

Cardiovascular system I

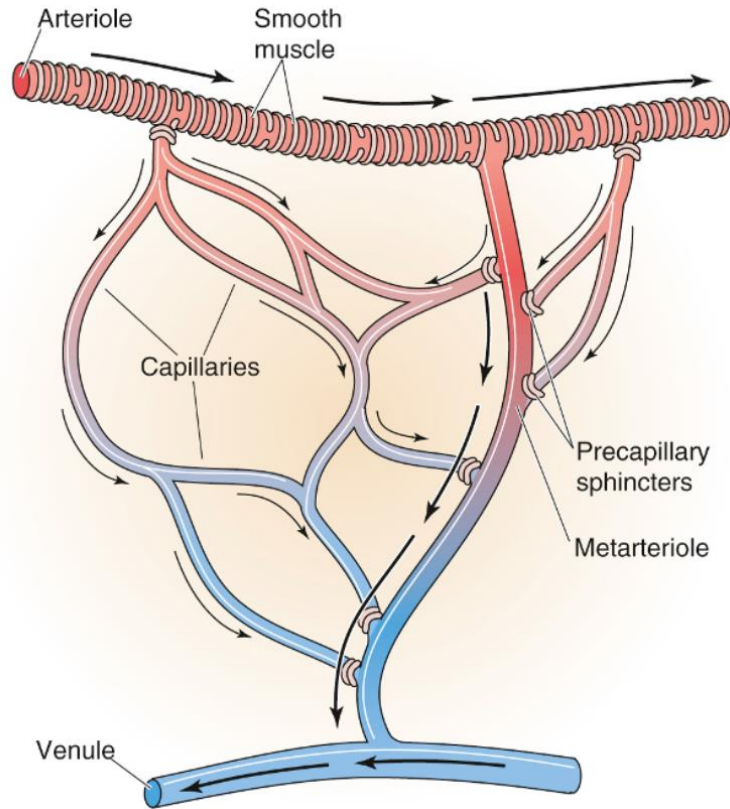
Organization of cardiovascular system. Blood. Arteries and veins. Microcirculation. Cardiac electrophysiology and ECG. Heart rate.

Heart sounds. Polygraphic record.

