THE MODULE: CARDIOVASCULAR SYSTEM

SESSION: 5, LECTURE: 2

DURATION: 1hr

PRESSURES AND FLOW IN SYSTEMIC CIRCULATION

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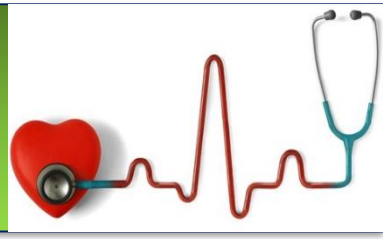
As in work book

For more discussion, questions or cases need help please post to the session group



Learning outcomes (LO)

(LO1)

- **Define the terms 'Systolic' and 'Diastolic' arterial pressure and 'Pulse Pressure'.**

(LO2)

- **Define the term 'Total Peripheral Resistance'.**

(LO3)

- **Describe how the elastic nature of arteries acts to reduce arterial pressure fluctuation between systole and diastole.**

Learning outcomes (LO)

(LO4)

- **Draw the typical arterial pressure wave form.**

(LO5)

- **Describe the pulse wave.**

(LO6)

- **Describe the role of arterioles as resistance vessels.**

Learning outcomes (LO)

(LO7)

- **Define the terms vasoconstriction and vasodilatation.**

(LO8)

- **Describe what is meant by 'vasomotor tone' and list the main factors which affect it.**

(LO9)

- **Describe how 'vasodilator metabolites' modify vasomotor activity to permit local control of blood flow.**

Learning outcomes (LO)

(LO10)

- Describe **reactive hyperaemia**.

(LO11)

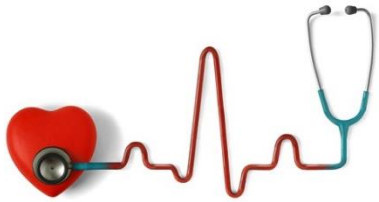
- Describe **autoregulation**.

(LO12)

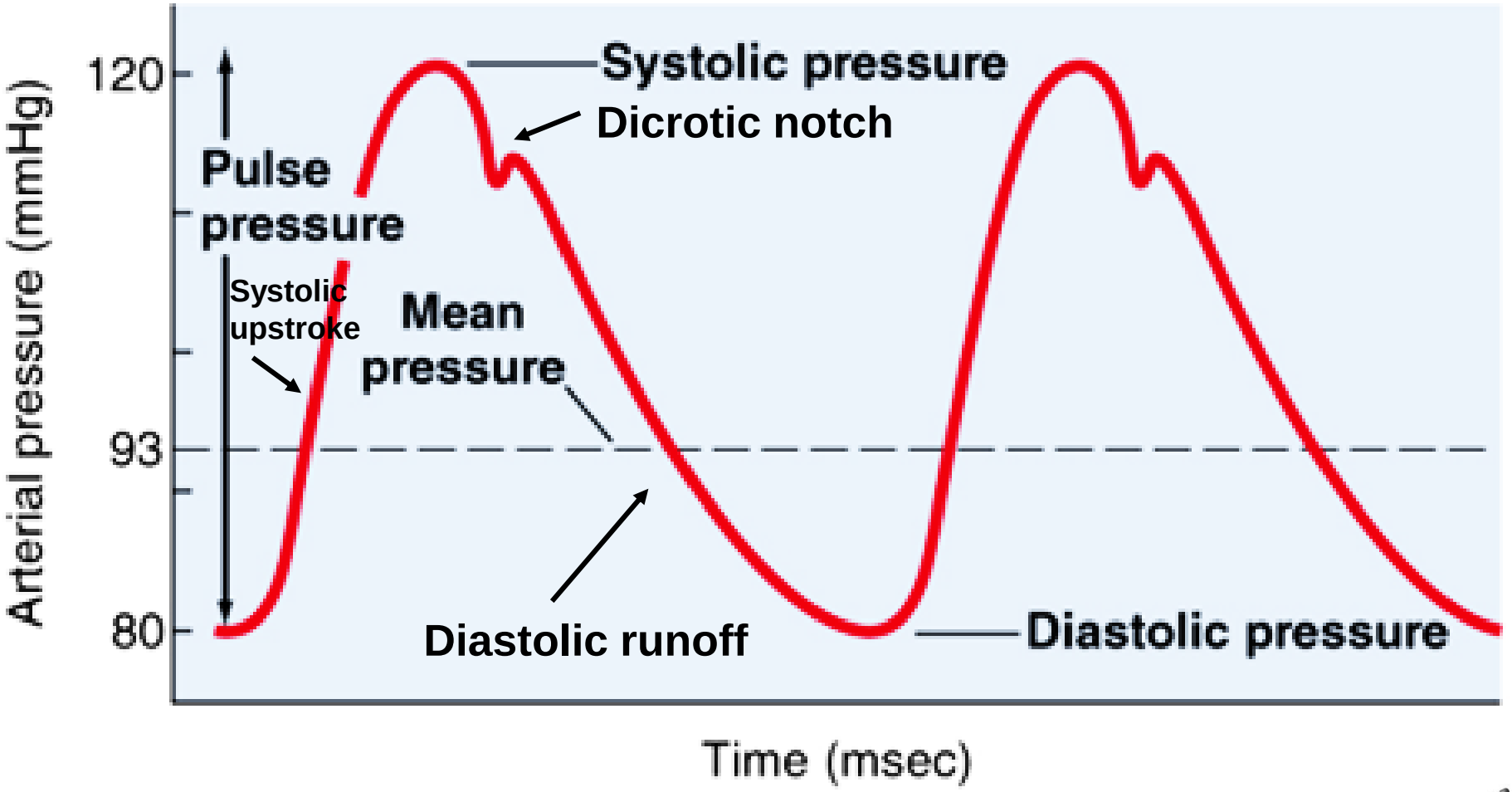
- Define the terms '**central venous pressure**' and '**venous return**'.

