Determination of Packed cell volume (%)

Determination of Mean corpuscular values (MCV, MCH, MCHC)

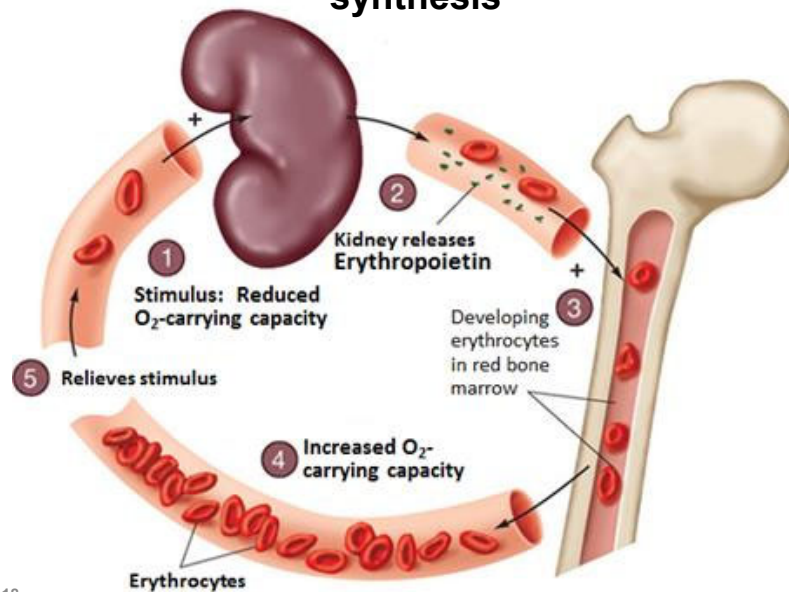
Determination of erythrocytes morphology

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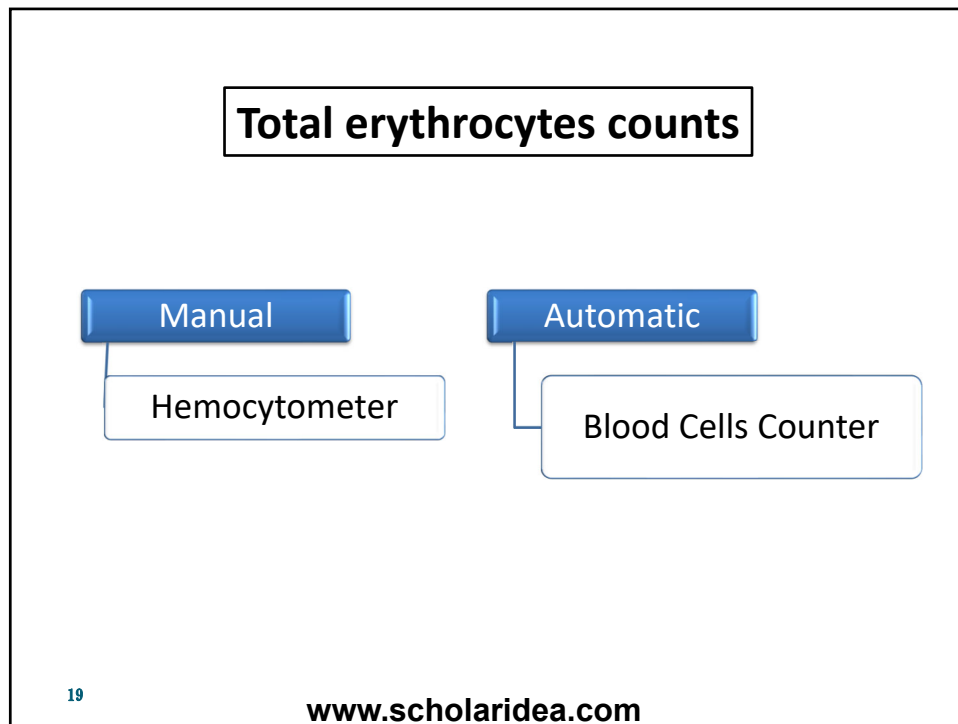
Mechanism of stimulation of Red blood cells synthesis