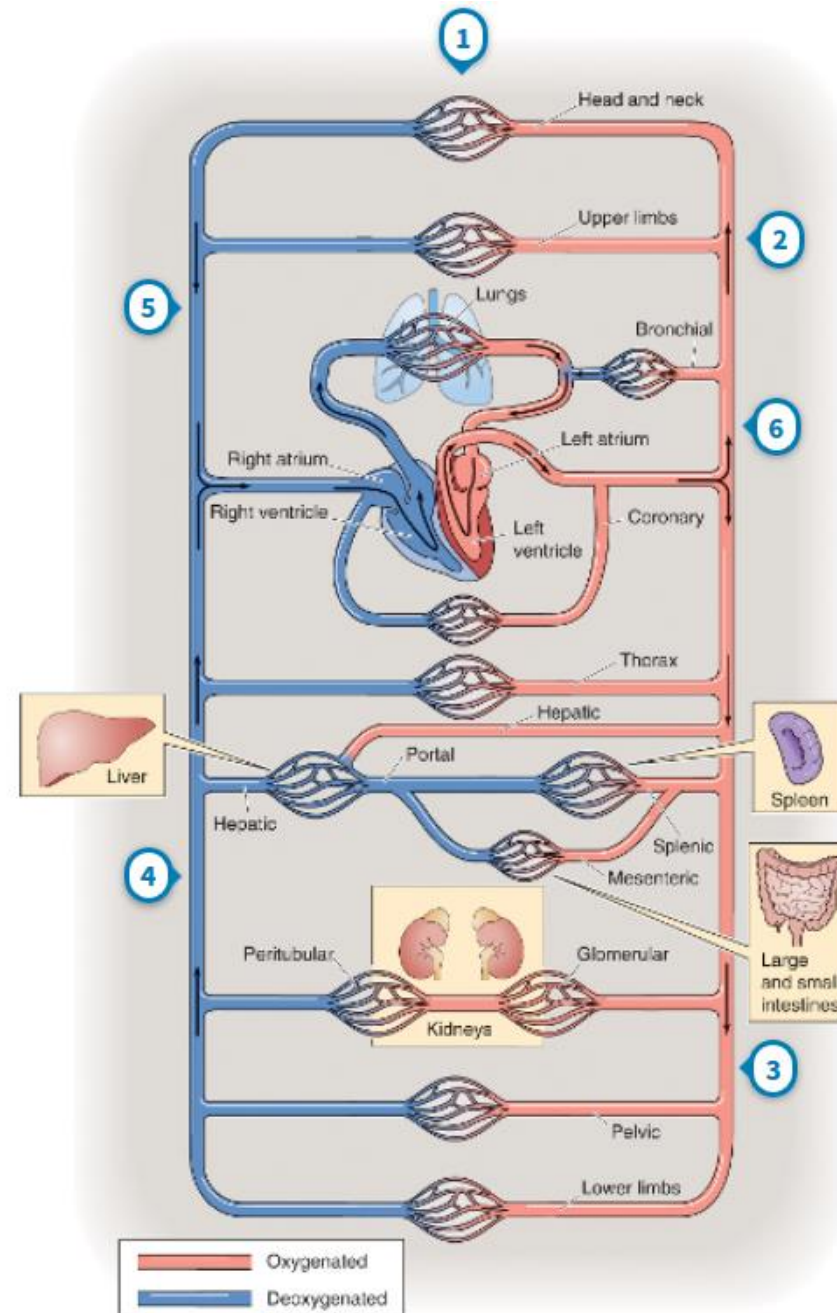
Compendium of Physiology

Tibor Stračina

Organization of CVS



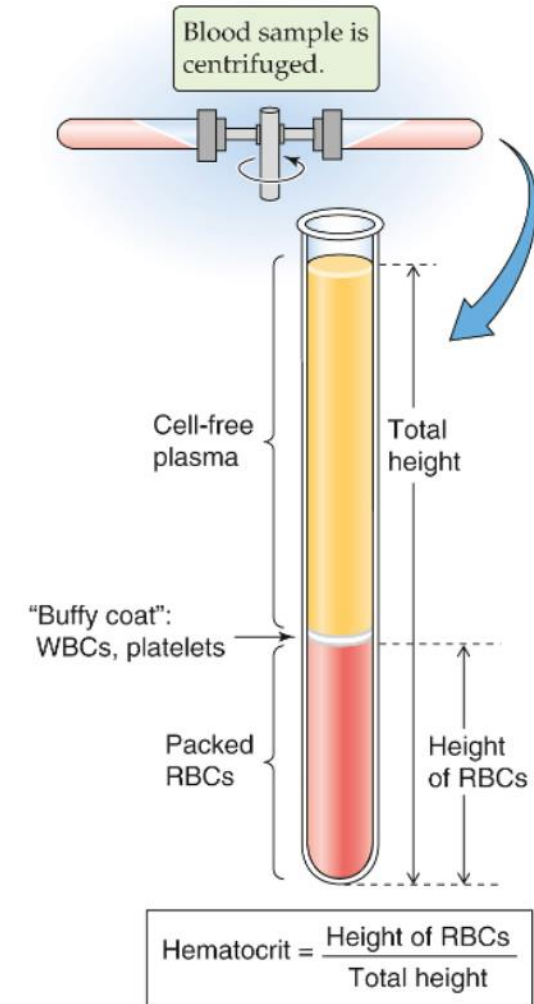
<https://studentconsult.inkling.com/read/boron-medical-physiology-3e/chapter-20/figure-20-1>



<https://studentconsult.inkling.com/read/boron-medical-physiology-3e/chapter-17/figure-17-3>

Blood

- Blood plasma
 - Water
 - Ions
 - Proteins
 - Urea, glucose, etc.
- Erythrocytes
- Leukocytes
- Platelets



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Red blood cells. Haemolysis

- Erythropoiesis
- Life span
- Degradation
- Function
 - Transport (O₂, CO₂)
 - Buffer (hemoglobin)

Haemolysis

- Physical
 - Mechanical
 - Osmotic
 - Thermic
- Chemical
- Biological
 - Immune response

Blood groups. AB0 system

- Surface antigens on the RBCs
- AB0 system
 - The highest immunoactivity
 - 2 surface antigens (A, B), co-dominance
 - 4 blood groups: A, B, AB, 0
 - Antibodies constantly produced
- Other systems: Rh, MNS, P, Kell, Lewis, Duffy, Diego

ABO system – slide method

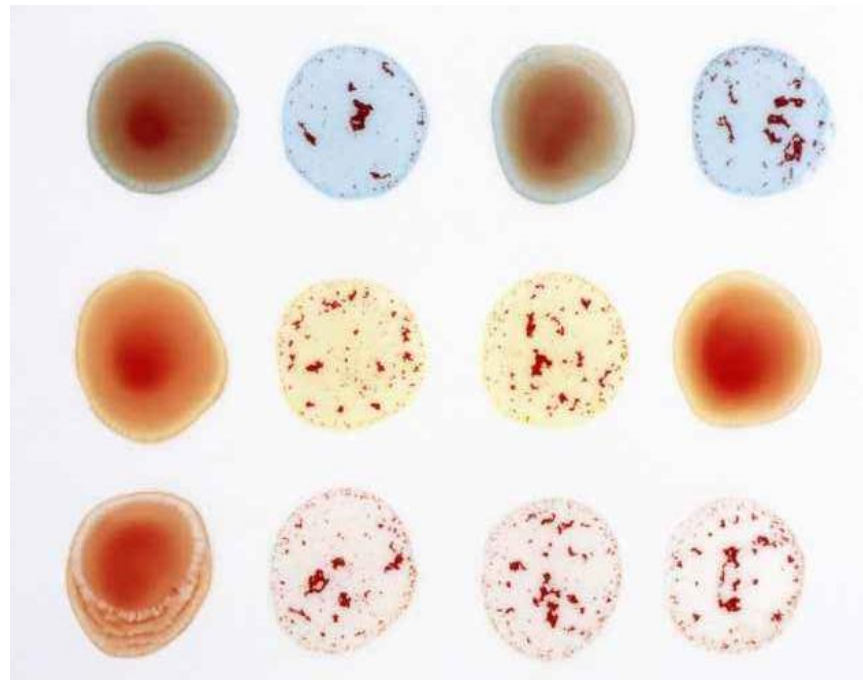
Serum (antibodies)

