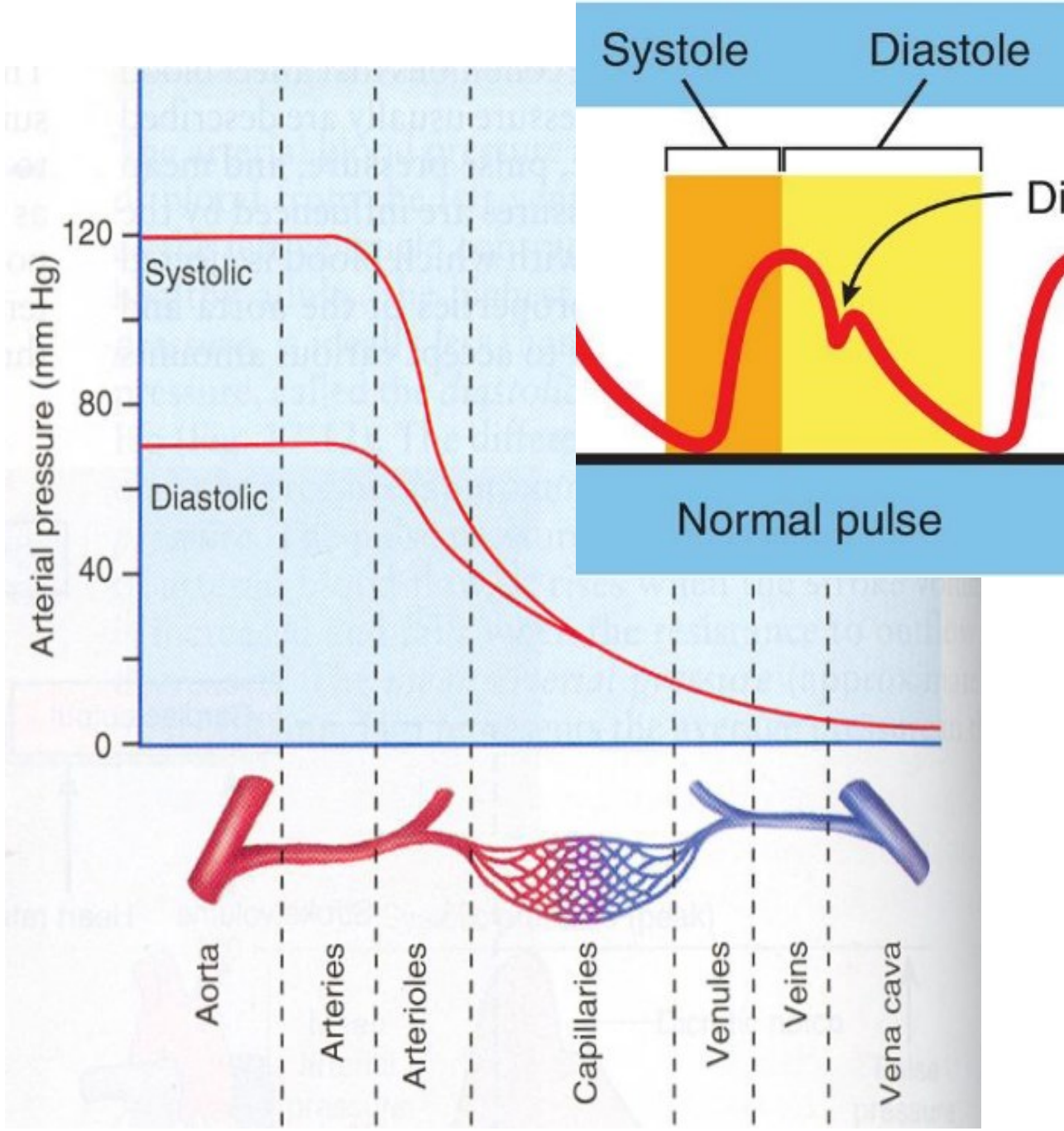
I. Blood pressure & plethysmography

Blood-vessel system

- **Arteries** – aorta, soften pulse waves, highest pressure
- **Arterioles** – resistance vessels, regulation of blood flow in body parts (→plethysmography)
- **Capillaries** – Exchange
- **Veins** – holds up to 75% of blood, almost zero pressure, valves



