Introduction to circulatory system

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Outline

- components of cardiovascular systems
- systemic circulation
- pulmonary circulation
- blood vessels
- blood pressure & blood flow
- pulse pressure

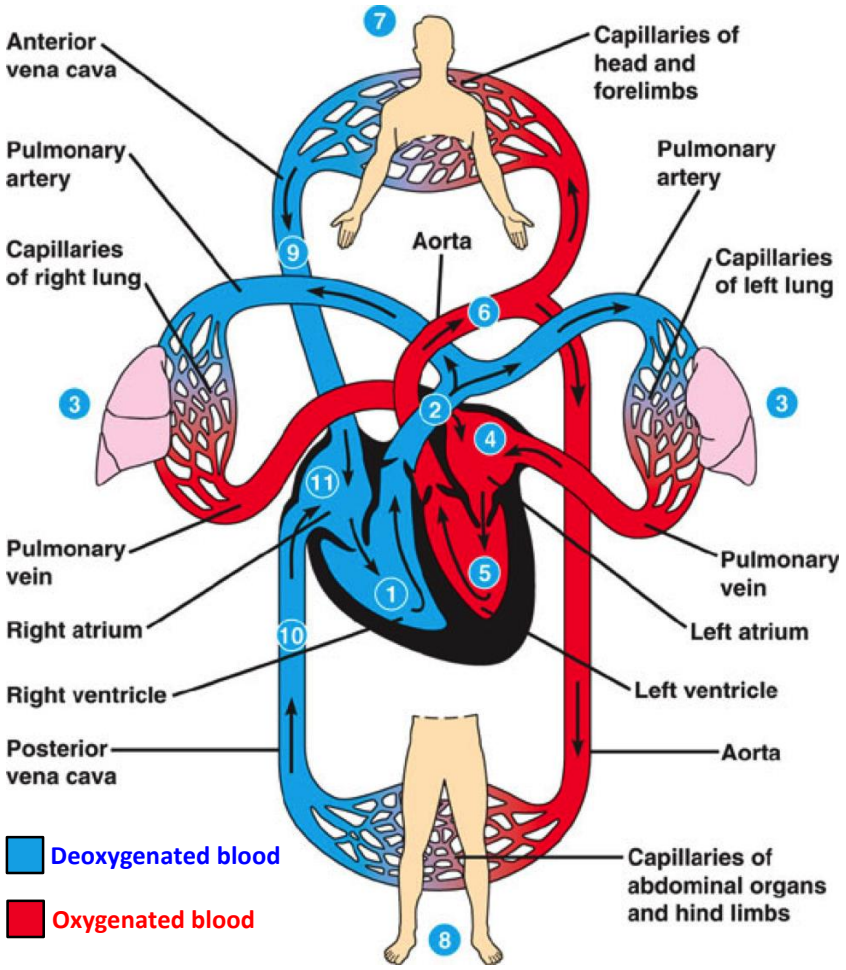
What cardiovascular system can do for us?

- to transport **nutrients** & **O_2** (by red blood cells)
- to transport **waste** such as
  - **urea to kidney**
  - **carbon dioxide to lung**

  → for disposal
- to control **body temperature**
- to transport **hormone** to target organs/tissues.
- to deliver **white blood cells** & **antibodies**
- to deliver **clotting factors** & **platelets**

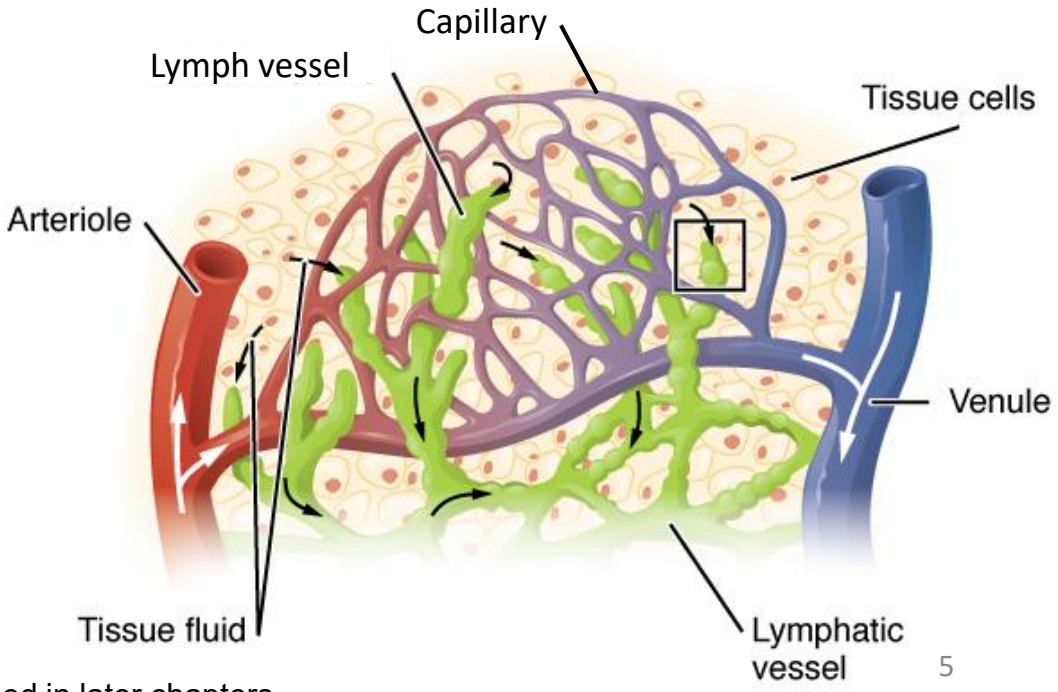
Components of cardiovascular system

- **heart**
  - functions as a **p _ _ _** to systemic & pulmonary circulations.
- **arteries**
  - carry blood **away from heart**
  - carry **oxygenated blood** except **pulmonary arteries** & **umbilical artery**
- **veins**
  - carry **blood back to heart**
  - carry **deoxygenated blood** except **pulmonary veins** & **umbilical vein**