LO1

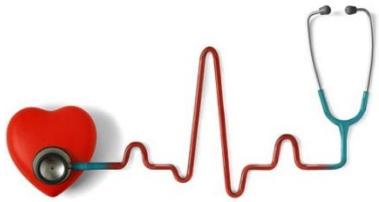
Systolic Pressure	**The maximum arterial pressure, 120 mmHg.**
Diastolic Pressure	**The minimum arterial pressure, 80 mmHg.**
Pulse Pressure	**The difference between systolic and diastolic pressure, 40 mmHg.**



LO4



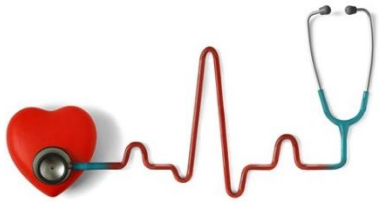
https://biology.stackexchange.com/questions/31286/what-causes-a-small-bump-in-the-arterial-pressure-plot?rq=1



Total peripheral resistance (TPR)

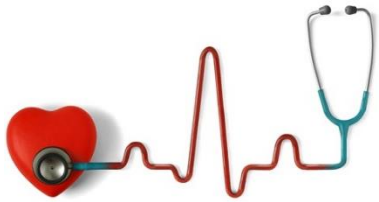
- Total peripheral resistance is the sum of the resistance of all of the peripheral vasculature in the systemic circulation.

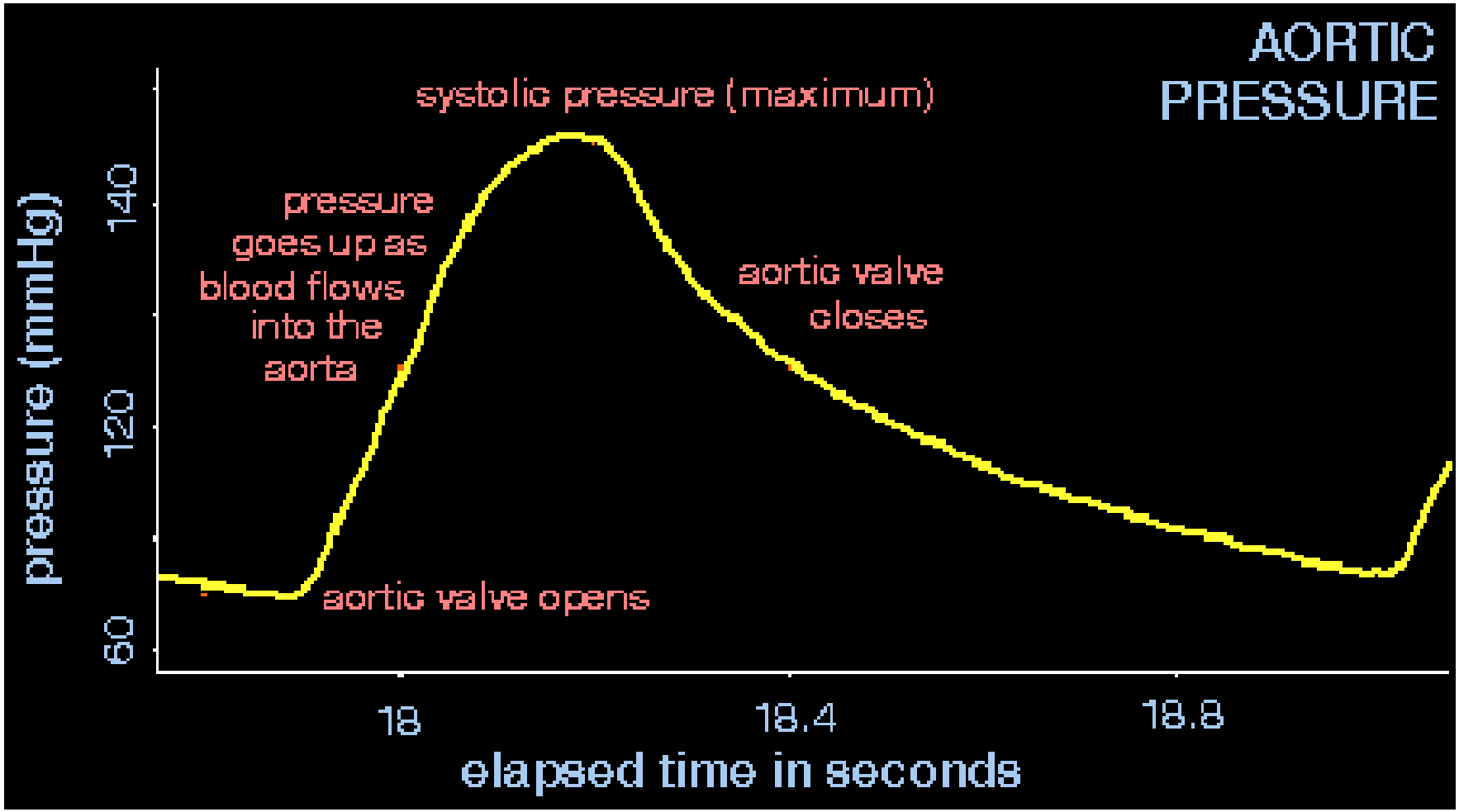
What are the factors that influence TPR?