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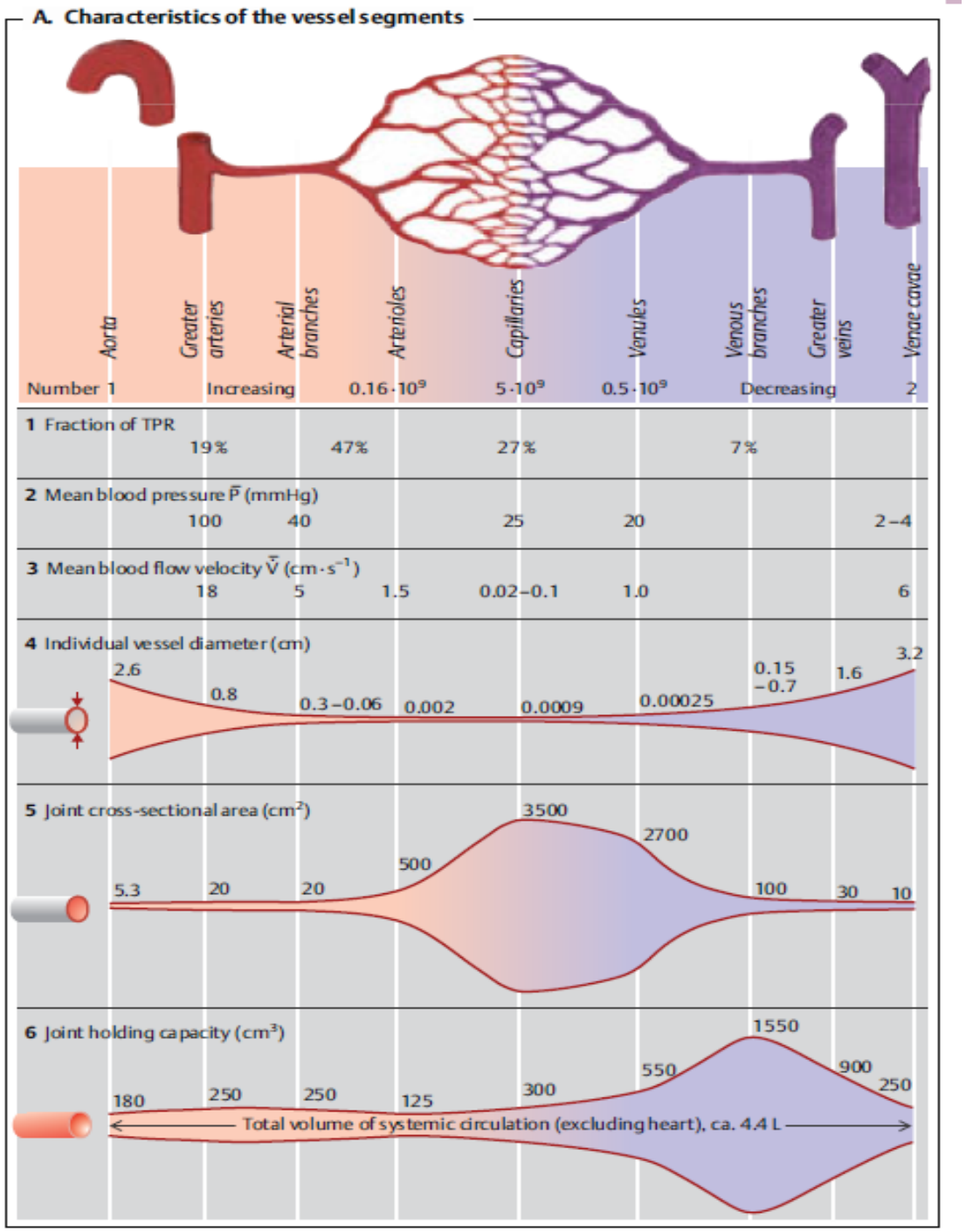
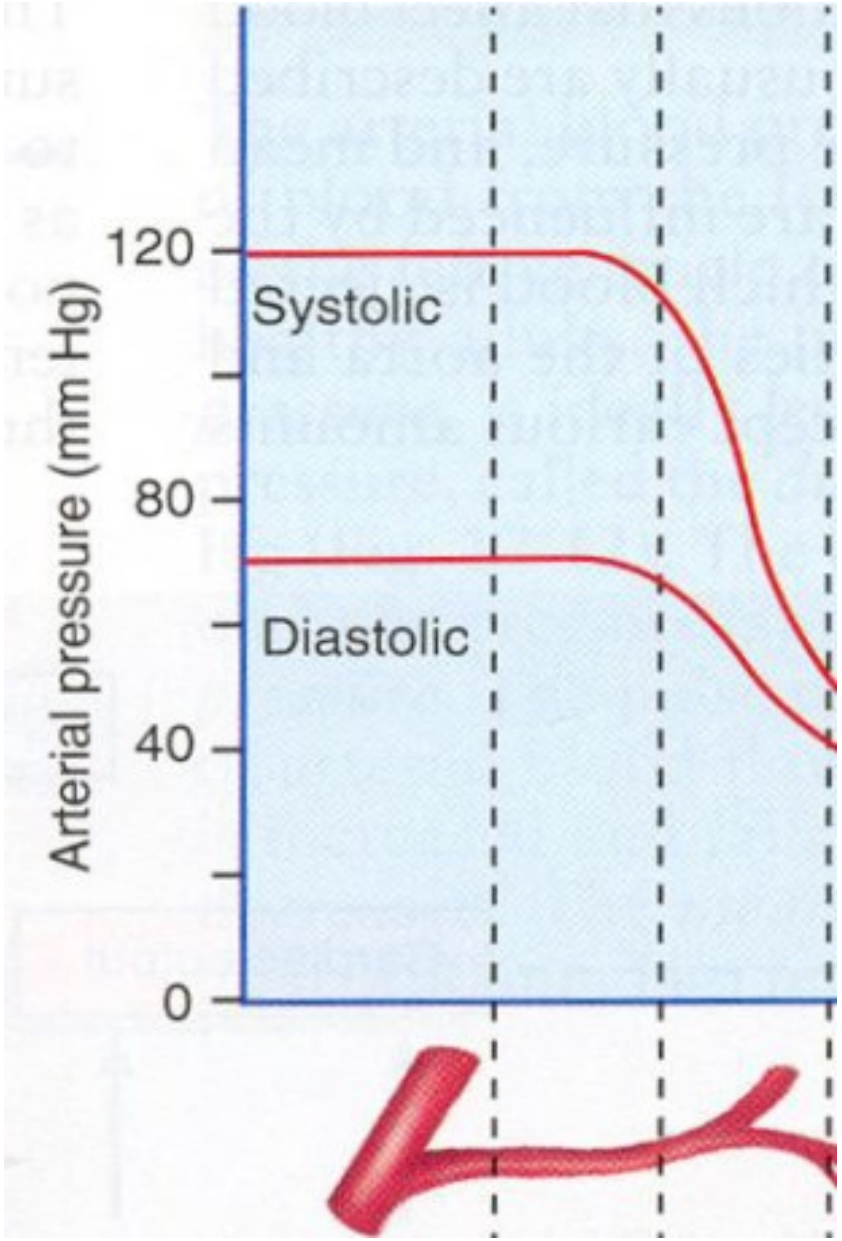


Blood pressure

= **is the pressure exerted by circulating blood upon the walls of blood vessels**

- Systole of left ventricle → 70 – 100 ml of blood goes to aorta, aorta has **to expand**
- Pulse wave of stretching goes through the cardiovascular system
- Tension of arteries sends blood further

