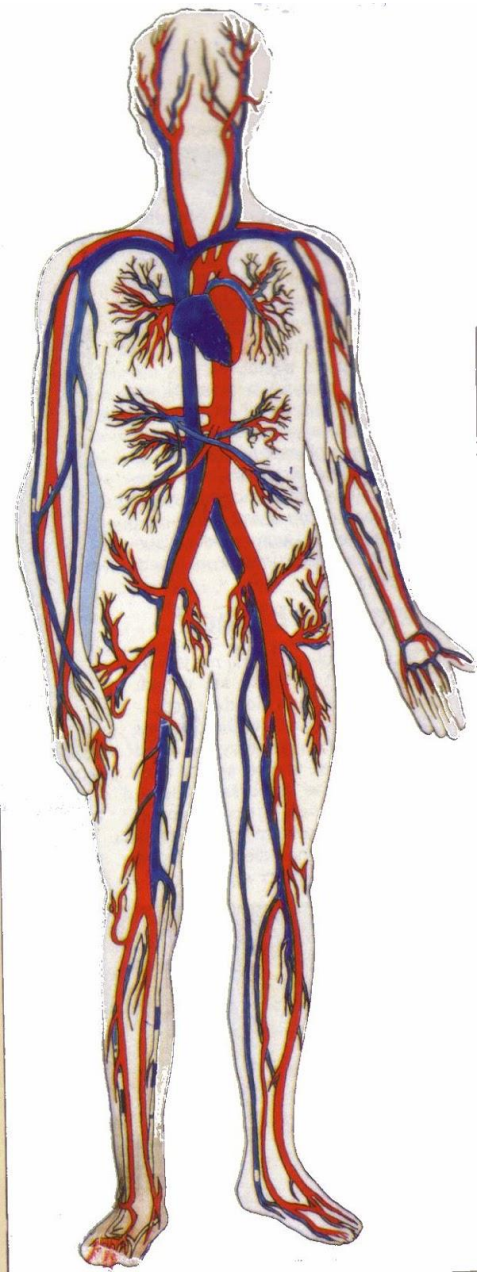


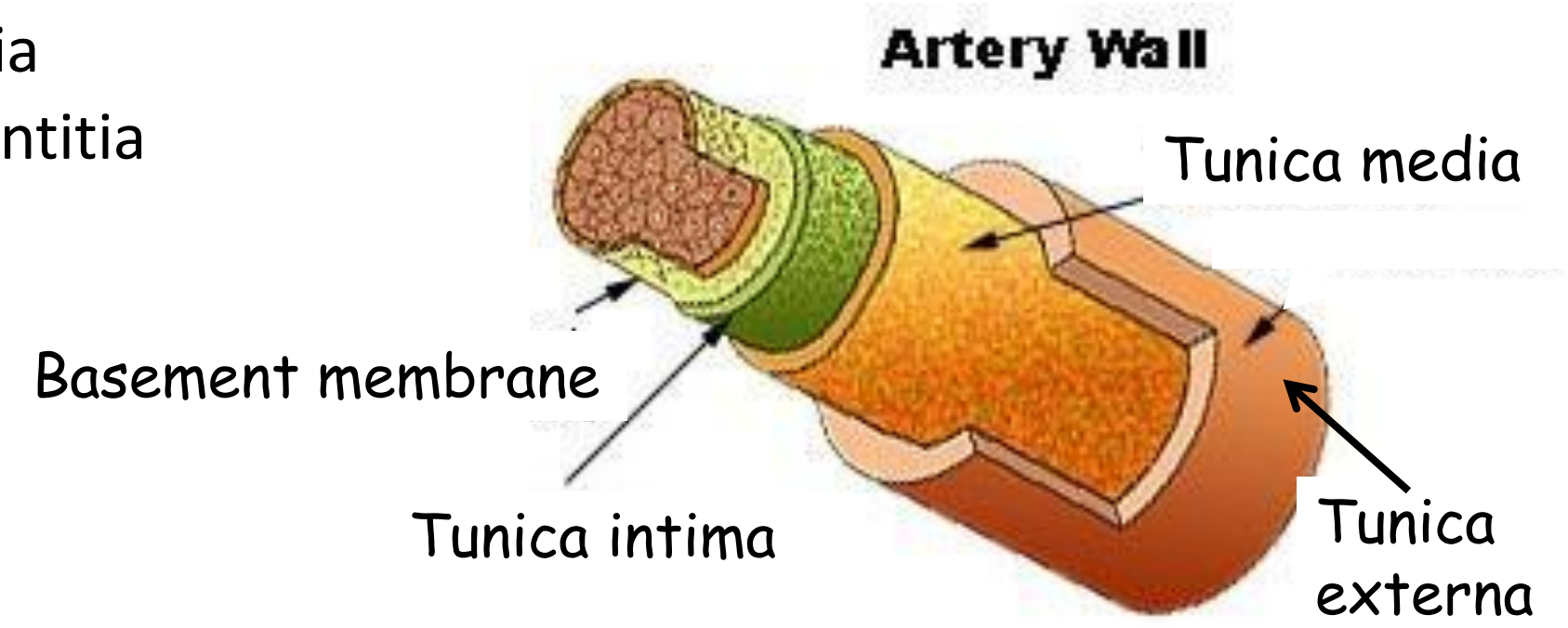
Structural Features of the Circulation

Professor Deepthi de Silva

Department of Physiology

Blood vessels- Basic structure

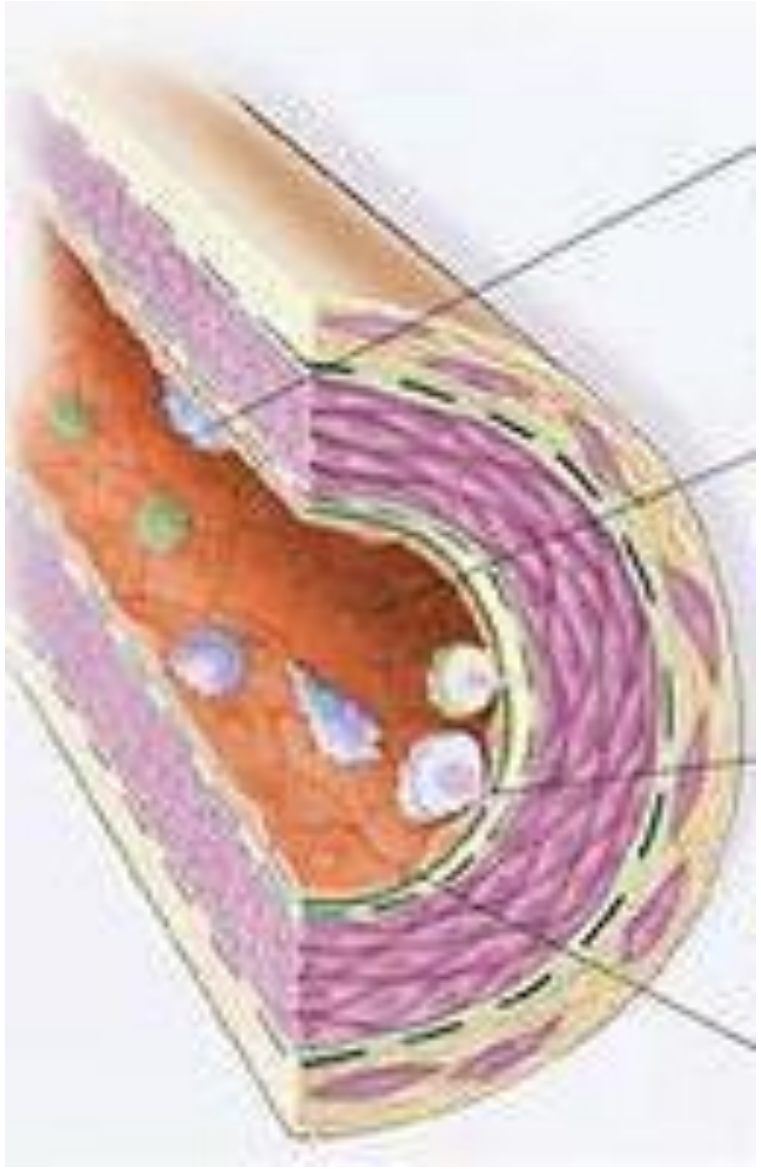
- Three layers - differences between vessels
  - Tunica intima
  - Tunica media
  - Tunica adventitia



Tunica Intima

- Vascular endothelium
  - Secretory function
  - Respond to chemicals in blood
  - Able to respond to changes in flow, stretch

- Elastic fibres (Internal elastic lamina)



