Introduction to medical science

Lab, 2018/2019

Wykładowca

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Room: 406 (4th floor)

Consultation hours: individual – send mail

Introduction to medical science – lab content

5 meetings, 5 topics = 15h

- Hematology
- Blood pressure, flow and resistance
- Elektrocardiography (ECG)
- Spirometry
- Reaction time

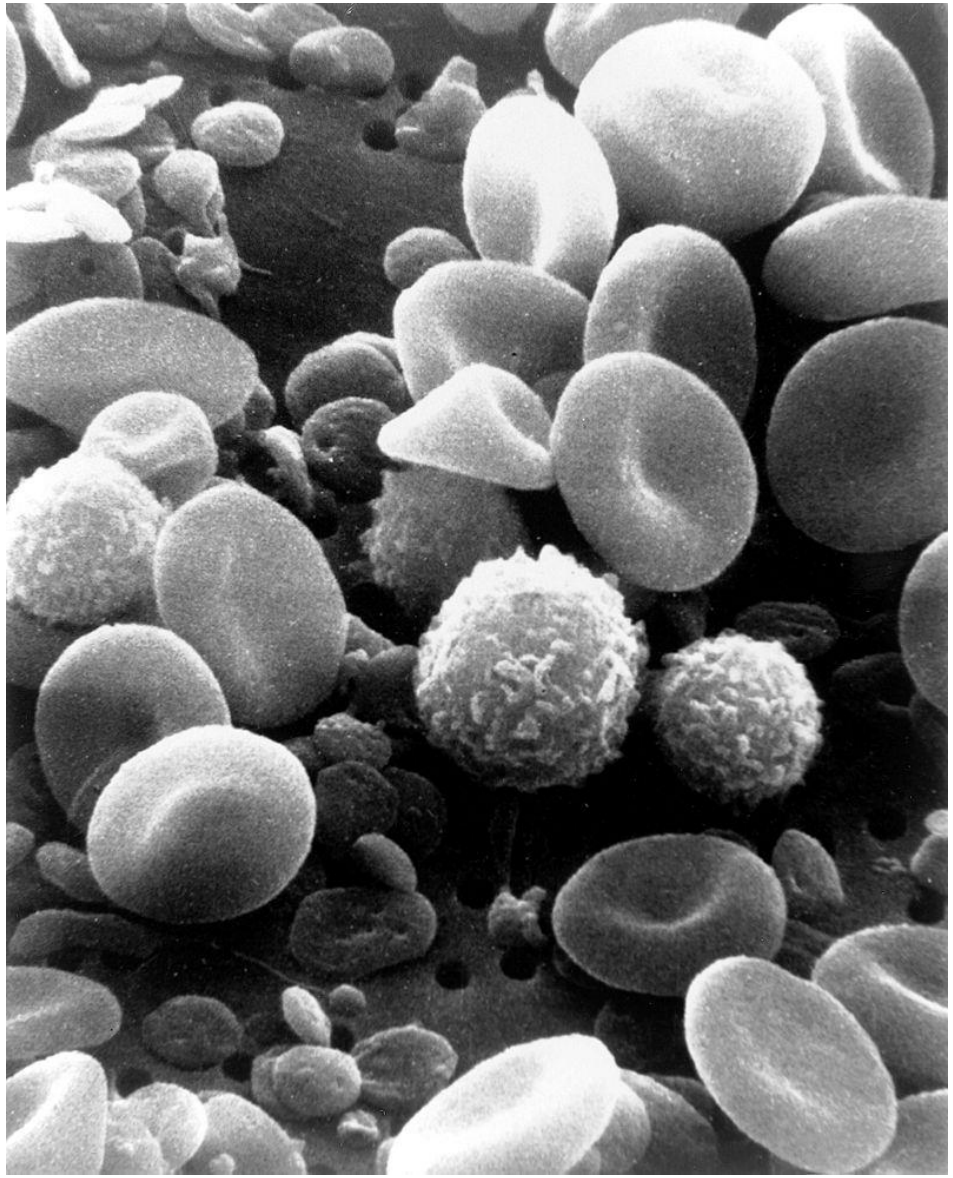
- Entrance and exit tests – the basis for assessment (2x4 tests)
- Entrance test: ~10 min. – 3 topic-related questions
- Exit test: ~10 min. – 3 questions related to practical aspects
- Scoring: 0 pts. – **2**, 1 pts. – **3**, 2 pts. – **4**, 3 pts. – **5**.

Hematology

- A branch of medicine that studies the causes, prognosis, treatment and prevention of blood-related diseases
- Treatment of diseases influencing:
  - The blood cells: erythrocytes, leukocytes
  - Hemoglobin
  - White blood cells
  - Bone marrow
  - Blood platelets
  - Blood vessels
  - The spleen
  - Coagulation mechanisms

Blood cell types

- Red blood cells - erythrocytes
- White blood cells - leukocytes
  - Granulocytes:
    - neutrophils
    - eosinophils
    - basophils
  - Agranulocytes:
    - lymphocytes
    - monocytes
- Blood platelets - thrombocytes



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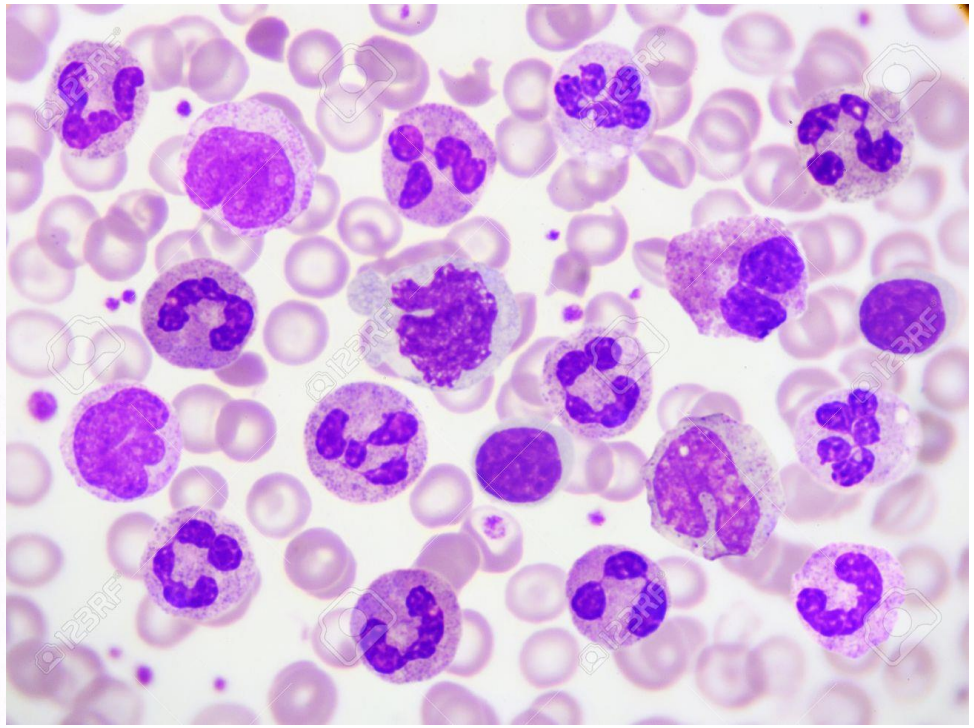
Peripheral blood smear

- It is used for the microscopic assessment of blood components and for determining the percentage of white blood cells



