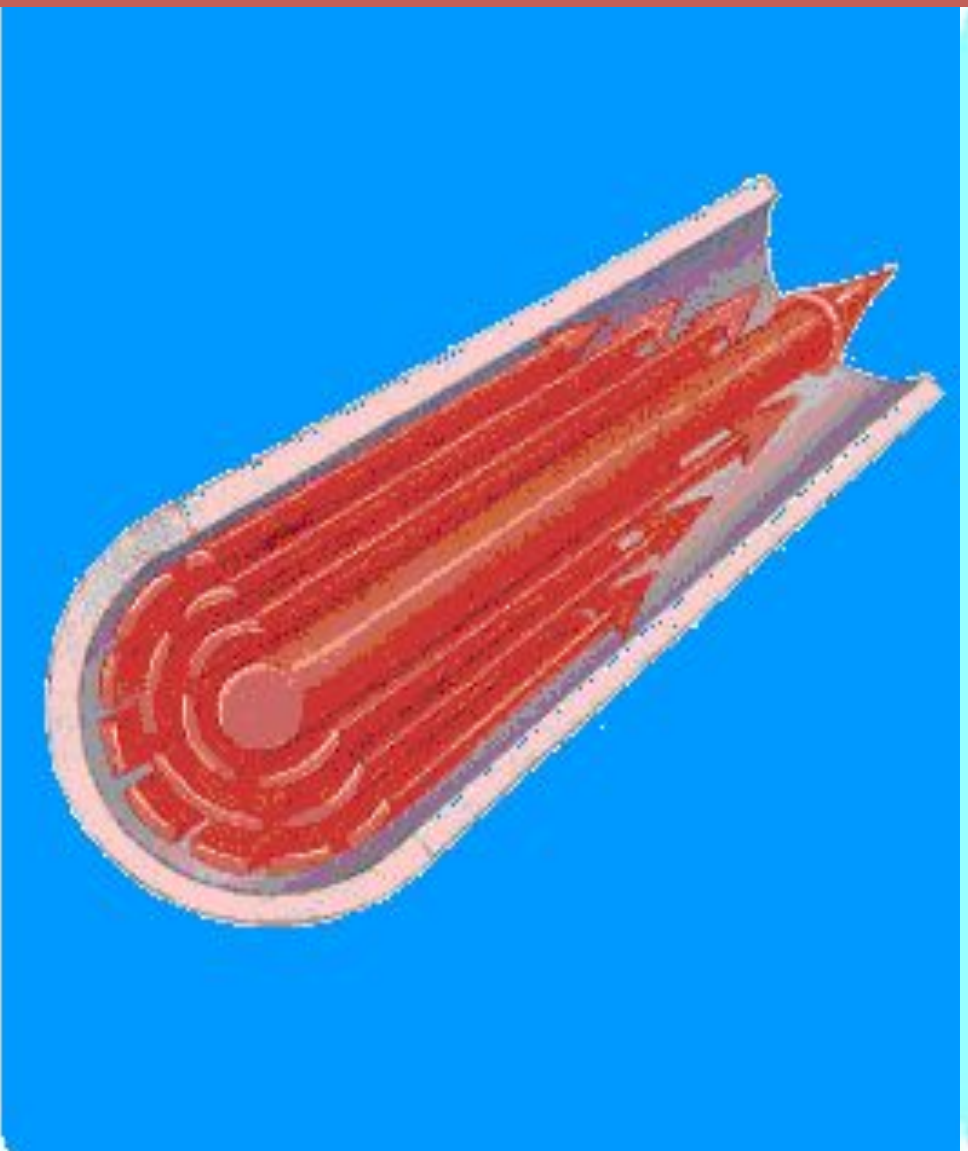
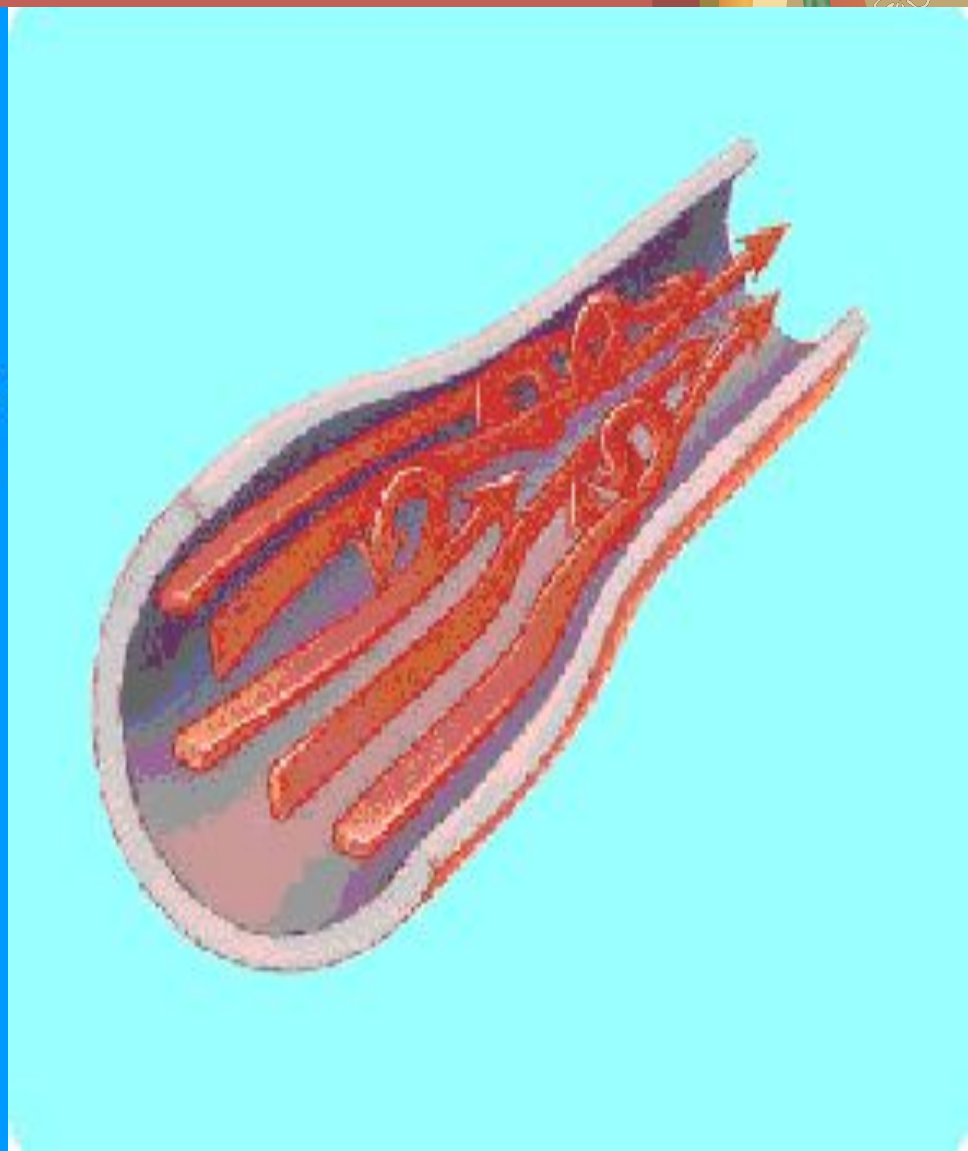
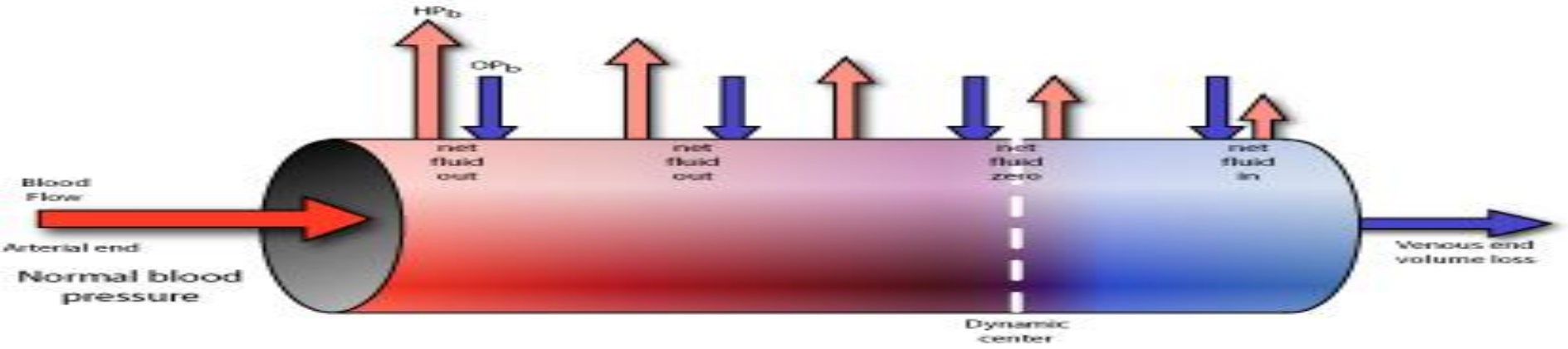
Physiological bases of hemodynamic.