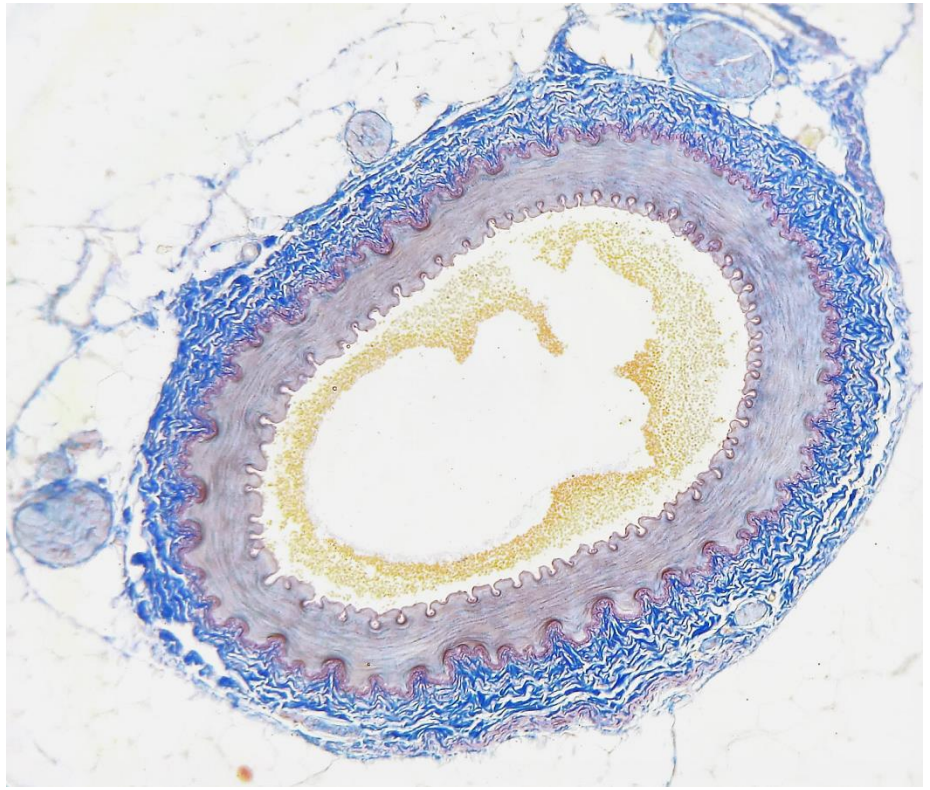
Tunica Media

- Smooth muscle in circular arrangement
- Contain Ca^{++}, K^{+} and Cl^{-} channels

- ***Revise contractile mechanism***
- Contraction- reduces vessel diameter
  - ‘constriction’
- Relaxation- increases vessel diameter
  - ‘dilatation’

Tunica adventitia

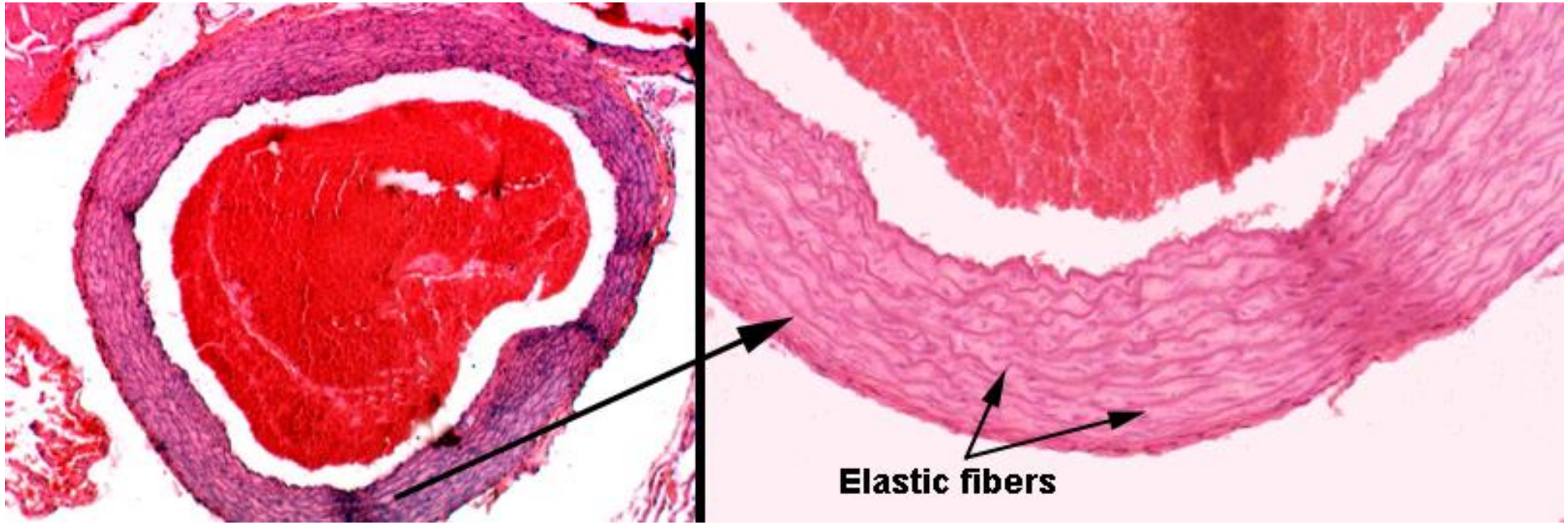
- External elastic lamina and Collagen fibres
- Prevents overstretching of vessel



