

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

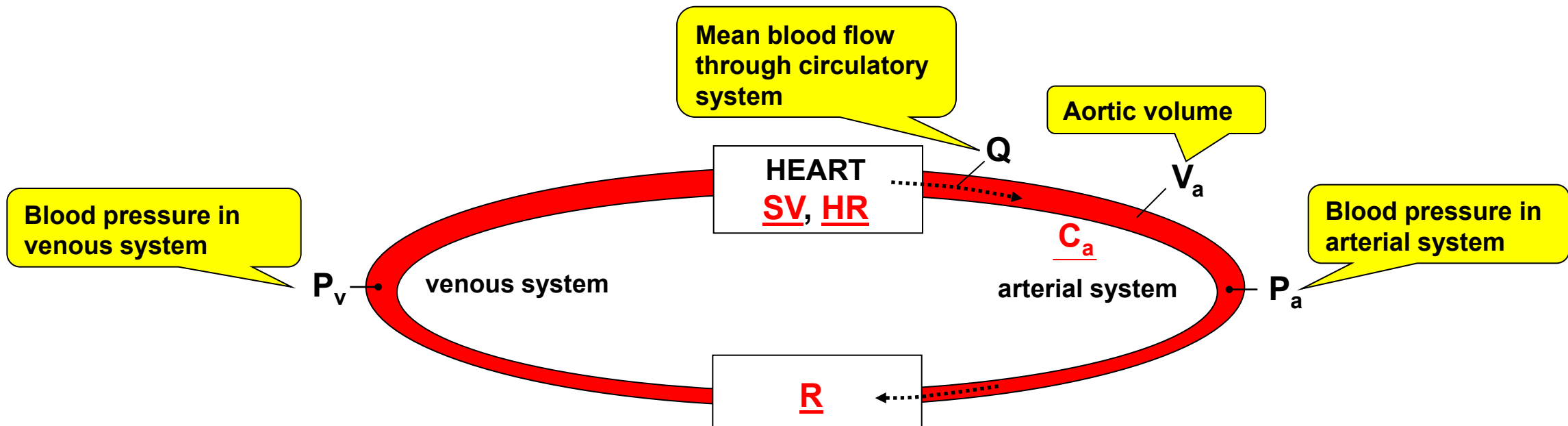
# Definitions of key words and symbols

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

*Heart rate (HR)* – number of heart contractions per 1 minute

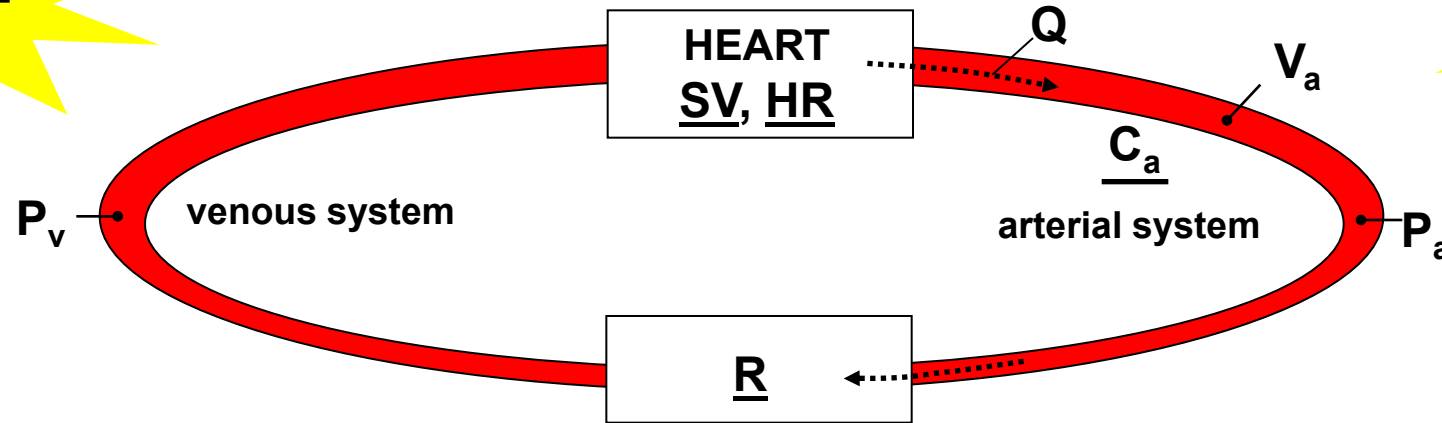
*Peripheral vascular resistance (R)* – resistance of small arteries (mainly arterioles and capillaries)