- **Systolic/diastolic** (125-140)/(80-90) mmHg, Torr
  - **systolic** – high pressure wave due to **contraction of the heart**
  - **diastolic** – low pressure wave due to **tension of the aorta** and arteries as they return to their normal diameter



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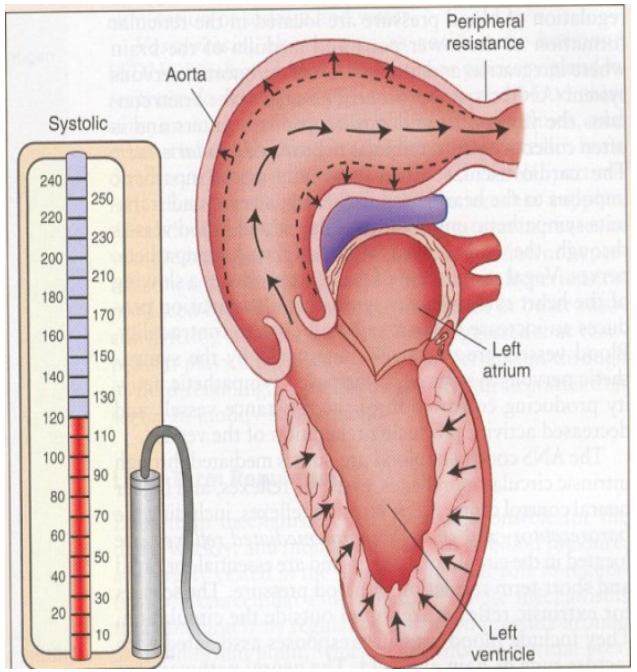
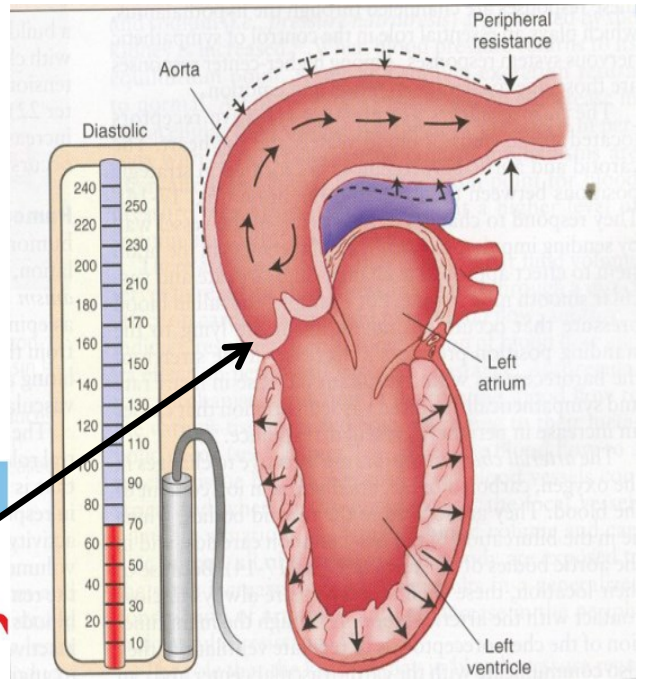
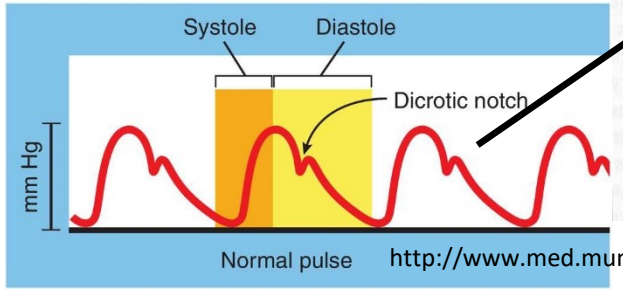
- **Dicrotic notch** – aortic valve closure