Elastic arteries

- E.g. aorta, brachial artery
  - Elastin in internal and external elastic lamina
- Recoil ability-
  - In systole – vessel stretches and stores energy and this is released in diastole
  - Stretch- causes energy to be stored and released when the force stretching it is released
- Collagen fibres in media and adventitia prevent over stretching

Elastic Arteries

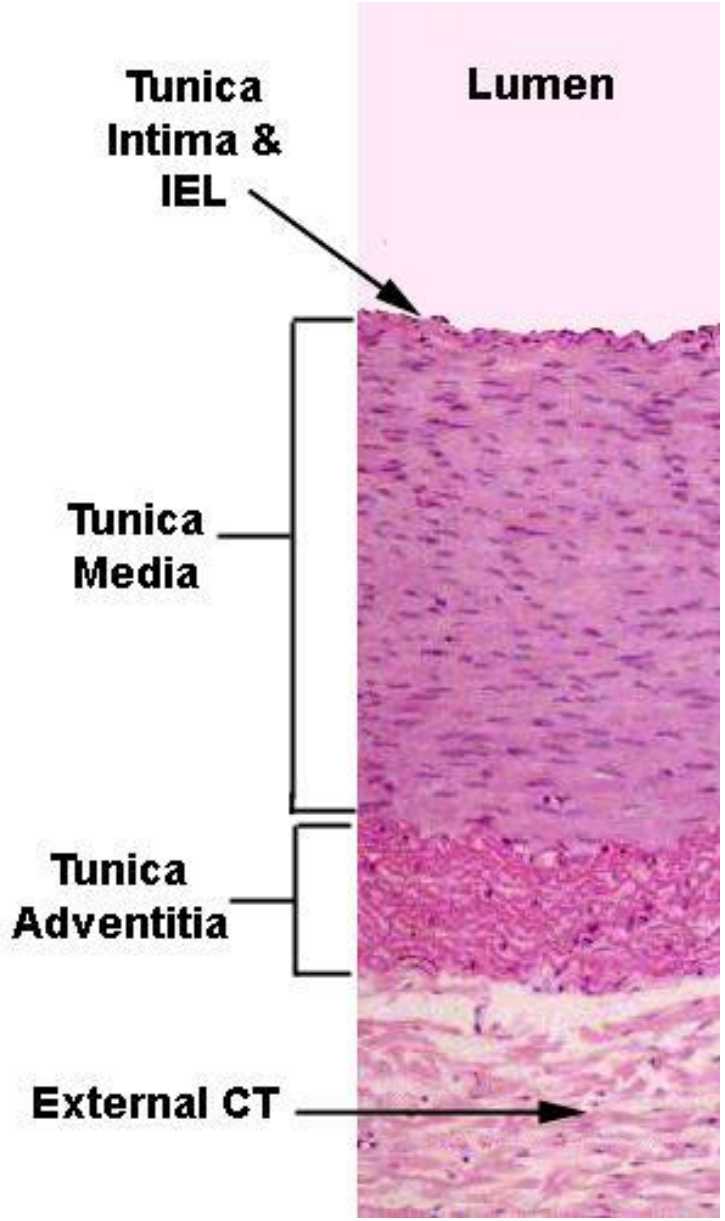


The Pulse

- Wave of pressure travelling along arteries at systole
  - Causes a palpable expansion of the vessel
- Velocity greater than the flow rate for blood
- Pulse weak in shock; strong when stroke volume is high [exercise, anxiety]