Anti-A

Anti-B

Anti-A + Anti-B

Blood group



O

AB

B

A

Legend:

Negative reaction

Positive reaction



Rh system and other systems

- Rh system
- Antigen D
- Anti-D antibodies
- Rh incompatibility (Rh- mother vs. Rh+ fetus)

Arteries: blood pressure, resistance, blood flow

- Systemic arteries – high-pressure system
 - Elastic arteries (low resistance, high compliance)
 - Resistance arteries (high and regulable resistance)
- Pulmonary arteries – low-pressure system

Veins: blood pressure, R, blood flow. Venous return. Venostasis.

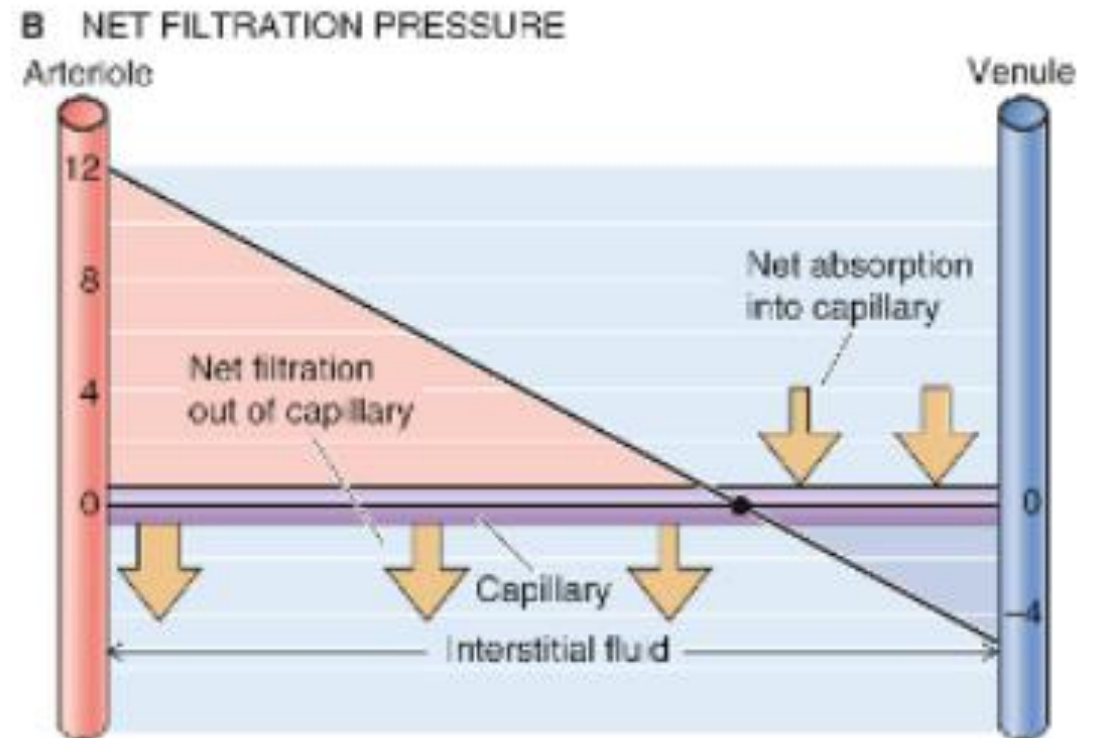
- High capacity - volume reserve
- Low pressure gradient
- Mechanisms of venous return
 - Muscle pump
 - Valves
 - Blood flow (pressure) through capillaries – *vis a tergo* = force from behind
 - Suction force of ventricular systole – *vis a fronte* = force from the front
 - Suction force of inspiration

Microcirculation

– Net filtration pressure

(Starling forces)

