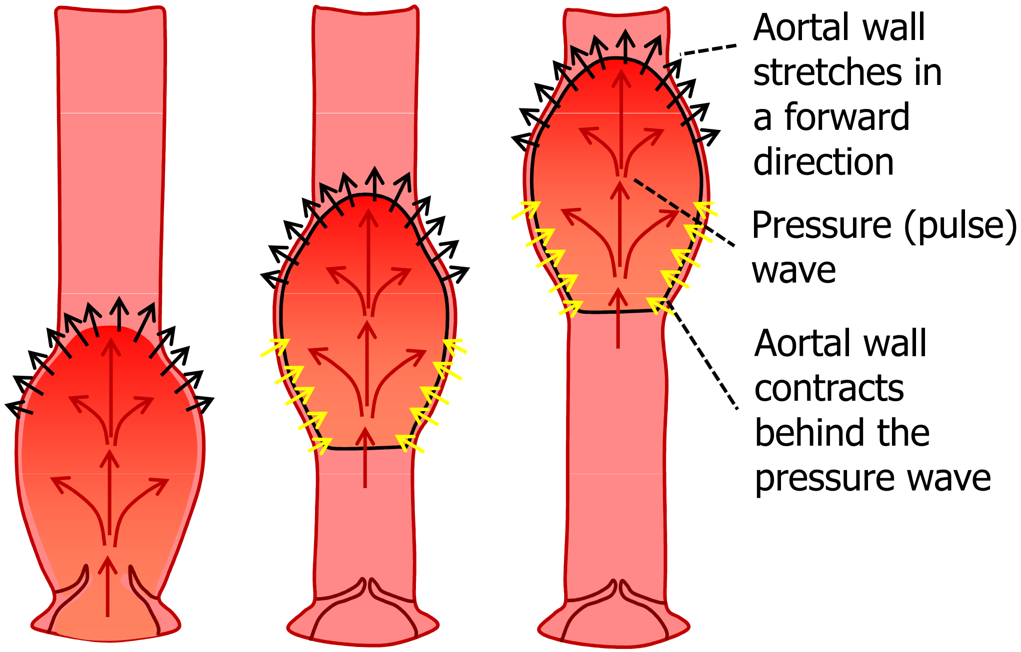
Examination of pulse by palpation

Physiology II – practice
Spring, weeks 4–6

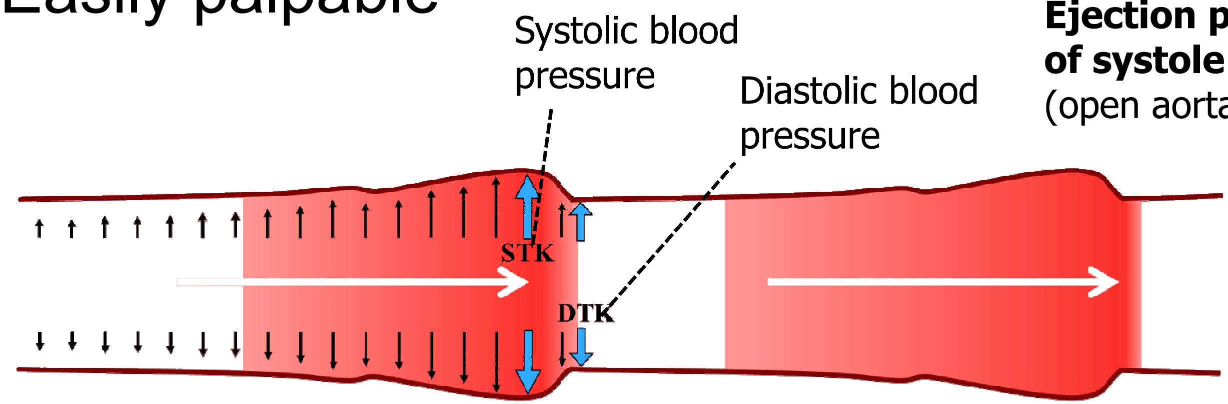
Pulse (*pulsus*)