Pressure fluctuation

- Ventricle ejects blood intermittently.
- Arteries have distensible walls, allowing them to stretch in systole. More blood flows in than out, so pressure does not rise so much.
- The arteries recoil in diastole and flow continues through the arterioles.

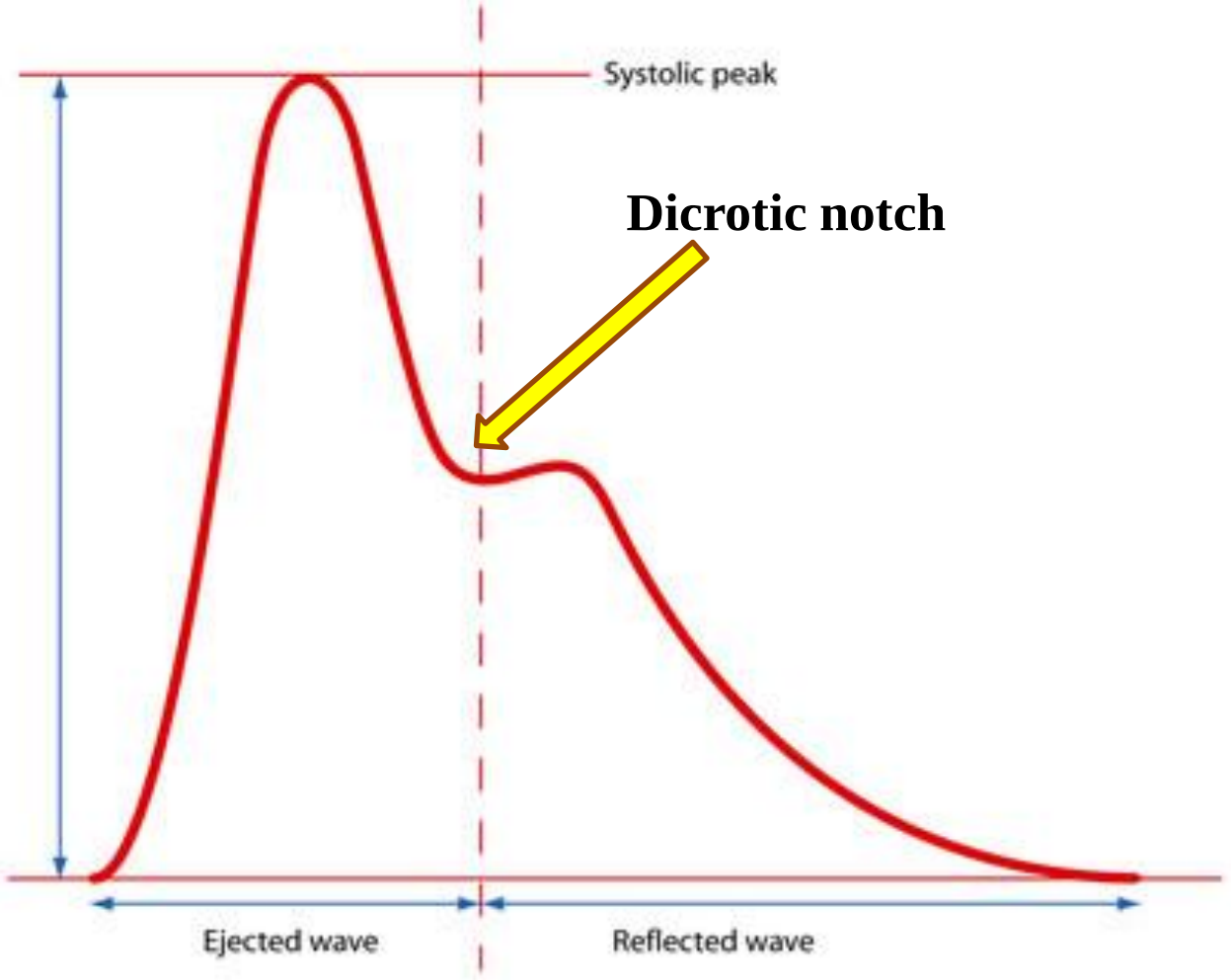




http://int-prop.lf2.cuni.cz/heart_sounds/ekg5/cham2.htm

LO4

Arterial pulse wave



(Systolic phase) **(Diastolic phase)**

http://www.centerforhearts.com/PULSE_WAVE.html

LO5

pulse wave

- Contraction of the ventricle generates a pulse wave.