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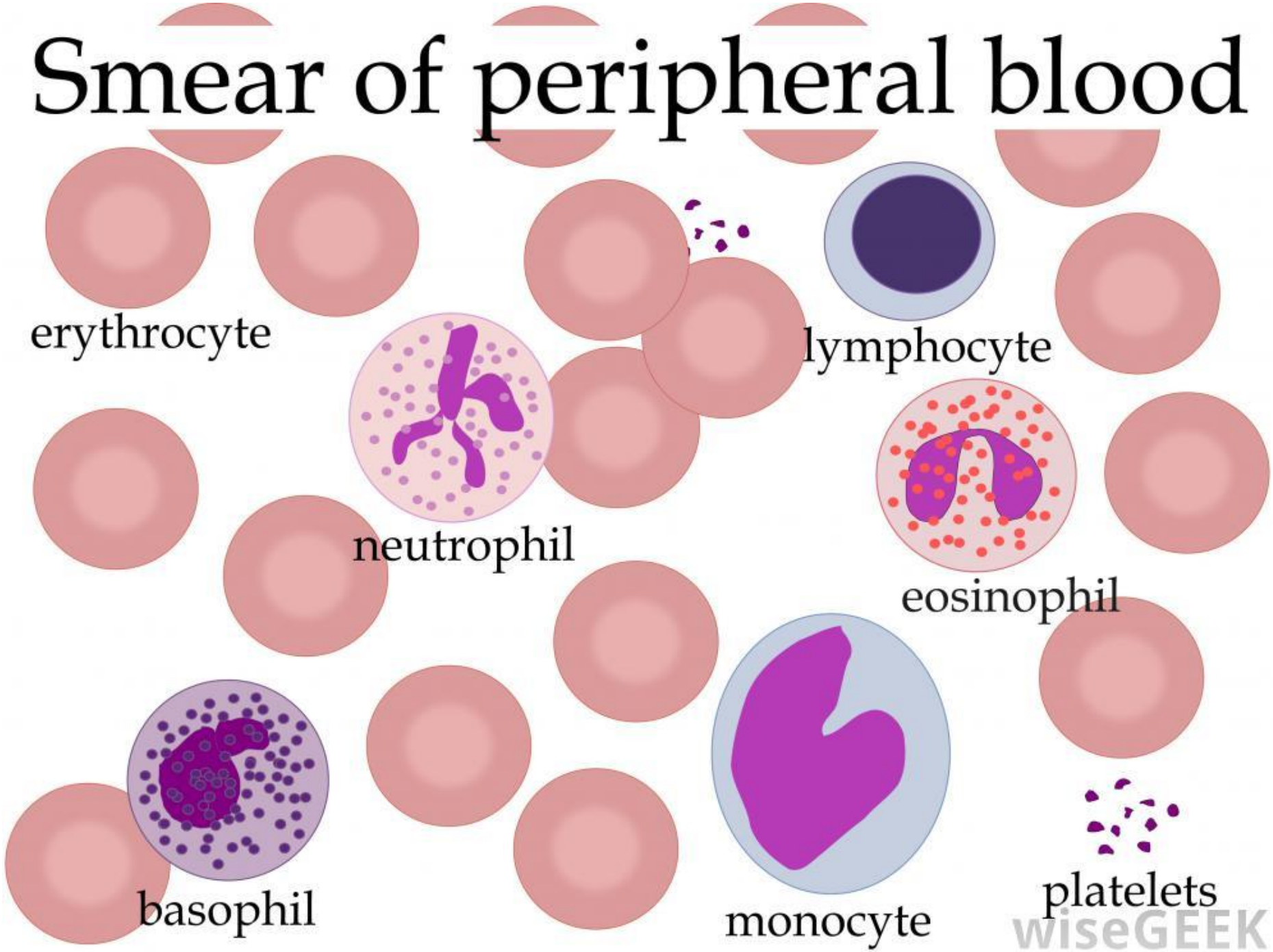
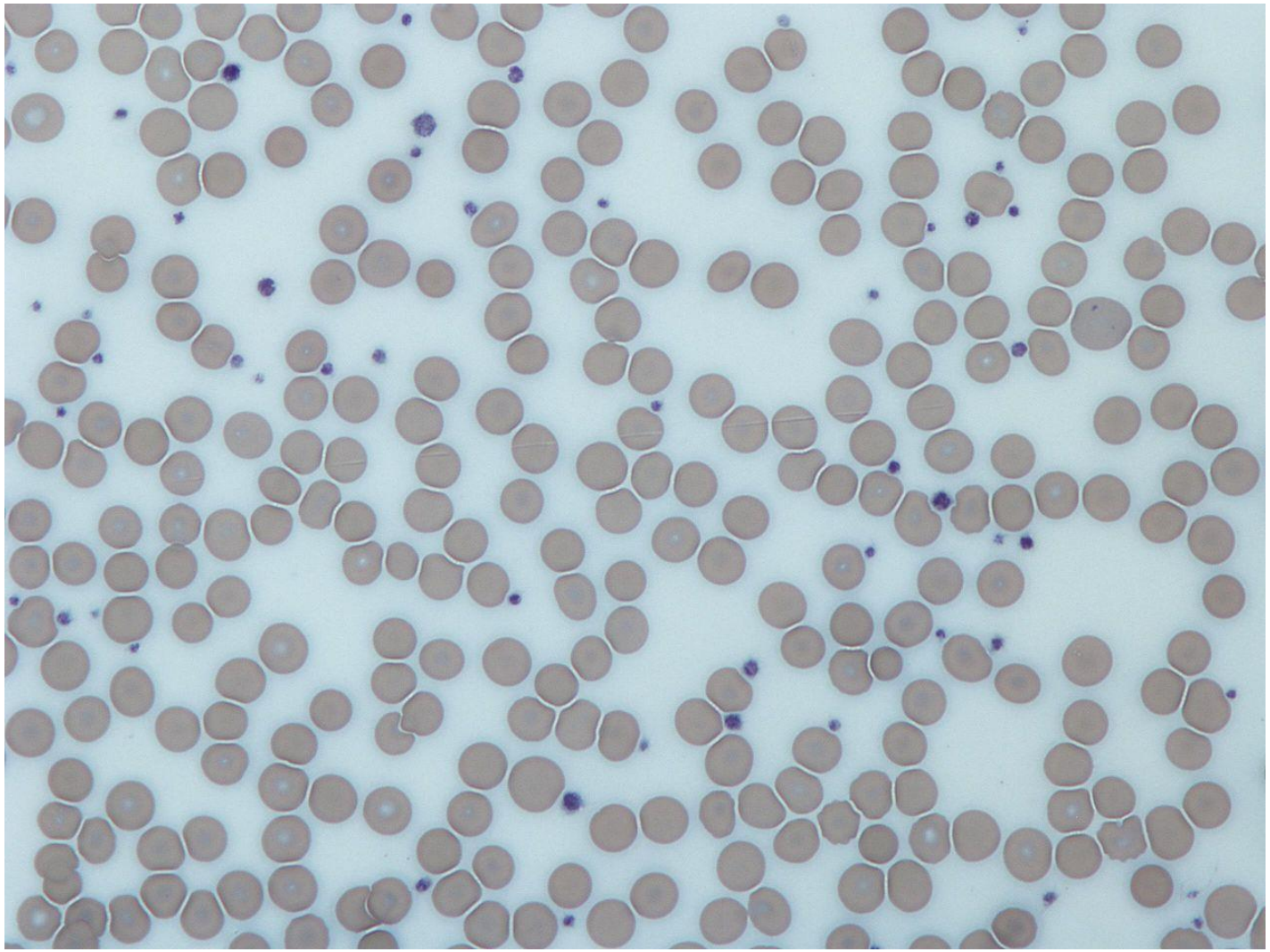
Smear analysis stages

- Taking the blood sample
- Smearing of the blood on a glass
- Staining
- Estimation of the number of red blood cells (RBC), white blood cells (WBC), platelets (PLT), percentages of different WBCs (NEUT, EOS, BASO, LYMPH, MONO)

Smear of peripheral blood

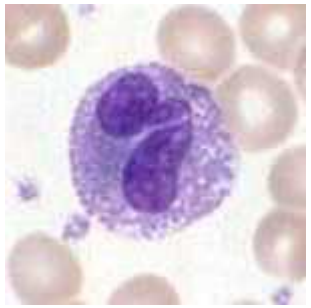


RBCs and platelets



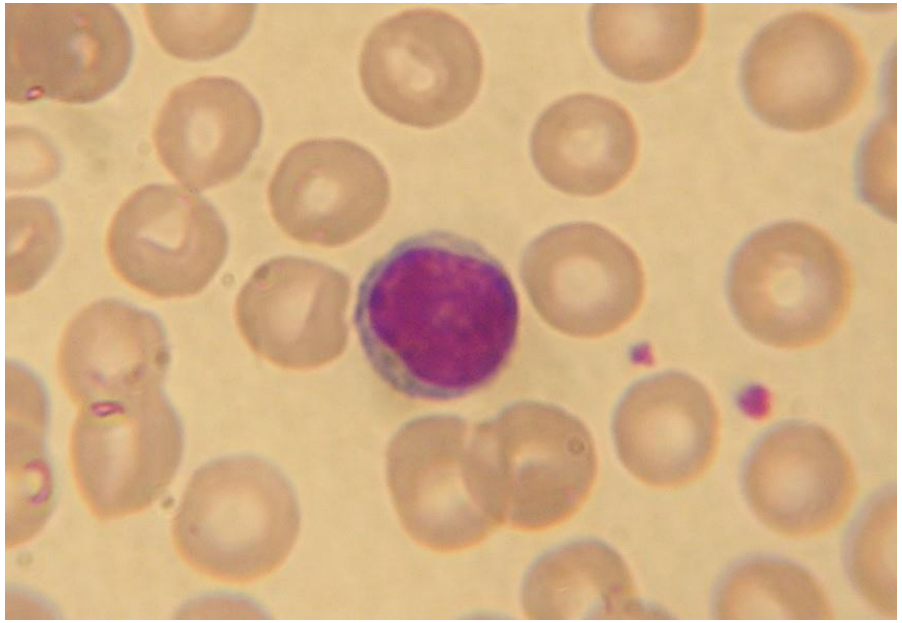
WBCs - appearance

Neutrophil (segmented nucleus)