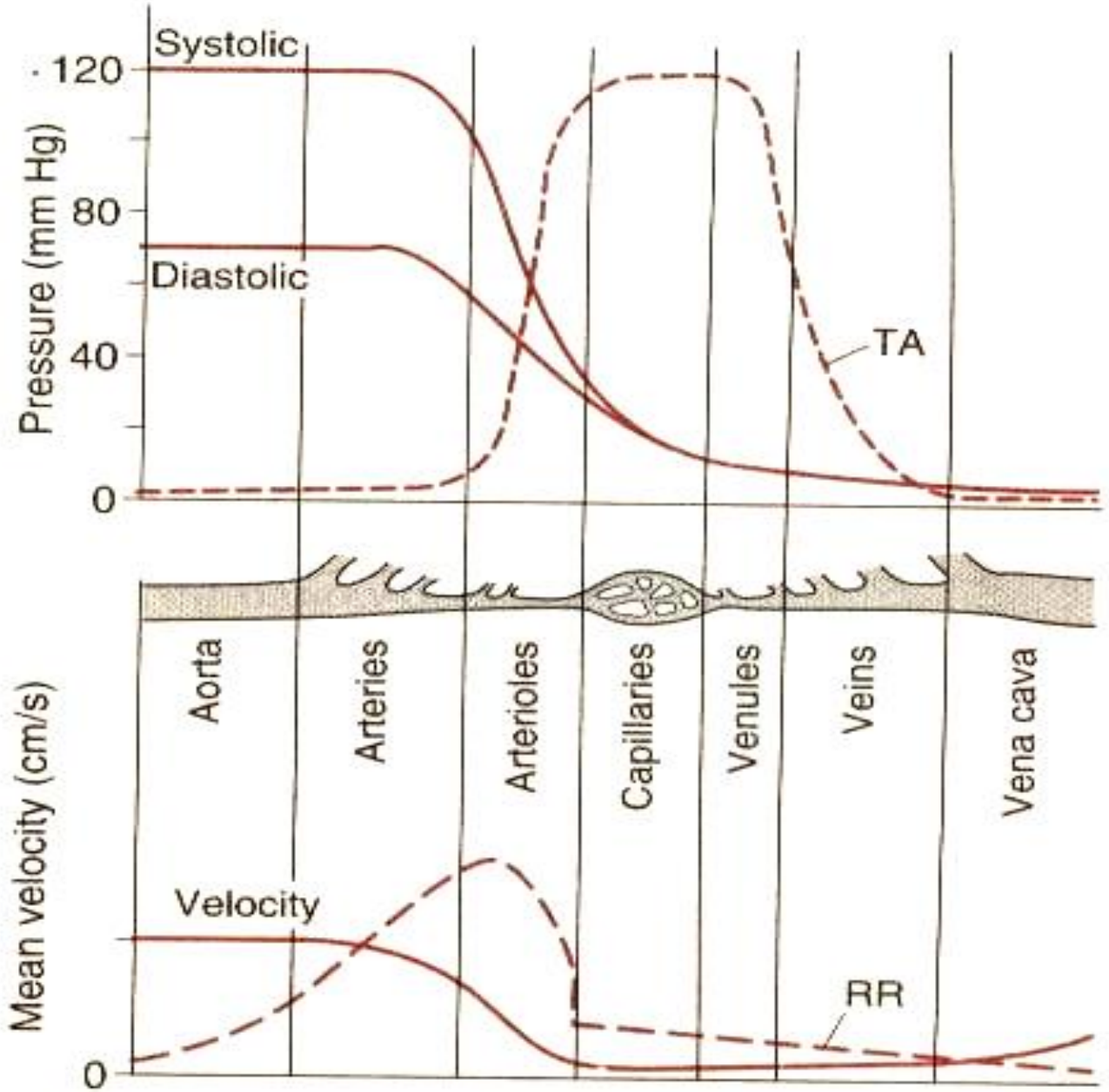
Muscular Arteries

- More smooth muscle / less elastin, collagen than elastic arteries
- Transport function
- Resting tone
  - Smooth muscle partially contracted under normal resting conditions



Arterioles

- Main importance in regulating the resistance in the circulation
  - *Resistance vessels*
- Arteriolar constriction (vasoconstriction)
  - Increase resistance
- Arteriolar dilatation (vasodilatation)
  - Reduce resistance