Components of cardiovascular system

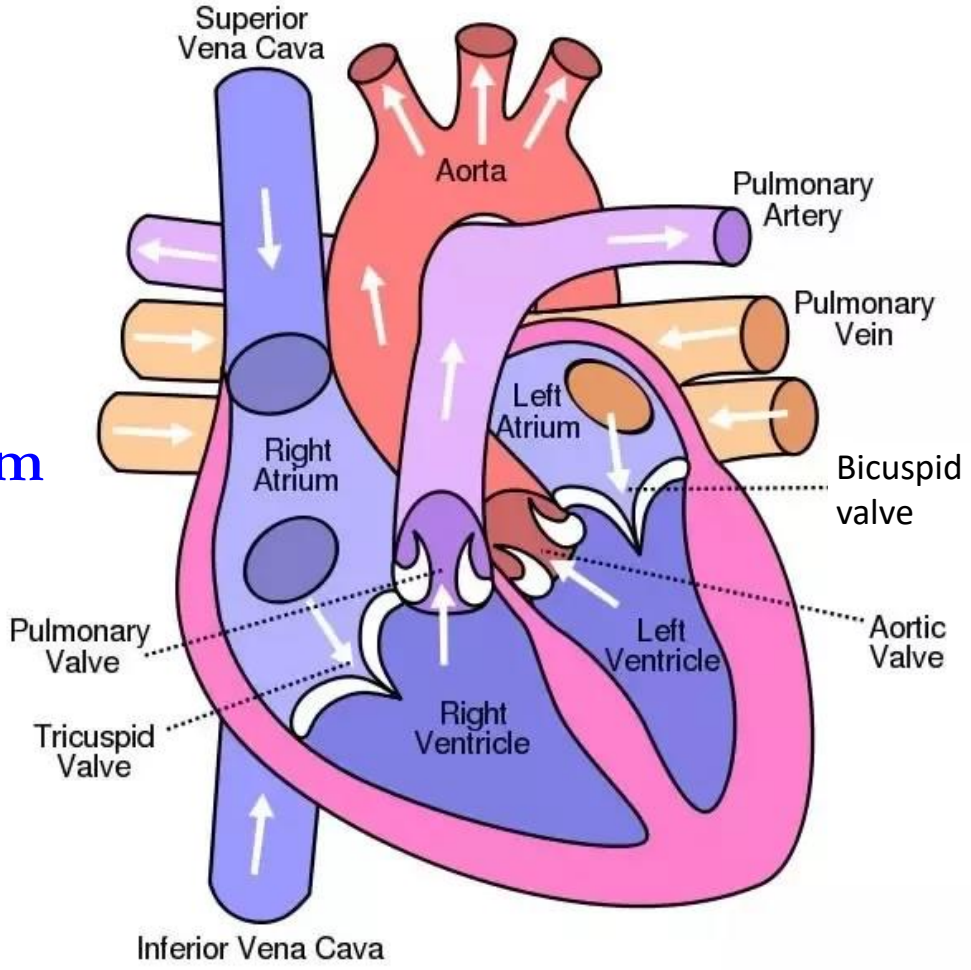
- **micro-circulation**
  - in every organs
  - **composed of arterioles, capillaries & venules**
  - **region of material exchange (nutrients, oxygen, wastes)**



Note: What is the use of lymphatic system? Will be discussed in later chapters…

The heart: structure

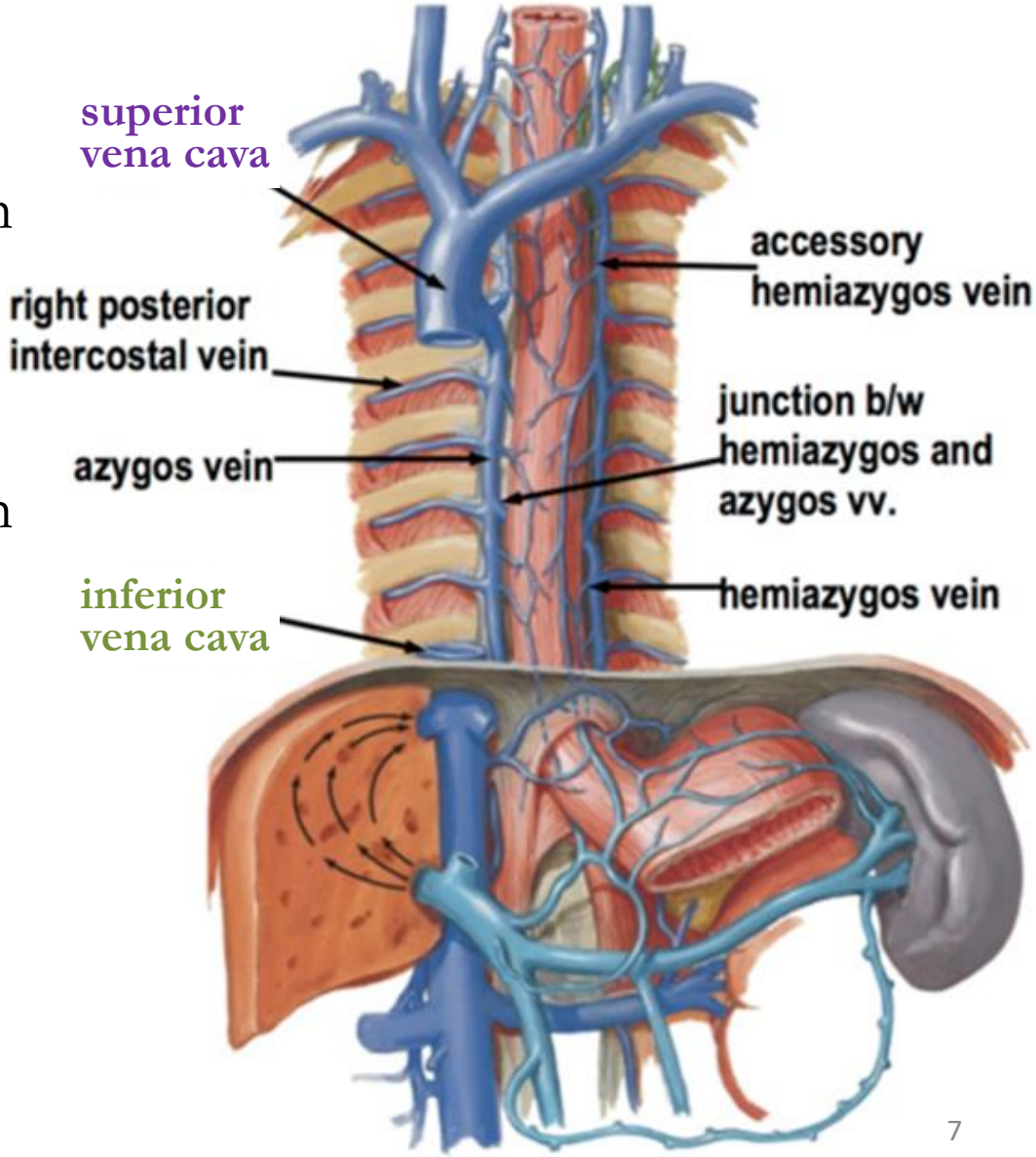
- four chambers:
  - two atria:
    - ➢ **right atrium receives from superior vena cava & inferior vena cava**
    - ➢ **left atrium receives from pulmonary veins**
  - two ventricles:
    - ➢ **right ventricle → pulmonary arteries → lung**
    - ➢ **left ventricle → aorta → systemic circulation → organs**