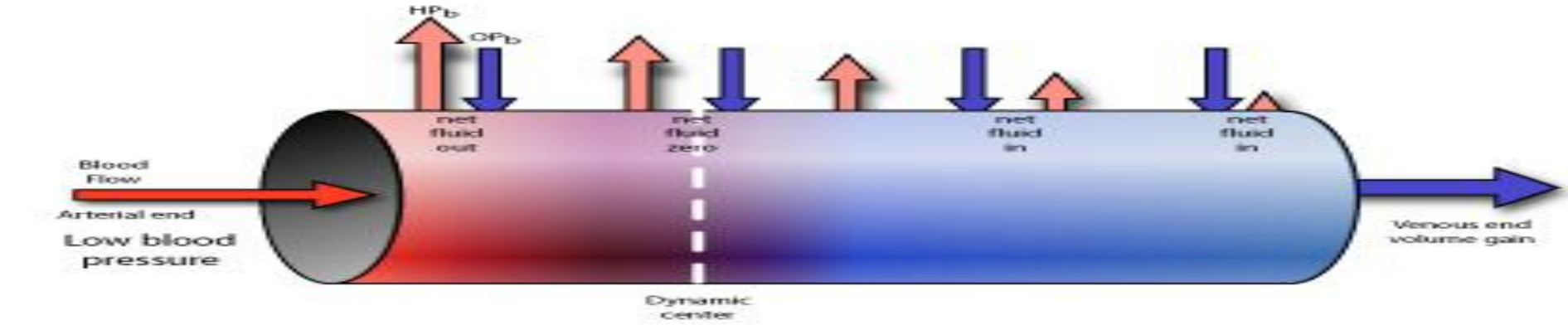
Kinds of blood movements

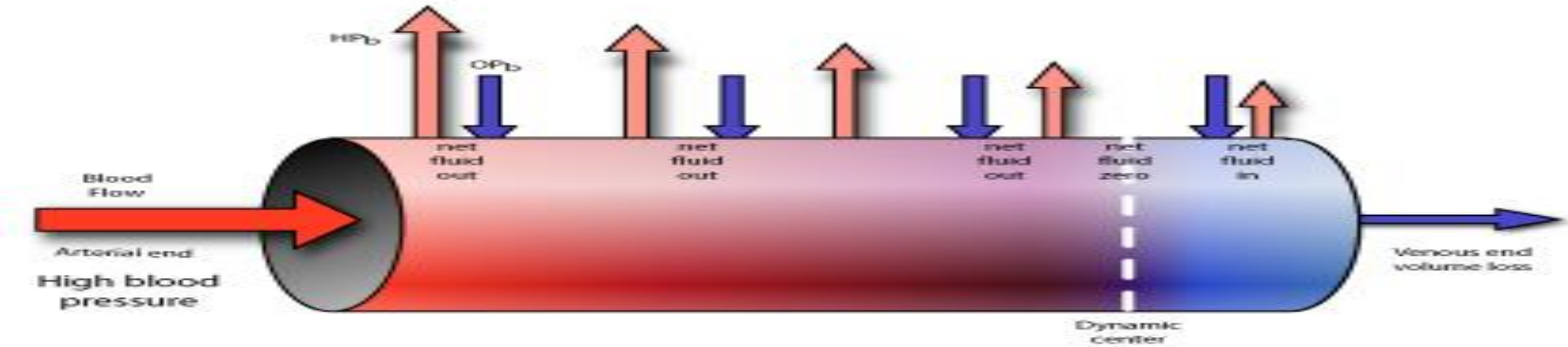




Capillary Dynamics





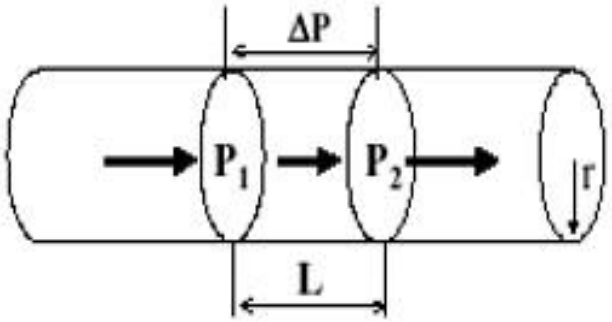


Formulas of hemodynamic

$$Q = \frac{\pi r^4 * P}{8\eta * l},$$

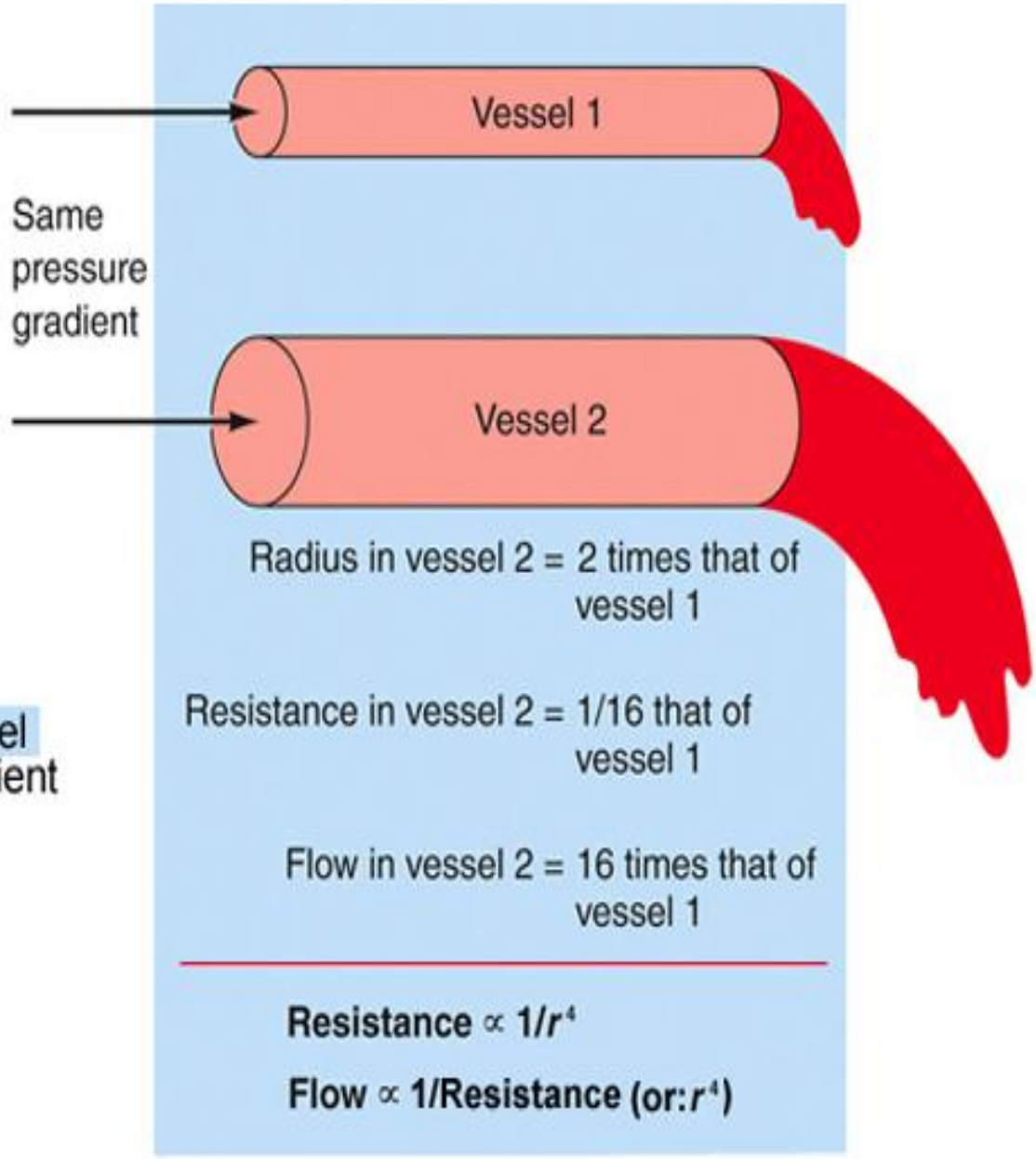
$$R = \frac{8\eta l}{\pi r}.$$

Poiseuille's Law



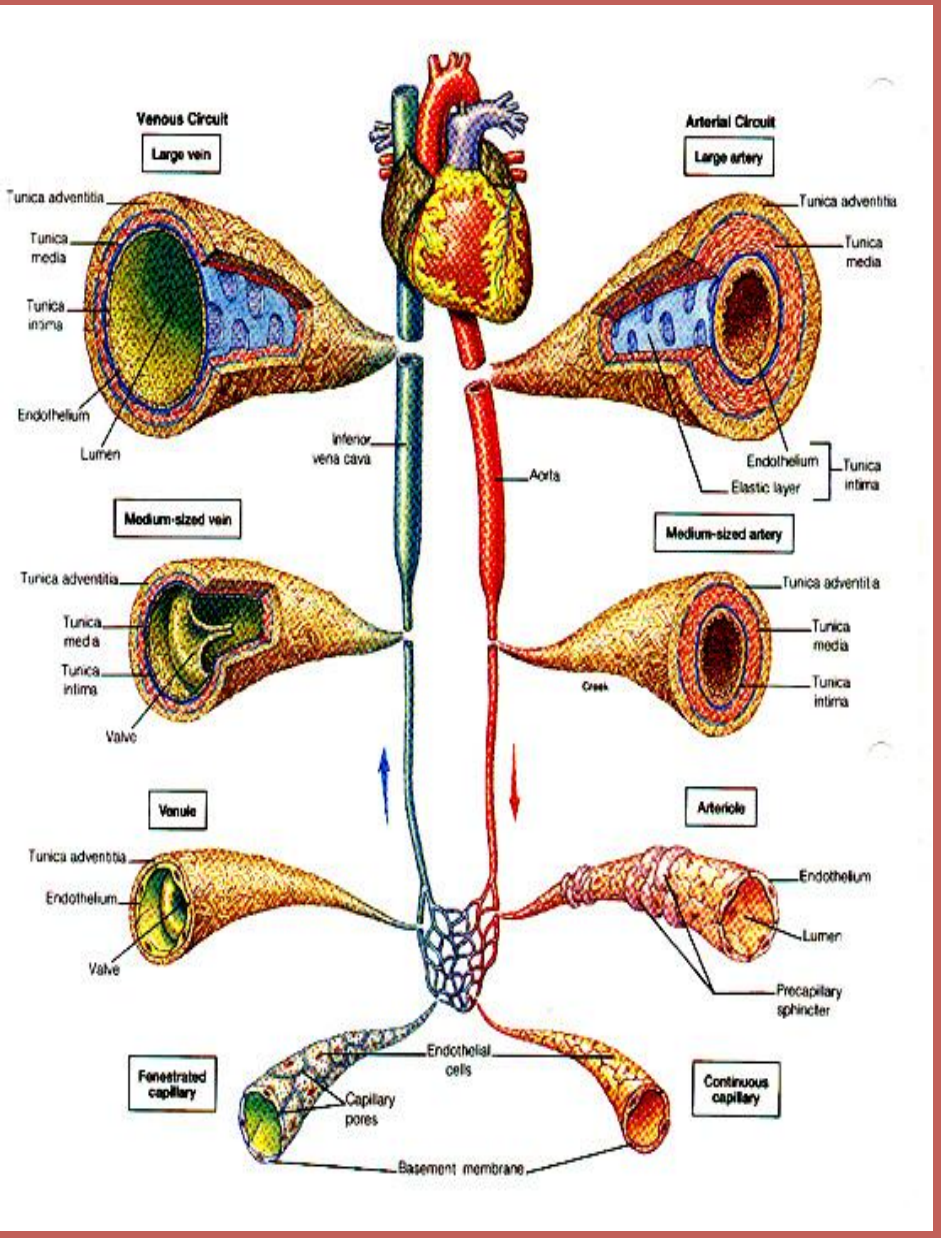
$$\text{Flow} \propto \frac{\pi \, \Delta P \, r^4}{8 \, \eta \, L}$$

r	radius of vessel
ΔP	pressure gradient
η	viscosity
L	vessel length

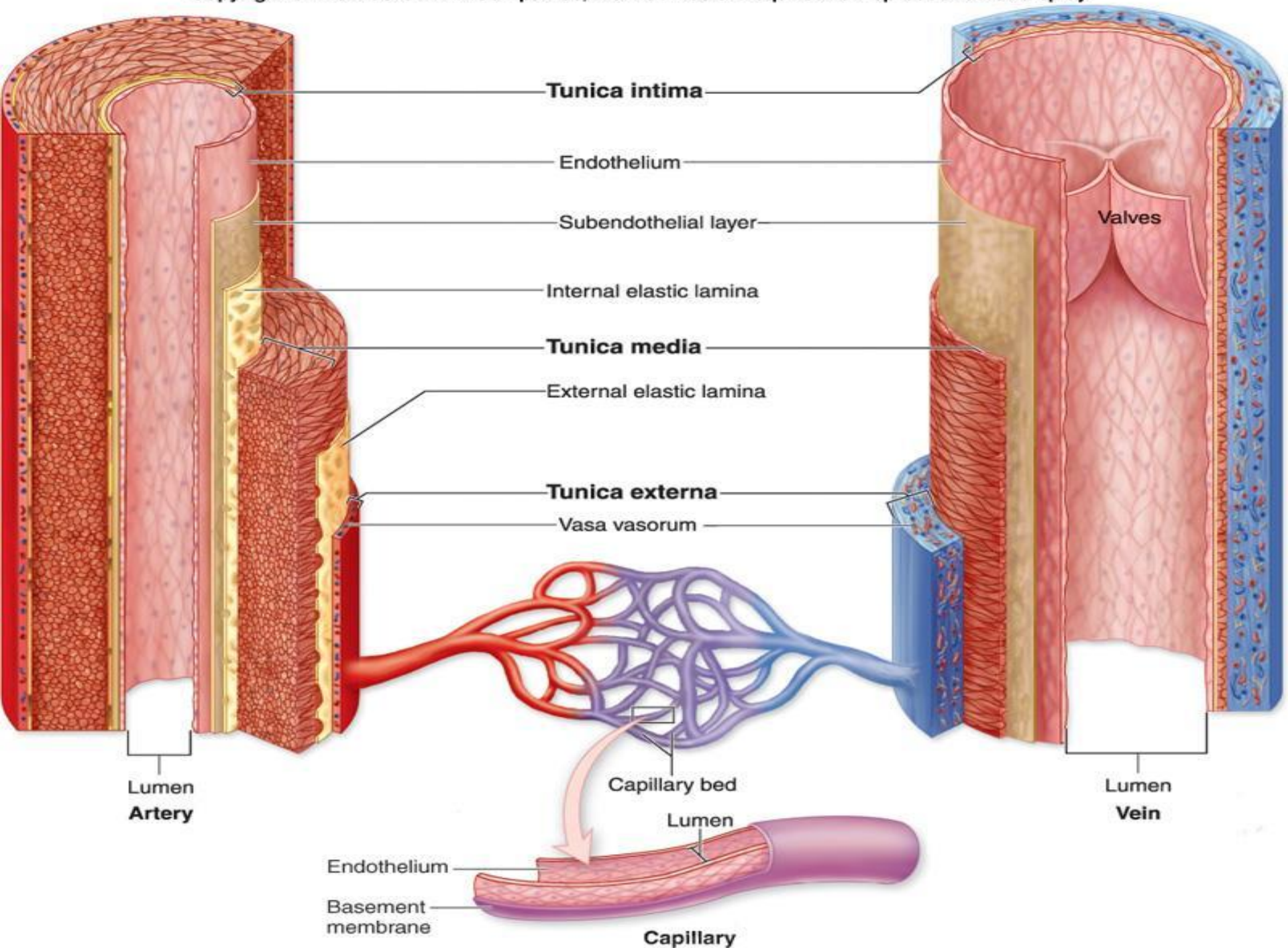