Systolic pressure



Diastolic pressure





http://www.med.muni.cz/patfyz/practic/prezentace/tk_MM.pdf

Blood pressure

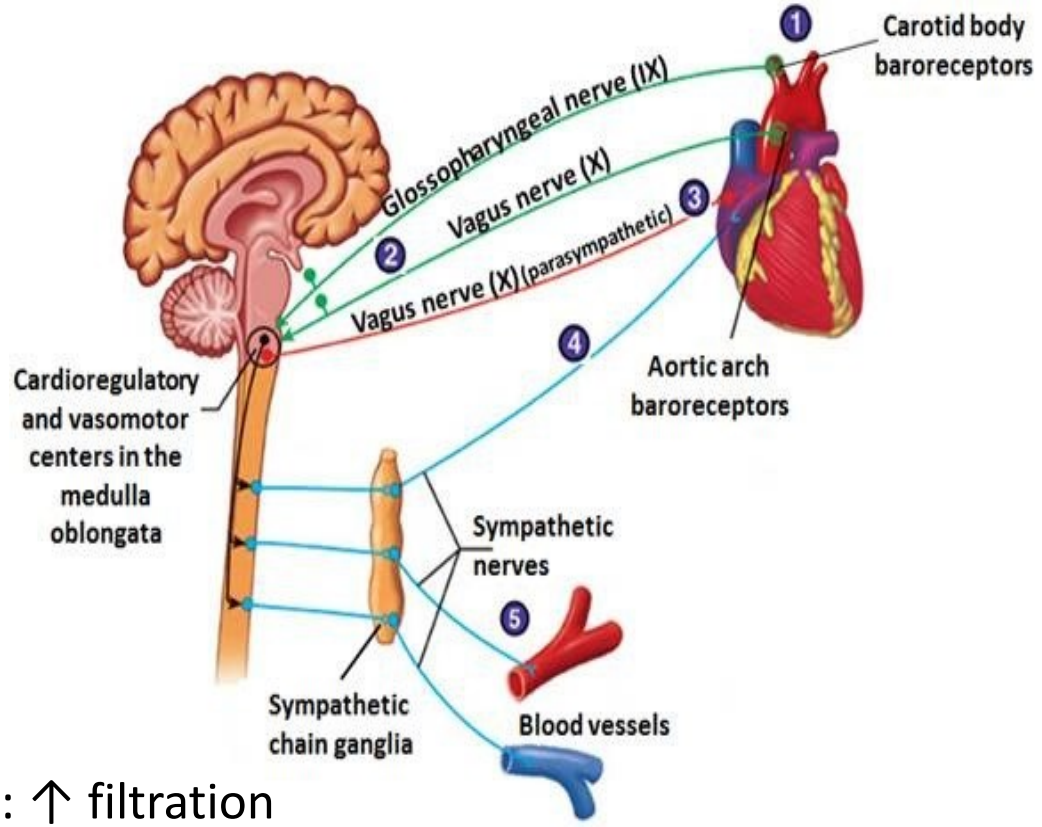
- BP = **cardiac output** x **peripheral resistance**

- Blood pressure can be modulated by:
  - **Heart activity**
  - **Elasticity** of arteries and **resistance** of blood vessels (radius of the vessels)
  - Smoothness of blood vessel walls (fatty deposits etc.), **blood volume**, viscosity of blood
  - age, sex, diesases, drugs, body position,…

Blood pressure regulation

- **Accute regulation – baroreceptor reflex**

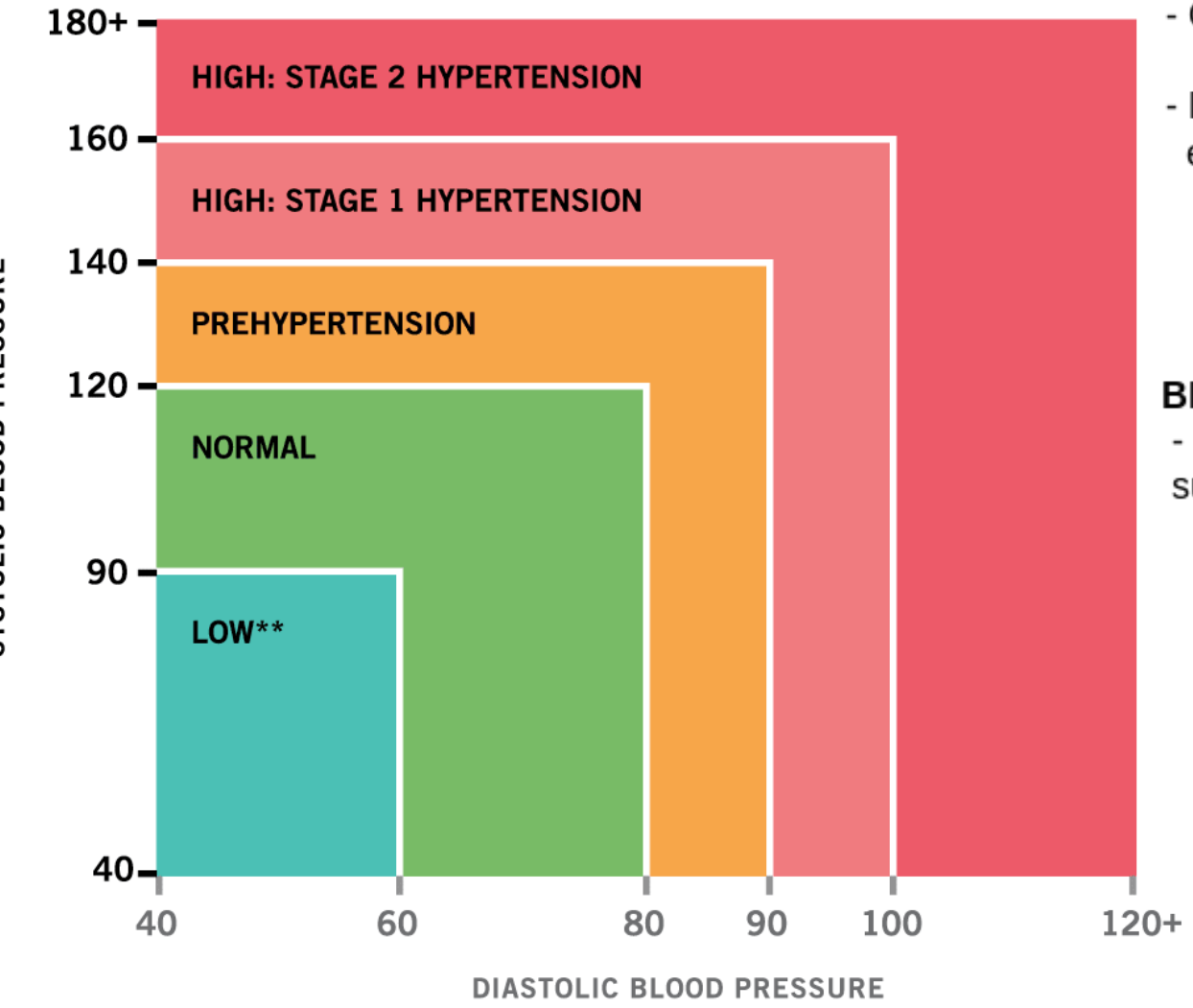
  Drop of pressure: ↓ artery wall tension, ↓ activity of baroreceptors,↑ activity of sympaticus, ↑ *heart frequency and contractility, peripheral vazoconstriction*, **blood pressure increase**