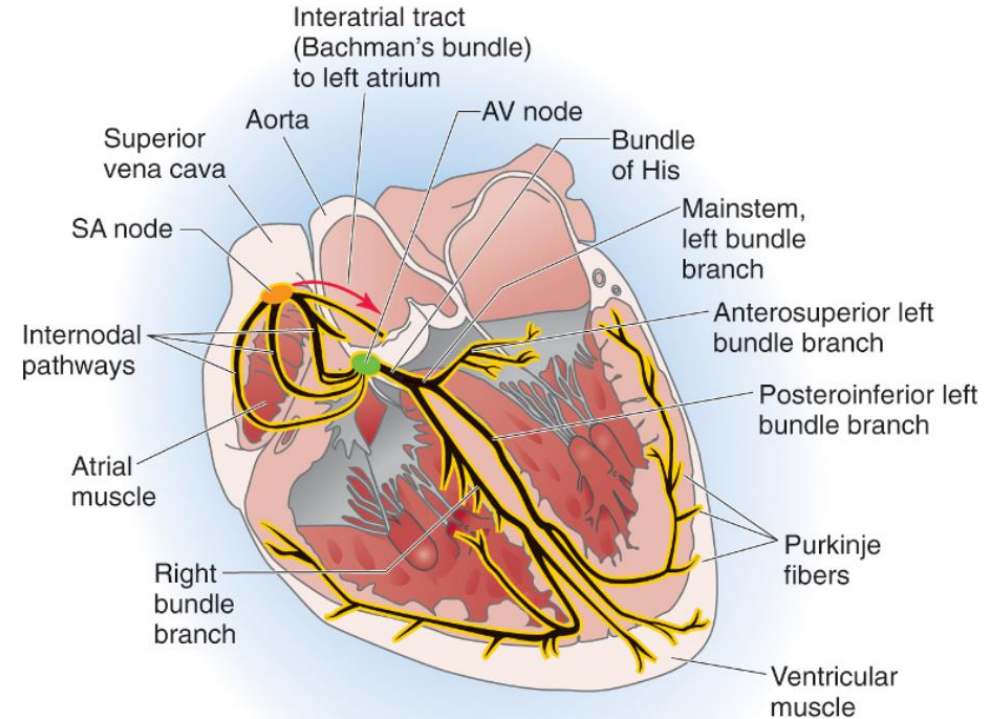
- Hydrostatic (blood) pressure in capillary
- Hydrostatic pressure in interstitium
- Osmotic pressure in capillary
- Osmotic pressure in interstitium



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Heart. Cardiac muscle as an excitable tissue

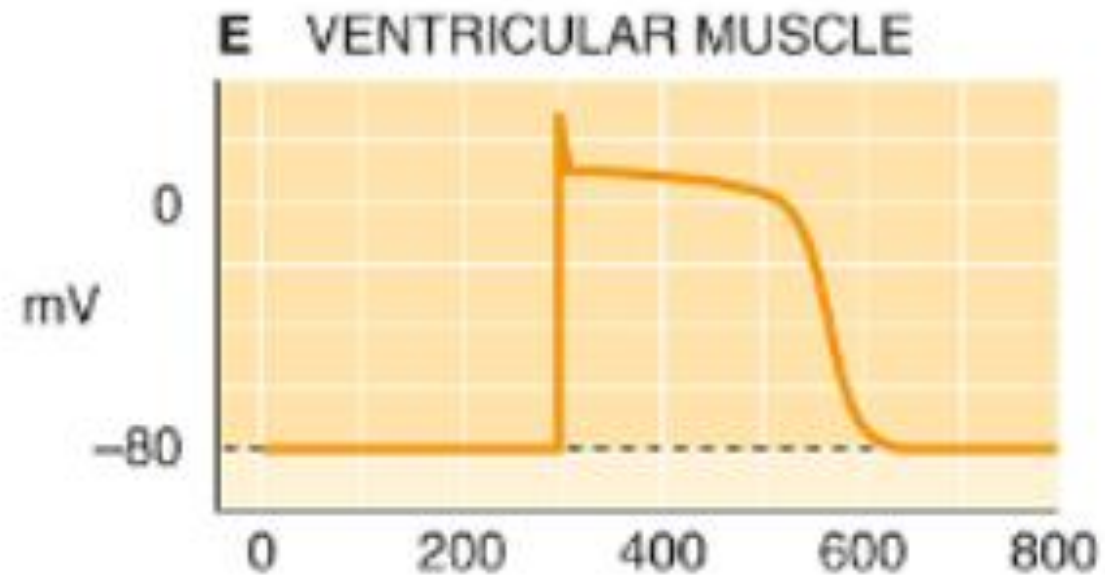
– Excitability



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– Task: Draw AP of working ventricular cardiomyocyte.