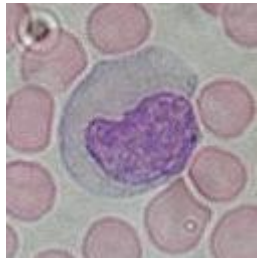


Eosinophil (2-4 lobes, kidney-shaped)

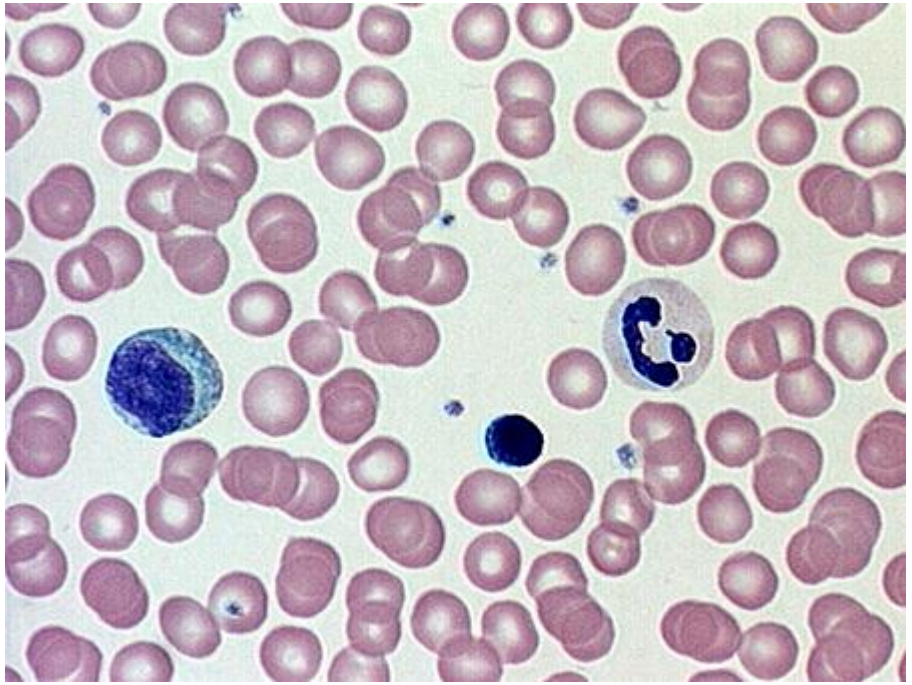
Basophil (also bilobed)