- Mechanical manifestation of heart activity palpable in the periphery
- Mechanical wave (pulse wave) arises after each contraction of LV and propagates along the arterial wall to the periphery
- Easily palpable



Ejection phase of systole (open aortal valve)

Diastole (closed aortal valve)



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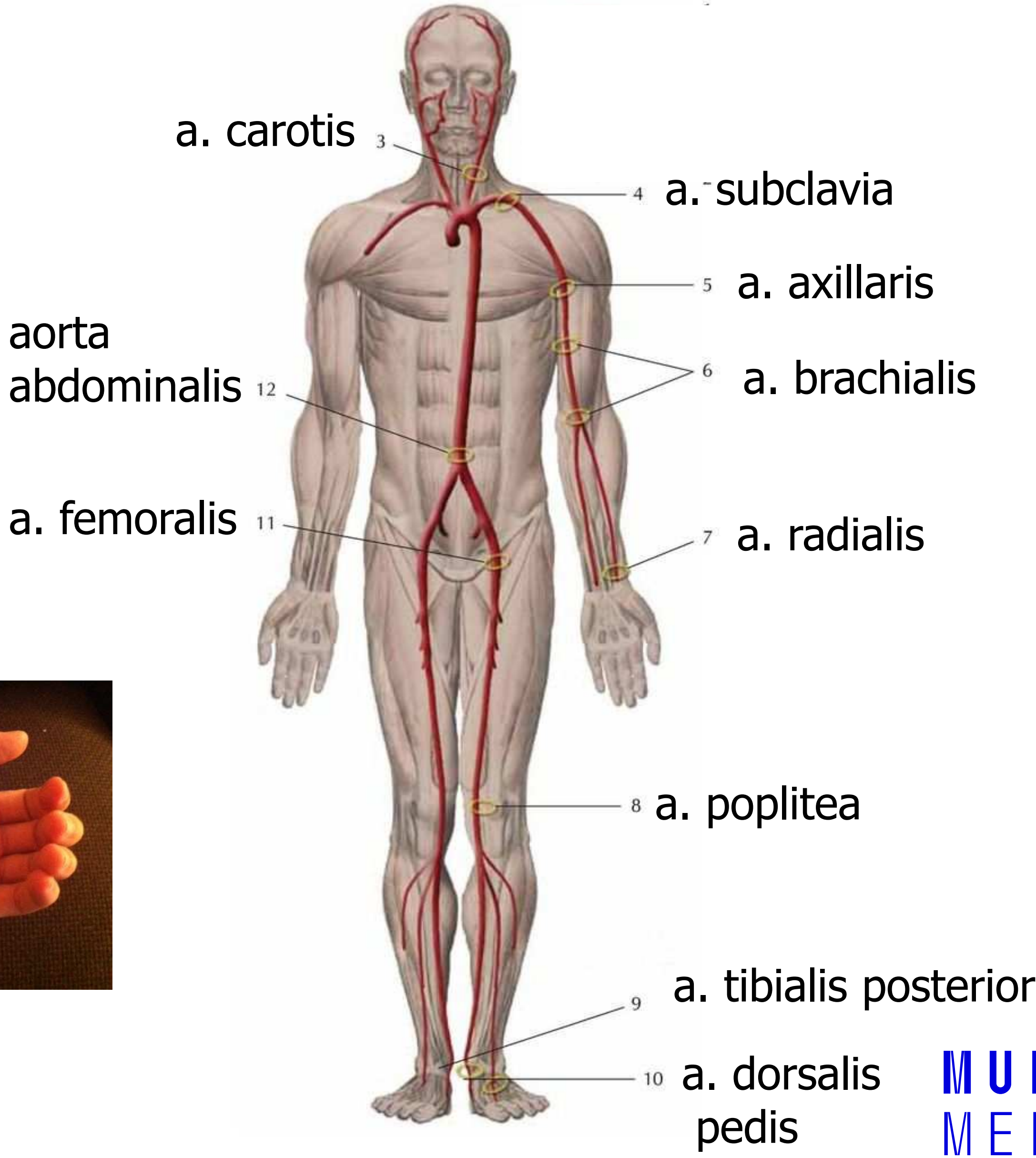
Palpation of a pulse