Superior vena cava, inferior vena cava

- superior…
  receives venous blood from organs **above** diaphragm

- inferior…
  receives venous blood from organs **below** diaphragm



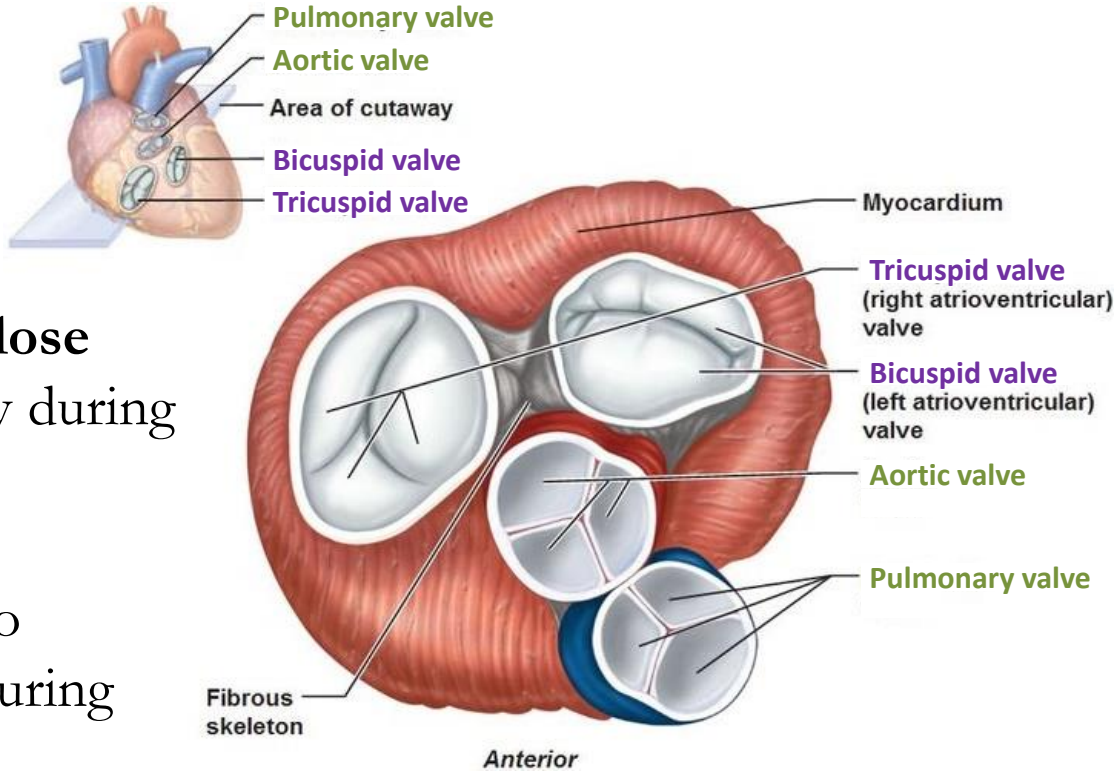
Additional info: blood filling into ventricles

Why not mention contraction of atria ?

Can atrial contraction pump the blood to ventricles?

- Yes….but only 20% of blood
- blood is mainly filled into ventricles by
  - v _ _ _ _ _ _ _ _ _ _ _ r _ _ _ _ _ _ _ _ _ _ because:
    - atria are fully filled with blood,
      atria pressure > ventricular pressure, blood → ventricles
    - (at the same time,) ventricles relax that creates suctional force to draw atrial blood

The heart: structure



- **Two pairs of heart valves:**
  - **atrioventricular valves close** to prevent blood backflow during **ventricular contraction**
  - **semilunar valves close** to prevent blood backflow during **ventricular relaxation**

Additional info: heart sounds

- two heart sounds in each heartbeat:
  - closure of atrioventricular valves followed by
  - closure of semilunar valves

Pulmonary VS systemic circulations

- **pulmonary circulation**
  - **lower blood pressure** (SP/DP: 24/10) &
  - **lower resistance**
    - **pulmonary vessels are shorter & wider**