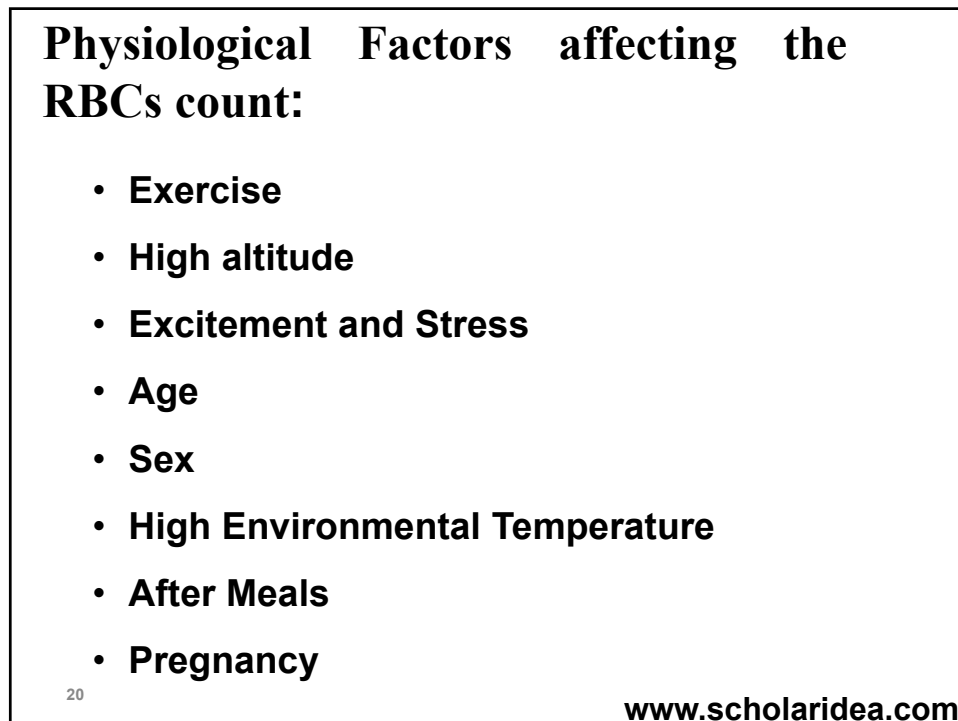
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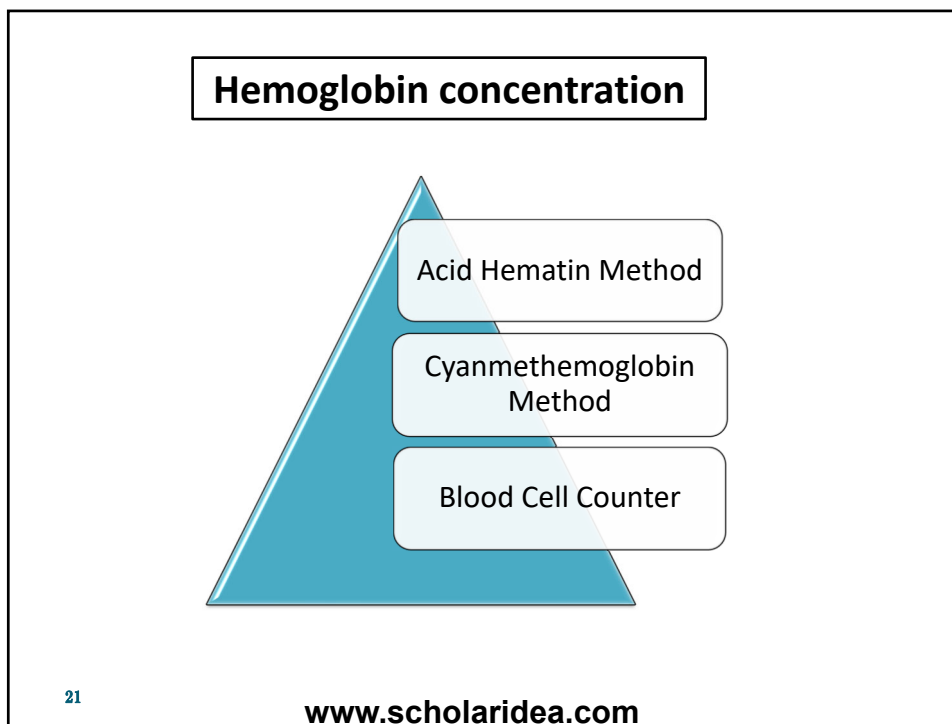
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Hemoglobin concentration

Increase haemoglobin concentration

- ❖ Chronic carbon monoxide poisoning.
- ❖ Polycythemia.
- ❖ Cardiac diseases.
- ❖ Pulmonary diseases.

Decrease hemoglobin concentration

- ❖ Anemia.
- ❖ Amyloid nephrosis.
- ❖ Leukaemia.
- ❖ Malignant tumors.