- Propagates along the arteries faster than blood.

- felt at a variety of locations where arteries come close to the surface and can be pushed against a reasonably hard surface.

LO6

Resistance vessels

- Arterioles control blood flow to tissues by variable flow restriction.

- Walls of arterioles contain much SM.
- State of contraction determines lumen diameter → flow resistance.

- Vasoconstriction leads to ↓ in flow.
- Vasodilatation leads to ↑ in flow.

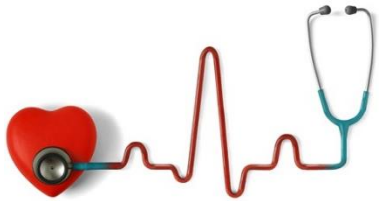
LO7

Vasoconstriction

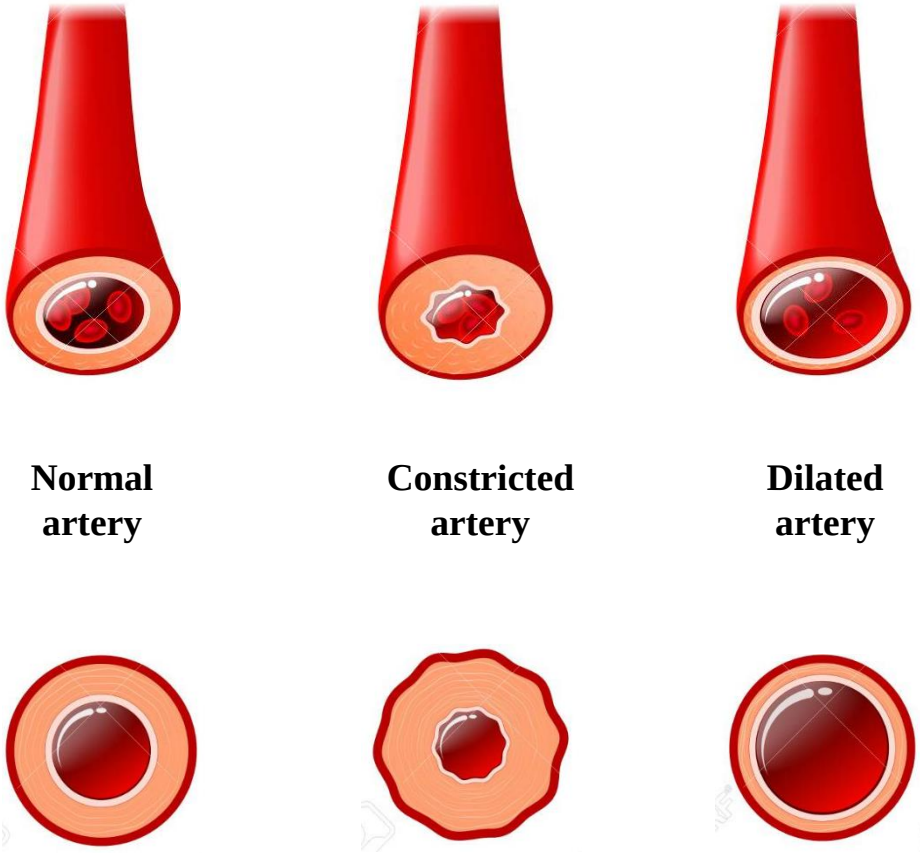
- Narrowing of blood vessels that results from contraction of the muscular walls of the vessels.

Vasodilatation

- widening of blood vessels that results from relaxation of the muscular walls of the vessels.



Vasodilatation and Vasoconstriction



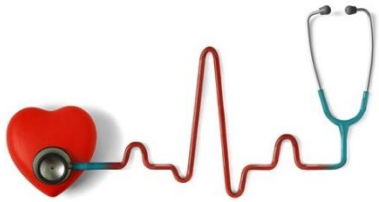
Normal artery

Constricted artery

Dilated artery

Vasomotor tone

- Muscles do not actively relax, so except under maximum flow conditions there must always be some vasoconstriction.
- Continuous contraction of the VSMCs is known as vasomotor tone.
- Vasomotor tone is mainly produced by the sympathetic branch of the ANS (α adrenergic receptors).