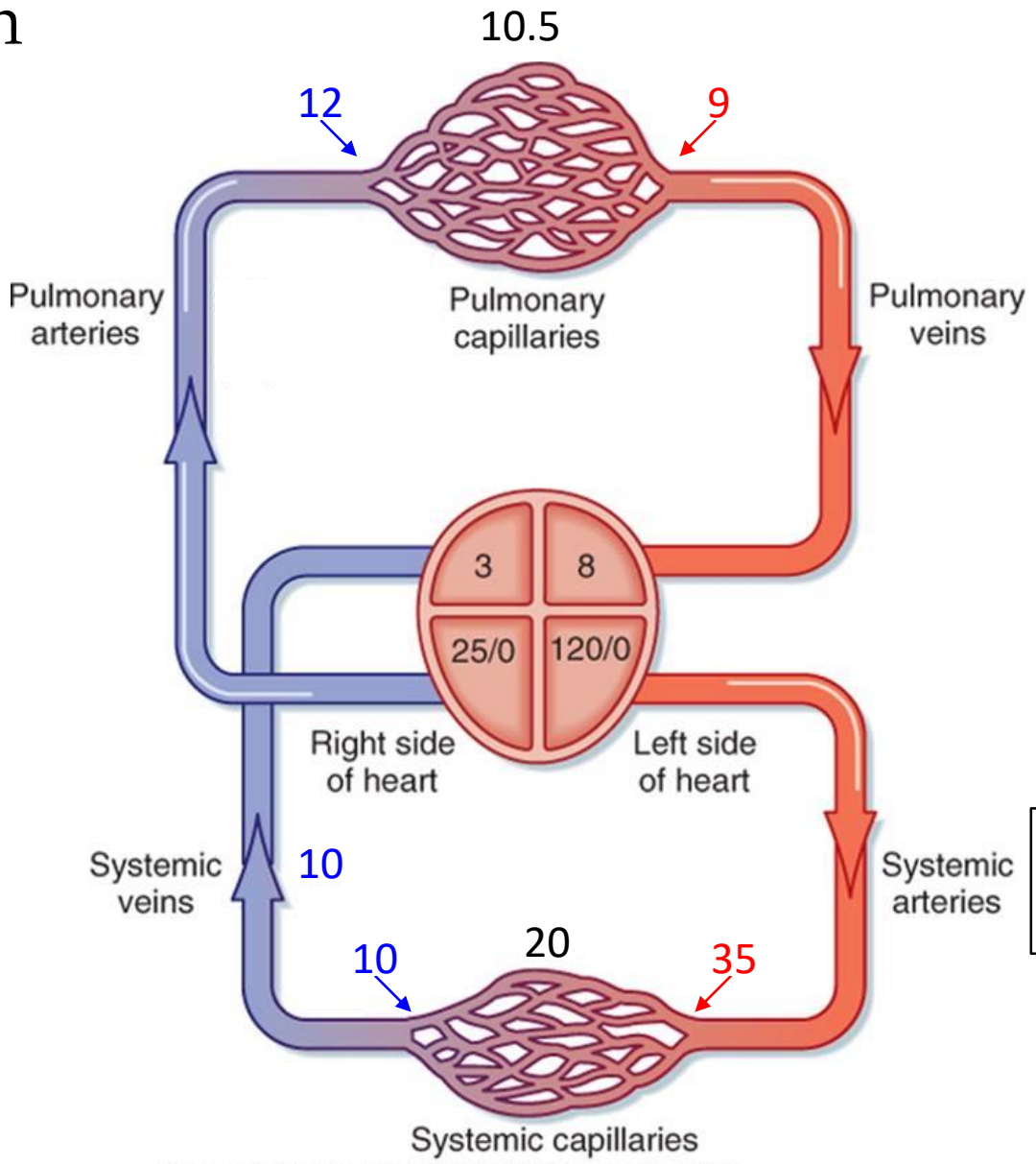
  - opposite oxygenation
    - pulmonary **arterial** blood: **deoxygenated** while
    - pulmonary **venous** blood: _____

  - **vasodilation & vasoconstriction mainly depending on blood oxygenation** rather than hormones such as adrenaline

  - higher / lower / same **blood flow** ?