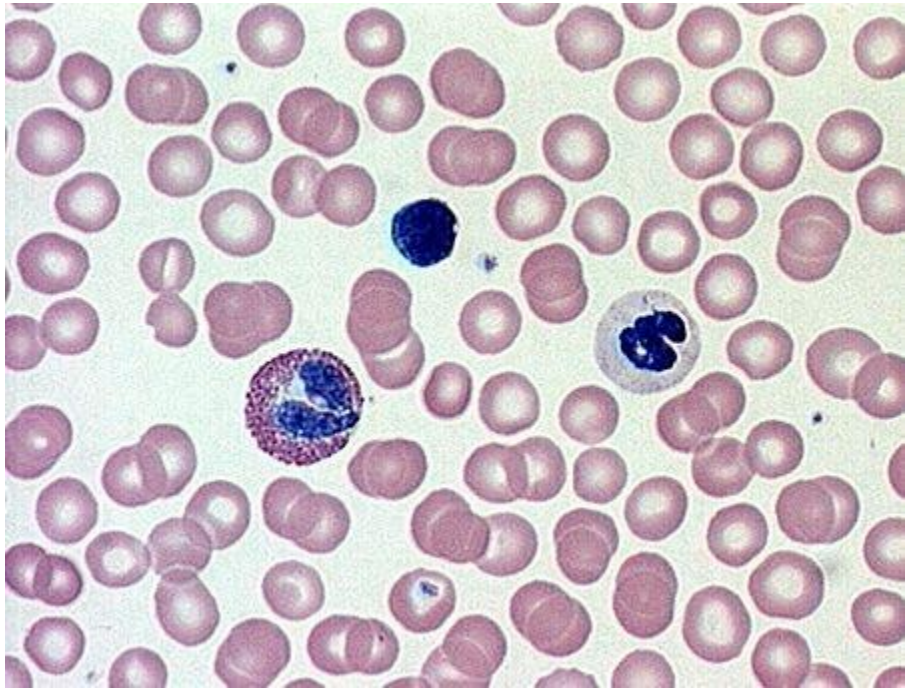


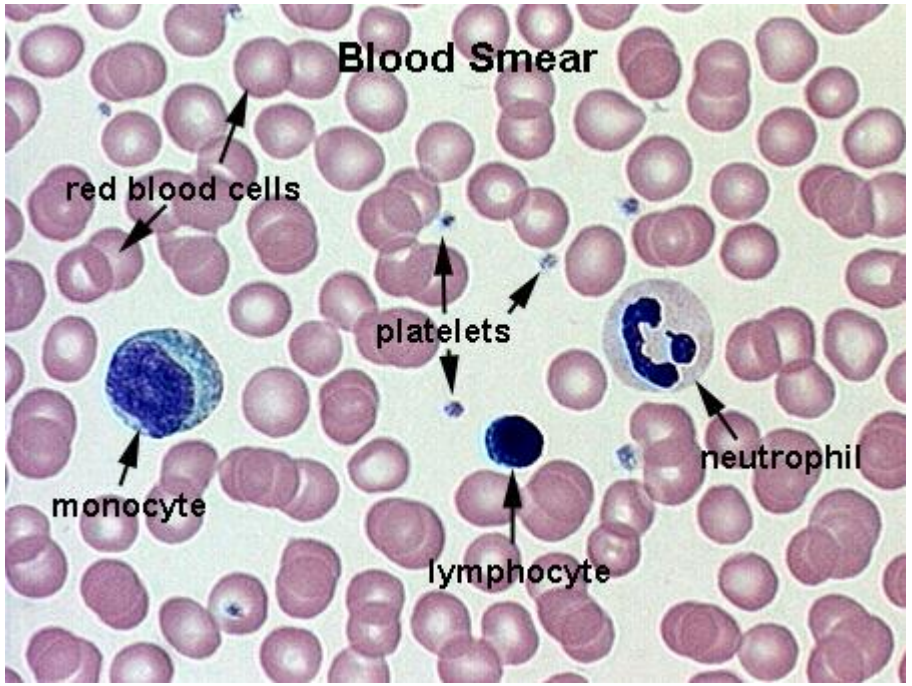
Lymphocyte

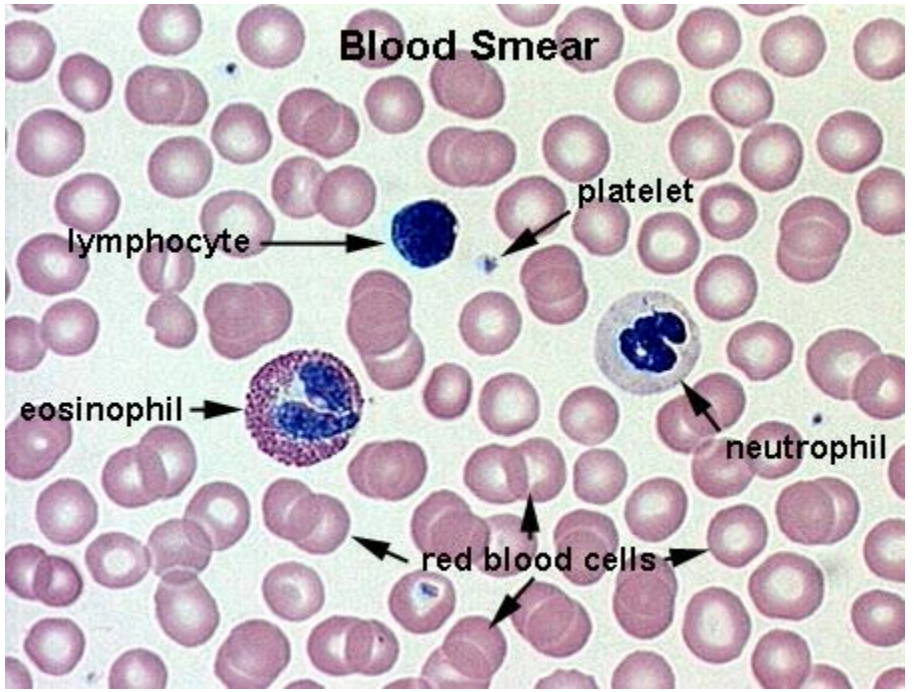


Monocyte

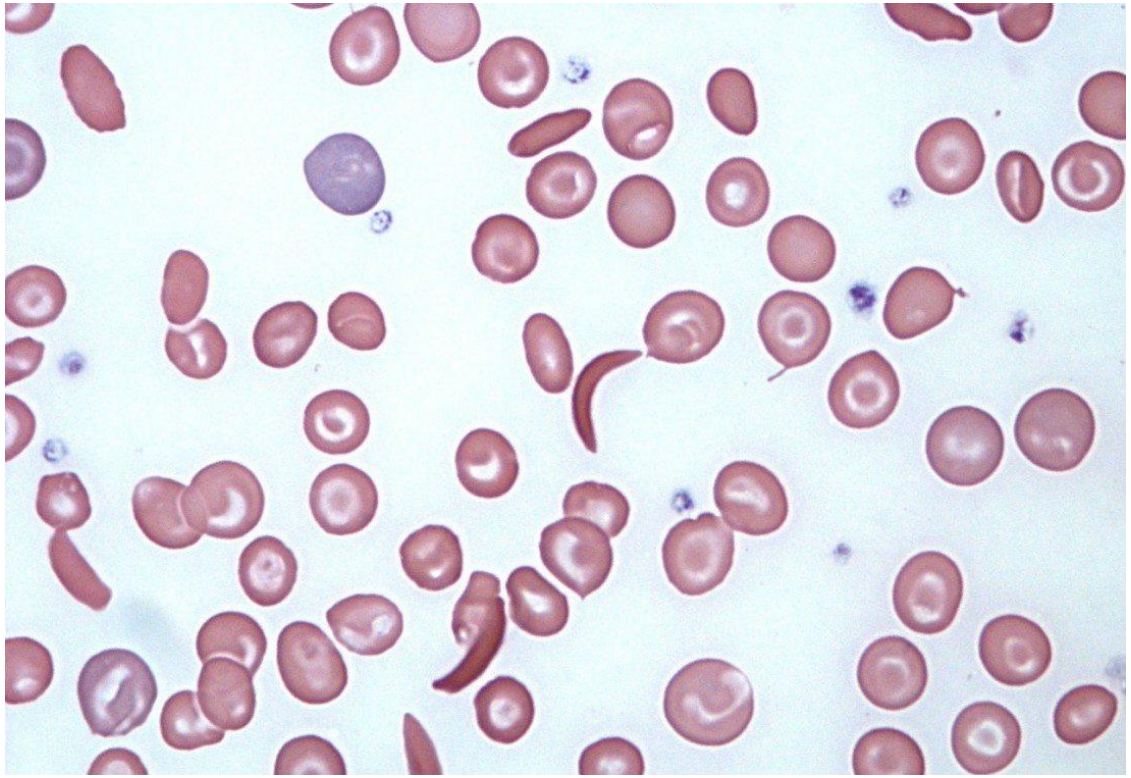




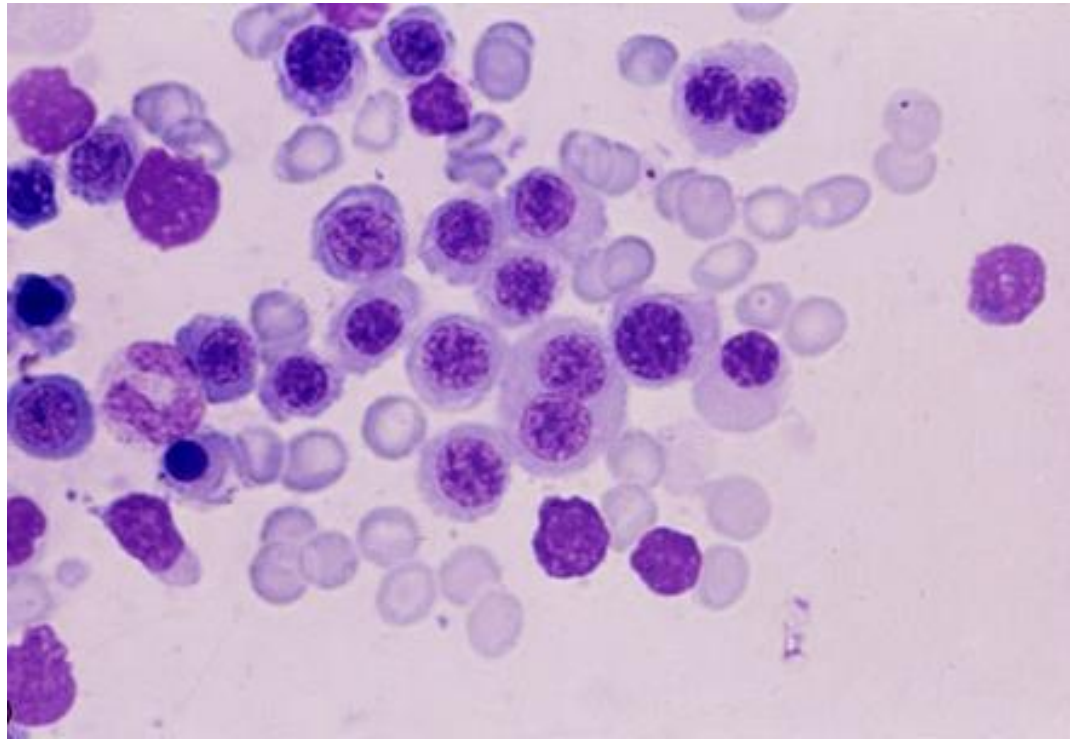

Blood Smear
red blood cells
platelets
monocyte
neutrophil
lymphocyte


Blood Smear
platelet
lymphocyte
eosinophil
neutrophil
red blood cells

Blood diseases

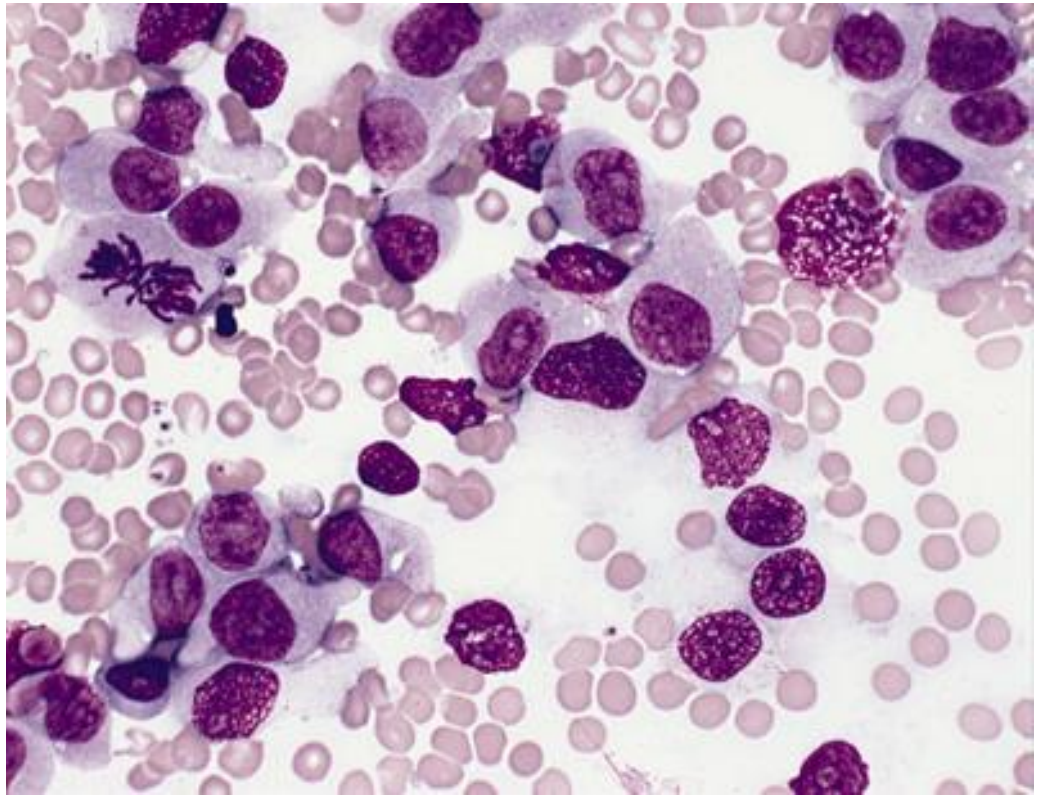


Sickle Cell Anemia
wrong hemoglobin structure

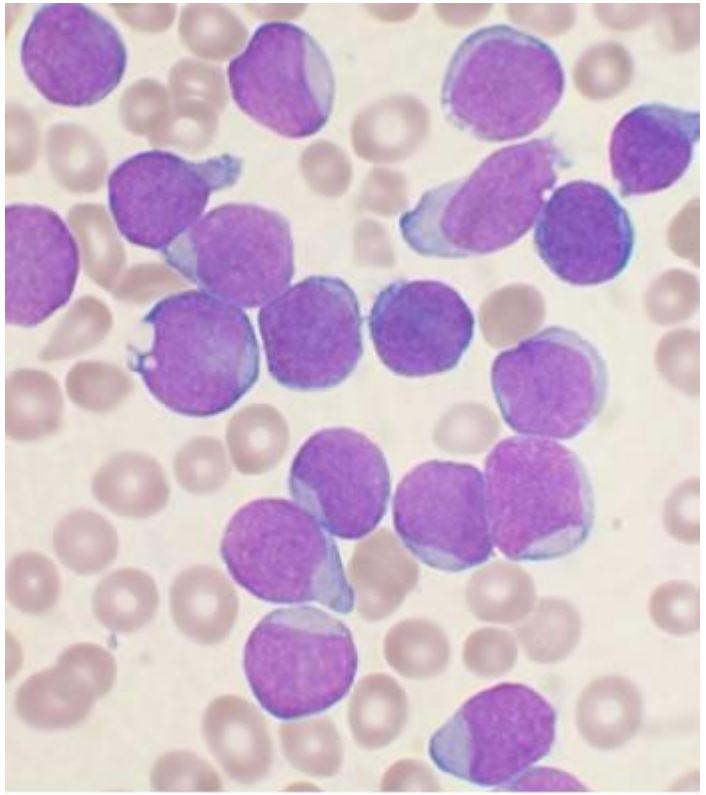


Thalassemia major
Reduction of hemoglobin production

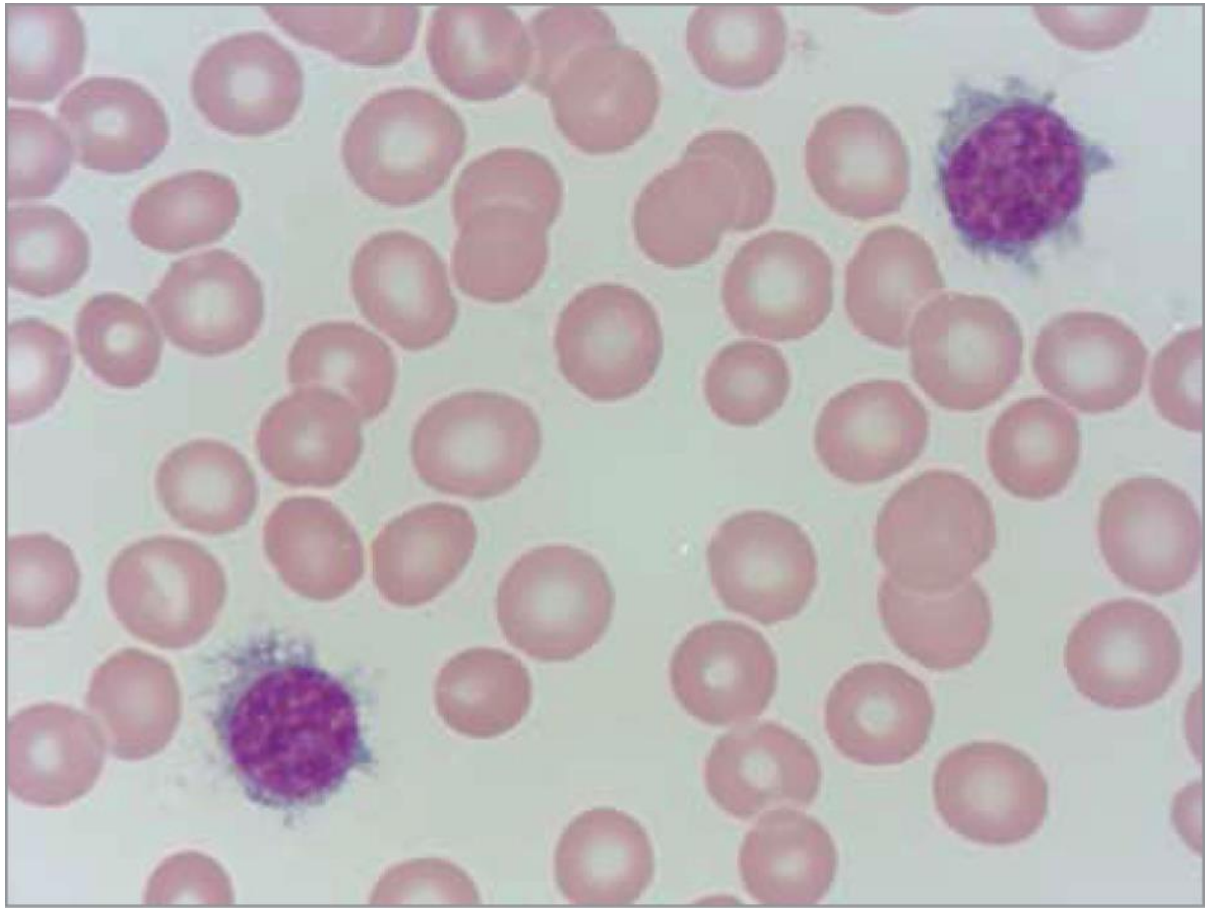
Blood diseases



Leukemia

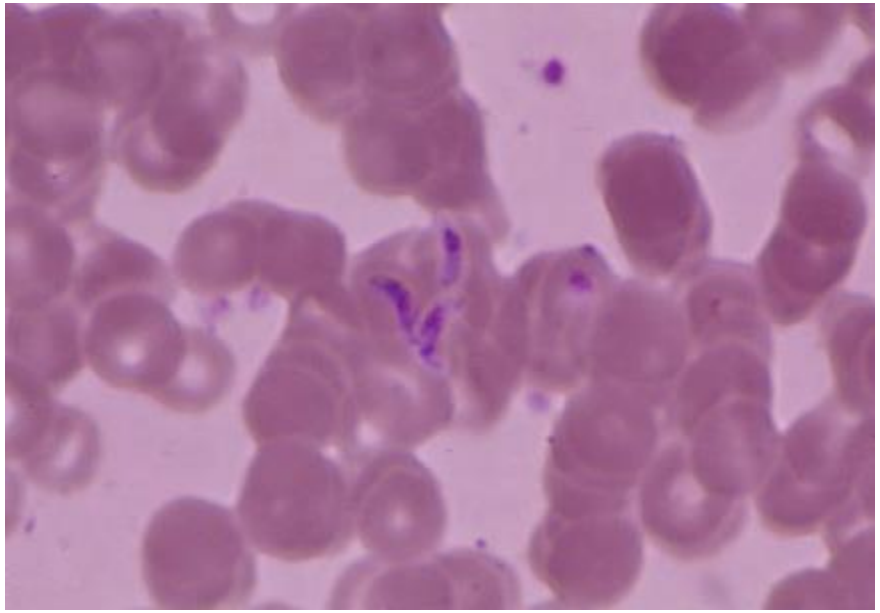


Blood diseases

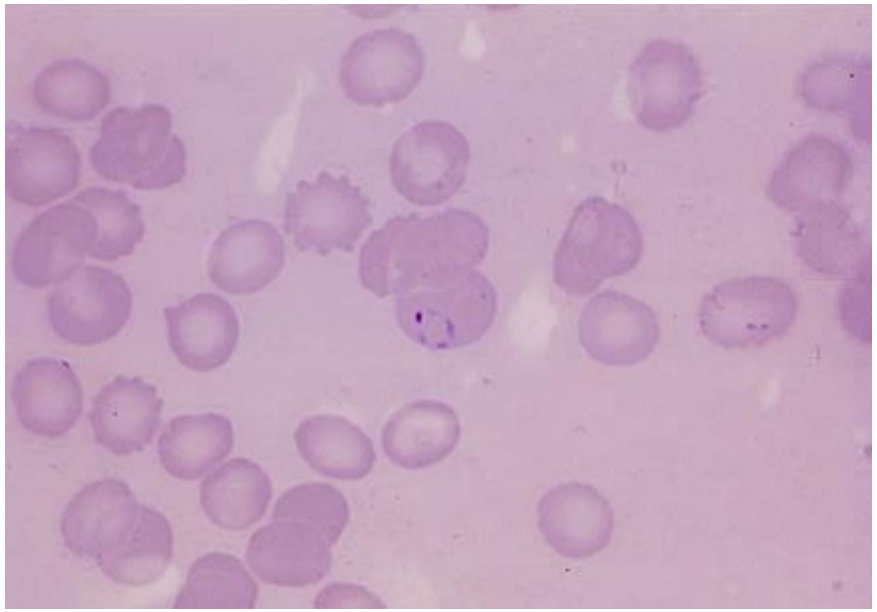


Hairy Cell Leukemia
(accumulation of abnormal B lymphocytes

Blood diseases

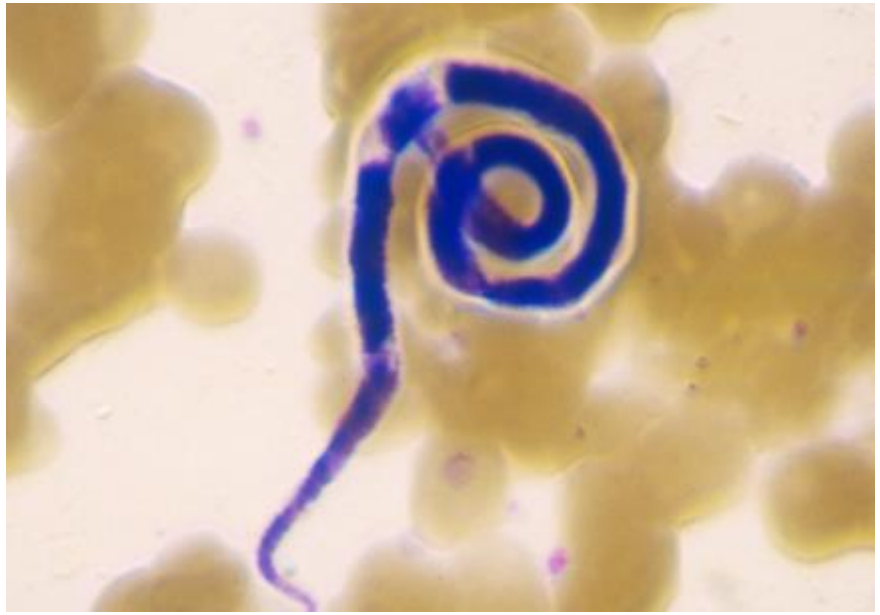


Toxoplasmosis
(parasitic, caused by *Toxoplasma gondii*)
Half of world population infected



Malaria
(caused by *Plasmodium* microorganisms)

Blood diseases



Lymphatic filariasis
(caused by e.g. *Wuchereria Bancrofti)*

Hematology – laboratory excercise

- Analysis of microscopic blood images: blood cell counting and measurements
- Identification of blood diseases based on miscroscopic images

Blood pressure

- The source of blood pressure – the cardiac cycle