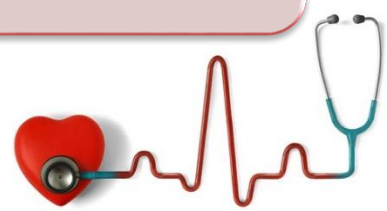


LO9

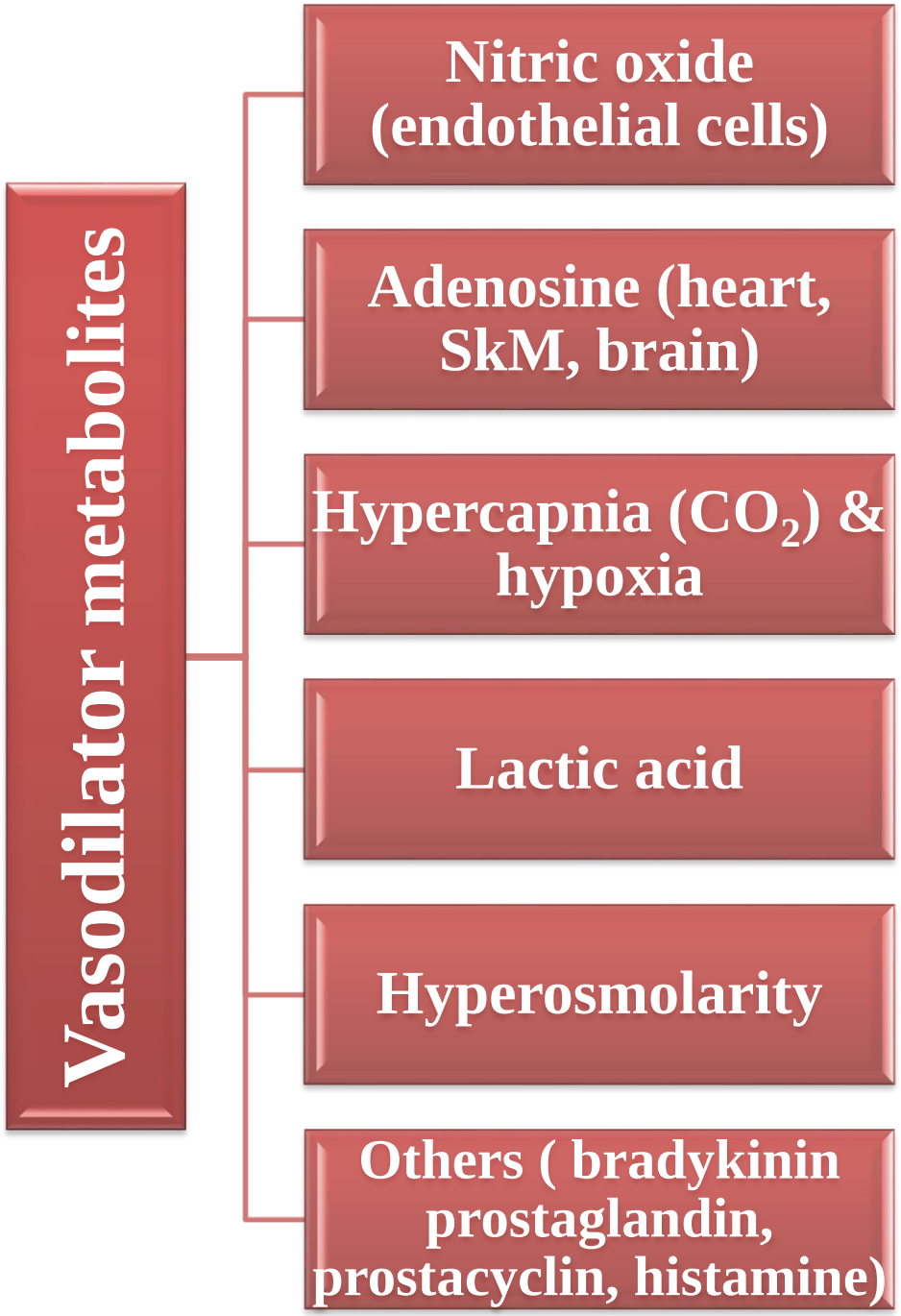
Vasodilator metabolites

Metabolically active tissues produce vasodilator metabolites (H^+, K^+, Adenosine)

- relaxation of local smooth muscle
- lowering resistance
- increasing blood flow



LO9

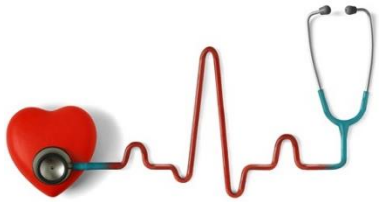

Vasodilator metabolites
Nitric oxide (endothelial cells)
Adenosine (heart, SkM, brain)
Hypercapnia (CO_2) & hypoxia
Lactic acid
Hyperosmolarity
Others (bradykinin prostaglandin, prostacyclin, histamine)