See Figure 14-5 in Silverthorn

Vessel Structure



- Structure/function relationships change as one moves through the cardiovascular tree
- Tunic thickness and composition of the three layers are variable



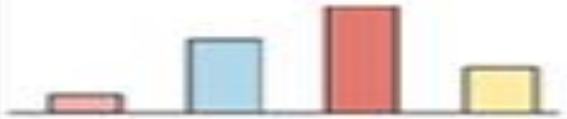
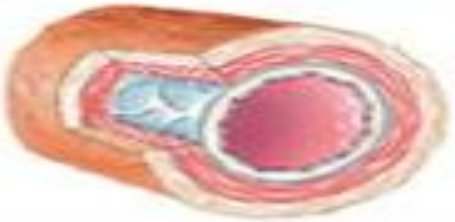
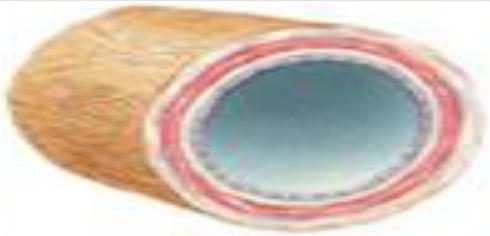
	Mean diameter	Mean wall thickness	Endothelium / Elastic tissue / Smooth muscle / Fibrous tissue	
Artery	4.0 mm	1.0 mm		
Arteriole	30.0 μm	6.0 μm		
Capillary	8.0 μm	0.5 μm		
Venule	20.0 μm	1.0 μm		
Vein	5.0 mm	0.5 mm		