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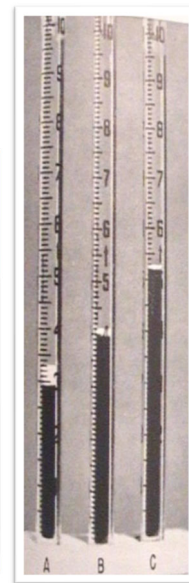
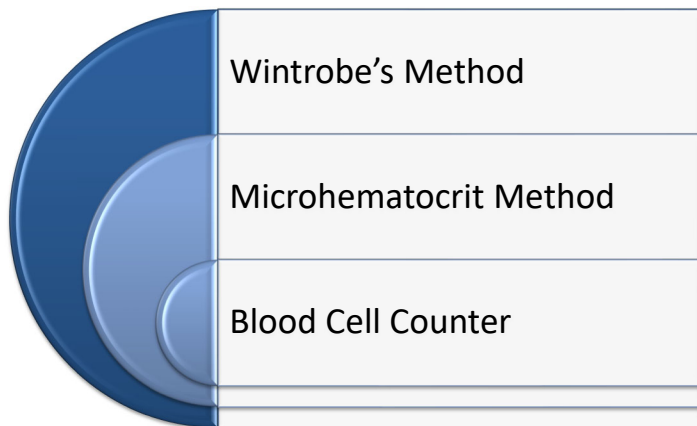
Hematocrit Packed cell volume (PCV)

Packed cell volume (PCV) or Hematocrit, is defined as the percentage of blood occupied by RBCs, or simply you can define PCV as the percentage of RBCS in whole blood.

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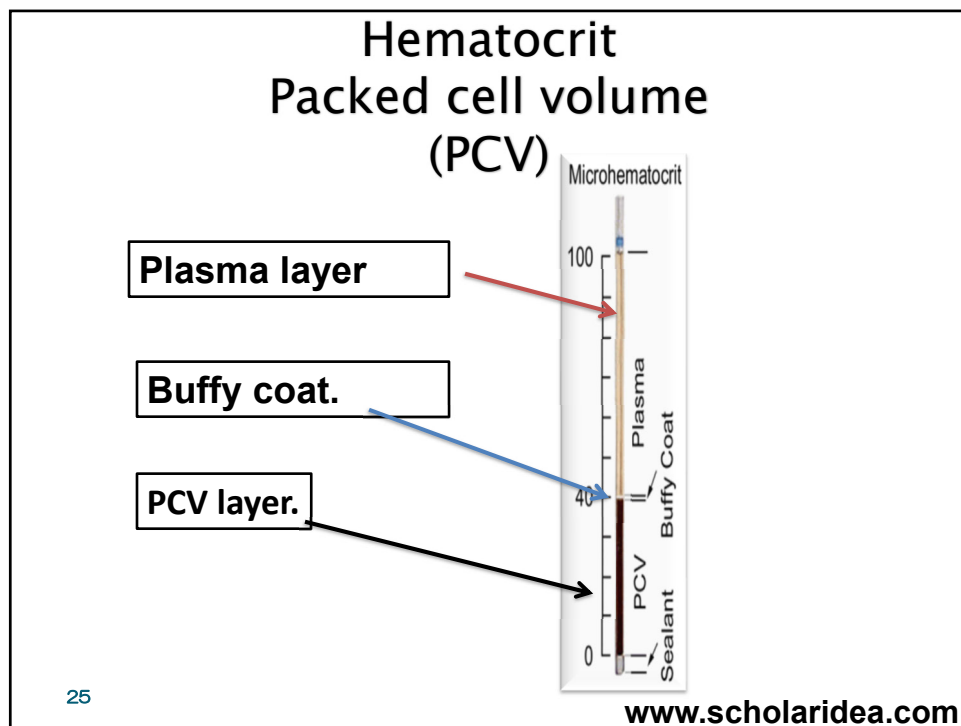
Packed cell volume (PCV)



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Packed cell volume (PCV)

Advantages of the microhematocrit method:

- The amount of blood required is considerably less.
- Time required for the entire procedure is less.
- accurate.

Disadvantages of the microhematocrit method

- Special reader is required for reading.
- It is impossible to determine E.S.R. in such small tubes.
- It is difficult to evaluate the depth of the buffy coat.

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Interpretation of packed cells volume

a. PCV layer

An elevated PCV layer occurs in cases of:

- 1- Physiological causes.**
- 2- Hemoconcentration following dehydration.**
- 3- Chronic obstructive pulmonary disease.**
- 4- Pulmonary diseases that associated with hypoxia.**
- 5- Congestive heart failure.**
- 6- Polycythemia**

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Lowered PCV layer occurs in cases of:

- Oligocythemia (Erythrocytopenia).**
- Hemodilution.**
- Renal failure, as a result of decreased secretion of erythropoietin.**
- Malignant tumors.**
- Leukemia.**

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2. Buffy coat

In blood from normal animal, the buffy coat consists of a white to gray layer 0.5 to 1.2 mm. In size occurring immediately above the PCV layer.