Reactive hyperaemia

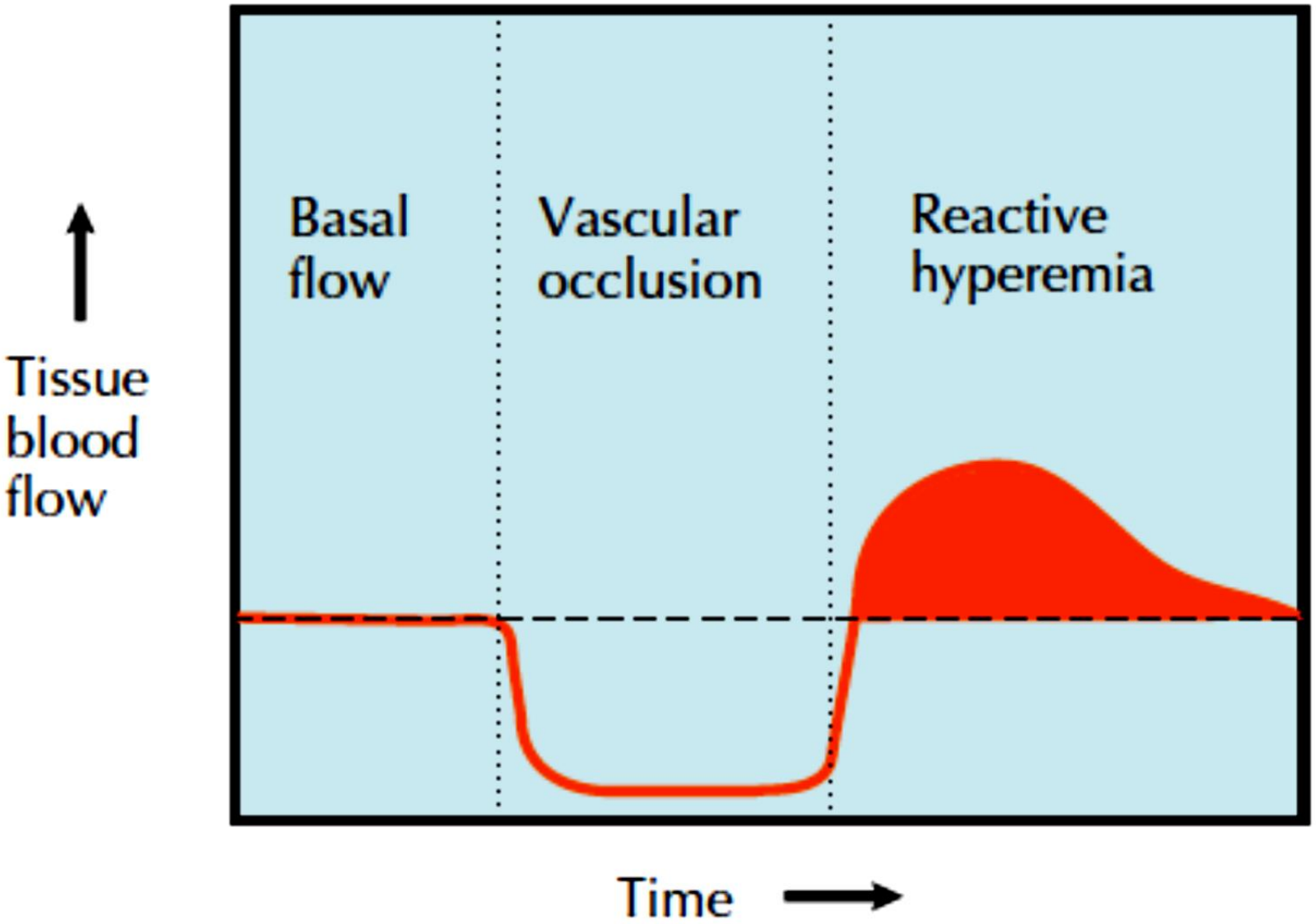
Circulation to an organ or tissue is cut off (1-2) minutes.

The organ or tissue continues metabolising & producing vasodilators (no circulation).

When circulation is restored, the local arterioles dilate maximally and blood flow is very high.