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



# Arterial blood pressure in case of changes in circulatory parameters and cardiac output

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



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

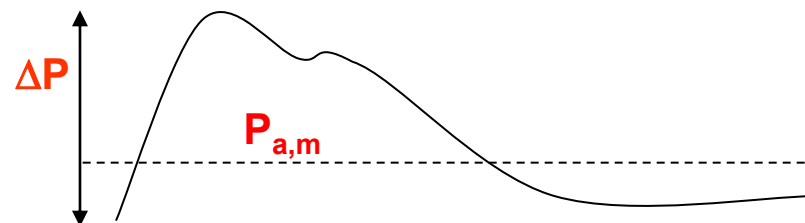
$$P_{a,m} - P_{v,m} = Q \cdot R$$

$$\Delta V_a \cong SV$$

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

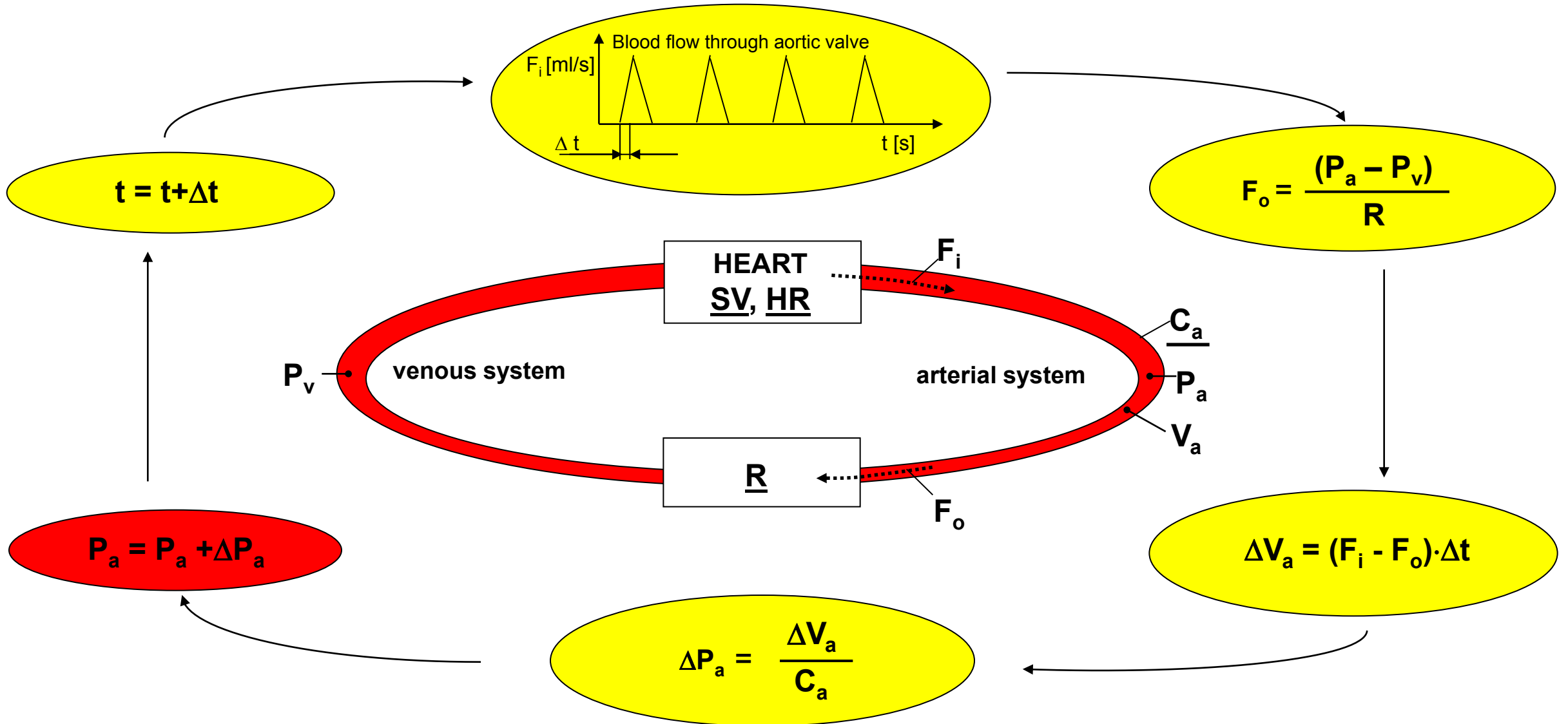
$$\Delta P_a \cong \frac{SV}{C_a}$$

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



# Model of aortic function

Calculation of  $P_a$