- Variability of blood pressure
- Flow and perfusion
- Pressure- and flow-related parameters
- Blood pressure measurements

Arterial blood pressure and the cardiac cycle

- Blood pressure results from the force exerted by the blood on the vessel walls
- Pressure varies with distance from the heart
- Measurements are usually taken on the left brachial artery

Variability of blood pressure

- Long-term (life scale, e.g caused by aging)
- Mid-term (daily oscillations)
- Short-term (induced by the cardiac cycle)

Flow resistance

- Flowing blood experiences resistance from the vessel walls
- It depends on the length and diameter of a vessel, as well as on blood viscosity

$$R = \frac{8L\eta}{\pi r^4}$$

- Conclusion: vasoconstriction influences the resistance
- Summation of the resistance – analogous to electric circuits (connections in parallel and in series)

Flow and perfusion

- Flow: volume of blood per unit of time
- Perfusion: volume of blood per unit of time per tissue mass

Pressure, flow and resistance - relation

- The pressure drop between two points in the vascular system equals the product of blood flow and resistance between these points

$$\Delta P = QR$$

Parameters related to blood pressure

- SV, stroke volume – the volume pushed out of the heart in a single beat
- CO, cardiac output – the volume pumped by the heart in one minute
- HR, heart rate – the frequency of a beating heart (beats/minute)
- TPR, total peripheral resistance – the total resistance of blood flow in the vascular system
- MAP, mean arterial pressure – the average blood pressure in a single cardiac cycle

Blood pressure measurement methods

- Riva-Rocci:
  - Sphigmomanometer + fingers (pulse palpation)
- Korotkov (auscultative):
  - Sphigmomanometer + stethoscope (pulse auscultation)
  - 5 phases
- oscillometric:
  - Sphigmomanometer + computer (signal analysis)
  - Analysis of small pressure oscillations

Blood pressure, flow and resistance – lab excercise

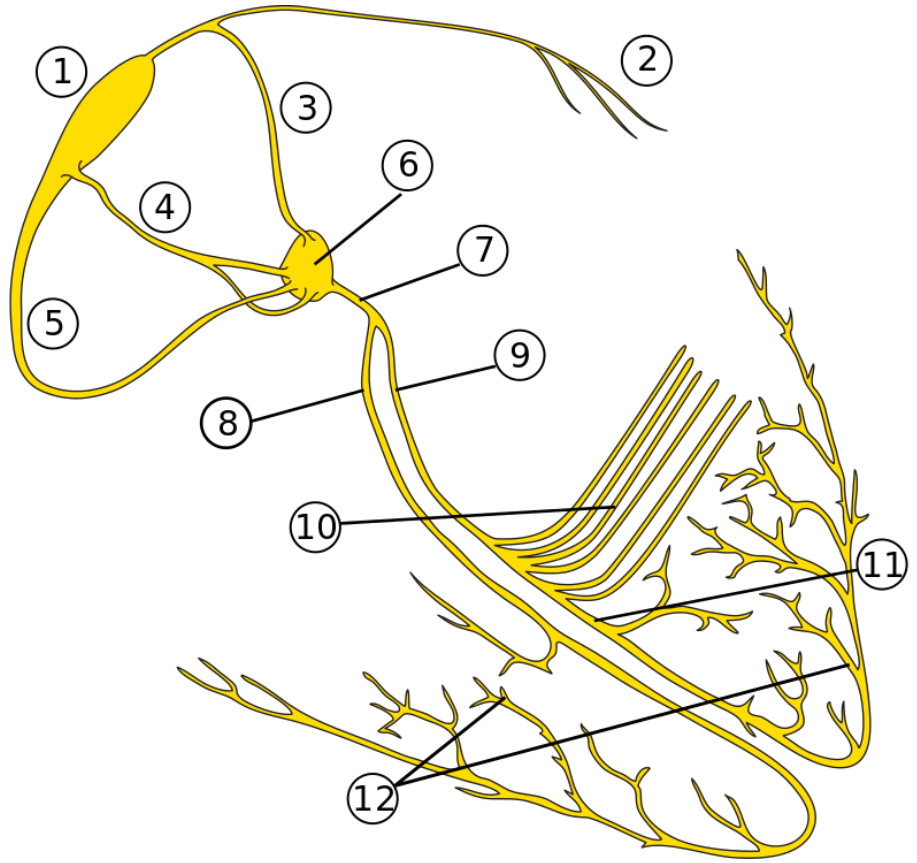
- Measurements:
  - Riva-Rocci, Korotkov, oscillometric
  - Resting-state pressure and after physical excercise

- Problems:
  - Flow, resistance and perfusion calculations

Electrocardiography – studying the electrical activity of heart

- The basic heart cell – cardiomiocyte
- Cells depolarize-repolarize alternately
- The electrical activity of the heart is regulated by the electrical conduction system (with specialized pacemaker cells)

- Depolarization direction: sinoatrial node (SA-1) – atrioventricular node (AV-6) – Purkinje fibers-12)
- ECG allows to detect heart diseases



