Changes in size, shape and colour shade of red blood cells (RBC)

Mature RBC are highly specialized cells of discoid shape, which lost all organels including nucleus during their maturation. In the blood film, RBC seem like round elements with central cave.

Changes in size of RBC (*anisocytosis*):
Measuring the size of RBC we can obtain ***Price-Jones curve*** of RBC size distribution in the peripheral blood (Fig. 1). Variability in size of RBC may be observed also in healthy humans (***physiological anisocytosis***). In healthy people, up to 5-7 % of all RBC may have smaller or bigger diameter than the mean value. RBC with reference values of size, shape and content of hemoglobin are called **normocytes**.

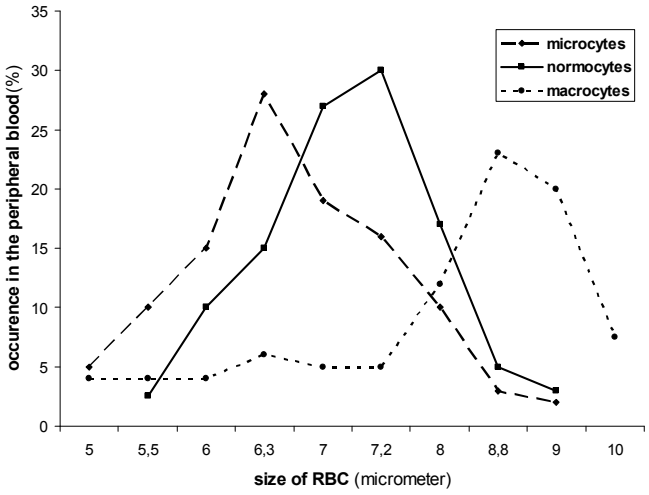

Fig. 1. **Price-Jones curve.**

Finding of higher number of **microcytes** (diameter <6.7 μm) may indicate inherited derangement in hemoglobin structure (*hemoglobinopathia*) or more often an iron deficiency in the body due to decreased iron intake in food, insufficient utilization or excessive losts (*sideropenic anemia*). Occurance of big RBC (**macrocytes**, **megalocytes** or **gigantocytes)** is usually associated with deficiency of folic acid and vitamin B_{12} (*macrocytic, megaloblastic, pernicious anemia*), e.g. in hepatic diseases (deteriorated metabolism of the mentioned substances) or during pregnancy and compensatory increase in erythropoiesis after bleeding or hemolysis (insufficient supply) (Table 1).

Table 1. Changes in size of RBC

Name	Characteristics	Reasons
normocytes	∅ 7.2±0.5 μm, MCV 85±10 fl	
microcytes	∅ <6.7 μm, MCV <75 fl	iron deficiency (sideropenic anemia), hemoglobinopathia
macrocytes	∅ 7.7-9 μm, MCV >95 fl	folic acid or vitamin B_{12} deficiency (macrocytic, megaloblastic anemia), young RBC
megalocytes	∅ >9 μm	
gigantocytes	>4-fold of normal size	

Changes in shape of RBC (***poikilocytosis***) (Table 2).

Table 2. Changes in shape of RBC

Name	Characteristics	Reasons
macrocytes	bigger MCV, lack of Hb	stimulated erythropoiesis, shortage of folic acid or vitamin B_{12}
hypochromic microcytes	bigger central bleach	Fe shortage, deterioration of globin or porphyrin, thalassemia
eliptocytes	eliptic, ovoid shape	inherited or acquired (megaloblastic anemia)
spherocytes	spheric microcytes without central bleach	inherited or acquired (vascular diseases, artificial cardiac valves)
leptocytes	thin, hypochromic RBC	dysfunction of membrane (thalassemia)
target-like RBC	thin, hypochromic RBC, central Hb	inherited, dysfunction of membrane, hepatic diseases, enzymopathia
drepanocytes	sickle cells	HbS, hemoglobinopathia
schistocytes	fragments of various shade (triangle, helmet-like)	artificial cardiac valves, vascular diseases, uremia, hemolytic anemia
acantocytes	5-10 thick irregular excrescences	membrane dysfunction, enzymopathia, hemolytic anemia, hepatic disorders
echinocytes	20-30 tiny regular excrescences	metabolic disorders, uremia, enzymopathia, newborns
dacryocytes	shade of drop, hypochromic microcytes	osteomyelofibrosis
stomatocytes	central bleach of fissure or mouth shape	dysfunction of membrane, alcoholism, metabolic disorders, hepatic diseases
xerocytes	shrink flat RBC	tumors, inherited disorders
helmet-like RBC	shape of bell or helmet	metabolic disorders, hepatic diseases

Changes in colour shade of RBC (***polychromasia***):

Normocyte with appropriate content of hemoglobin (32±2 pg) is homogenously stained with central bleach. In lower Hb content, RBS is more pale with larger central bleach (*hypochromic RBC*). Contrary, higher Hb content indicate big cells (macrocytes, megalocytes). Since Hb concentration never exceeds 36 %, the term „*hyperchromic RBC" is not used*. Lack of central bleach is usually caused by change in shape (spherocytosis), not by change in Hb content. Staining of RBC to blue-violet colour shade (***polychromasia***) is typical for young (premature) cells.

Material

Slides, needs for capillary blood taking, panchromatic staining by Pappenheima (or May-Grünwald and Giemsa-Romanowski) (see the task Differential WBC count), microscope, immerse oil.

Methods

In 100 RBC, determine roughly the percentage of small and big RBC compared to mean size. Compare your finding with other physiological and pathological findings from the photodatabase.