– Sites of palpaction:
  – *A. radialis*
  – *A. carotis*
  – *A. femoralis*
  – *A. brachialis*
  – *A. poplitea*
  – *A. tibialis posterior*
  – *A. dorsalis pedis*



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Examination of pulse by palpation

- Frequency: number of pulses (beats) per one minute (bpm) = **pulse rate**
- Characteristics: regularity, compressibility, force, …
- According to characteristics, we can describe:
  - Pulsus regularis
  - Pulsus irregularis
  - Pulsus celer – individual heartbeats have a short duration – peripheral vasodilation, aortic regurgitation (*Corrigan‘s pulse: P. celer, altus, frequens*)
  - Pulsus tardus
  - Pulsus durus – hardly compressible pulse – hypertension
  - Pulsus mollis – easily compressible pulse – hypotension
  - Pulsus magnus – high amplitude of pulse
  - Pulsus parvus – small amplitude of pulse
  - Pulsus filiformis – threadlike pulse – circulatory shock

Heart rate and pulse rate

- Physiological values: 60–100 beats per minute (bpm) at rest
- Tachycardia: increased heart rate (>100 bpm at rest)
- Bradycardia: decreased heart rate (<60 bpm at rest)
- Arrhythmia: an abnormality in the heart's rhythm or heartbeat pattern (except for respiratory sinus arrhythmia)

- Heart rate vs pulse rate
  - Heart rate (HR) is a number of heart cycles in one minute. We accurately determine it from the ECG.
  - Pulse rate is a number of pulse cycles per minute (determined by palpation of artery). It is usually the same as heart rate (but in some pathologies, it is not!)

Modulation of HR by autonomic nervous system (ANS)

- ANS modulates heart automaticity by modulation of SA node activity
- Parasympathetic system – the vagus nerve – „*nervi retardantes*"
  - Via M2 receptors
  - Negative chronotropic effect
  - Decreased tonus of vagus nerve = increased HR and visa versa
- Sympathetic system – sympathetic cardiac nerves – „*nn. accelerantes*"
  - Via β1 receptors
  - Positive chronotropic effect
  - Increased sympathetic activity = increased HR