Flow = $\frac{\text{Pressure}}{\text{Resistance}}$

Velocity = $\frac{\text{Flow}}{\text{Area}}$

Capillaries

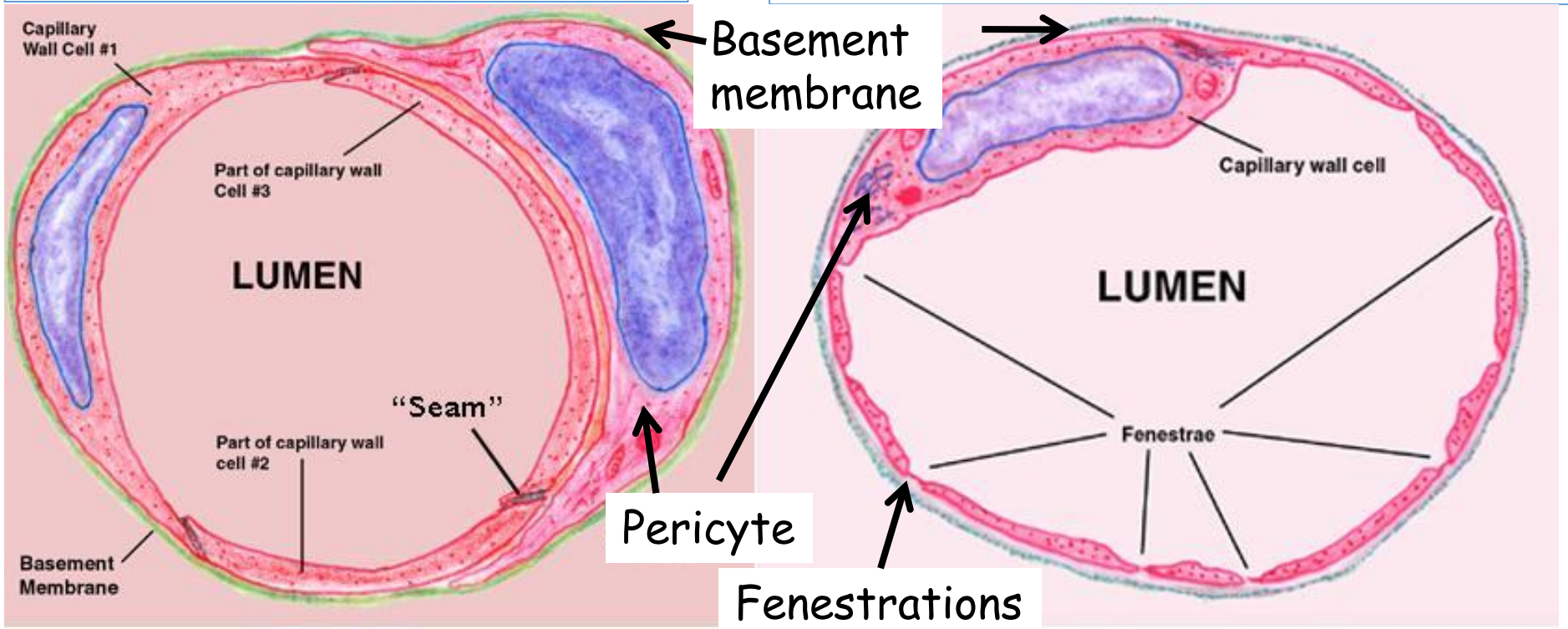
- Single layer of endothelial cells
  - No smooth muscle/ collagen/ elastin
  - Large total surface area
- Function as exchange vessels
  - Substances moved in and out of the circulation
- Pericytes surrounding endothelium-
  - Contractile
  - Secrete substances
  - Regulate flow between endothelial cells