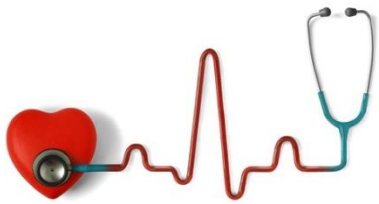


LO10

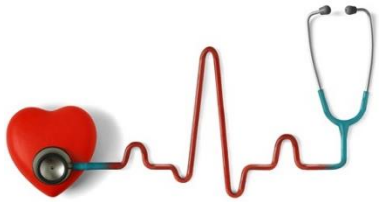

Basal flow
Vascular occlusion
Reactive hyperemia
Tissue blood flow
Time

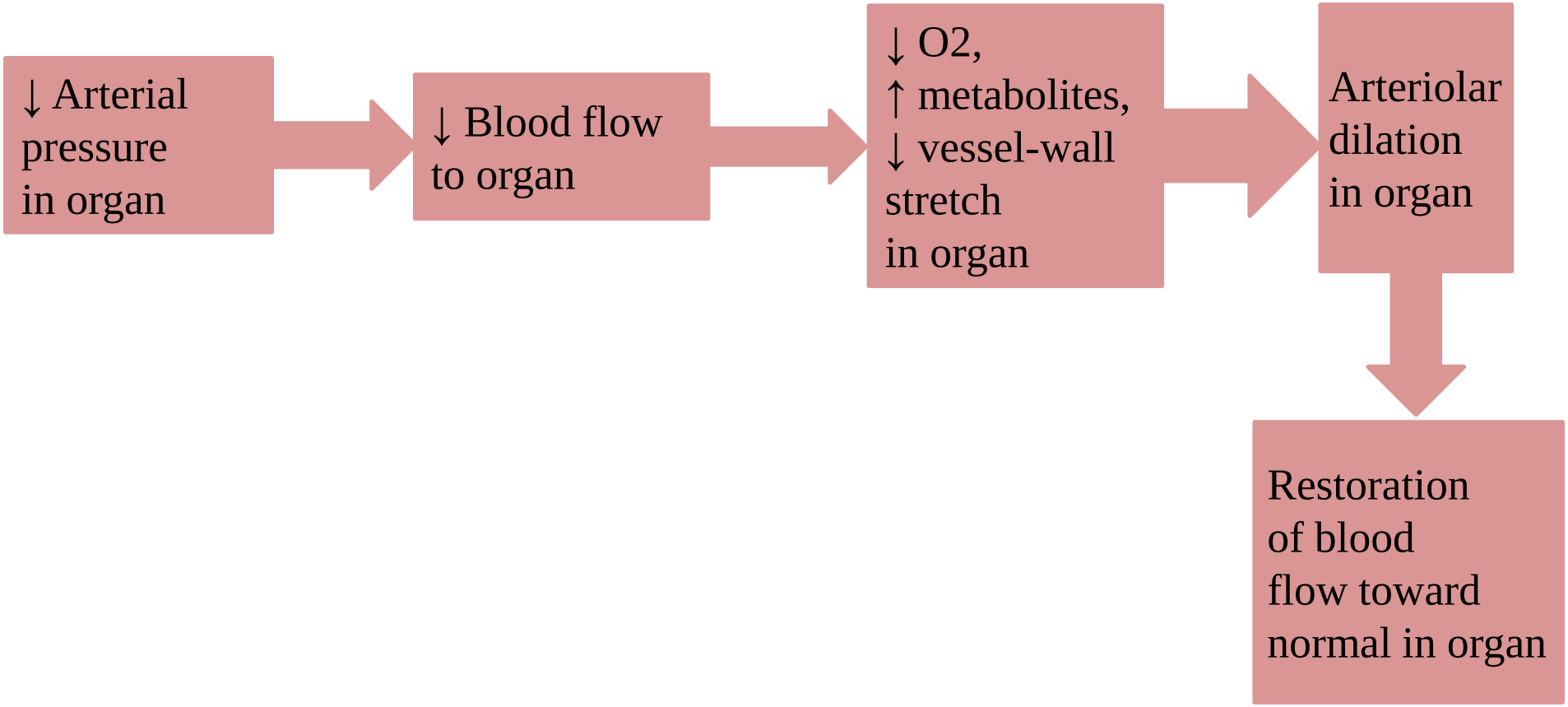
Autoregulation

- Autoregulation is the capacity of tissues to regulate their own blood flow.
- Vascular beds have an intrinsic capacity to compensate for moderate changes in perfusion pressure.
- The contraction of VSMCs that underlies autoregulation is autonomous.
- That is entirely local control.

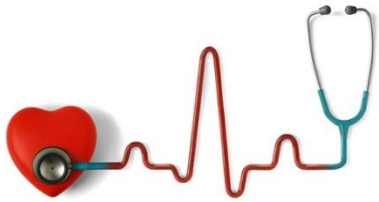


- Independent of neural or endocrine mechanisms.
- Both myogenic & metabolic mechanisms play an important role.
- Autoregulation is very important for brain, heart & kidneys. It has also been observed in the mesentery, skeletal muscles and liver.





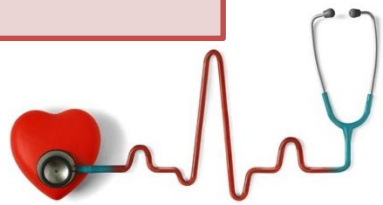
- **↑ in BP would produce opposite changes**