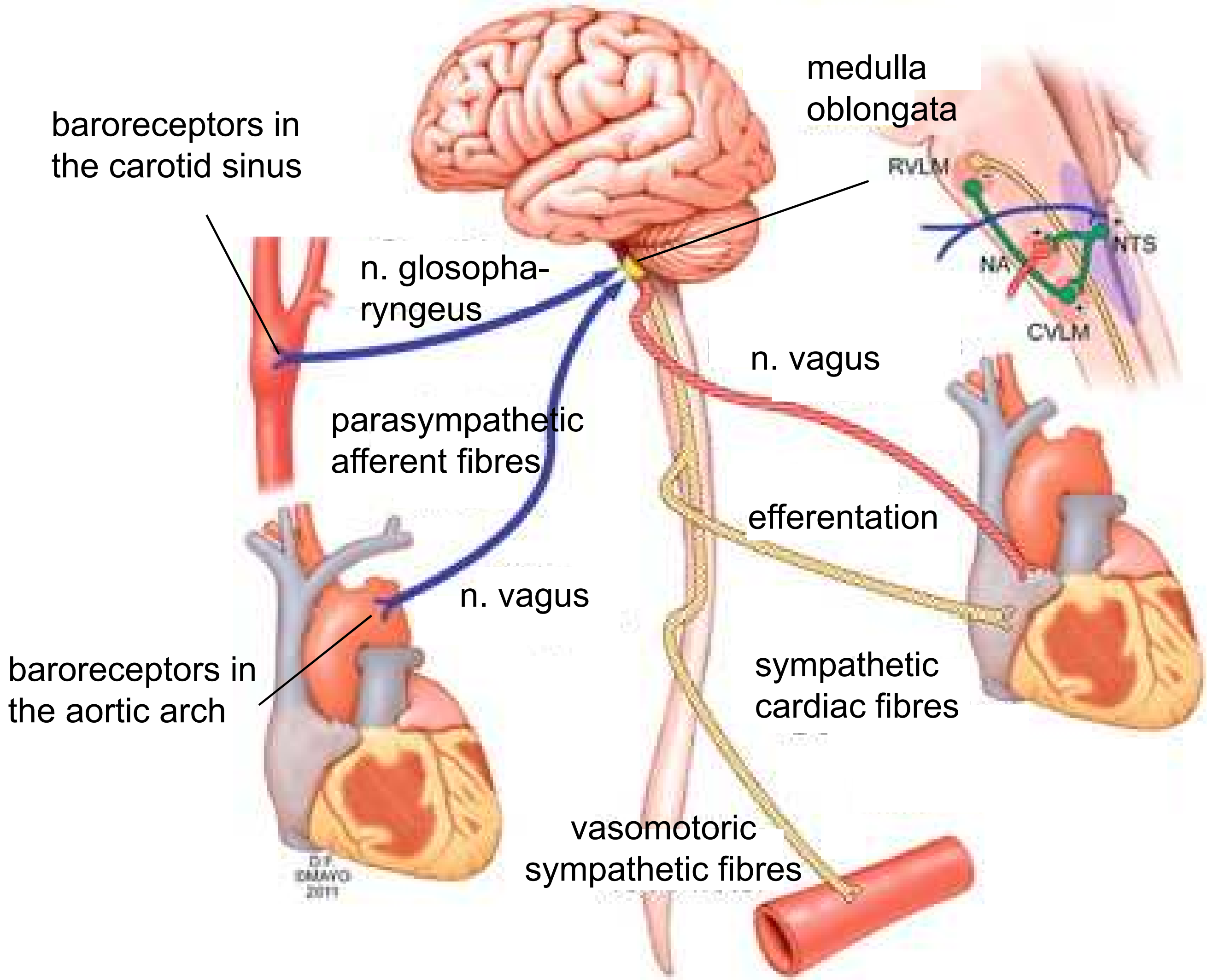
- Sympathetic and parasympathetic systems are active simultaneously, but with different intensities.

Baroreflex

- Reflex for a short-termed control of arterial blood pressure. Optimal values of blood pressure are essential for optimal blood flow in the brain.
- Mean arterial pressure (MAP) is detected by **baroreceptors** in **the aortic arch** and **carotid sinus**
  - stretch-receptors (mechanoreceptors)
- Afferent fibres: vagus nerve (n. X) and glossopharyngeal nerve (n. IX)
- Centre: rostral part of nucleus solitarius in the **medulla oblongata**
- Efferent pathways:
  - Cardiac branch: parasympathetic fibres of n. vagus and sympathetic cardiac nerves – heart rate and contractility changes
  - Peripheral (vascular) branch: sympathetic vascular innervation – changes in total peripheral resistance (TPR)