Additional info: more about pulmonary & systemic circulation

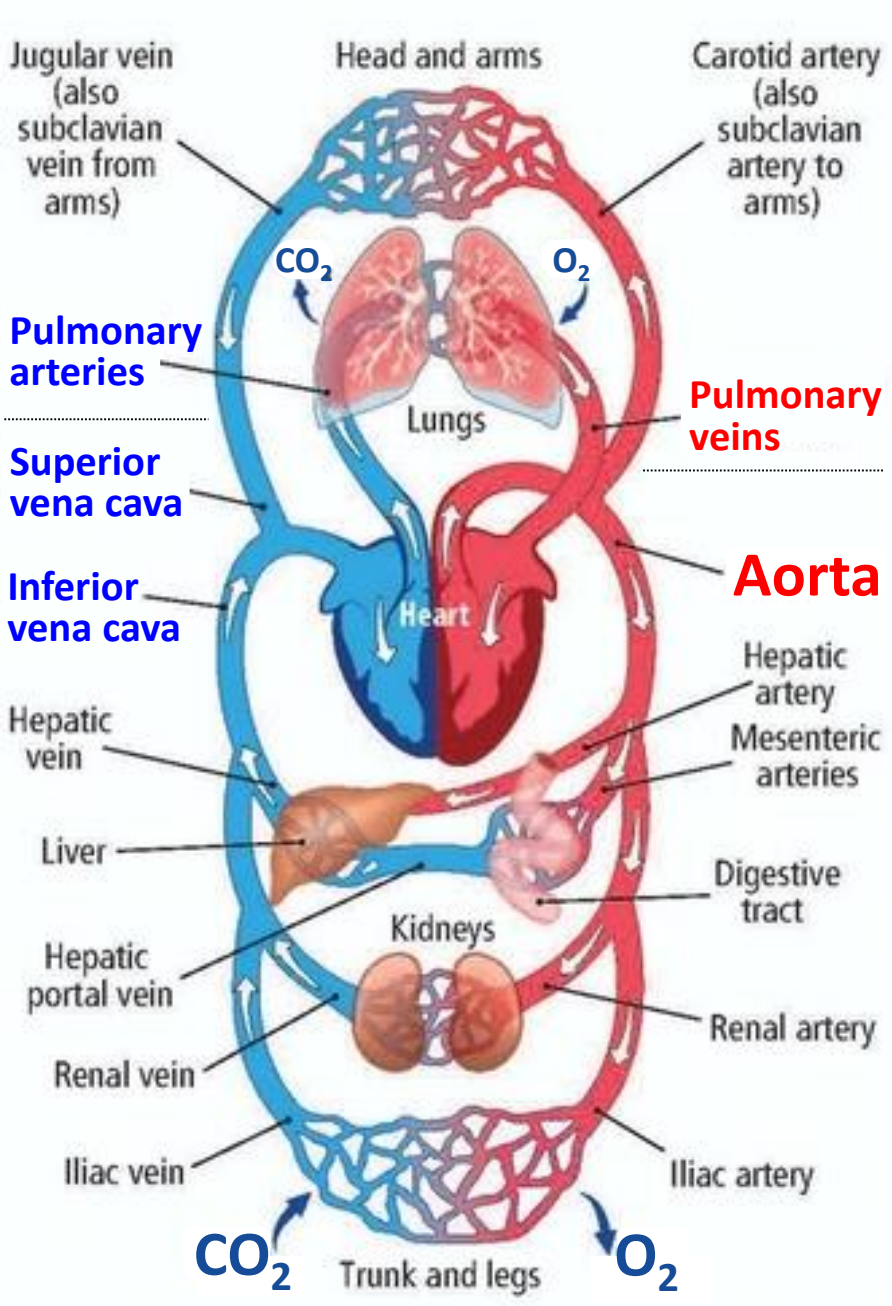
SP/DP: 24/10
Mean: 15



SP/DP: 120/80
Mean: 90

Blood circulation

- no matter pulmonary or systemic circulation
  - blood is supplied to every organ in **parallel**, to make sure
    - ➢ **same arterial composition** (O_2, CO_2, pH, glucose…)
    - ➢ **similar arterial pressure**