- **Long-term (chronic) regulation**
  - **Volume of urine produced by kidneys –** increased pressure: ↑ filtration pressure in kidneys, ↑ urine volume, ↓ blood volume, decreased BP
  - **ADH, aldosteron, renin-angiotenzin** – increased back resorption of water in kidneys ↑ BP

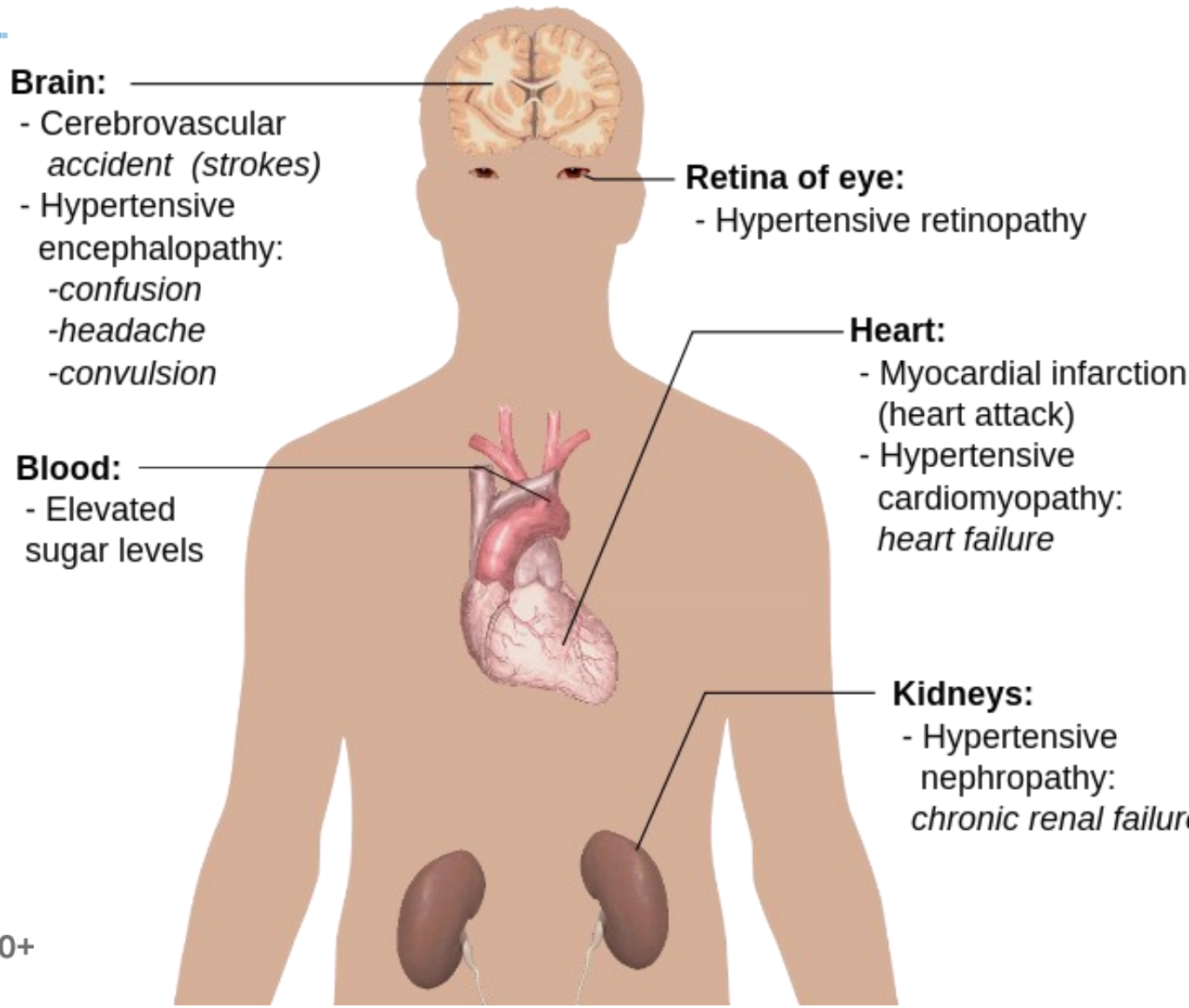
Blood Pressure Chart*

vertex42

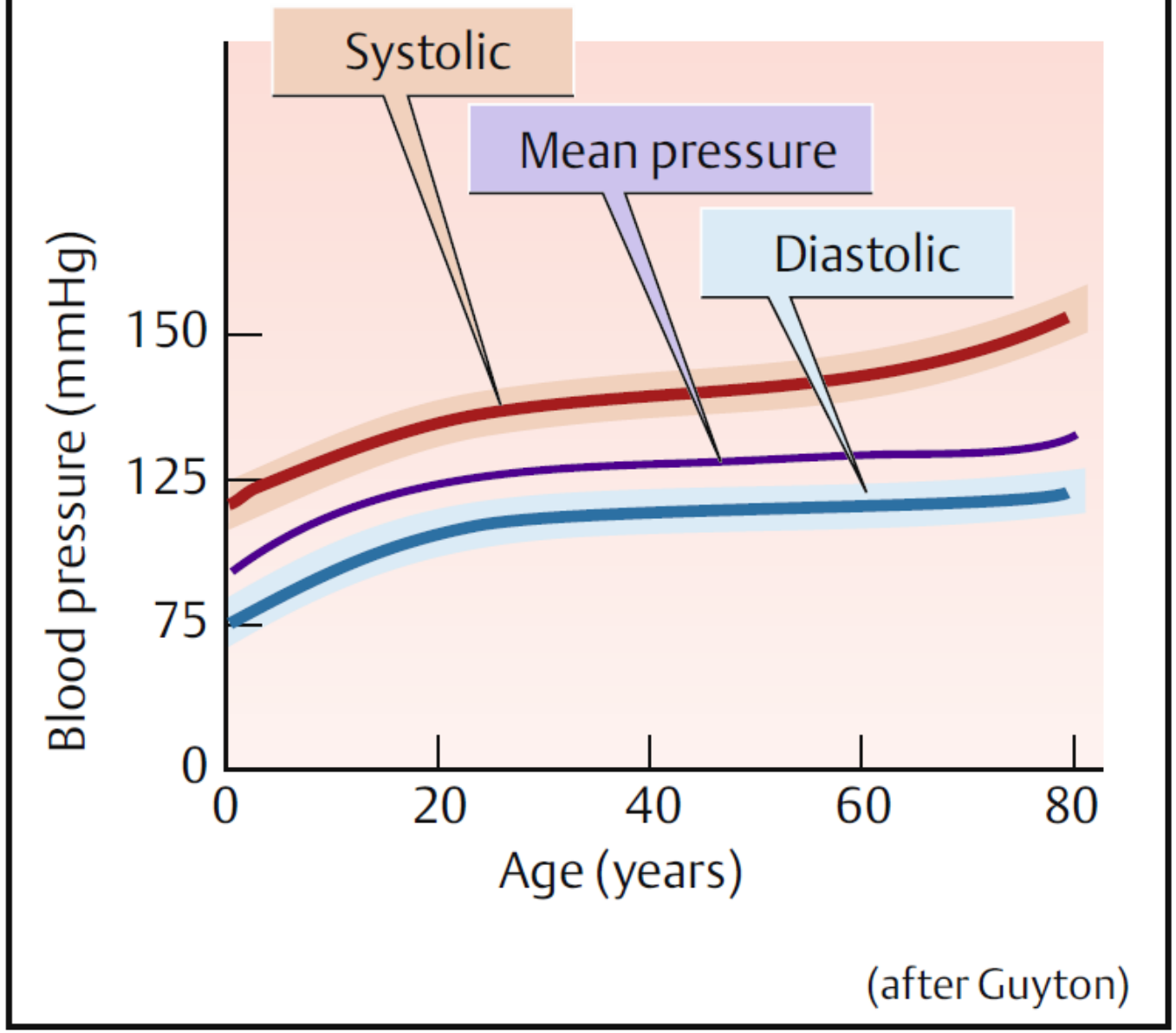


Main complications of persistent

High blood pressure



C. Age-dependency of blood pressure



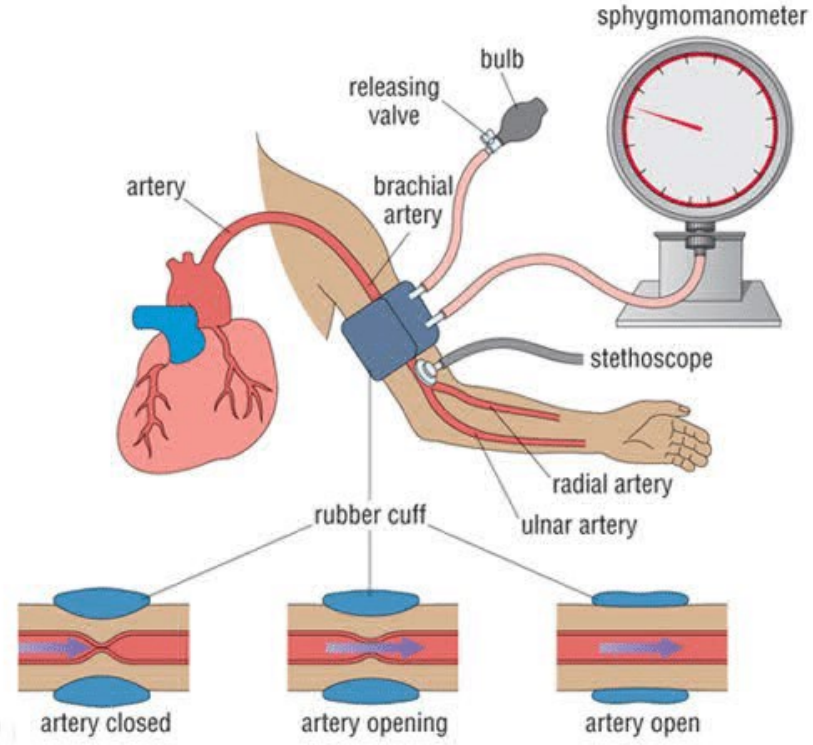
Meassurement of BP:

- **Diastolic pressure** – condition and elasticity of **vessels**
- **Systolic pressure** – condition of **heart**

- Invasive methods:
  S. Hales - 1733 – lenght of blood spray

- **Non invasive methods:**
  auscultatory - listening of blood in vessels

- Sphygmomanometers (*sphygmos* = pulse) – mercury manometers, digital manometers, aneroid m. etc.



