(XI.) Digital model of aortic function
(XVI.) Blood flow in veins

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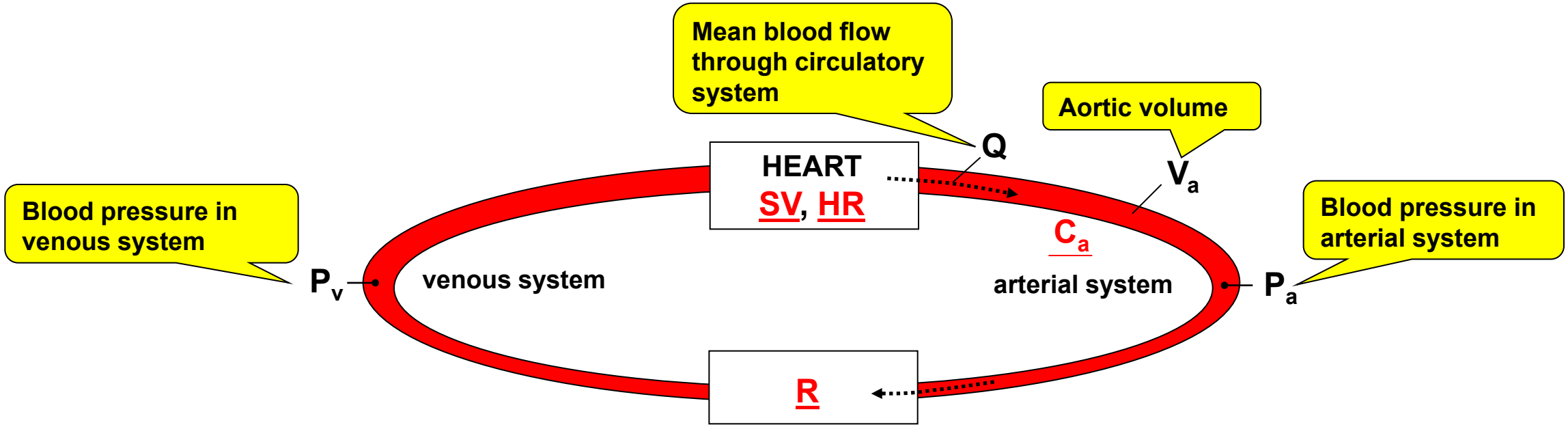
Definitions of key words and symbols

Stroke volume (SV) – volume of blood ejected from the left ventricle to the aorta during one contraction

Heart rate (HR) – number of heart contractions per1 minute

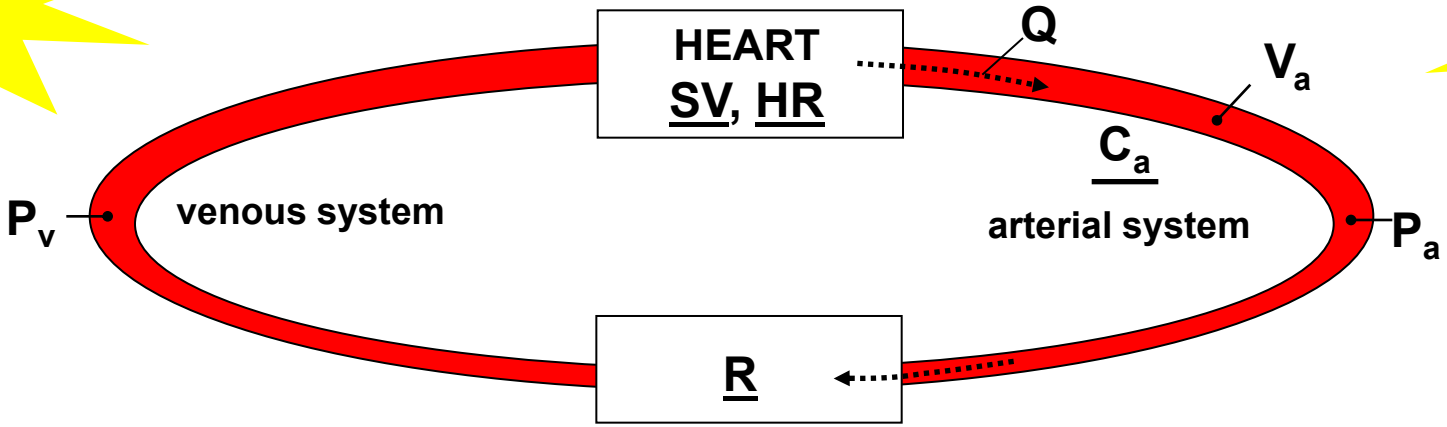
Peripheral vascular resistance (R) – resistance of small arteries (mainly arterioles and capillaries)