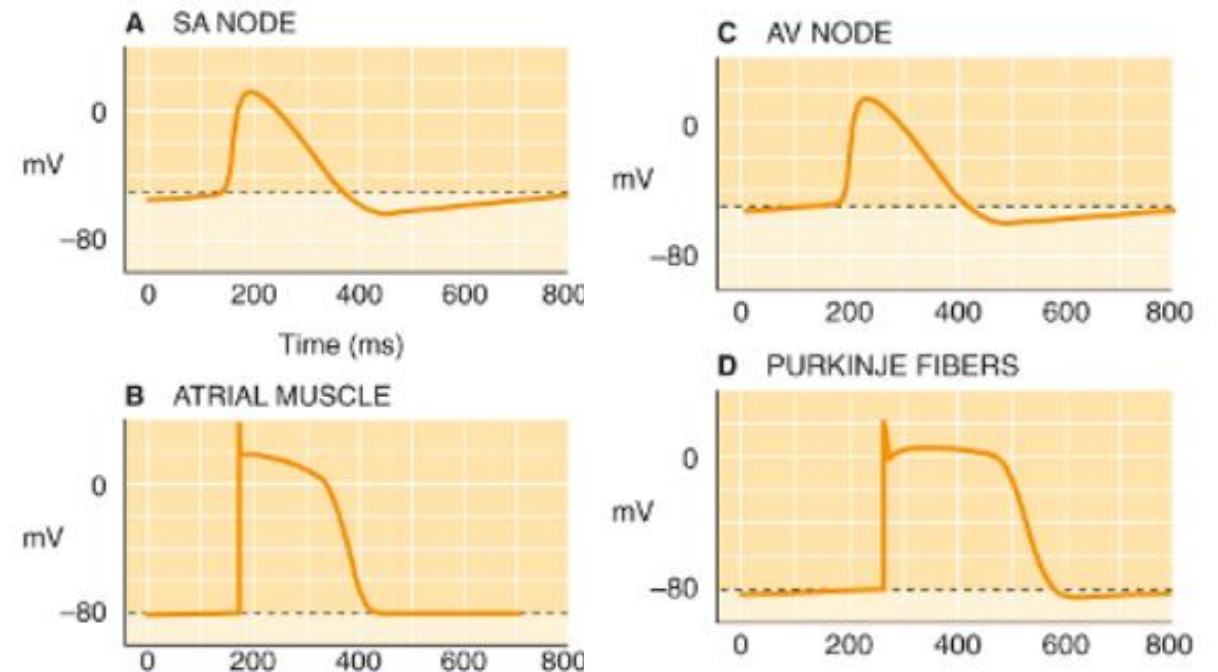
Action potential: Ventricular muscle cells



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Cardiac automaticity. Conductive system

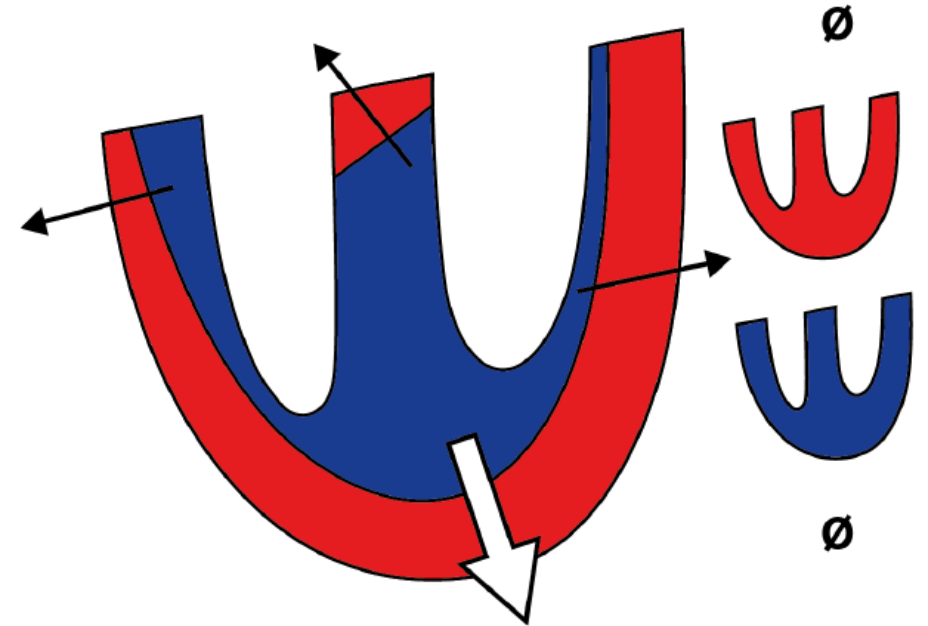
- Pacemaker activity
 - SA node >> AV node >> Purkinje fibres
- Conductive system
 - Fast conduction
 - Delay (AV-His)



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Electric vector of the heart. ECG