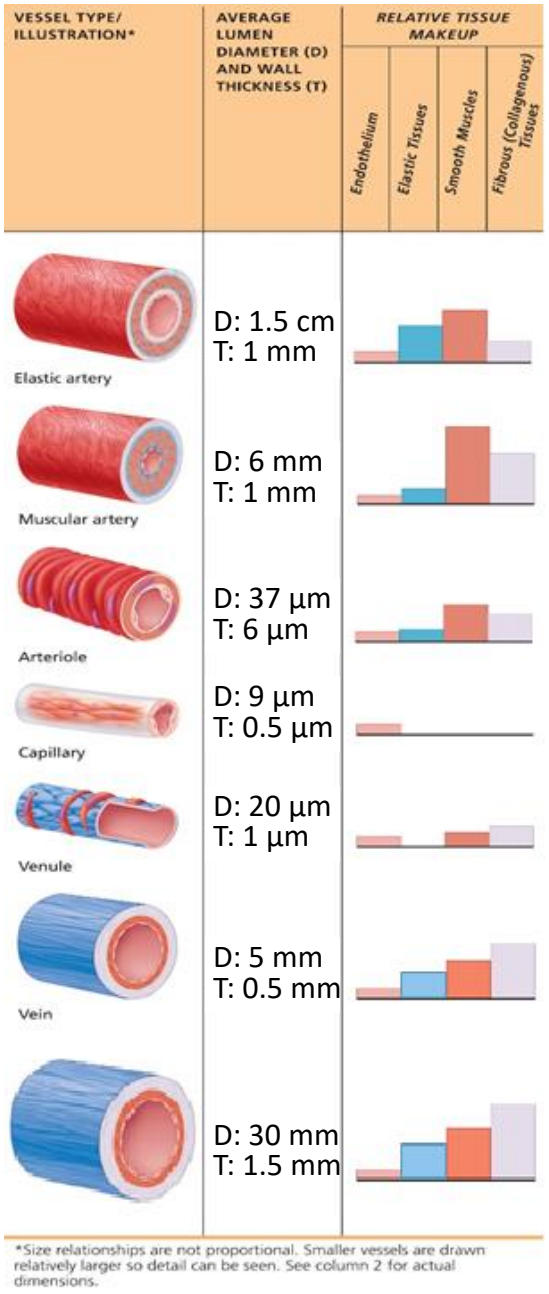


Blood vessels: three main types

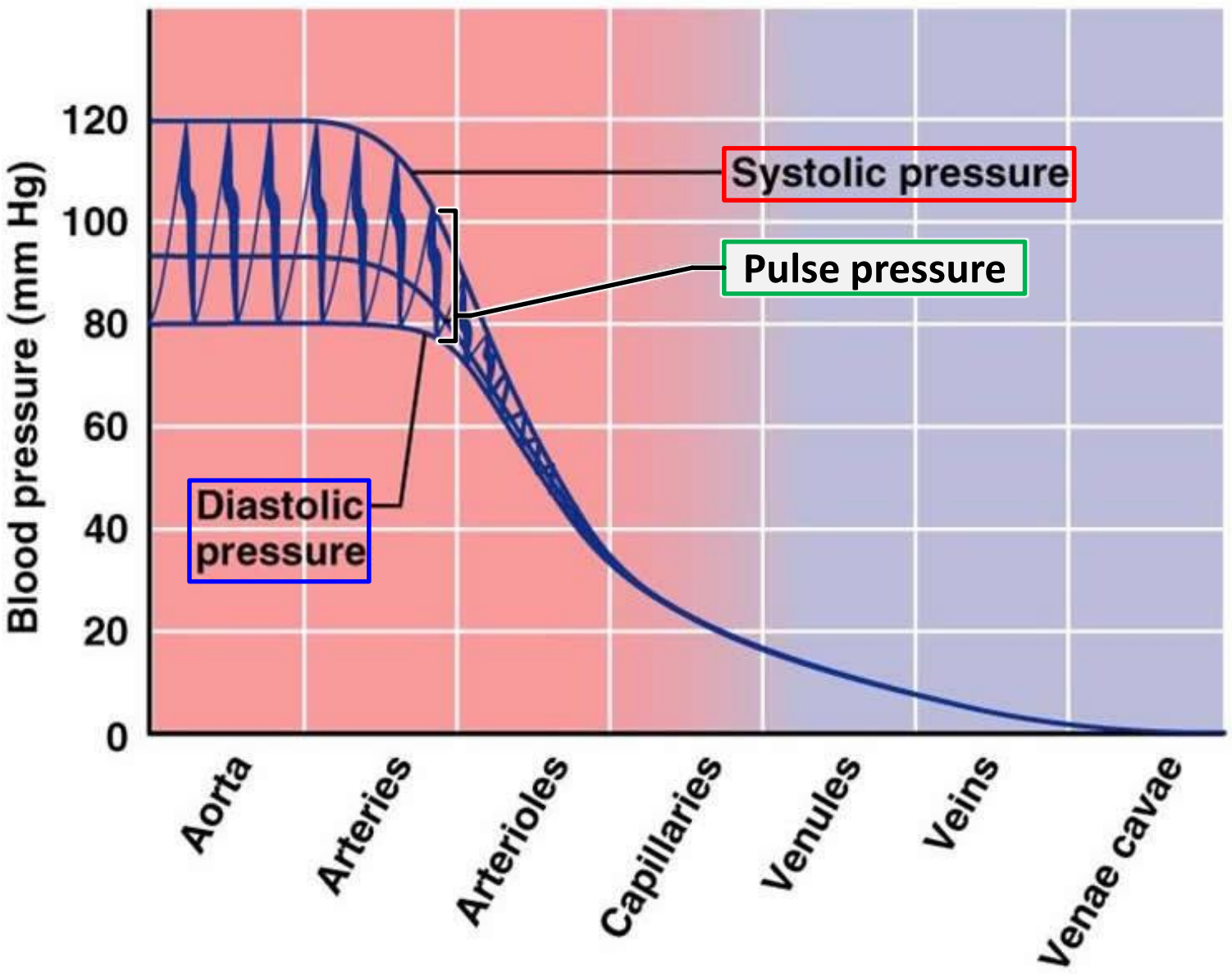
- arteries
  - **muscular for high blood pressure**
  - **control blood flow** to various organs by **vasoconstriction or vasodilation**

- capillaries
  - **material exchange**

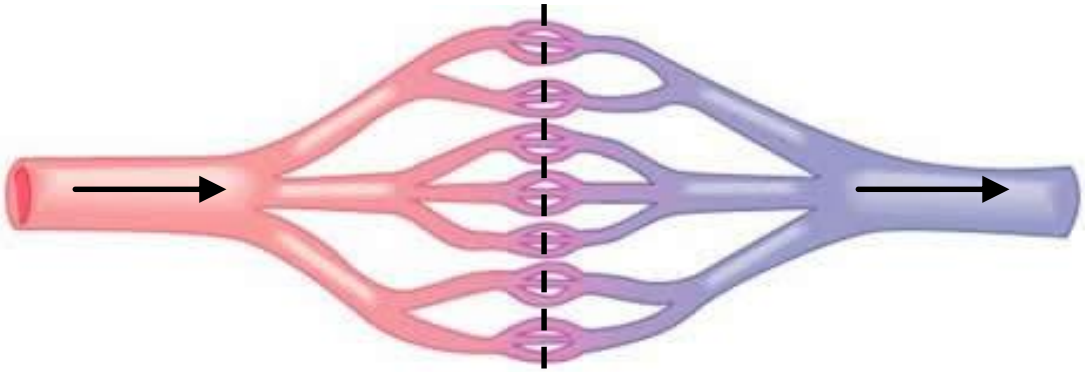
- veins
  - less muscular but
  - **relatively more elastic fibers**
    - ➢ **much more distensible** (~20X) **than arteries**
      - ❖ act as **reservoir** to store ~70% of circulating blood