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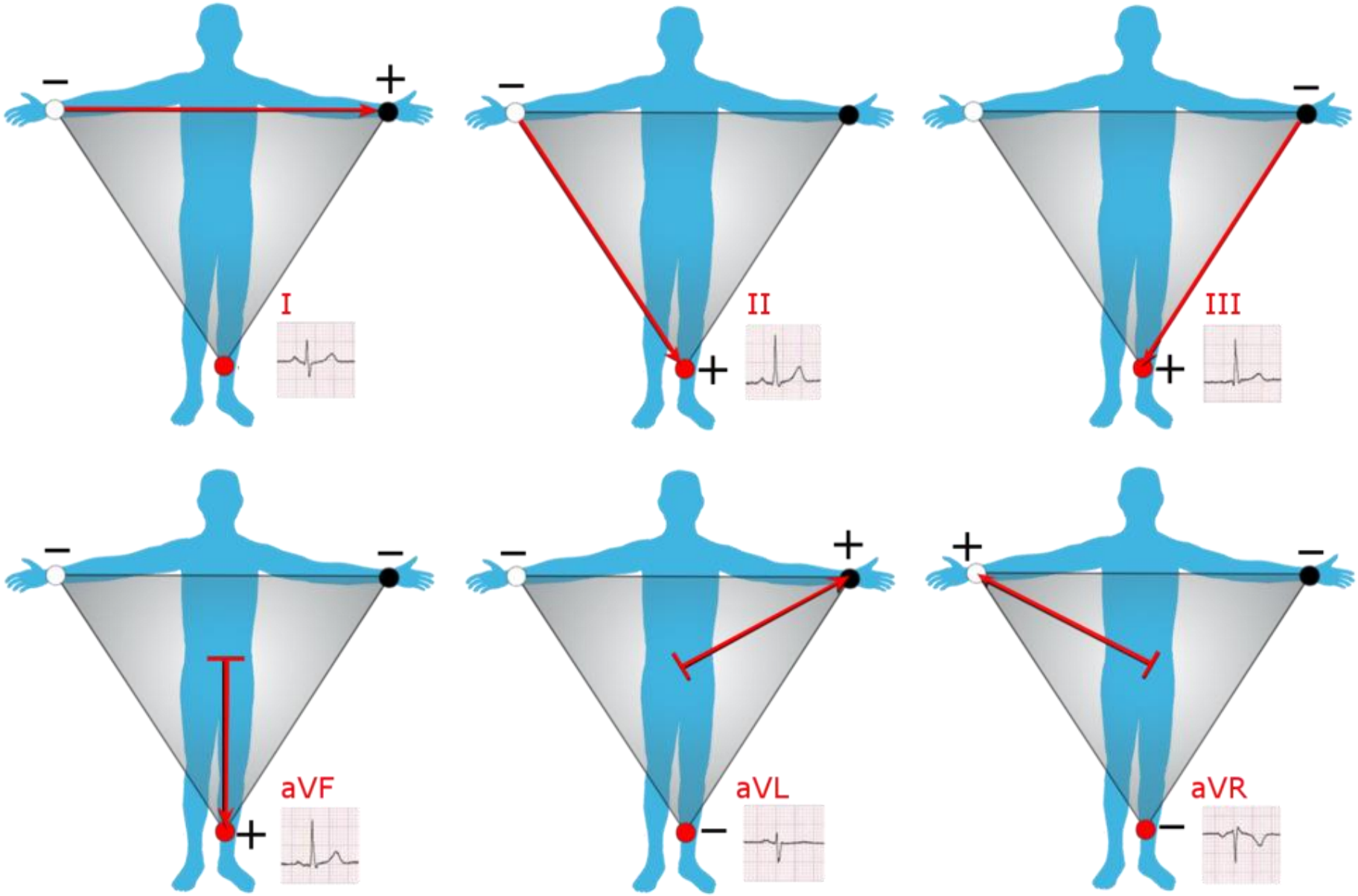
Electrodes and leads

- Electrode – a conducting junction placed on the body
- Lead – the source of the current vector measurement
- Standard 12-lead ECG (10 electrodes)
  - 3 bipolar limb leads (I,II,III – W. Einthoven)
  - 3 unipolar augmented limb leads (aVR, aVL, aVF – E. Goldberger)
  - 6 unipolar precordial leads (V1-V6, F. Wilson)



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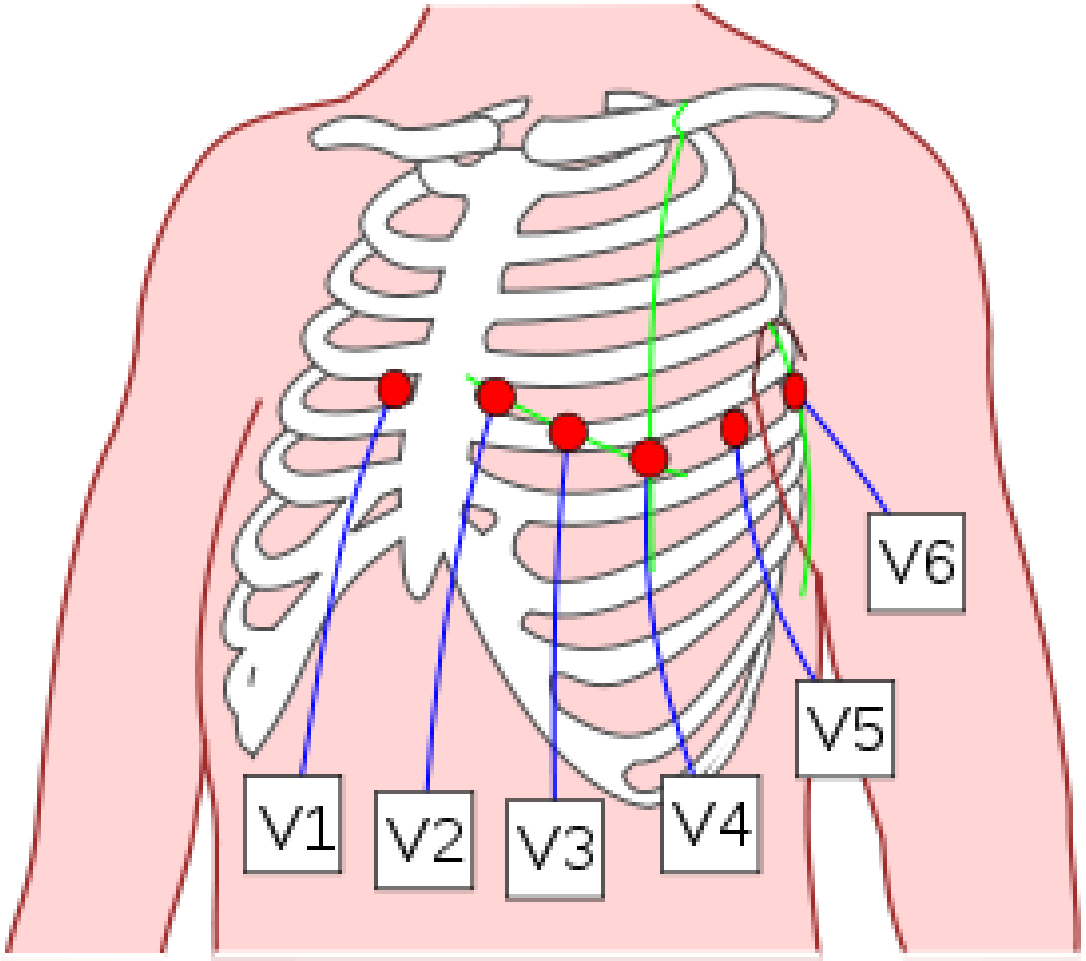