- Potential differences
- Summary of all partial vectors
- Changes in time



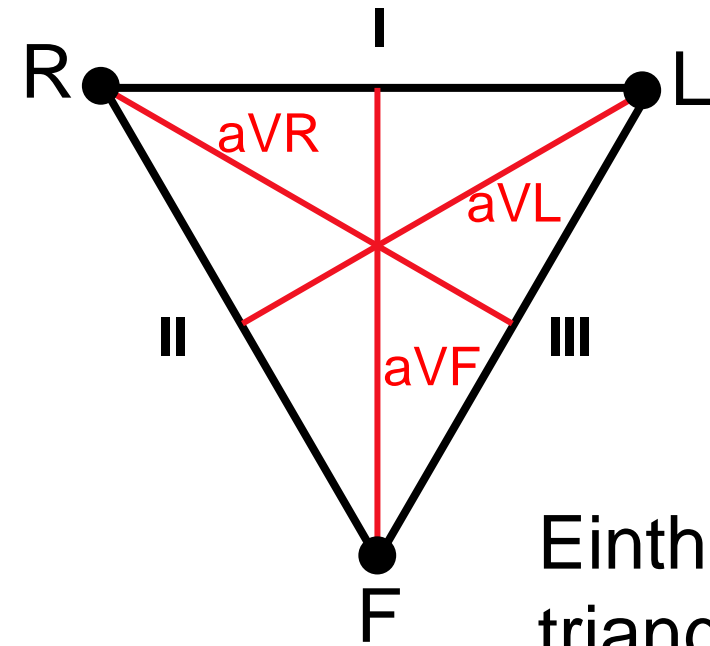
Author: MN; <https://is.muni.cz/auth/el/med/jaro2020/aVLFY0422p/um/ECG-2020-GM.pdf>

ECG electrodes. ECG leads

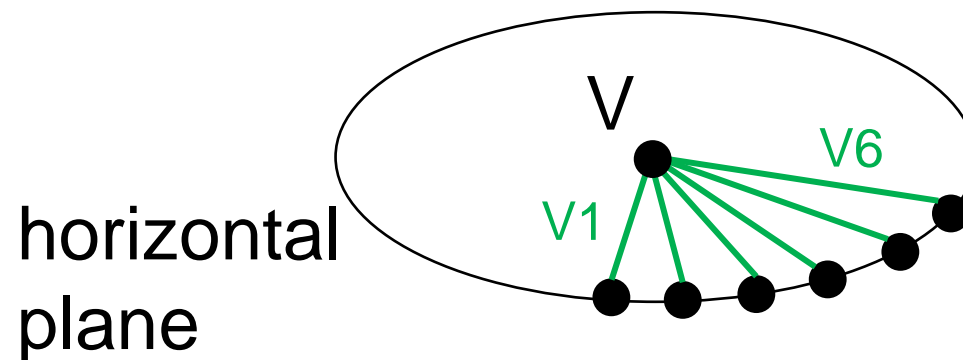
- ECG electrode
- ECG lead – connection of two active exploring electrodes (bipolar lead) or one exploring electrode and one reference electrode/clamp (unipolar lead)

Standard 12-lead ECG

- 3x bipolar limb leads
 - I, II, III
- 3x unipolar augmented limb leads
 - aVR, aVL, aVF
- 6x unipolar chest leads
 - V1, V2, V3, V4, V5, V6



Einthoven triangle – frontal plane



Standard 12-lead ECG record

Patient's name; date and time of measurement

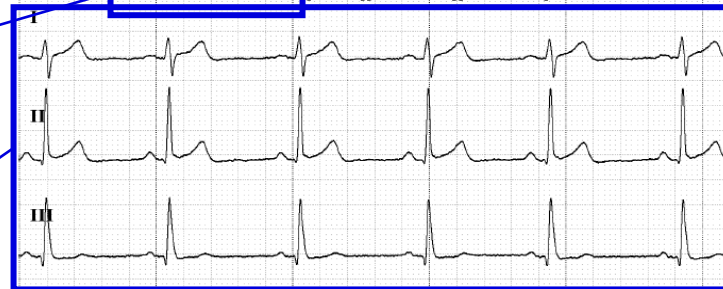
7.11.2017 8:27:58

EKG Praktik SEIVA
8s1 - 2007/11/27 [SEIVA A01.002]

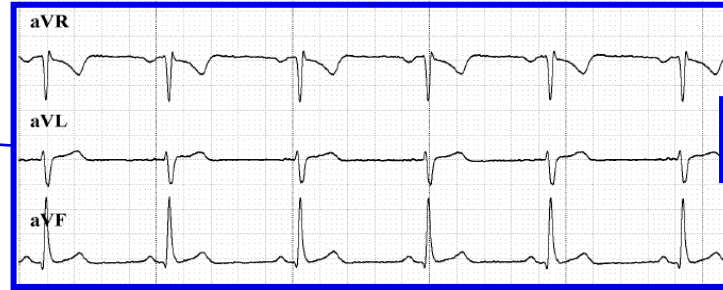
25 mm/s 10 mm/mV [35 Hz][AC 50 Hz][ad 0.3 Hz]