Fig. 15.2

Vessel Characteristics

Muscular and Elastic, Thick walled

Artery

Muscular. Little connective tissue

Arteriole

Endothelial layer, no muscle

Capillary

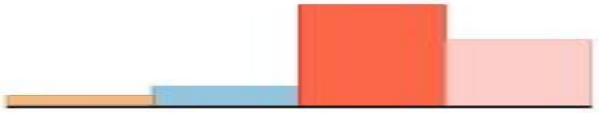
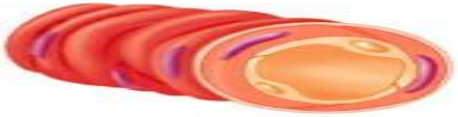
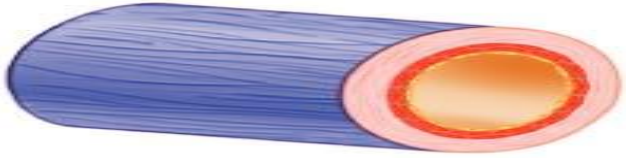
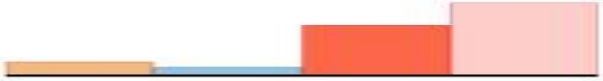
Thin walls with some smooth muscle

Venule

Thin walled with smooth muscle, flacid

Vein

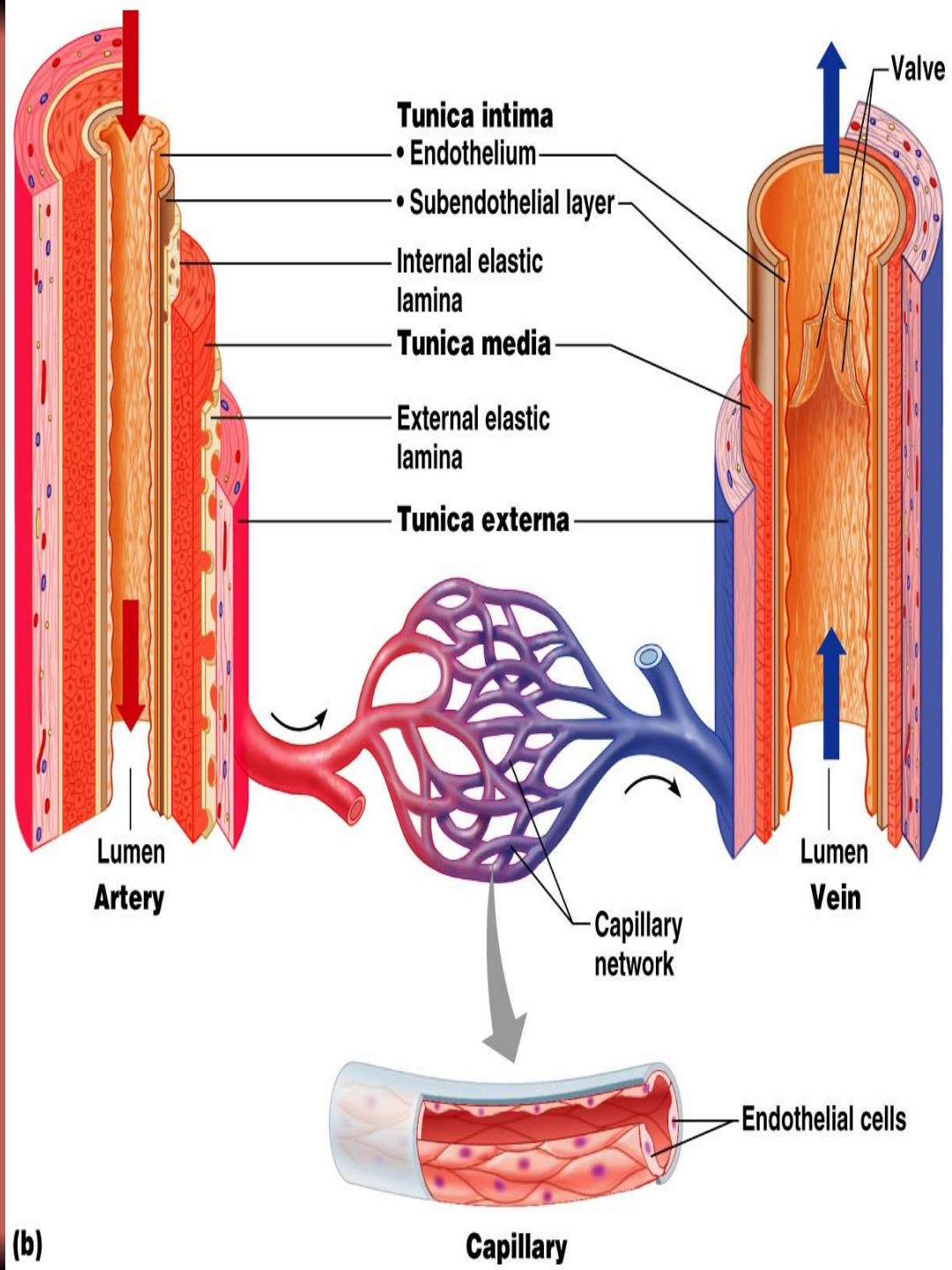
TABLE 19.1 Summary of Blood Vessel Anatomy

VESSEL TYPE/ ILLUSTRATION*	AVERAGE LUMEN DIAMETER (D) AND WALL THICKNESS (T)	RELATIVE TISSUE MAKEUP: Endothelium	Elastic Tissues	Smooth Muscles	Fibrous (Collagenous) Tissues
 Elastic artery	D : 1.5 cm T : 1.0 mm				
 Muscular artery	D : 6.0 mm T : 1.0 mm				
 Arteriole	D : 37.0 µm T : 6.0 µm				
 Capillary	D : 9.0 µm T : 0.5 µm				
 Venule	D : 20.0 µm T : 1.0 µm				
 Vein	D : 5.0 mm T : 0.5 mm				

*Size relationships are not proportional. Smaller vessels are drawn relatively larger so detail can be seen. See column 2 for actual dimensions.

Functional types of vessels

- Amortization or compensatory vessels – arteries
- Volume vessels or veins
- Exchanged vessels or Capillary

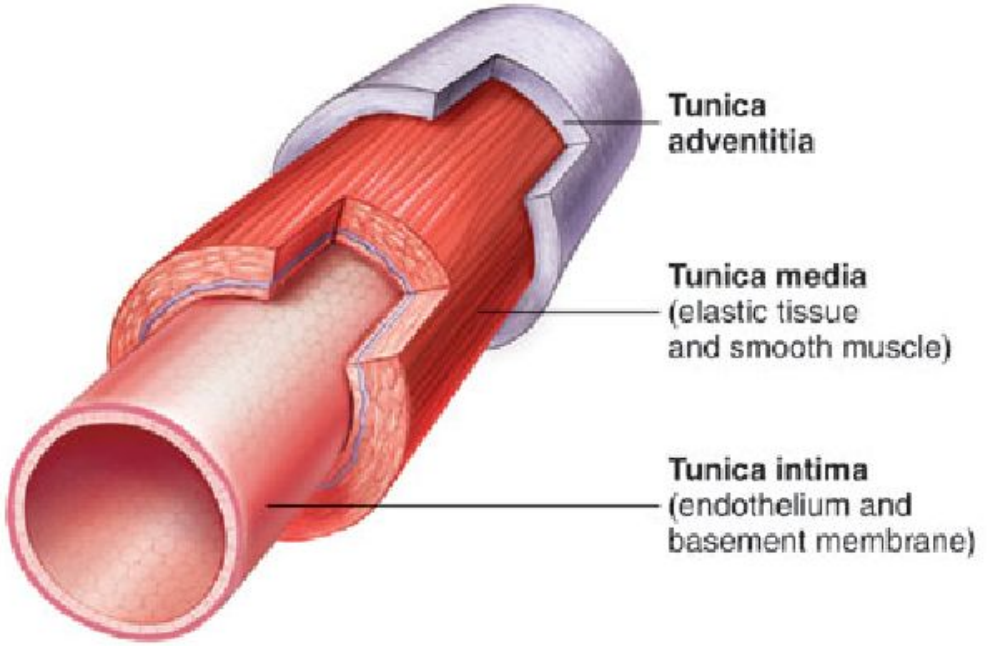


Functional types of vessels

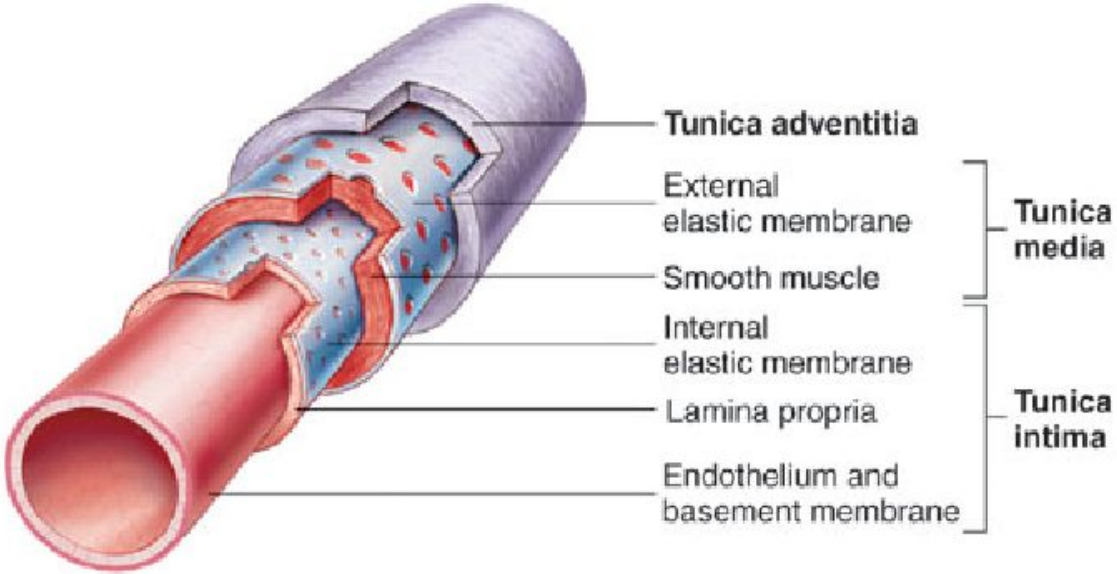
- Resistive vessels or arterioles, smallest arteries; lead to capillary beds
- Sphincters
- Shunts
- Arterial anastomoses provide alternate pathways (collateral channels) for blood to reach a given body region. If one branch is blocked, the collateral channel can supply the area with adequate blood supply