Compliance of aorta (C_a) – ability of aorta to change its volume according to changes of blood pressure



Arterial blood pressure in case of changing circulatory parameters and cardiac output

$$Q = \frac{P_a - P_v}{R}$$



$$C_a = \frac{\Delta V_a}{\Delta P_a}$$

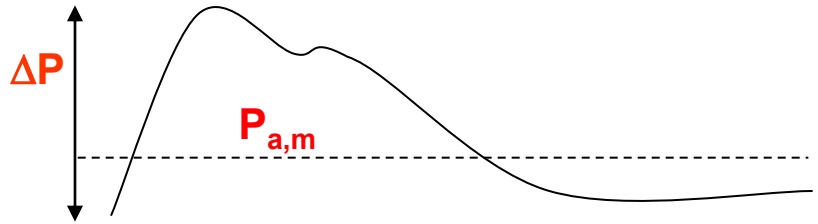
$$P_{a,m} - P_{v,m} = Q \cdot R$$

$$\Delta V_a \cong SV$$

$$P_{a,m} = SV \cdot HR \cdot R + P_{v,m}$$

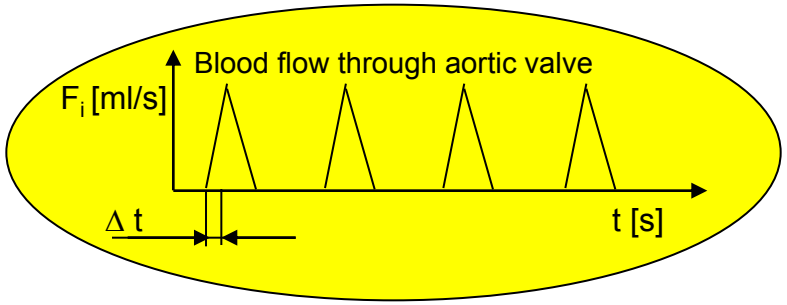
$$\Delta P_a \cong \frac{SV}{C_a}$$

$$P_{a,m} \cong SV \cdot HR \cdot R$$



Model of aortic function

Calculation of P_a



$t = t+\Delta t$

$$F_o = \frac{(P_a - P_v)}{R}$$

HEART
SV, HR

F_i

C_a

P_v

venous system

arterial system

P_a

V_a

R

F_o

$P_a = P_a + \Delta P_a$

$$\Delta V_a = (F_i - F_o)\cdot\Delta t$$

$$\Delta P_a = \frac{\Delta V_a}{C_a}$$

Modeled situations

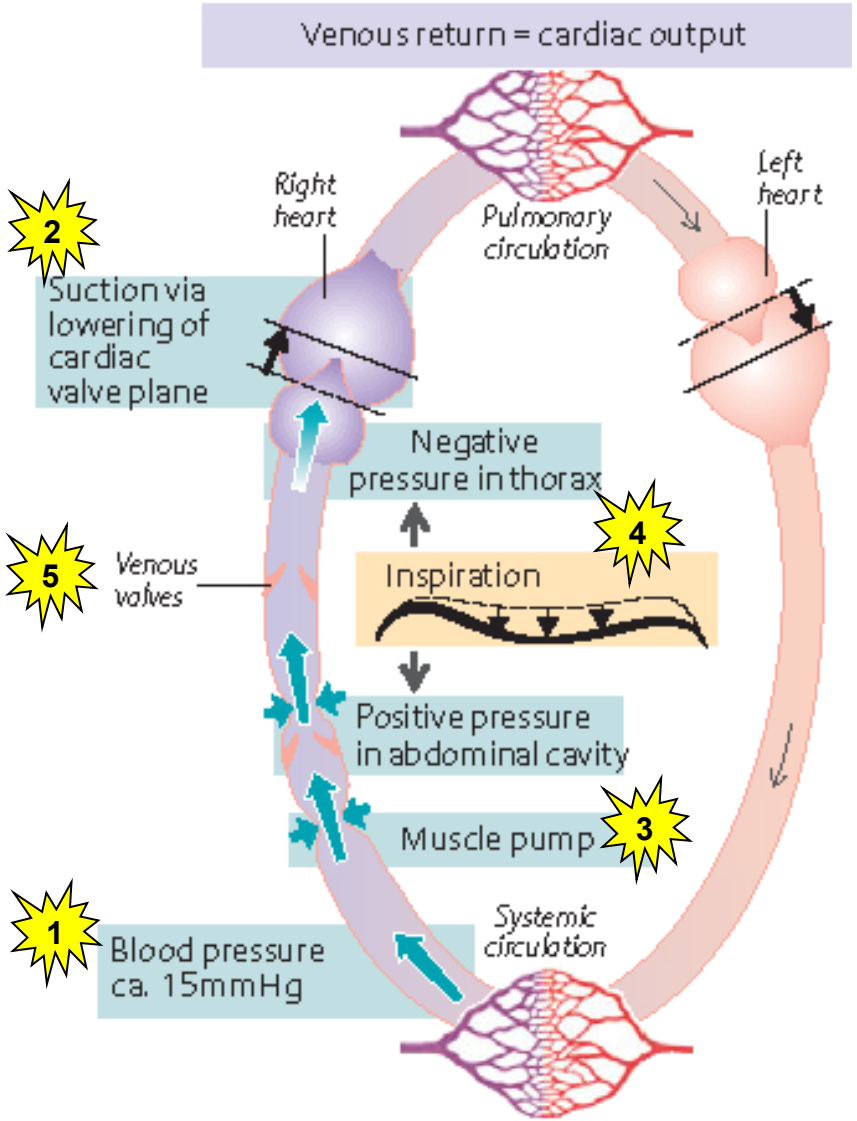
SV – increase: hyperhydration – rapid administration of i.v. infusion, intake of large amount of water in short time; **decrease:** dehydration, loss of blood (haemorrhage)

HR – increase: activation of sympathetic nervous system – stress, physical activity; **decrease:** increase of vague tonus, adaptation of heart in sportsmen (athletic heart)

R – increase: predominance of vasoconstriction – e.g. in cold environment; **decrease:** predominance of vasodilation – sauna, distributive shock (anaphylaxis, adrenal crisis)

C – higher values: in children, young people; **lower values:** in elderly people, atherosclerosis, elastic fibers degeneration – isolated systolic hypertension *(systolic blood pressure is higher than normal, diastolic blood pressure is predominantly at normal level)*

Mechanisms of venous return



1. **Pressure gradient between venous system and right atrium („a force acting from behind“ – *vis a tergo*)**

2. **Suction effect of systole („a force acting from in front“ – *vis a fronte*)**

3. **Skeletal muscle contractions – muscle pump**

4. **Suction effect of inspirium – increased intraabdominal pressure and decreased intrathoracic pressure**

5. **Venous valves**

Picture reference:

Slide 7 – Atlas Of Physiology, Silbernagl & Despopoulos, Georg Thieme Verlag 2003