Time and voltage scale

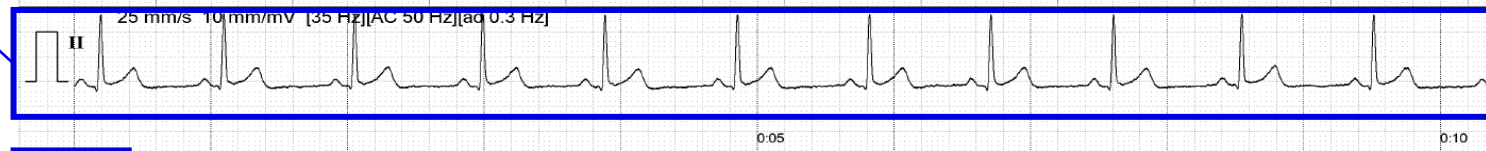
Bipolar limb leads (I, II, III)



Unipolar augmented limb leads (aVR, aVL, aVF)



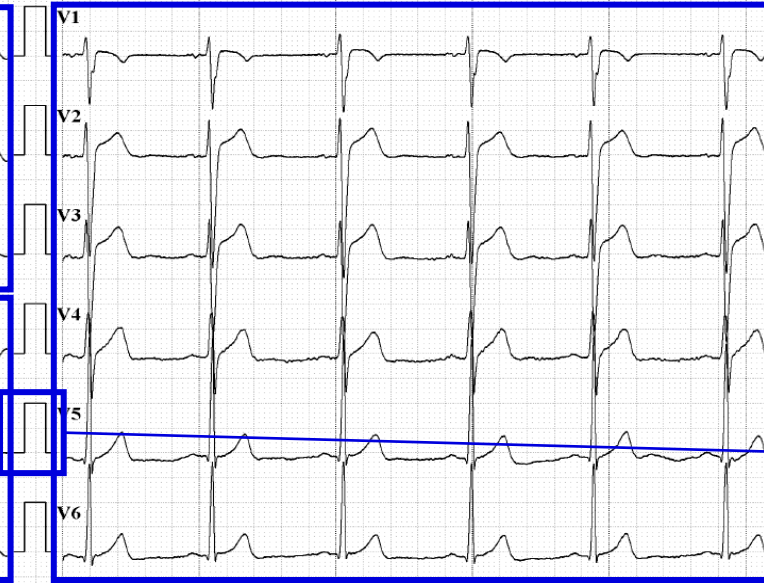
Lead II in long time scale



Values from automatic analysis (TF – heart rate)

TF [1/min]
66

Unipolar chest leads (V1 – V6)