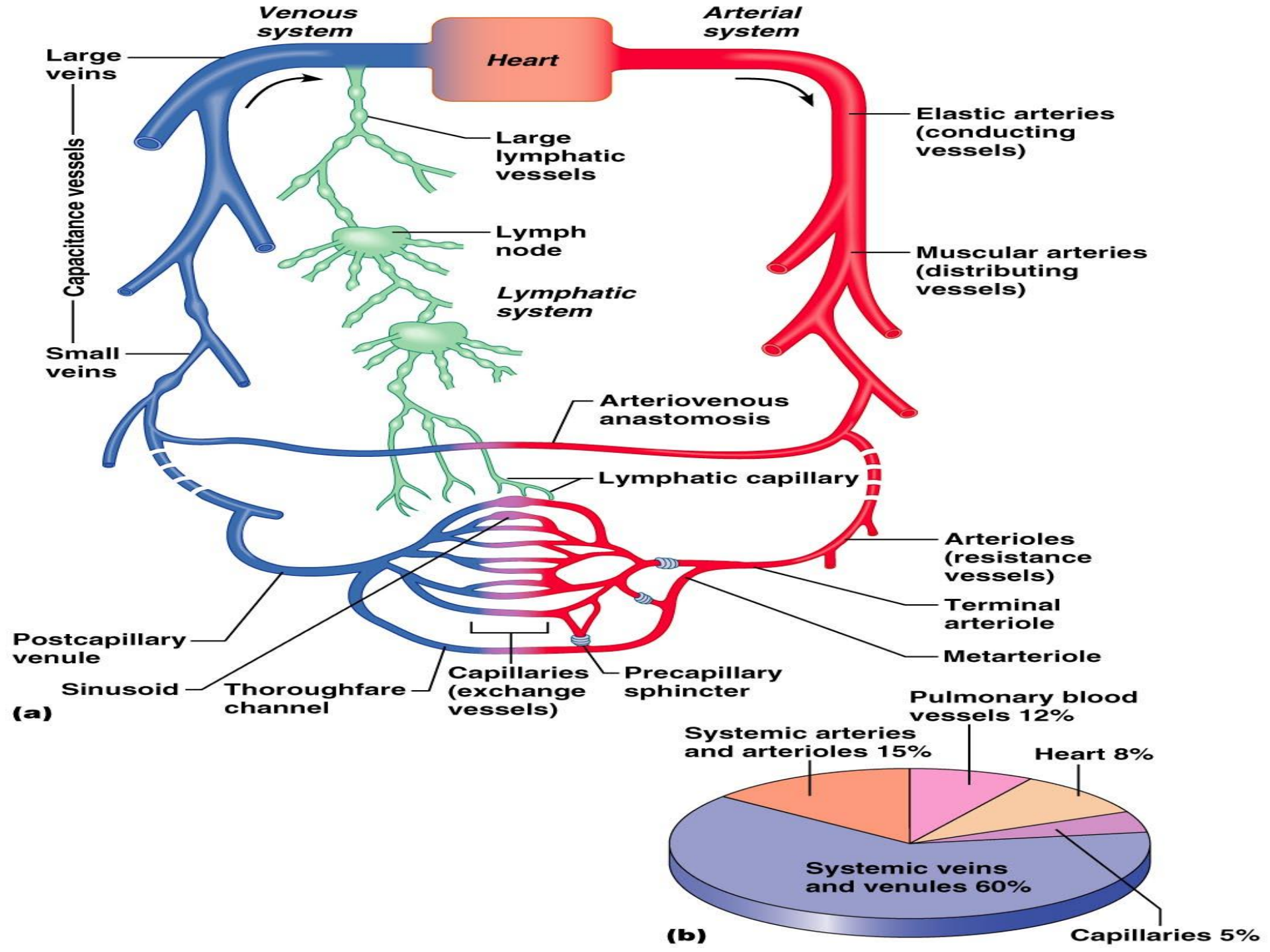
Fig. 13.1a

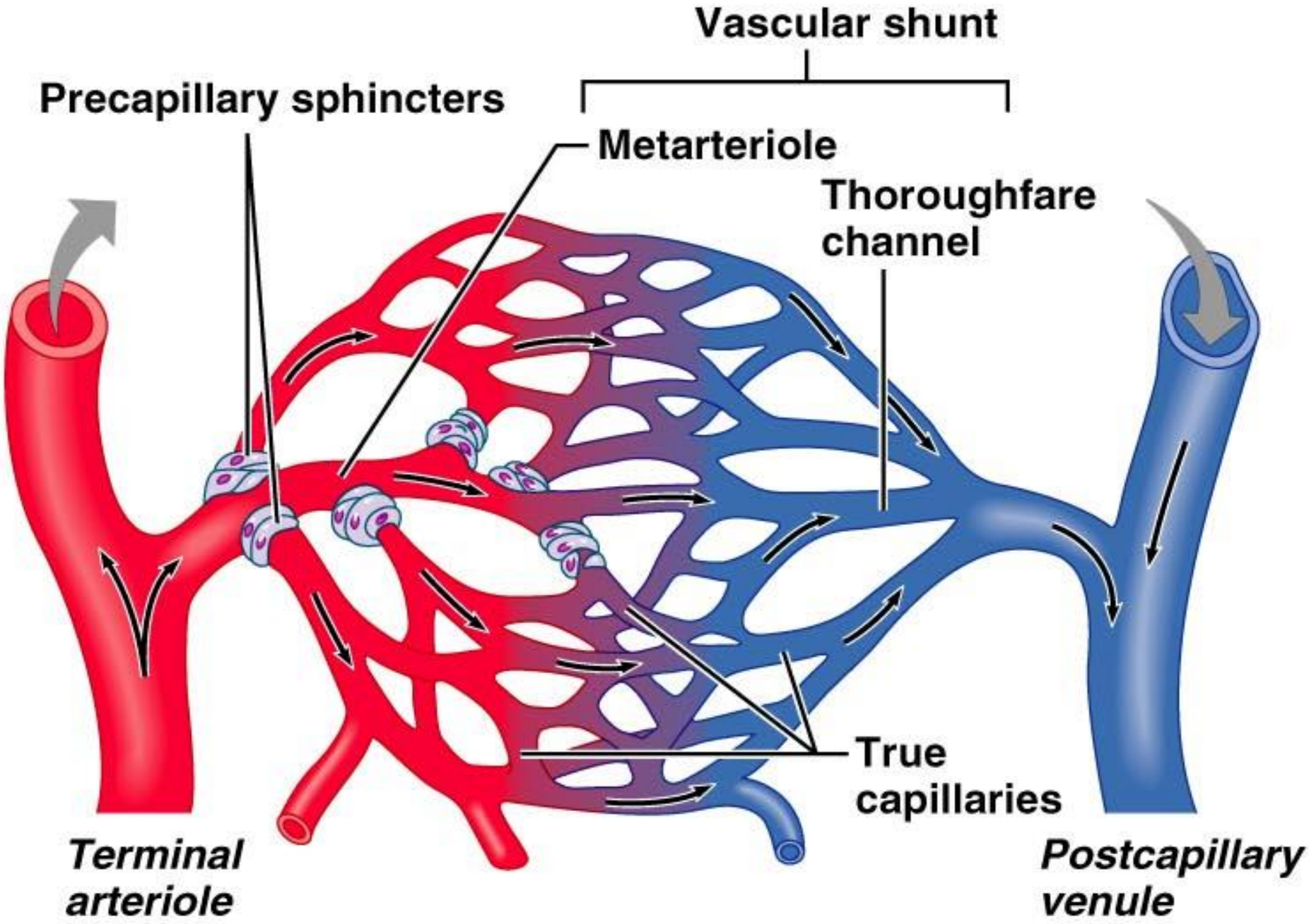
(a) **Elastic Arteries.** The tunica media is mostly elastic connective tissue. Elastic arteries recoil when stretched, which prevents blood pressure from falling rapidly.