For routine clinical application, a buffy coat of less than 0.5 mm would suggest leucopenia, while above 1.5 mm indicate Leucocytosis

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3. Plasma layer

The color of the plasma can help with :

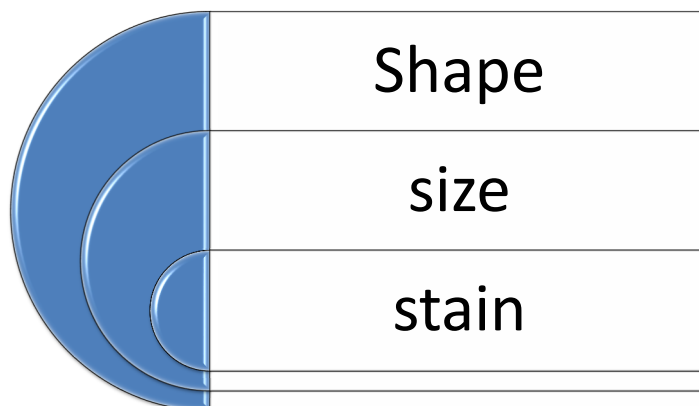
- a) Dark yellow color is an indicator for hemolytic, hepatic and obstructive jaundice.
- b) The pink color of plasma is indicative for hemolysis of erythrocytes, which associate some diseases as bacillary hemoglobinuria and blood parasites as Babesia species .
- c) Milky color of plasma indicates the increase of lipids in blood.

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Determination of erythrocytes morphology



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Morphological examination of erythrocytes

All parameters of the erythrocyte picture can be determined using a blood cell counter, except assessing the morphology of the RBCs, which must be evaluated using a blood smear. This means, that both electronic blood cell count and blood smear are required to perform the erythrocyte picture.

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Morphological examination of erythrocytes

Morphological examination of erythrocytes is carried out by:

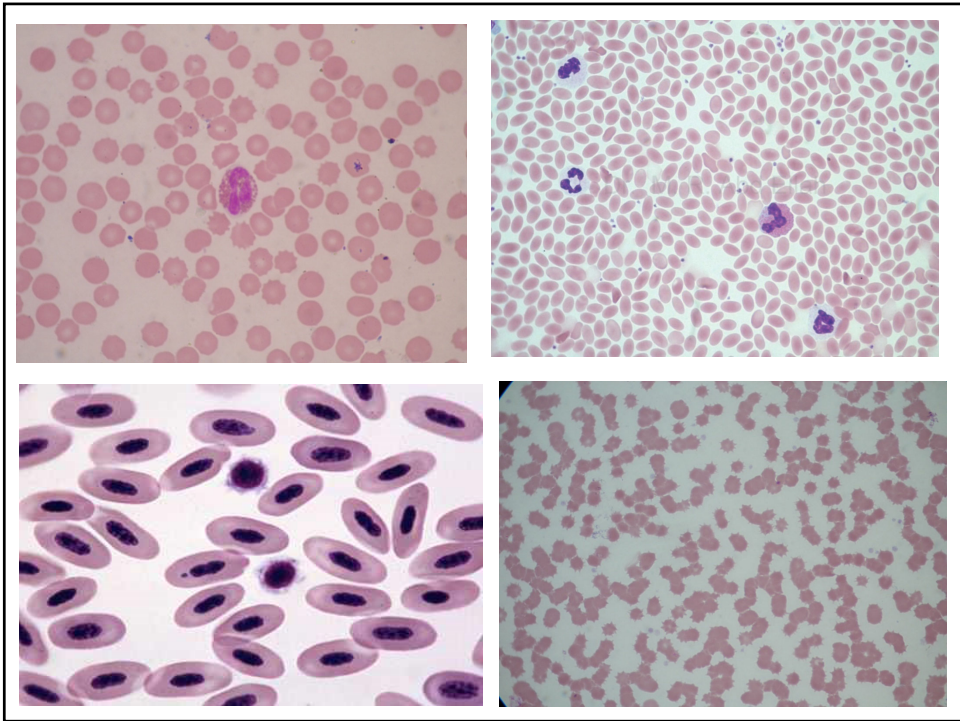
- Examination of a stained blood film (Giemsa stain) under the light microscope and by using the oil immersion lens (X100), the RBCs are examined for shape, size, and stain.
- Calculating and interpreting the mean corpuscular values (indices).