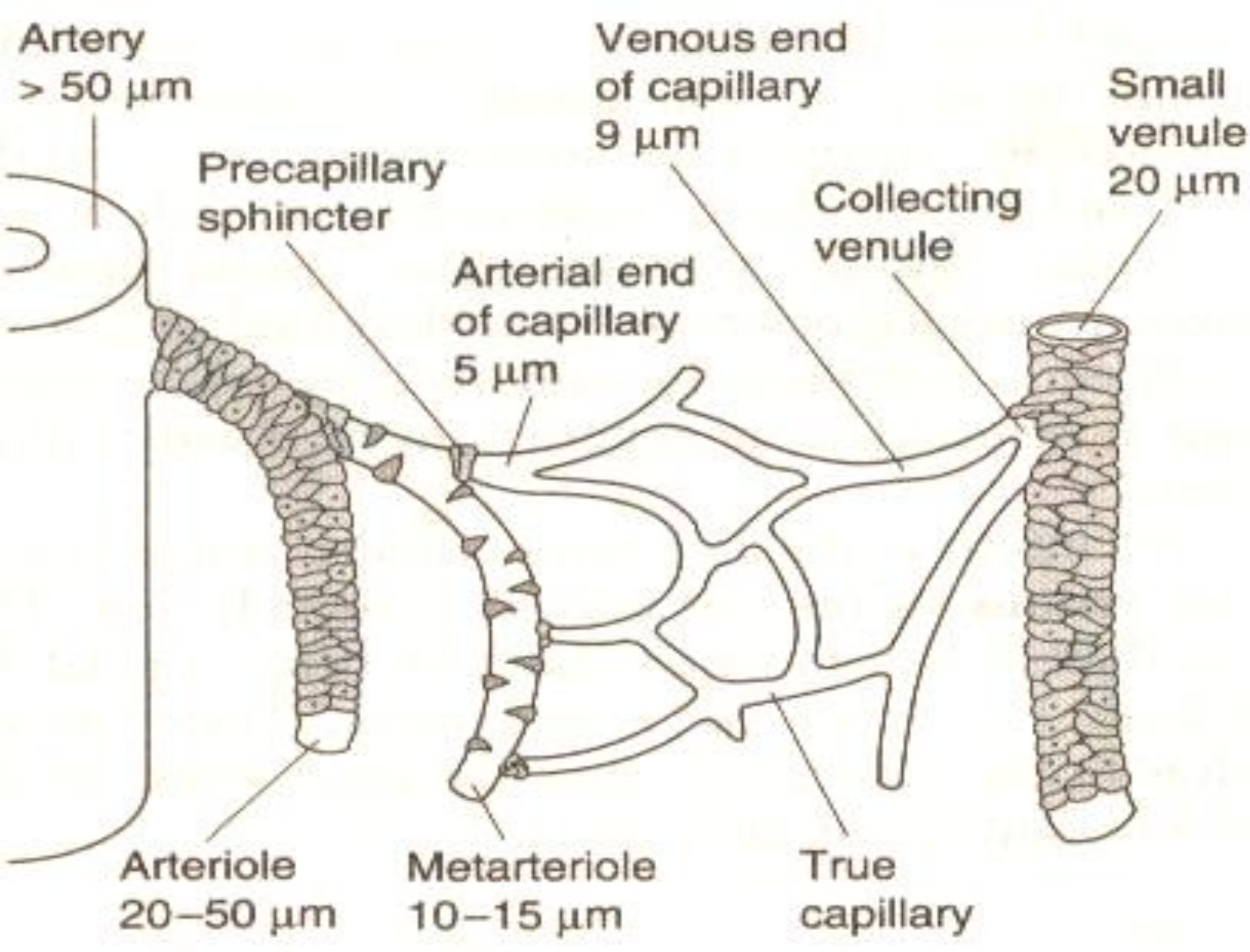
Continuous capillary

- Passage of molecules <10nm between endothelial cells
- Vesicular transport
- E.g. In muscles

Fenestrated capillary

- Holes with thin membrane cover
- 20-100nm molecules
- GIT, endocrine organs
- Liver- no membrane; large particles can cross