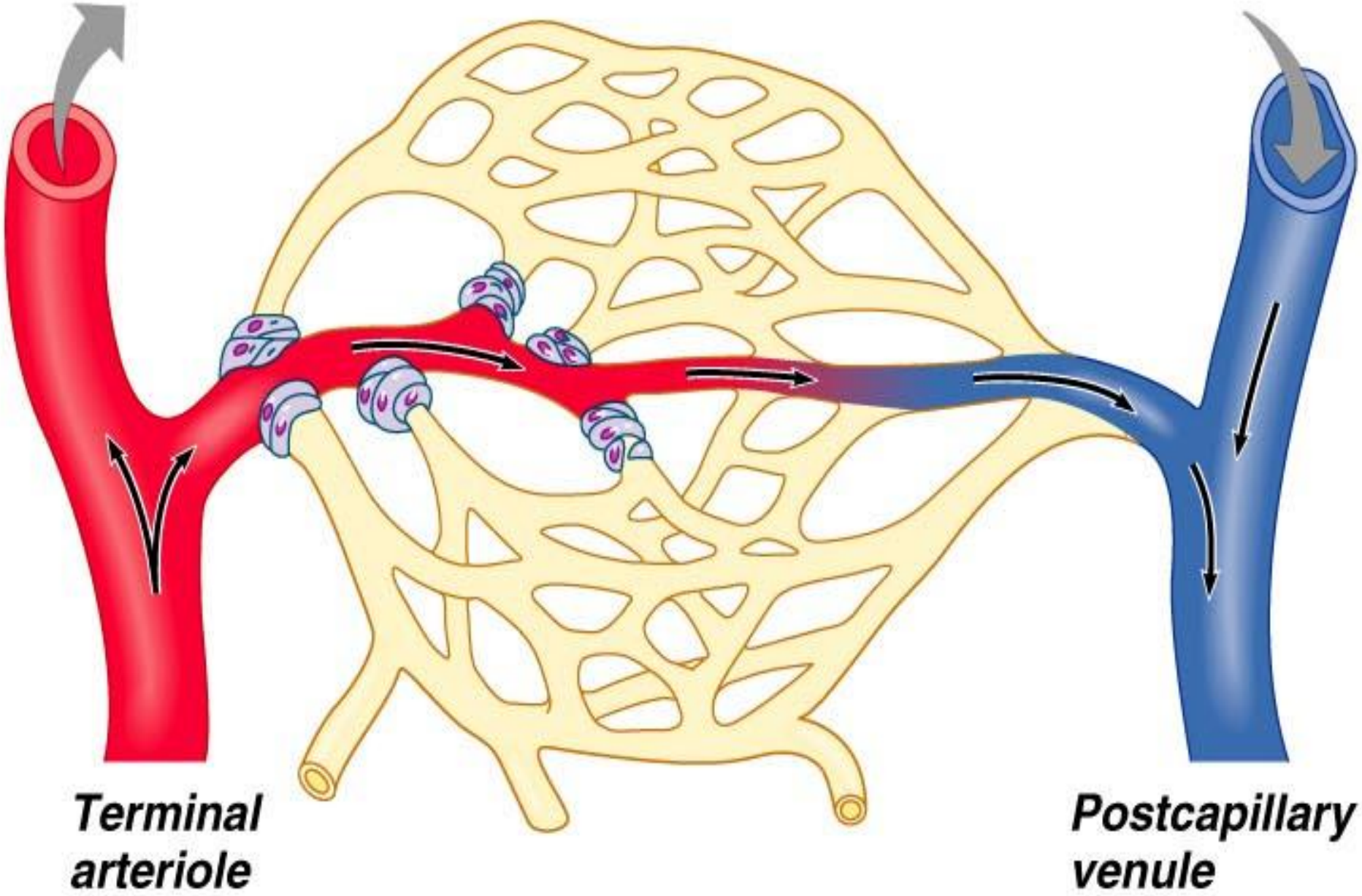
(b) **Muscular Arteries.** The tunica media is a thick layer of smooth muscle. Muscular arteries regulate blood flow to different regions of the body.




Venous system
Arterial system
Heart
Large veins
Capacitance vessels
Small veins
Large lymphatic vessels
Lymph node
Lymphatic system
Elastic arteries (conducting vessels)
Muscular arteries (distributing vessels)
Arteriovenous anastomosis
Lymphatic capillary
Arterioles (resistance vessels)
Terminal arteriole
Metarteriole
Postcapillary venule
Sinusoid
Thoroughfare channel
Capillaries (exchange vessels)
Precapillary sphincter
(a)
Pulmonary blood vessels 12%
Systemic arteries and arterioles 15%
Heart 8%
Systemic veins and venules 60%
Capillaries 5%
(b)