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Evaluating the shape of the RBCs

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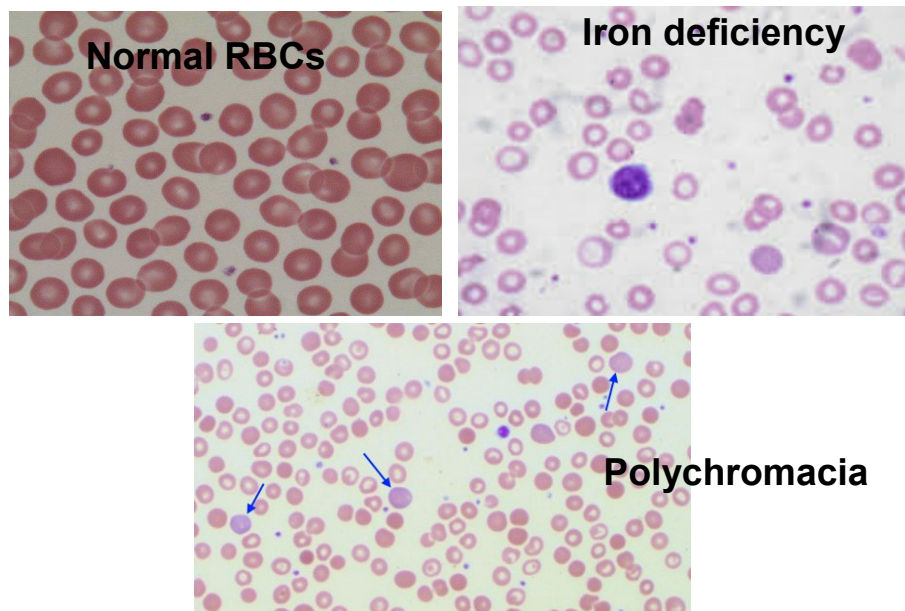
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Evaluation of the Size of the RBCs

This block contains two microscopic images. The left image shows a field of normal red blood cells, labeled "Normal RBCs". The right image shows a field of red blood cells, with several larger cells indicated by arrows and labeled "Macrocytic RBCs". A leukocyte is also visible in the right image.

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Evaluation of the stain of the RBCS



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Mean corpuscular values

1. Mean Corpuscular Volume (MCV)

Mean corpuscular volume (MCV, fl or femtoliter) is a measure of average size of RBC and represents the volume of a single RBC.

This value used to classify red cells as:

- Normocytic red blood cells are of normal size.
- Microcytic red blood cells are smaller than normal.
- Macrocytic red blood cells are larger than normal.

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2. Mean Corpuscular Hemoglobin (MCH)

Mean corpuscular hemoglobin (MCH, pg or pictogram) is average weight hemoglobin of erythrocyte in a population of erythrocytes.

3. Mean Corpuscular Hemoglobin concentration (MCHC)

Mean corpuscular hemoglobin concentration (MCHC, g/dl) is the average percent of hemoglobin occupied by the erythrocyte (g/dl)

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Mean corpuscular values

1. Mean Corpuscular Volume (MCV)

$$\text{MCV (fl)} = \frac{\text{PCV (\%)} \times 10}{\text{RBC count} \times 10^6/\text{ul}}$$

2. Mean Corpuscular Hemoglobin (MCH)

$$\text{MCH (pg)} = \frac{\text{Hb. g/dl} \times 10}{\text{RBC count} \times 10^6/\text{ul}}$$

3. Mean Corpuscular Hemoglobin concentration (MCHC)

$$\text{MCHC (g/dl)} = \frac{\text{Hb. g/dl} \times 100}{\text{PCV (\%)}}$$

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Based on MCH and MCHC red blood cells may be:

- Normochromic red cells with normal Hb concentration.
- Hypochromic red cells with lowered Hb concentration.
- Hyperchromic red cells with elevated Hb concentration.

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Complete Blood Count:

	Patient Value	Normal Range 2 years – 6 years
WBC	$8.4 \times 10^9 / L$	(5.0 – 17.0)
RBC	$2.77 \times 10^{12} / L$	(3.90 – 5.30)
Hgb	7.5 g/dl	(11.5 – 13.5)
Hct	21.8 %	(34.0 – 40.0)
MCV	78.6 fl	(75.0 – 87.0)
MCH	26.9 pg	(25.0 – 31.0)
MCHC	34.2 gm/dl	(31.0 – 36.0)
RDW	17.3 %	(11.5 – 15.0)
PLT	$192 \times 10^9 / L$	(150 – 450)

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