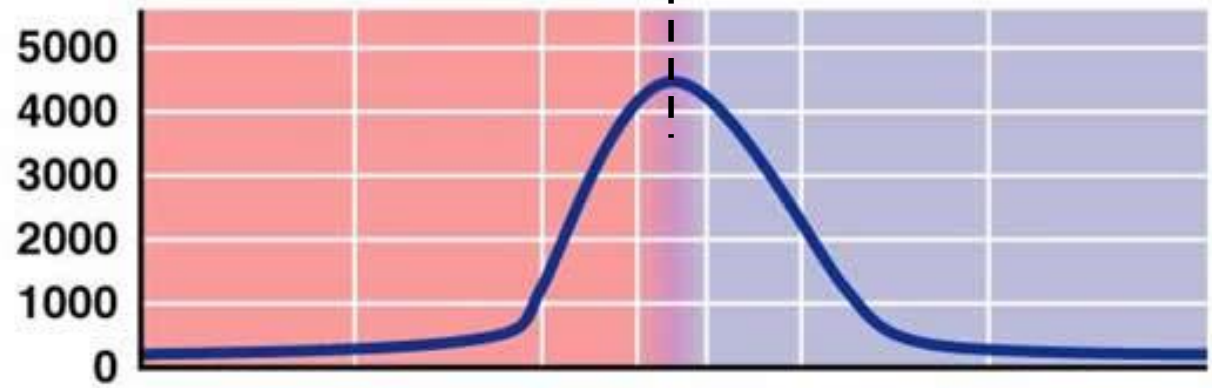
Blood pressure and blood flow



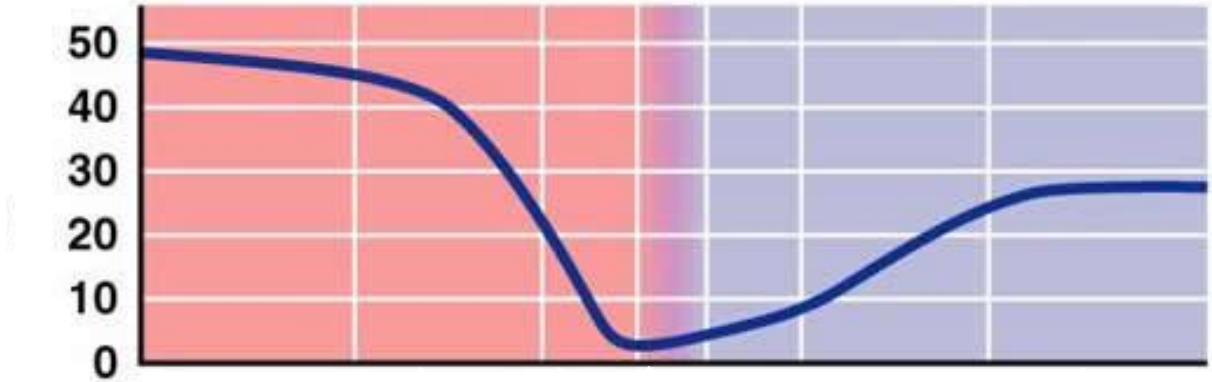
Relative cross sectional area of each vessel



Total cross sectional area (cm^2) of vascular bed



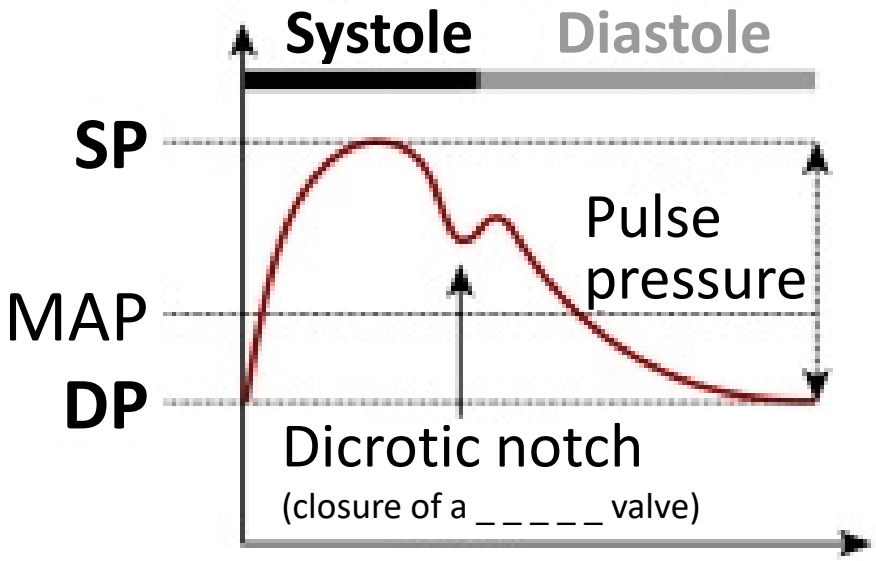
Blood flow in each vessel (cm/sec)



Aorta
Arteries
Arterioles
Capillaries
Venules
Veins
Vena cavae

Pulse pressure

= (SP) **systolic pressure** − (DP) **diastolic pressure**



Normal value:

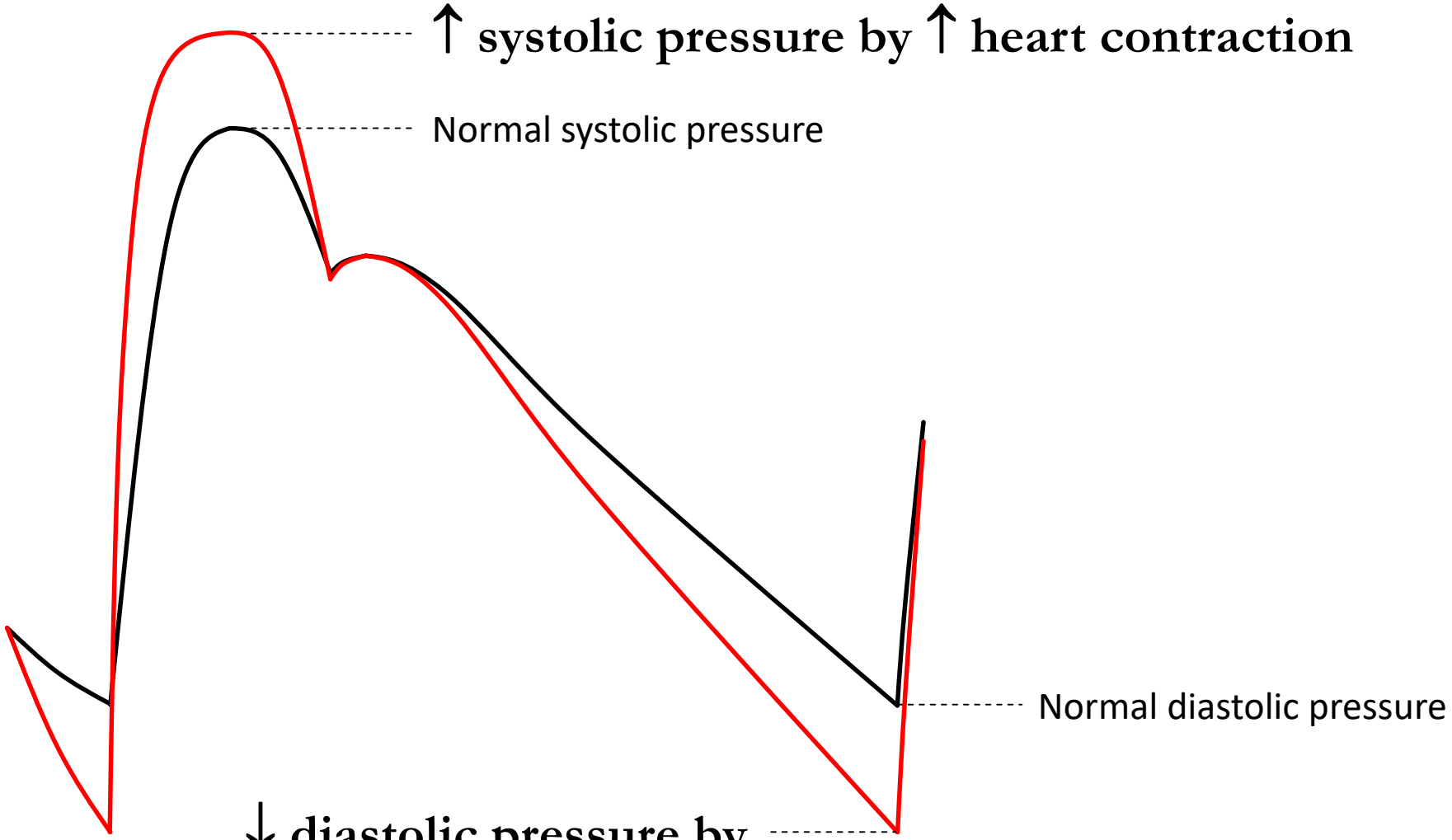
- systolic: ~120mmHg ;
- diastolic: ~80mmHg
- pulse pressure: ~40mmHg (30 – 50mmHg)