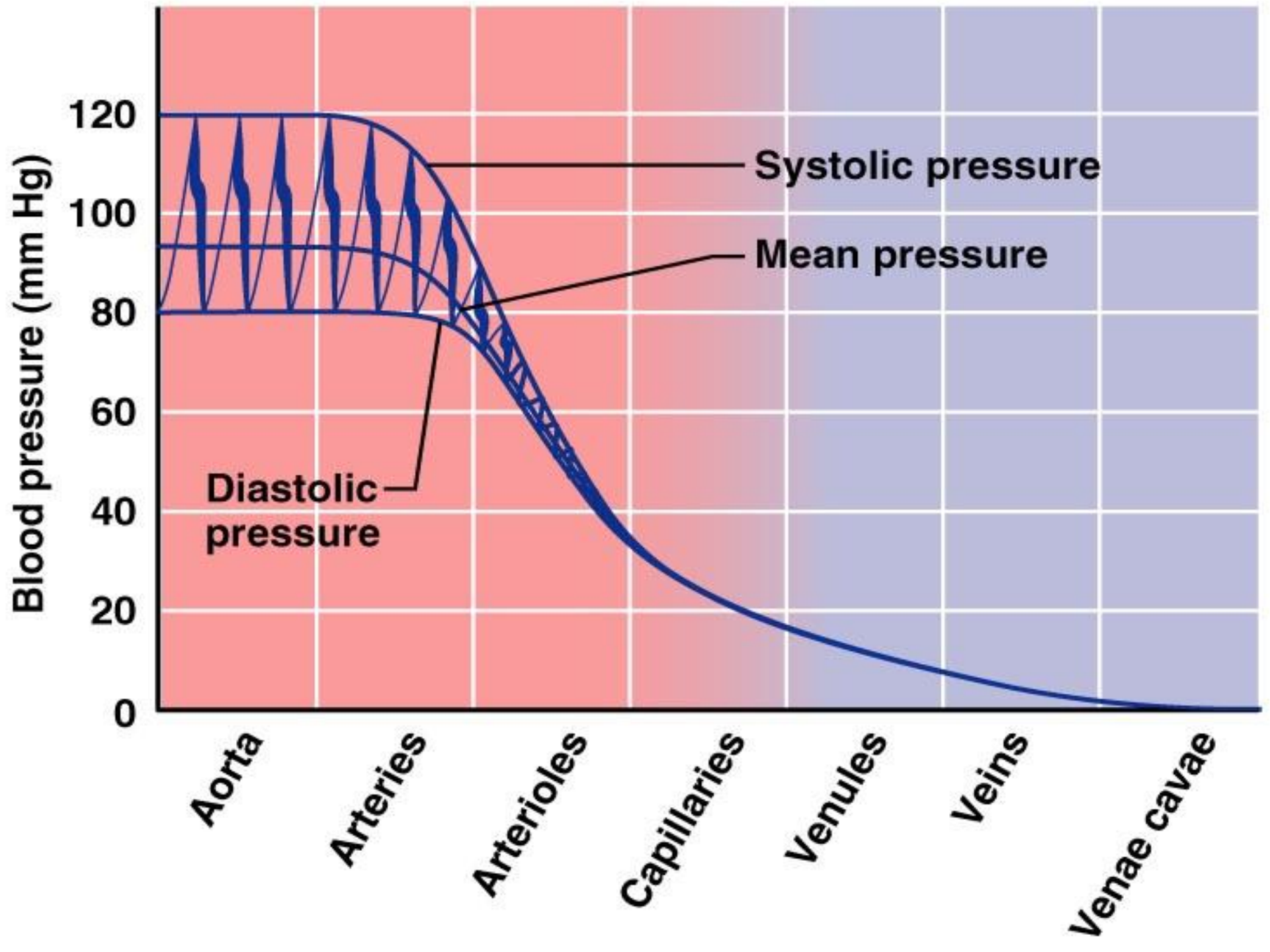
(a) Sphincters open



(b) Sphincters closed

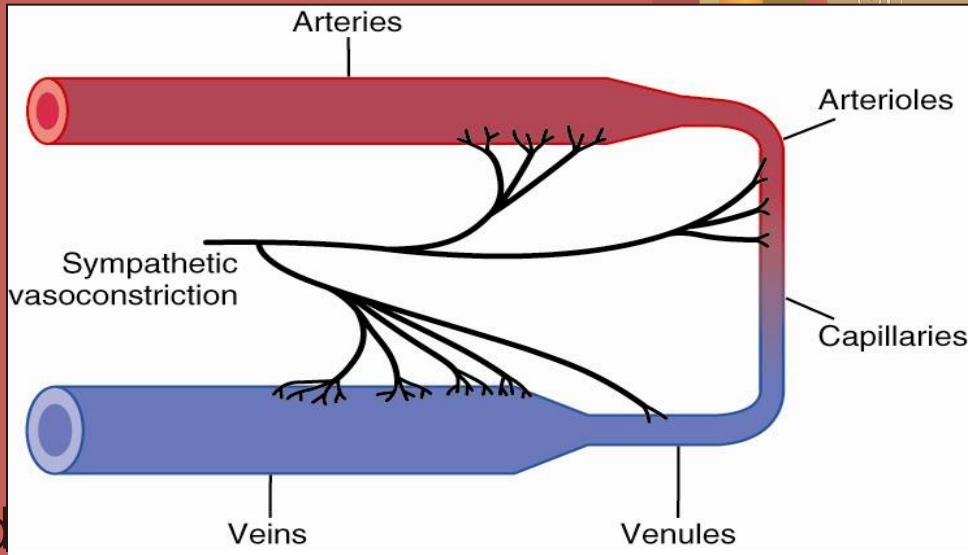
Arterial pressure

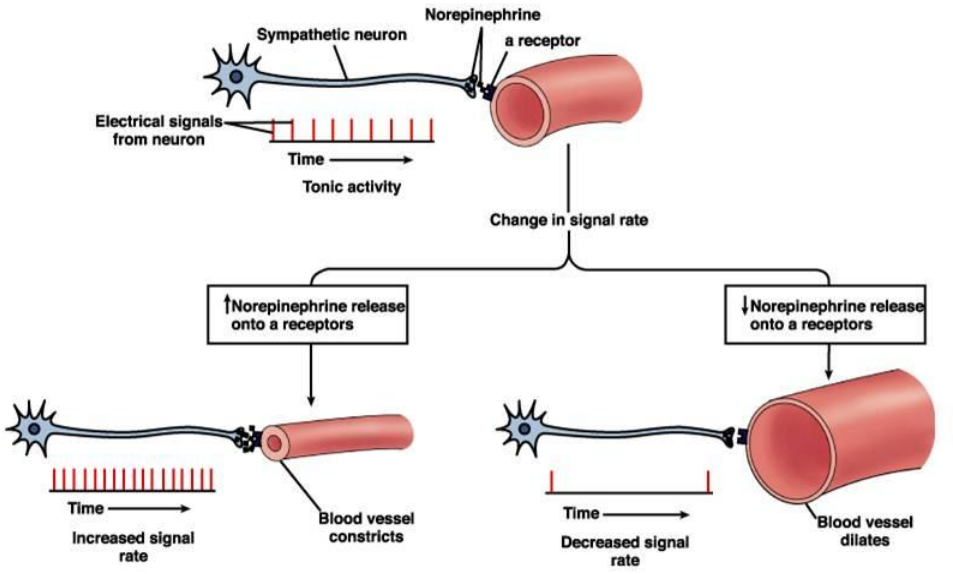
- **Determine the influences of factors:**
- **1. cardiac – systolic volume, speed of blood ejection from the ventricles, heart beat;**
  2. vascular – elasticity of compensatory arteries, tone of resistive vessels, volume of volume vessels;
- **3. blood – volume of blood, viscosity, hydrostatic pressure of blood.**


Blood pressure (mm Hg)
120
100
80
60
40
20
0
Systolic pressure
Mean pressure
Diastolic pressure
Aorta
Arteries
Arterioles
Capillaries
Venules
Veins
Venae cavae

Vasomotor control: Sympathetic Innervation of Blood Vessels

- *Sympathetic* nerve fibers innervate *all* vessels *except* capillaries and precapillary sphincters (precapillary sphincters follow local control)
- Innervation of small arteries and arterioles allow sympathetic nerves to *increase vascular resistance.*
- *Large veins* and *the heart* are also sympathetically innervated.





Kinds of arterial pressure

- 1. Systolic or maximal
- 2. Side or absolute systolic
- 3. Stroke (hemodynamic)
- 4. Diastolic or minimal
- 5. Pulse
- 6. Result – $P = Pd + \frac{Pc - Pd}{3},$
- де P – middle-dynamic pressure; Pd – diastolic pressure; Pc – systolic pressure.
- Ideal pressure:
- Systolic = 102 + (0,6 · age) mm Hg
- Diastolic = 63 + (0,4 · age) mm Hg

- **Systolic pressure** – pressure exerted on arterial walls during ventricular contraction
- **Diastolic pressure** – lowest level of arterial pressure during a ventricular cycle
- **Pulse pressure** – the difference between systolic and diastolic pressure
- **Mean arterial pressure (MAP)** – pressure that propels the blood to the tissues
- MAP = diastolic pressure + 1/3 pulse pressure

Classification of hypertension (1999)

Index	Level of arterial pressure	
	Systolic, mm Hg	Diastolic, mm Hg
Optimal AP	< 120	< 80
Normal AP	< 130	<85
Higher-normal AP	130-139	85-89
Hypertension I degree	140-159	90-99
Measure hypertension	140-149	90-94
Hypertension II degree	160-179	100-109
Hypertension of III degree	>180	>110
Isolated systolic hypertension	>140	<90
Measure hypertension	140-149	<90

Classification of hypertension (NHLBI, 2003).

Index	Level of arterial pressure	
	Systolic, mm Hg	Diastolic, mm Hg
Normal AP	< 120	< 80
Prehypertension	120-139	or 80-89
Hypertension I degree	140-159	or 90-99
Hypertension II degree	>160	or >100

Apparatuses

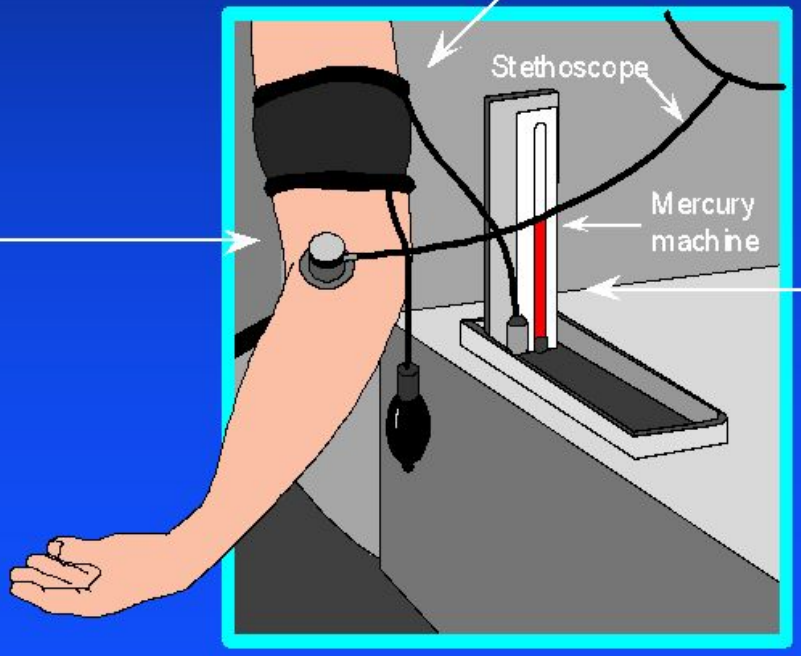
RECOMMENDED BLOOD PRESSURE MEASUREMENT TECHNIQUE

2.

- The cuff must be level with heart.
- If arm circumference exceeds 33 cm, a large cuff must be used.
- Place stethoscope diaphragm over brachial artery.

1.

- The patient should be relaxed and the arm must be supported.
- Ensure no tight clothing constricts the arm.

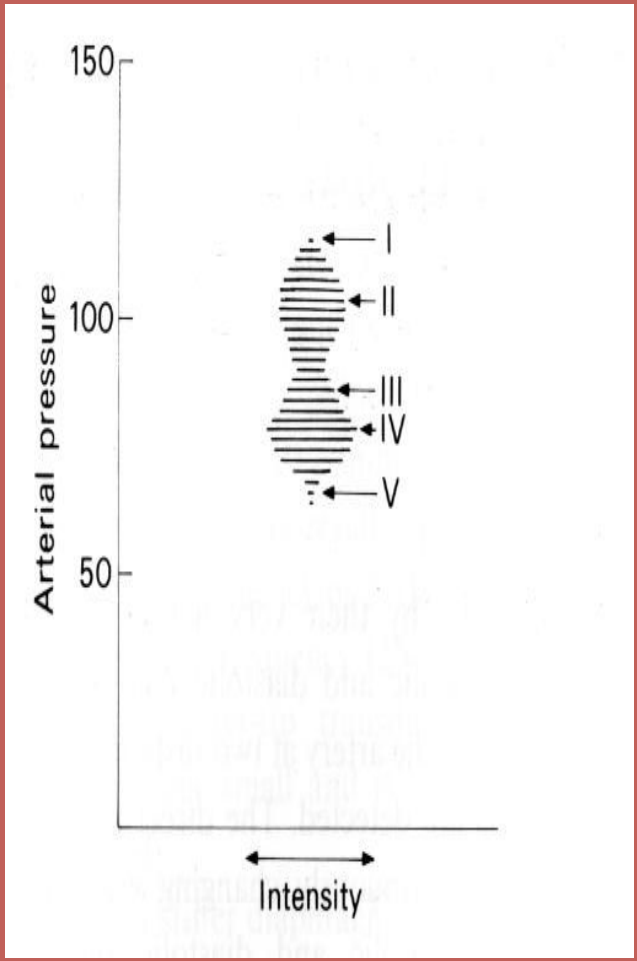


3.