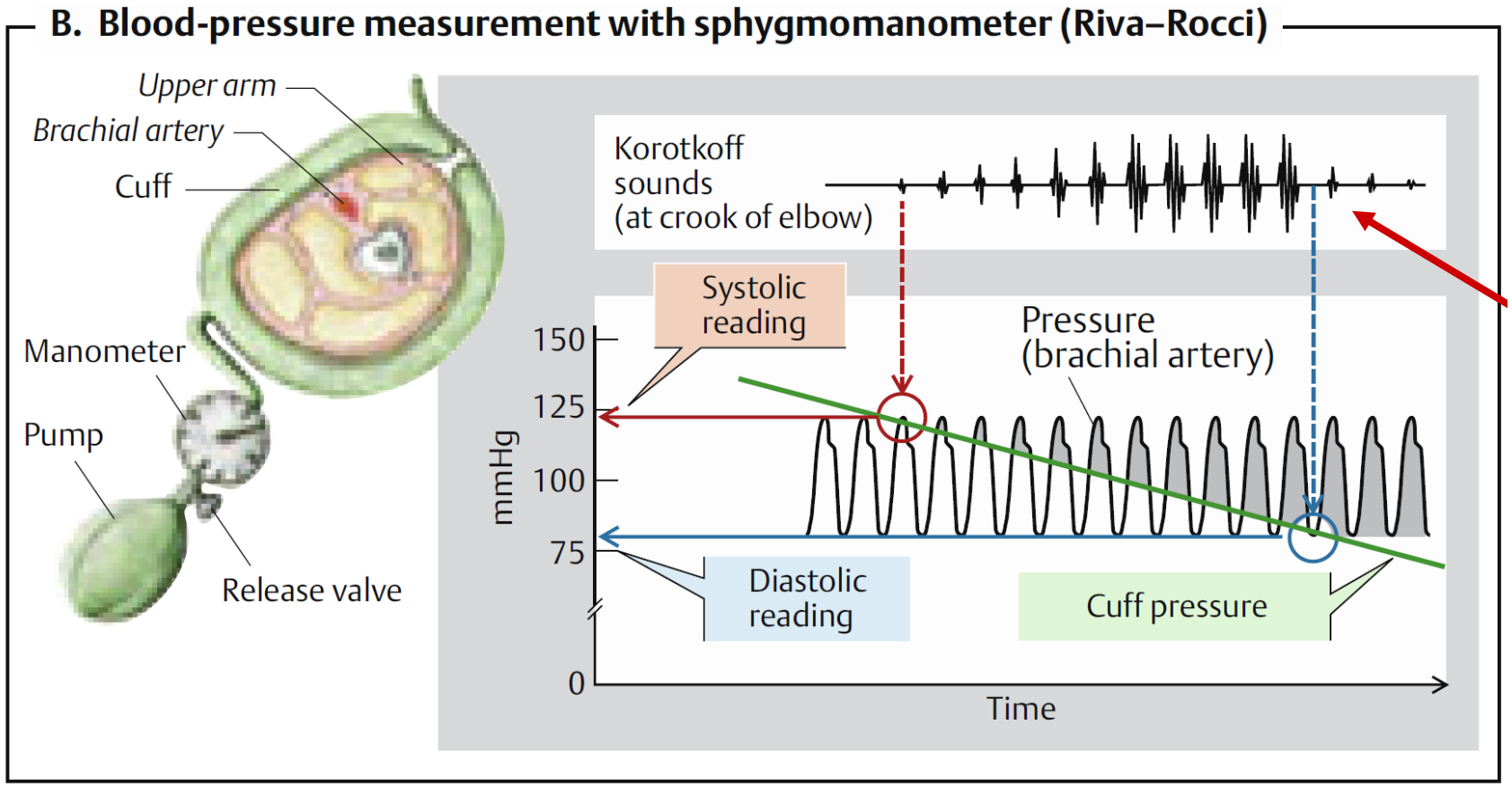
How to use a manometer:

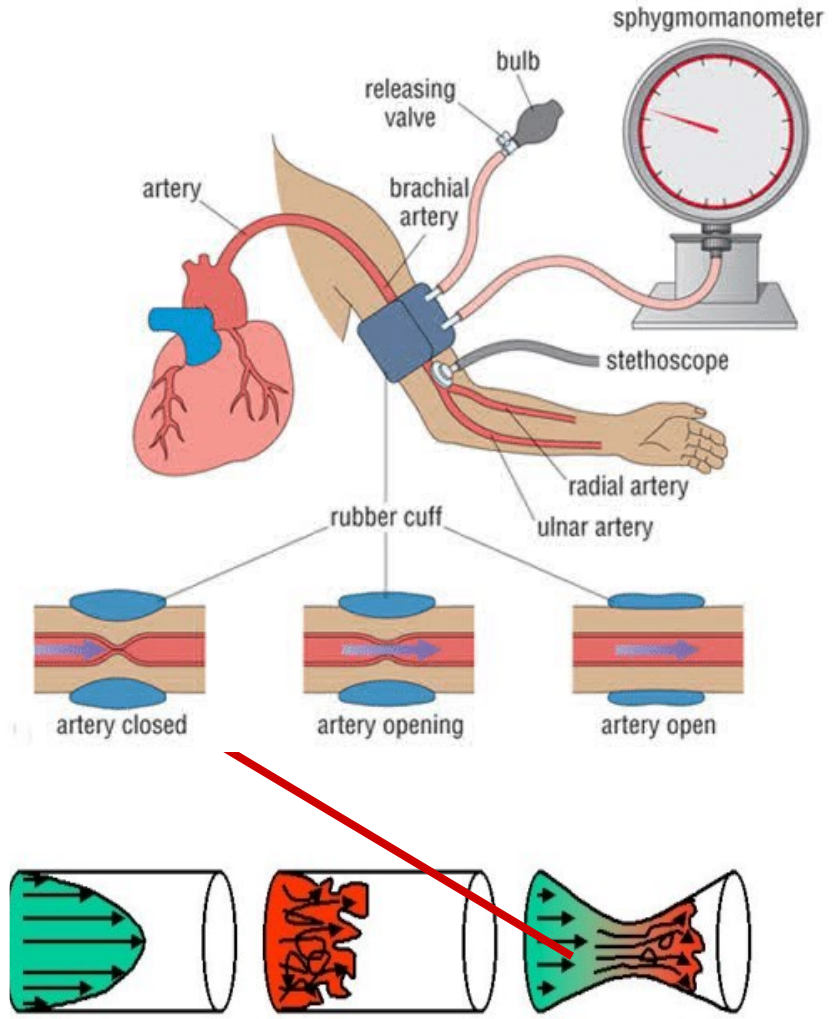
- A cuff is fitted smoothly and snugly, then inflated manually by **repeatedly squeezing a rubber baloon** until the artery is completely occluded.

- **Listening with the stethoscope** to the brachial artery at the elbow, the examiner slowly **releases the pressure** in the cuff.

- When blood just starts to flow in the artery, the turbulent flow creates a systolic echoes (first Korotkoff sound). The **pressure at which this sound is first heard is the systolic blood pressure**. The cuff pressure is further released until **no sound can be heard**, **at the diastolic arterial pressure**.

Principle of manometer:





Laminary vs. turbulent flow
Korotkoff sounds = blood turbulences

https://www.youtube.com/watch?v=KnYfreaRQe4

https://www.youtube.com/watch?v=9SNiwK8SydU

Experiment n.1

Determination of blood pressure and comparisson between several types of medical blood pressure gauges

- mercury manometer vs. digital manometer

Table of Results

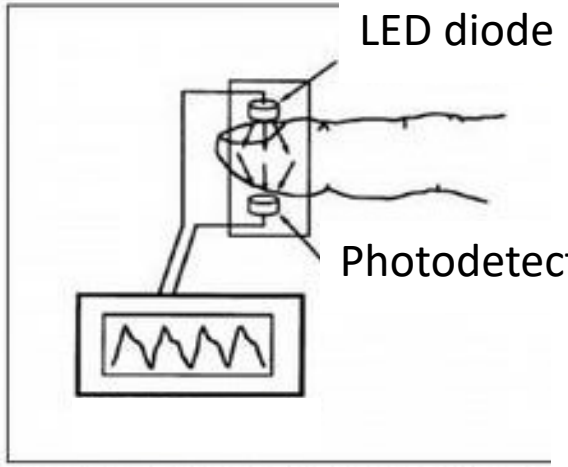
INITIALS	Blood pressure Stethoscope	Blood pressure Digital
	/	/
Means	/	/