# Modeled situations

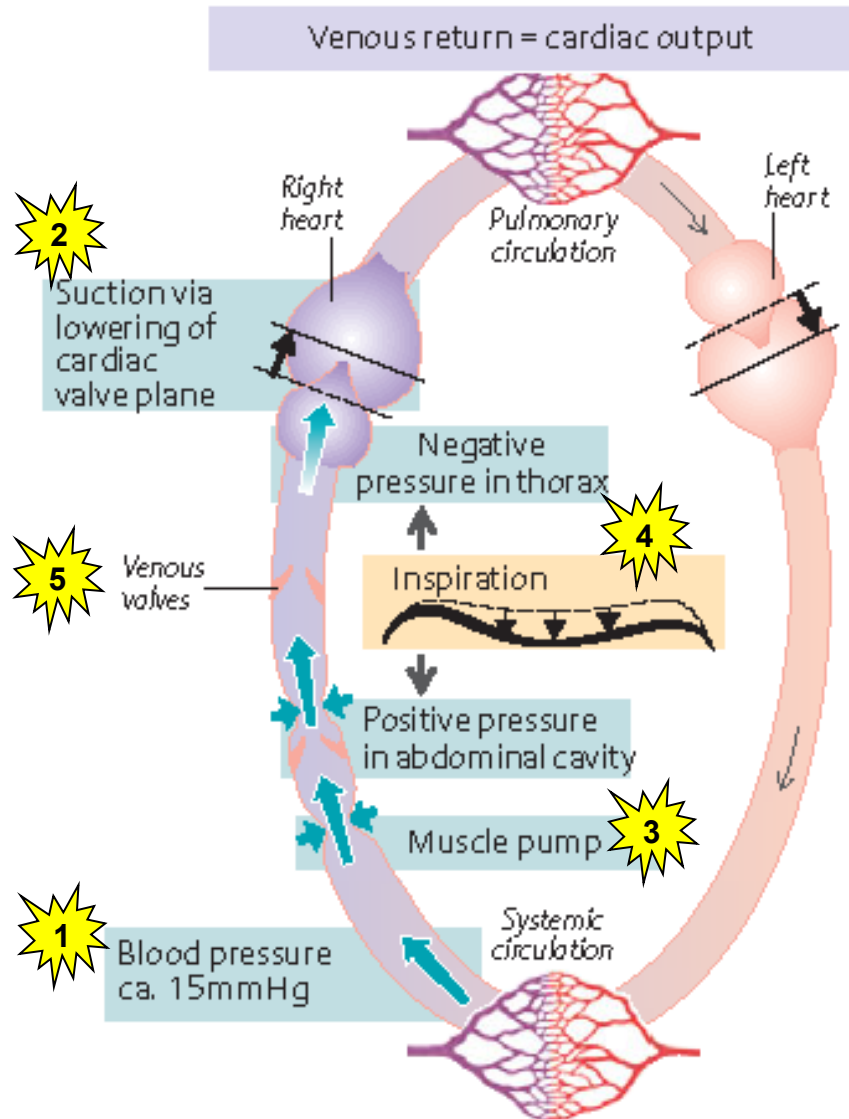
**SV – increase:** hyperhydration – rapid administration of i.v. infusion, intake of large amount of water in short time; **decrease:** dehydration, loss of blood (haemorrhage)

**HR – increase:** activation of sympathetic nervous system – stress, physical activity; **decrease:** increase of vagus 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 inspiration – increased intraabdominal pressure and decreased intrathoracic pressure

5. Venous valves

# Picture reference:

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