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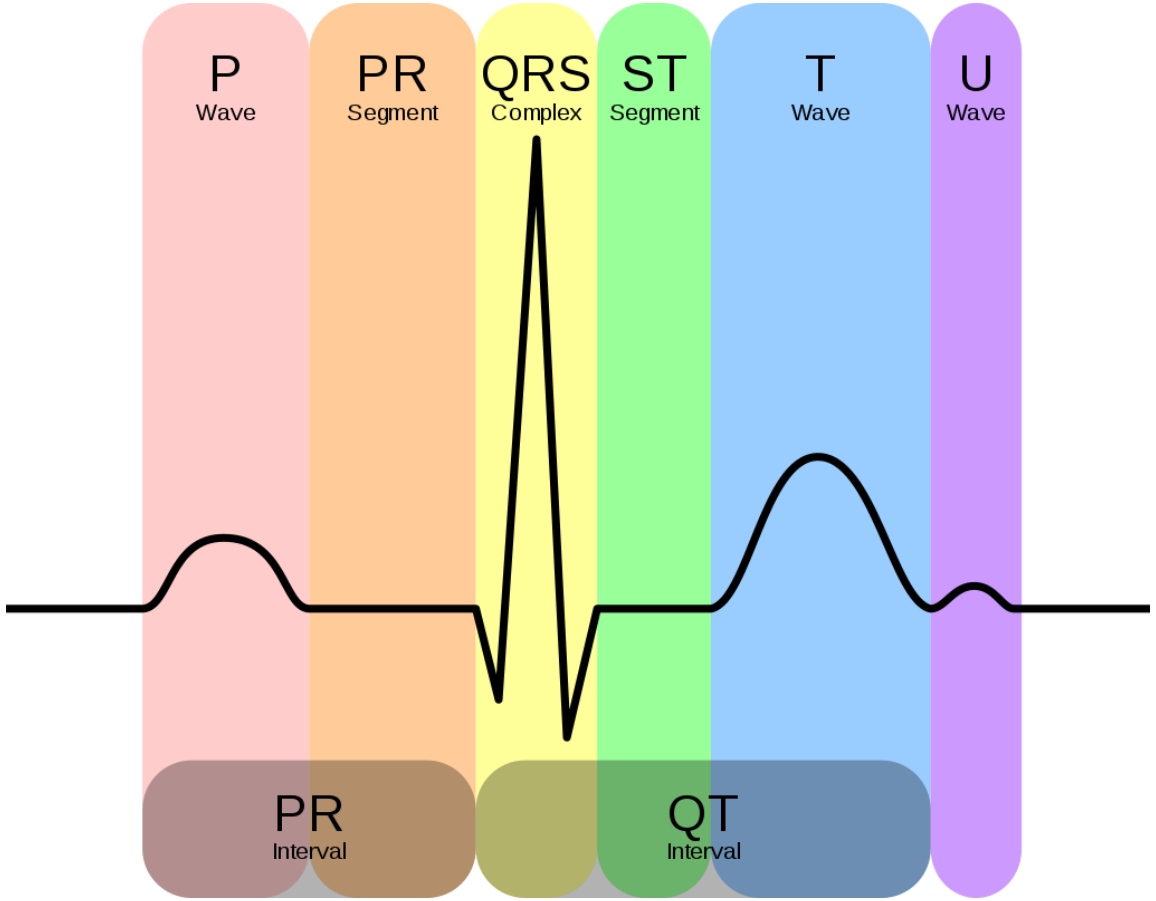
The electrocardiogram - intervals, segments and waves

- Wave P – 80 ms, depolarization of the atria, (SA-AV)
- PQ interval (PR) – 120 ms (max. 200 ms), (AV-HB)
- QRS complex – 80-120 ms, depolarization of the ventricles, repolarization of the atria, (HB-PF)
- ST segment – ventricle contraction
- T wave – 160 ms, ventricle repolarization
- U wave – occurs in ~25% ECG recordings



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Sinus rythm – the correct one

- Normal heart rate (60-100 /min)
- Regularity (<0.16 s deviation between the shortest and longest P-P segment)
- SA node controlling the tempo – round, always present and identical P waves
- Normalna P wave axis (0-75 deg.)
- Normal PR, QT segments and the QRS complex
- Positive QRS complex in I, II, aVF, V3-V6, negative in aVR

Electrocardiography – lab excercise

- BIOPAC Lesson 5 – ECG I
  - ECG measurements in different body positions
  - ECG vs. breathing
  - Resting state and post-excercise ECG
- ECG with Easy ECG PC-80B device
  - Built-in electrodes
  - Limb leads
  - Resting/excercise
- ECG analysis
  - Signal observation
  - Measurements of the signal

Spirometry

- An examination of lung volumes and capacities
- Examination apparatus – the spirometer
- Allows diagnosis and control over lung diseases such as asthma and chronic
- Umożliwia rozpoznanie i kontrolę chorób, np. astmy i przewlekłej choroby obturacyjnej

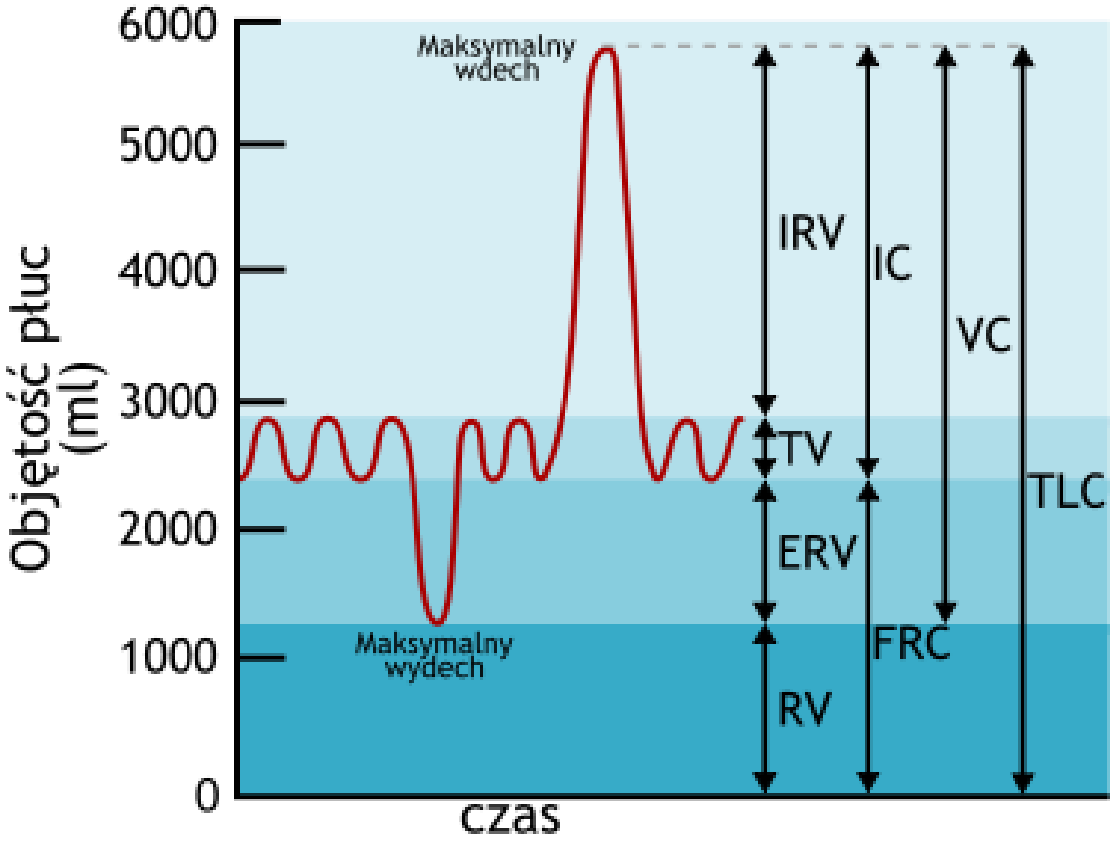
Lung volumes and capacities

IRV –*inspiratory reserve volume*
TV –*tidal volume*
ERV –*expiratory reserve volume*
RV – *residual volume*

IC – *inspiratory capacity*
VC –*vital capacity*
TLC –*total lung capacity*
FRC –*functional residual capacity*

IC=IRV+TV
VC=IRV+TV+ERV
TLC=IRV+TV+ERV+RV

Conclusion: capacities are sums of volumes, volumes are components of capacities



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Most common parameters

- VC
- FVC (*forced vital capacity*)
- FEV (*forced expiratory volume*) after 0.5, 1 (FEV1), 2, 3 seconds
- FEF (*forced expiratory flow*)
- MVV (*maximal volunatary ventilation*)

- Reference values are dependent on height, age, sex, race and weight

Spirometry – lab excercise

- BIOPAC Lessons 12 i 13 – Pulmonary Function I i II

  Lung parameters measurement – capacities, volumes, flow

  - Measurements:
    - „Normal” breathing (Lesson 12)
    - Forced expiration (Lekcja 13)
    - Fast and deep breathing (Lekcja 13)
  - Analysis:
    - Reading out the capacities and volumes from the figure
    - Comparison of the measured values to the reference
    - Calculation of FEV and MVV

Mental chronometry

- Studies the reaction time in perceptual-motor tasks and provides information about the content, duration and temporal sequencing mental operations
- Reaction time – the time between occurrence of a stimulus and the initiation of a motoric reaction of the subject (~200 ms)

Mental chronometry

- Examples:
  - Simple reaction time (RT) – between the stimulus and a simple reaction
  - Recognition RT – reaction to specified stimuli
  - Choice RT – adequate reaction dependent of the stimulus
  - Discrimination RT – choosing an object (displayed) of predefined attributes

Mental chronometry – lab excercise

- Measurement (MATLAB):
  - Simple RT to visual stimuli
  - Simple RT to auditory stimuli
  - Recognition RT to visual stimuli
  - Choice RT to visual stimuli

- Analysis:
  - Computation of reaction times for each segment, stimulus and person in the group
  - Statistical analysis