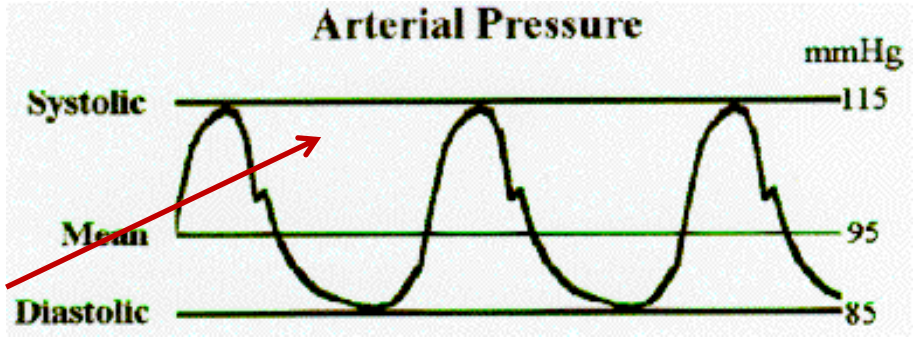
Plethysmography

- Determination of **optical parameters of translucent tissue**, depends of blood volume in capillaries under the skin, **modulated by arterioles** → reflexive changes in arterial radius (two layers of smooth muscle in arterioles wall)

- Meassurement on middle finger or index finger, detecting amount of light passing through a finger (contraction of arterioles → smaller radius → lower amount of light)

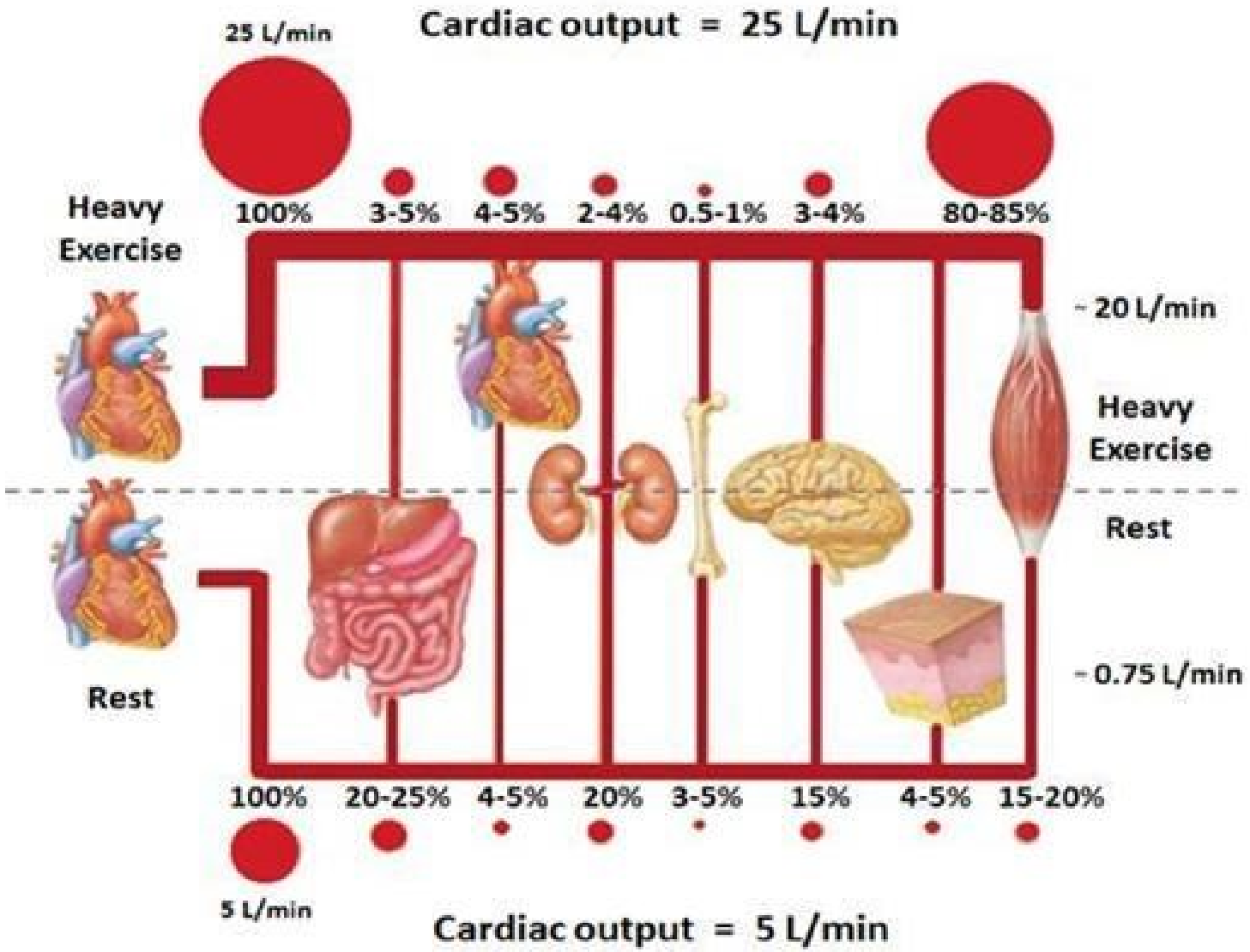
- **Pulse wave** in arterioles: dicrotic notch





Vasomotorics controls perfusion

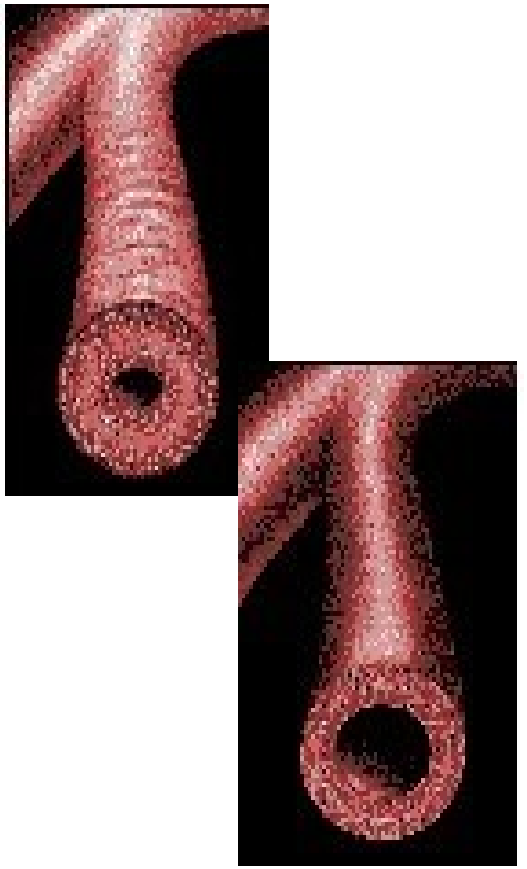
- In rest, different organs need to be perfused compared to exercise



Vasomotoric reactions

Various chemicals or physical stimuli causes reflexive reactions:

- **Vasoconstriction**
  - **Constriction** of smooth muscle cells
  - Sympatic nerves; adrenalin in gut, vasopresine,…
  - Parasympatic nerves in muscles
  - Narrow vessel- lower wave in graph