- The column of mercury must be vertical.
- Inflate to occlude the pulse. Deflate at 2 to 3 mm/s. Measure systolic (first sound) and diastolic (disappearance) to nearest 2 mm Hg.

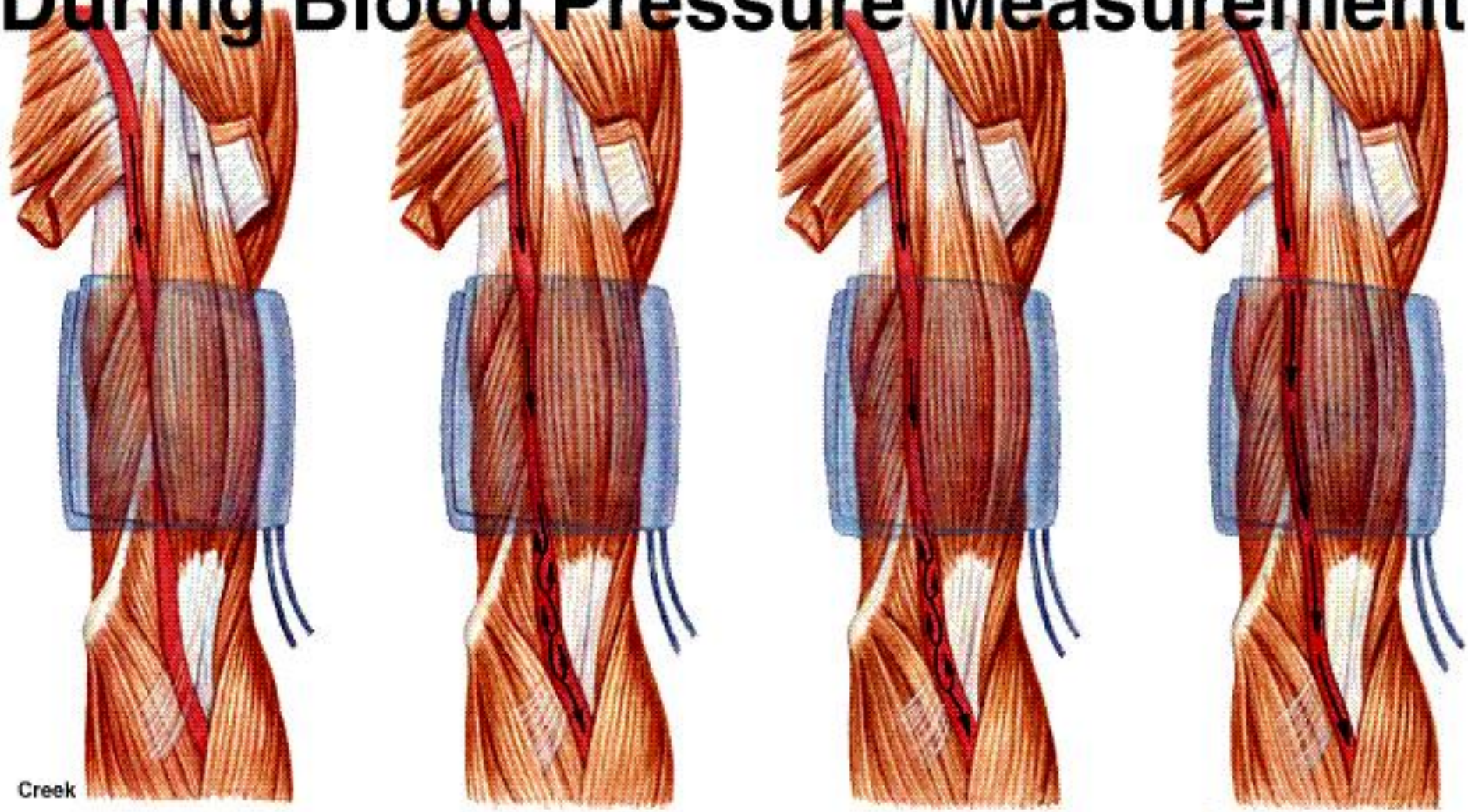
Korotkov Sounds

caused by vibration collapse of the arterial wall??



- Korotkoff IV is a better indication of diastolic pressure according to theory
- However Korotkoff V is the commonly recommended measuring point except in pregnant patients because
  - It is associated with less inter-observer variations
  - It is easier to detect by most observers

Blood Flow and Korotkoff Sounds During Blood Pressure Measurement



Creek

No sounds

Cuff pressure = 140

First Korotkoff sounds

Cuff pressure = 120

Sounds at every systole

Cuff pressure = 100

Last Korotkoff sounds

Cuff pressure = 80

Systolic pressure = 120 mmHg

Diastolic pressure = 80 mmHg

Blood pressure = 120/80

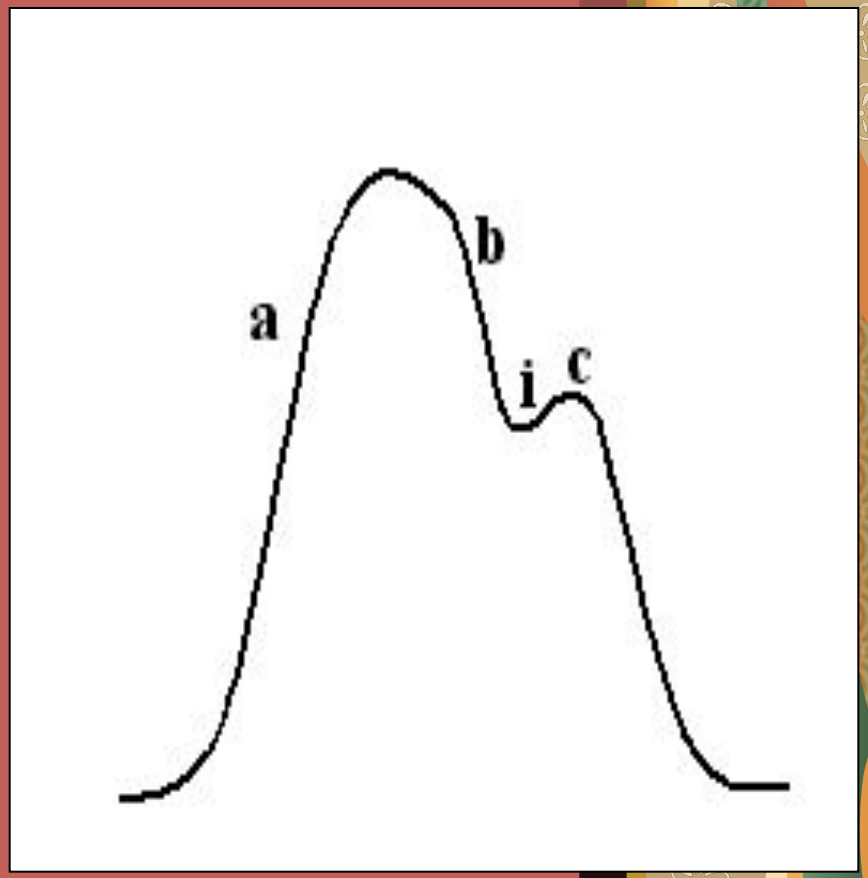
Sphygmogram

Anacrota -a

Catacrota b

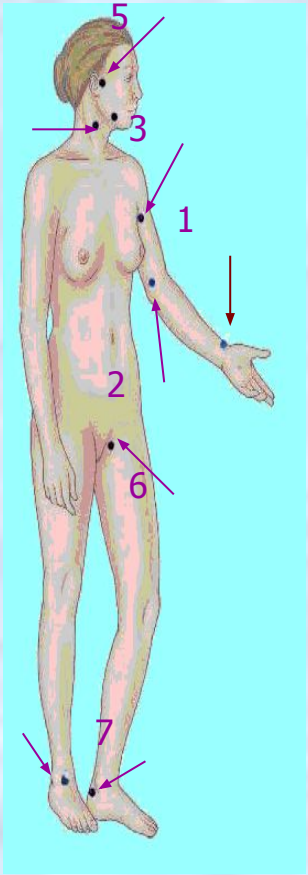
Incisura (i)

Addition wave *c or secondary increase*



Evaluation of arterial pulse

1A. radialis
2A. ulnaris
3A. brachialis
4A. carotica communis
5A. temporalis
6A. femoralis
7A. dorsalis pedis
8A. tibialis posterior



- ***THANCK YOU!***