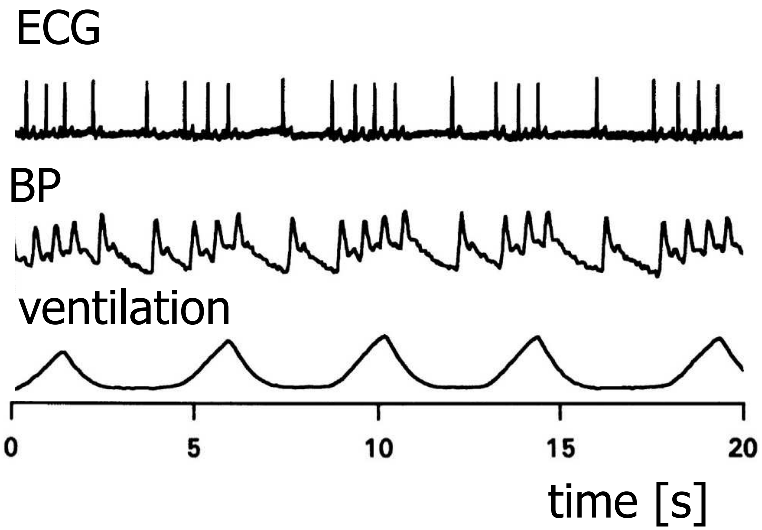
Baroreflex

- Mechanism:
  - ↓MAP
  - ↓afferentation from baroreceptors
  - processing in the reflex centre
  - ↓vagus activity and ↑sympathetic activity
  - ↑HR (and contractility) and ↑TPR (MAP = HR * SV * TPR)
  - ↑MAP
- … and conversely in case of MAP increase



Respiratory sinus arrhythmia (RSA)

- Changes of heart rate in accordance with breathing: increase of HR during inhalation, decrease of HR during exhalation
- The most evident in young people, associated with vagal activity, it is not pathological.
- RSA disappears with HR increase (stress, exercise, high age, sympathetic activity)



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Respiratory sinus arrhythmia (RSA)

- Mechanisms possibly causing RSA:
  - Baroreflex: during inspiration – ↓ intrathoracic pressure → ↑venous return (due to ↑ pressure gradient) → ↑systolic volume → ↑MAP → baroreflex (2 s lag) → ↓HR → ↑ (balance of) MAP
  - Central origin: irradiation of stimuli from the respiratory centre to cardiomotoric centre in the medulla oblongata
  - Bainbridge reflex: ↑venous return during inspirium – a stretch of atria – activation of stretch-receptors – stimulation of n. vagus – stimulation of SA node
  - Local source: a mechanical stretch of the SA node accelerates its depolarization (weak RSA is presented also in the transplanted heart)
  - Other reflexes influencing vagal activity, chemoreflex (oscillation of pCO2, pO2, pH during respiration)

Heart rate during body posture changes
(baroreflex demonstration)

- Body posture changes in the gravity field cause blood pressure (BP) changes depending on the position in relation to the heart (effect of hydrostatic pressure). These changes are minimized by short-term BP regulation (baroreflex).
- **Clinostatic reaction** – change of body position from standing (sitting) to lying:
  - ↑venous return from lower part of body → ↑heart filling (preload) → ↑SV → ↑BP → baroreflex causes ↓HR and ↓ TPR
- **Orthostatic reaction** – change of body position from lying to standing (sitting):
  - ↓ venous return from lower part of body → ↓ heart filling (preload) → ↓SV → ↓BP → baroreflex causes ↑HR and ↑TPR

- Cardiac branch of baroreflex is faster but less effective in BP maintenance - HR increases within 1 s after BP decrease, this prevents the decrease in brain perfusion
- Peripheral branch of baroreflex is slower but more effective: TPR increases approximately 6 seconds after BP decrease and stabilizes BP → HR decreases during long-lasting standing to the resting value.

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Heart rate changes due to physical exercise

- Working muscle has higher metabolic demands – perfusion is increased (autoregulation of blood flow, metabolic vasodilatation)
- Physical exercise increases sympathetic tonus („ergotropic system“)
  - Anticipation of exercise
  - There is compensatory vasoconstriction in those tissues which are not metabolically active (GIT, reproduction system, excretory system, skin) – resulting in the redistribution of blood.
- It affects heart function:
  - Vasodilatation in muscles → ↓TPR → ↓BP → baroreflex → ↑HR
  - Sympathetic system: ↑HR

- Athletes' heart – adaptation to frequent physical exercise – decreased HR at rest

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– Study how to record the pulse wave by the finger pulse transducer and how to estimate the heart rate
  – at rest,
  – during respiratory arrhythmia,
  – in changes of posture,
  – and during muscular load

– See textbook Physiology and neuroscience practicals, 2013, pg. 32 – 34.