- **Vasodilatation**
  - **relaxation** of smooth muscle cells
  - Parasympatic nerves; acetylcholin in gut, metabolites, NO, …
  - Sympatic nerves in muscles
  - Dilated vessel – higher wave in graph

Vasomotoric reactions

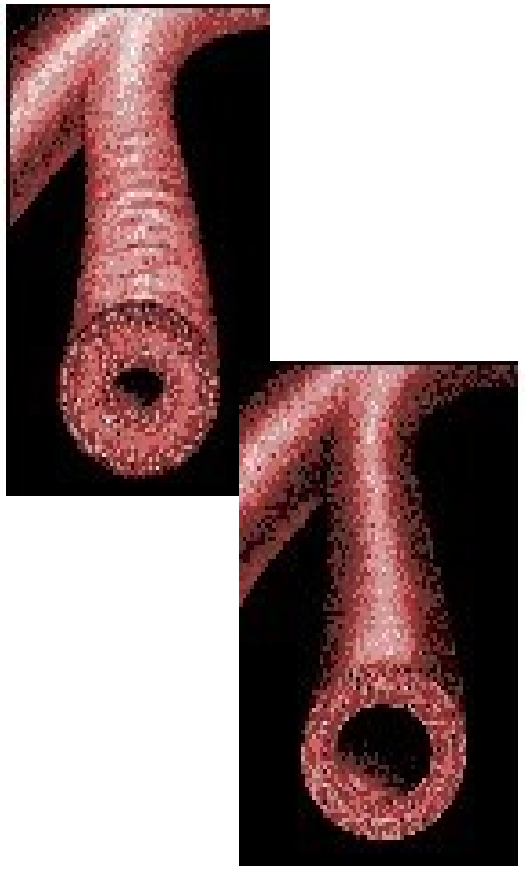
Local blood flow control

Autoregulation - more blood pressure in the vessel wall causes active constriction - this is a reflex of blood spilling over due to gravity. They maintain the same blood flow whether the limb is up or down.

Release of dilators, **metabolic factors**, accumulated metabolites dilate blood vessels (CO_2)

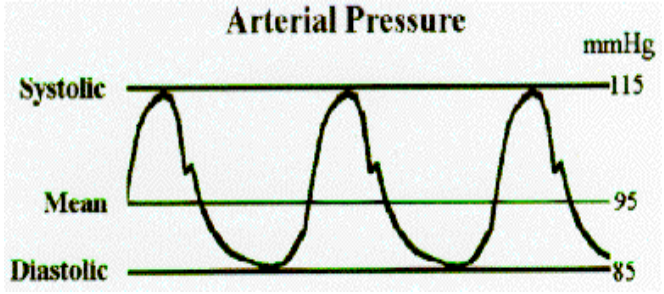
Local **hormones**; e.g. inflammation → release of histamine and bradykinin → vasodilation

Temperature - higher temperature has a vasodilating effect

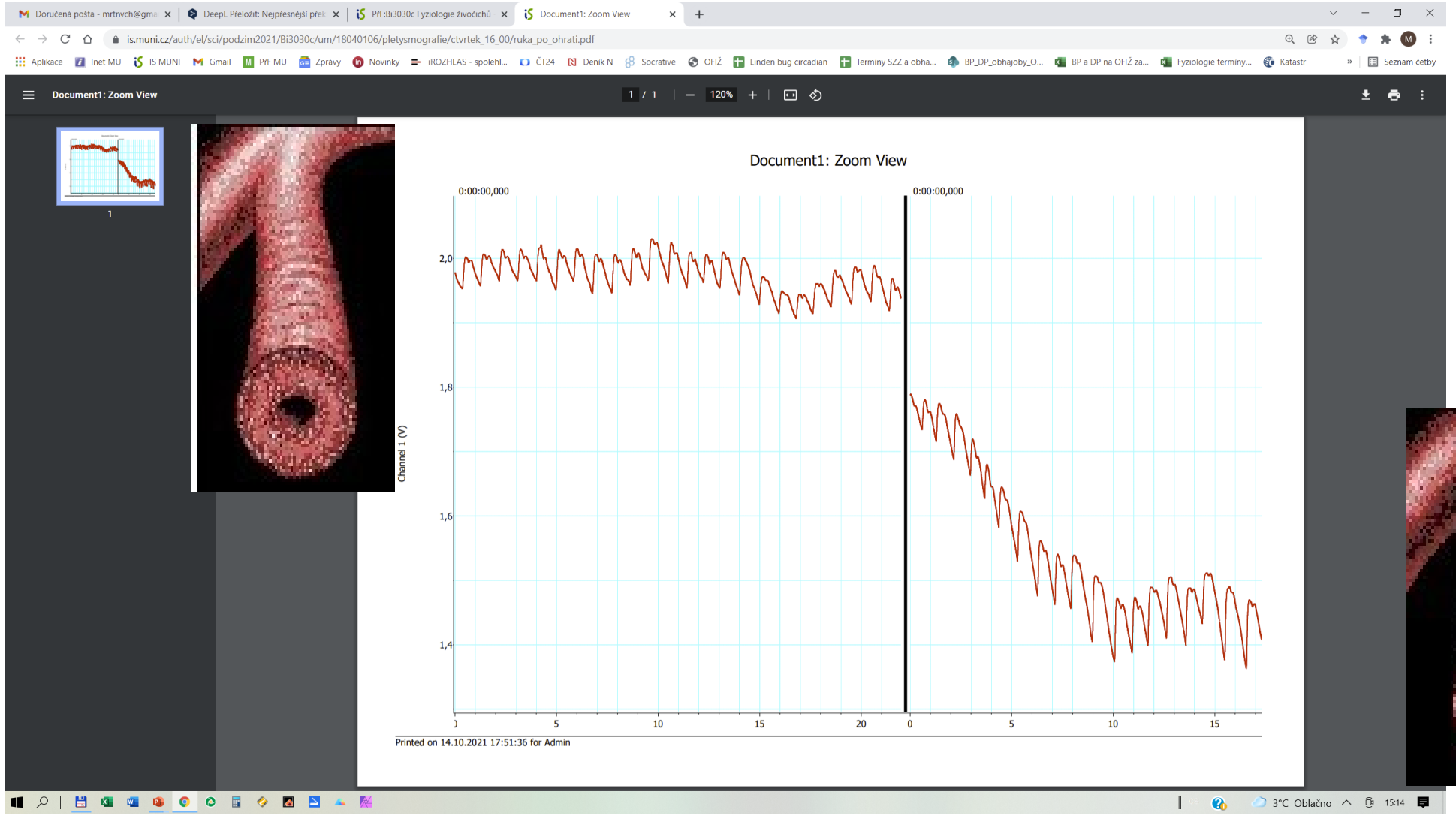


Experiment n.2

1. Pulse wave
2. Change of body position (sitting - standing)
3. Reactive hyperaemia (reaction to brachial artery strangulation)
4. Valsalva experiment - increase in intrathoracic pressure and peripheral hyperperfusion
5. Effect of temperature (cold - heat)



Finger heated



Artery strangulation (ischemia) and reperfusion – accumulated metabolites

Valsalva experiment – forceful attempt of exhalation against a closed airway