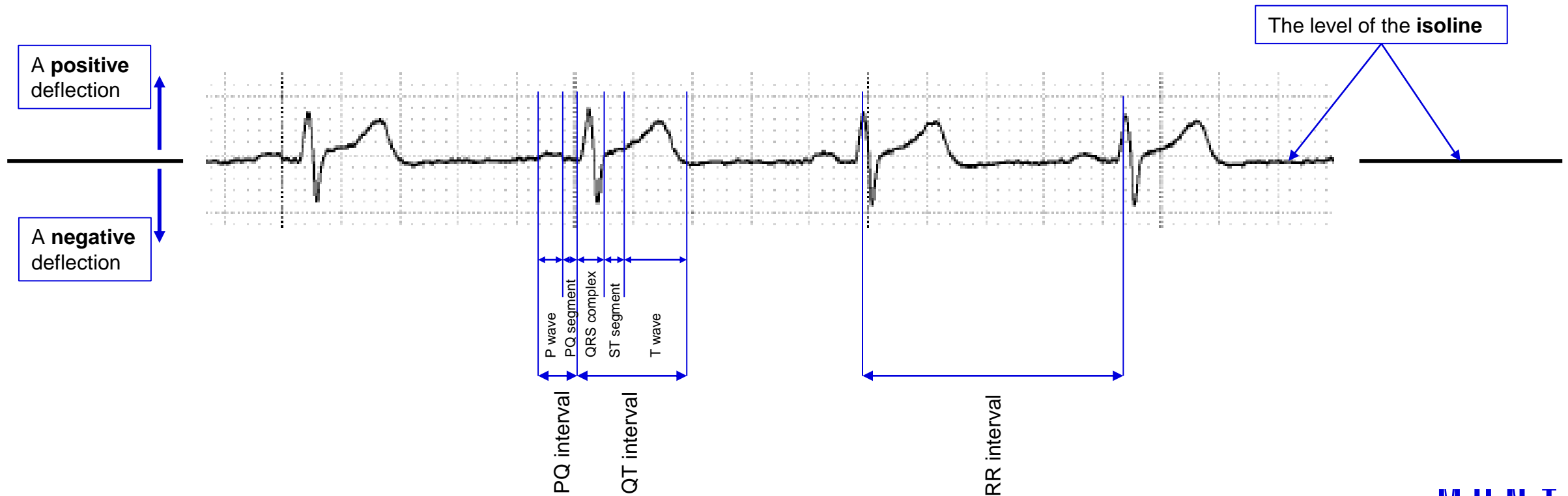
Calibration mark



Fysiologie
LF-MU

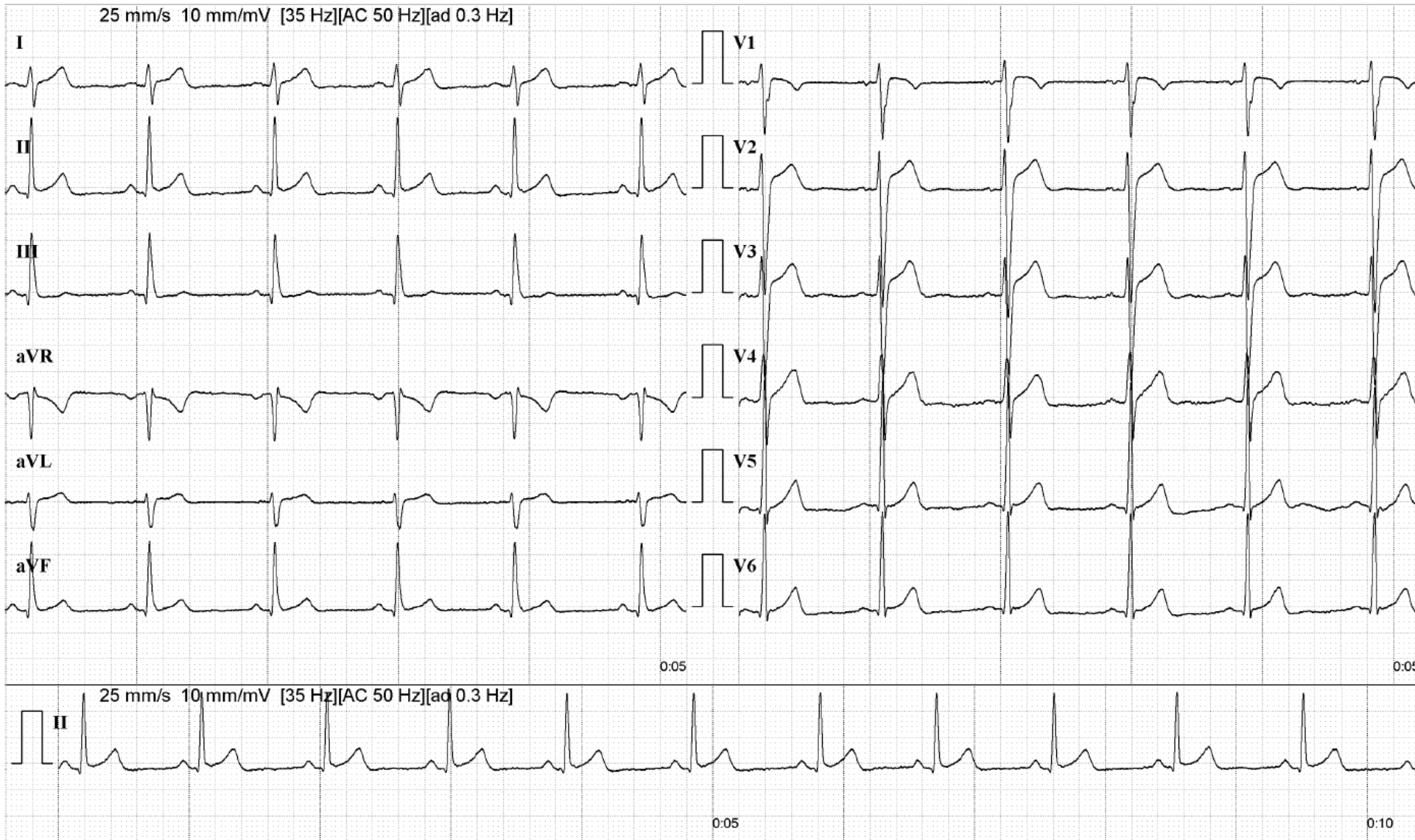
Normal ECG curve - nomenclature

– Changes of voltage (mV) in time



ECG evaluation – basic algorithm

1. Heart rhythm (regular/irregular; sinus/junctional/ventricular/other)
2. Heart rate (a value in bpm)
3. The duration of the P wave, the PQ interval, the QRS complex, and the QT interval (in ms)
4. Position of ST segment in each of the leads (in isoline/elevated/depressed)
5. Transitional zone (position; lead V1 – V6)
6. Electric axis of the heart (position in degrees)



TF [1/min]

66

Heart rate and its regulation

- 60 – 90 bpm at rest (vagotonia; denervated heart: cca 100 bpm)
- Sympathetic stimulation: positive chronotropic effect
- Parasympathetic stimulation: negative chronotropic effect

Heart sounds

- First sound – a-v valves
- Second sound – semilunar valves

- Third sound – rapid ventricular filling
- Fourth sound – atrial contraction

Polygraphic record

- ECG, phonoCG, Ao BP, LV BP, LV V