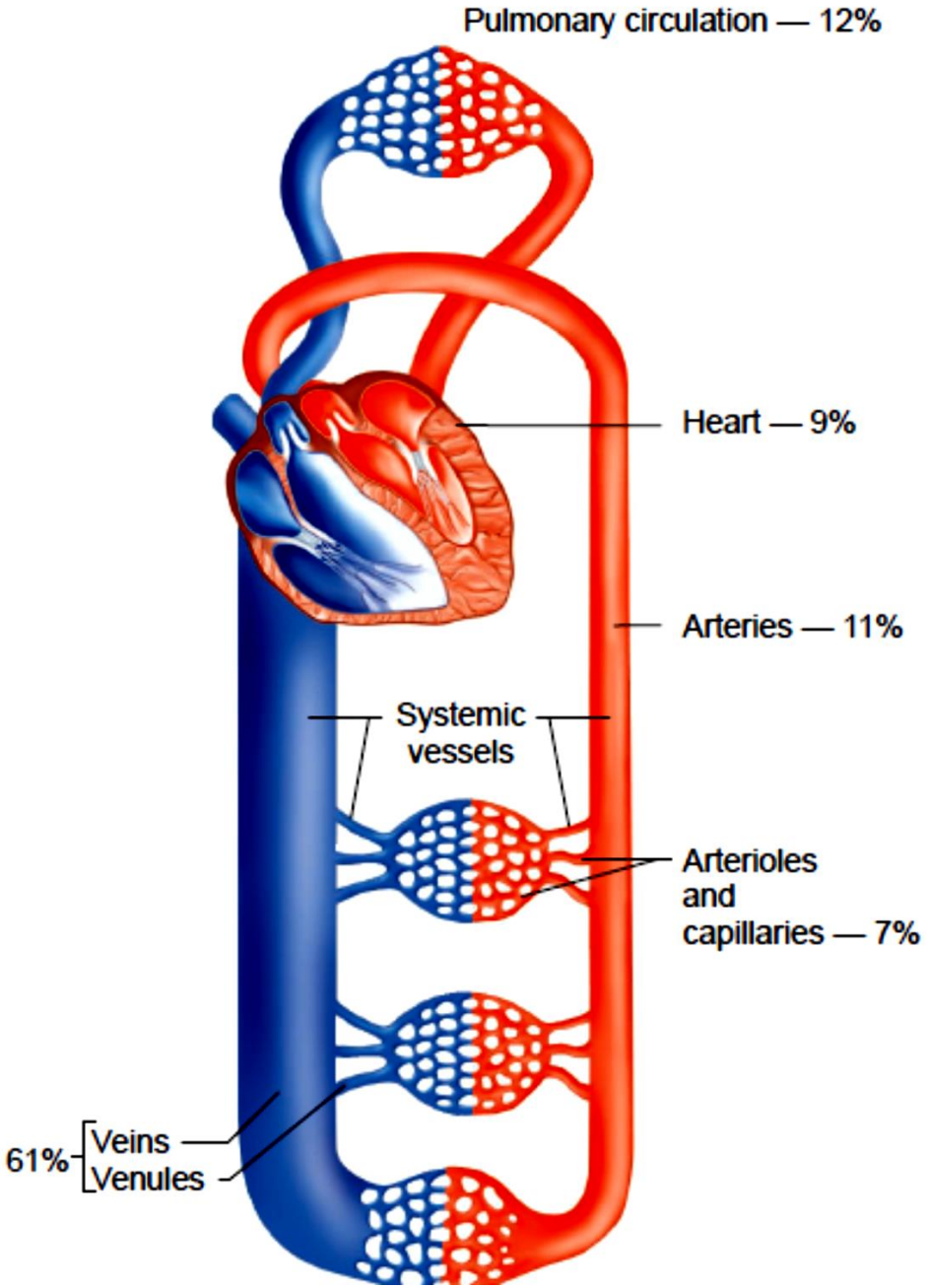
LO12

Veins

- Veins serve as low-resistance conduits for venous return and they are high capacitance vessels.
- The pressure in veins is much affected by volume of blood they contain.
- The veins contain most of blood in the vascular system.



LO12

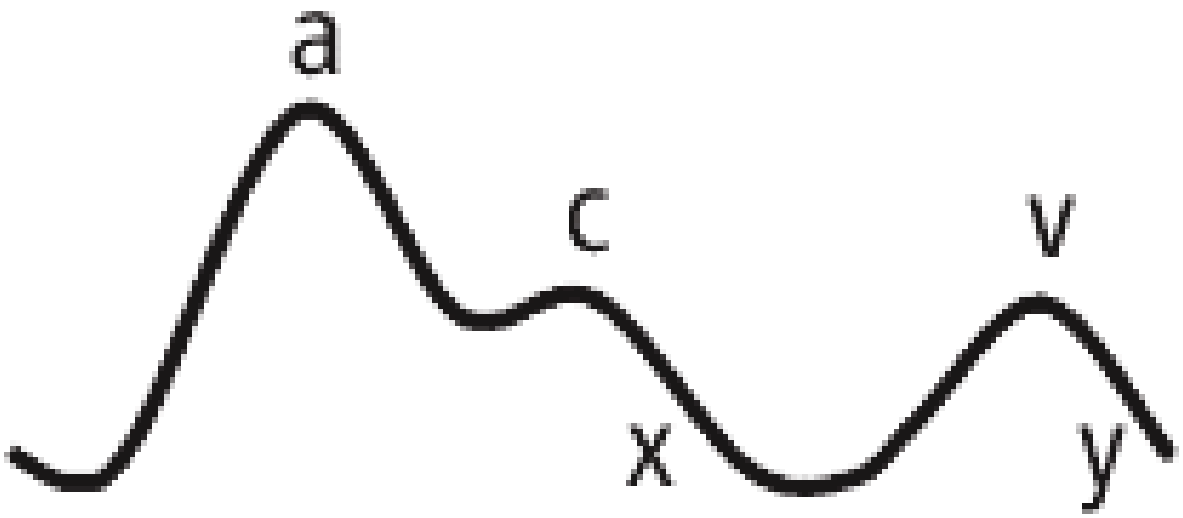

Pulmonary circulation — 12%
Heart — 9%
Arteries — 11%
Systemic vessels
Arterioles and capillaries — 7%
61%
Veins
Venules

Central venous pressure

- **The P. in the great veins supplying the heart.**

LO12

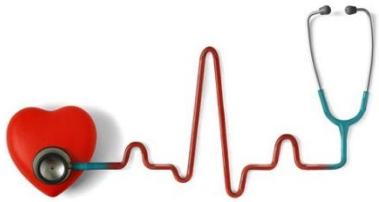
Central venous pressure



https://www.semanticscholar.org/paper/Central-venous-pressure-monitoring.-Chow-Dilley/a5cfc1f12a1b50a0b7f781c942bc92563d3767d3

Venous return

- The rate of blood flow back to the heart.



Thank you