Implications of cardiovascular conditions:

systolic pressure ⇗ **contractile strength of heart**

systolic pressure ⇖ **resistance of blood vessels** ⇨ **diastolic pressure**

Pulse pressure: physiological change during exercise



Pulse pressure: pathological change

Wide: ≥ 60 mmHg

- **increase in systolic pressure and/or decrease in diastolic pressure**

Narrow: ≤ 25 mmHg

- **decrease in systolic pressure and/or increase in diastolic pressure**

Does blood flow increase/decrease in narrowed pulse pressure?

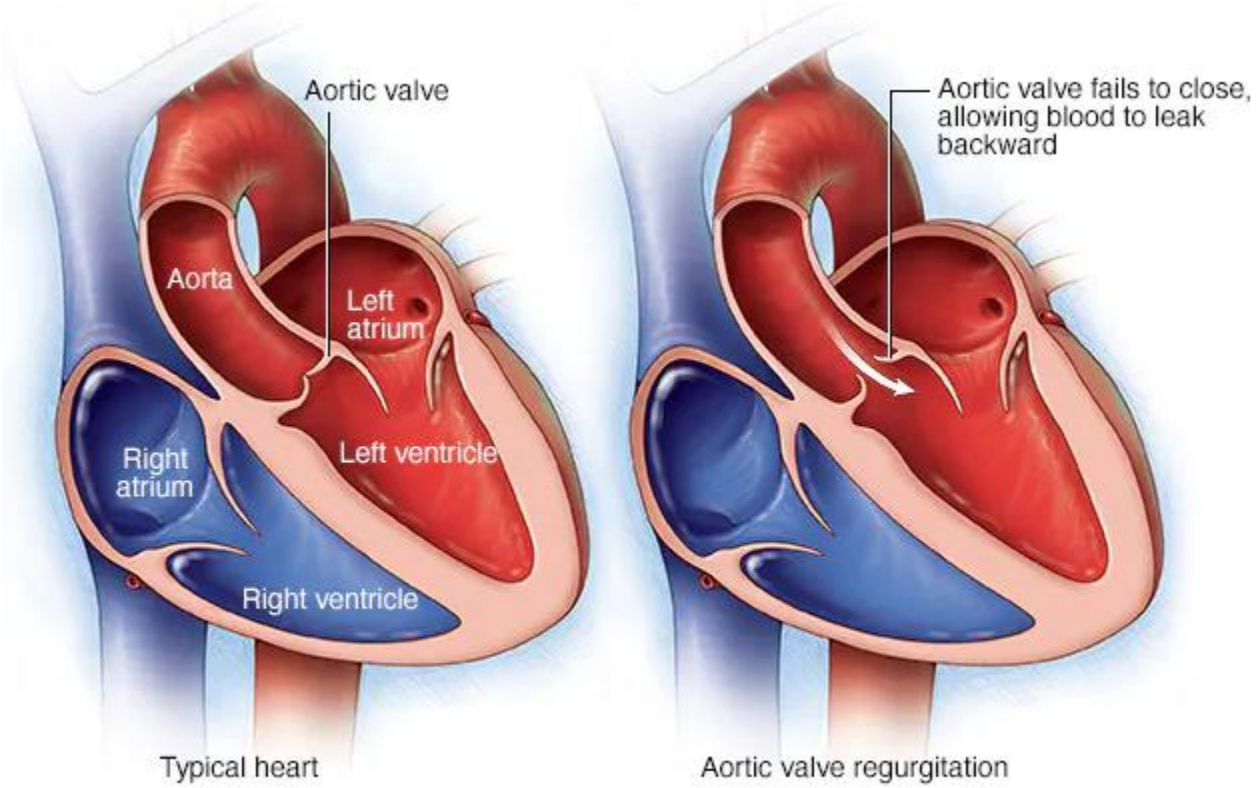
Does blood flow increase/decrease in widened pulse pressure?

Aortic regurgitation

- aortic valve cannot close properly during ventricular relaxation

Blood flow: ⇧/⇩ ?

Pulse pressure: **w**ide / narrow ? SP ? DP?



Aortic stenosis

- aortic valve cannot open properly during ventricular contraction

Blood flow: ⇧/⇩ ?

Pulse pressure: wide / narrow ?