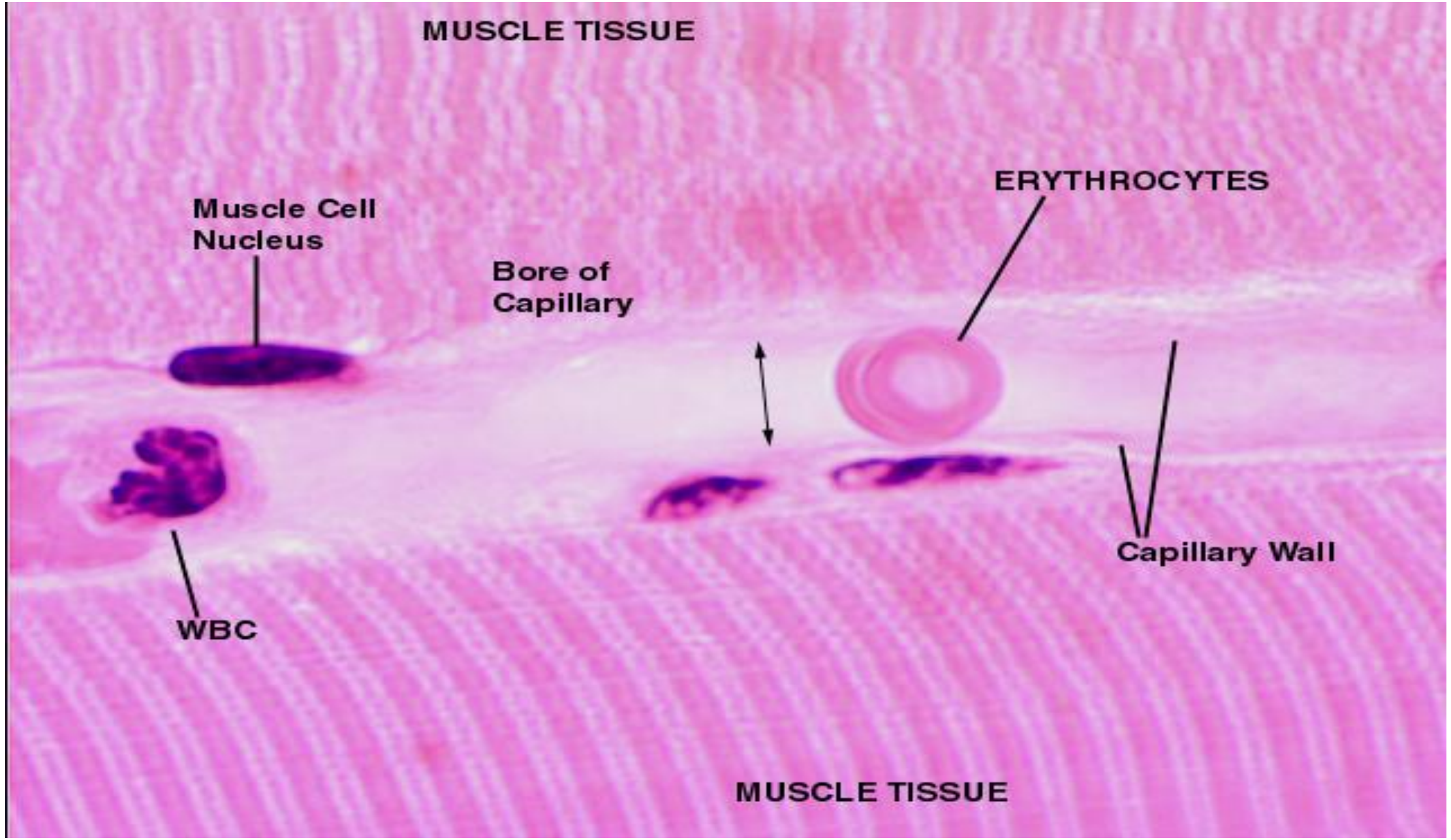



Artery
> 50 μm
Precapillary
sphincter
Arterial end
of capillary
5 μm
Venous end
of capillary
9 μm
Collecting
venule
Small
venule
20 μm
Arteriole
20–50 μm
Metarteriole
10–15 μm
True
capillary

Microcirculation

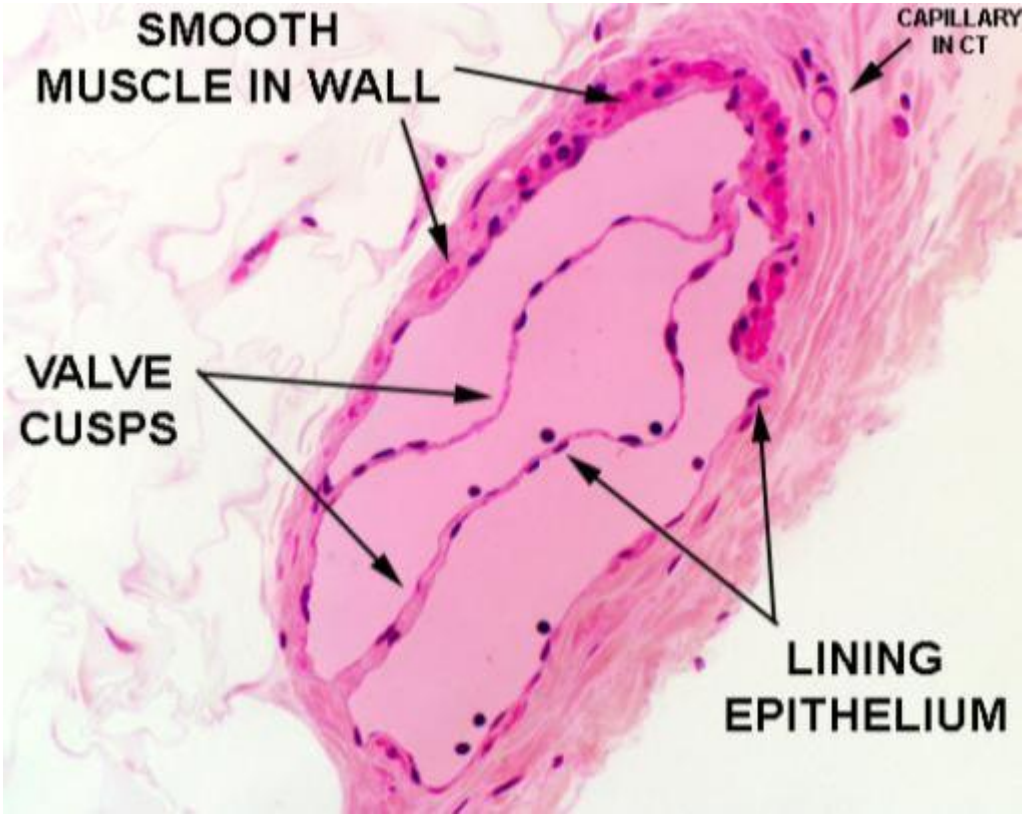
- Blood from metarterioles pass via a tiny sphincter ‘precapillary sphincter’

- 5μm –arterial end and 9 μm at venous end- allows a single red cell to pass in a thimble shape


MUSCLE TISSUE
ERYTHROCYTES
Muscle Cell Nucleus
Bore of Capillary
Capillary Wall
WBC
MUSCLE TISSUE

Collecting venules and veins

- Collecting vessels- single layer of smooth muscle & converge to form veins
- Veins : less thickness than arterial system
- Large veins have valves
  - aid return of blood to heart



Veins- Capacitance vessels

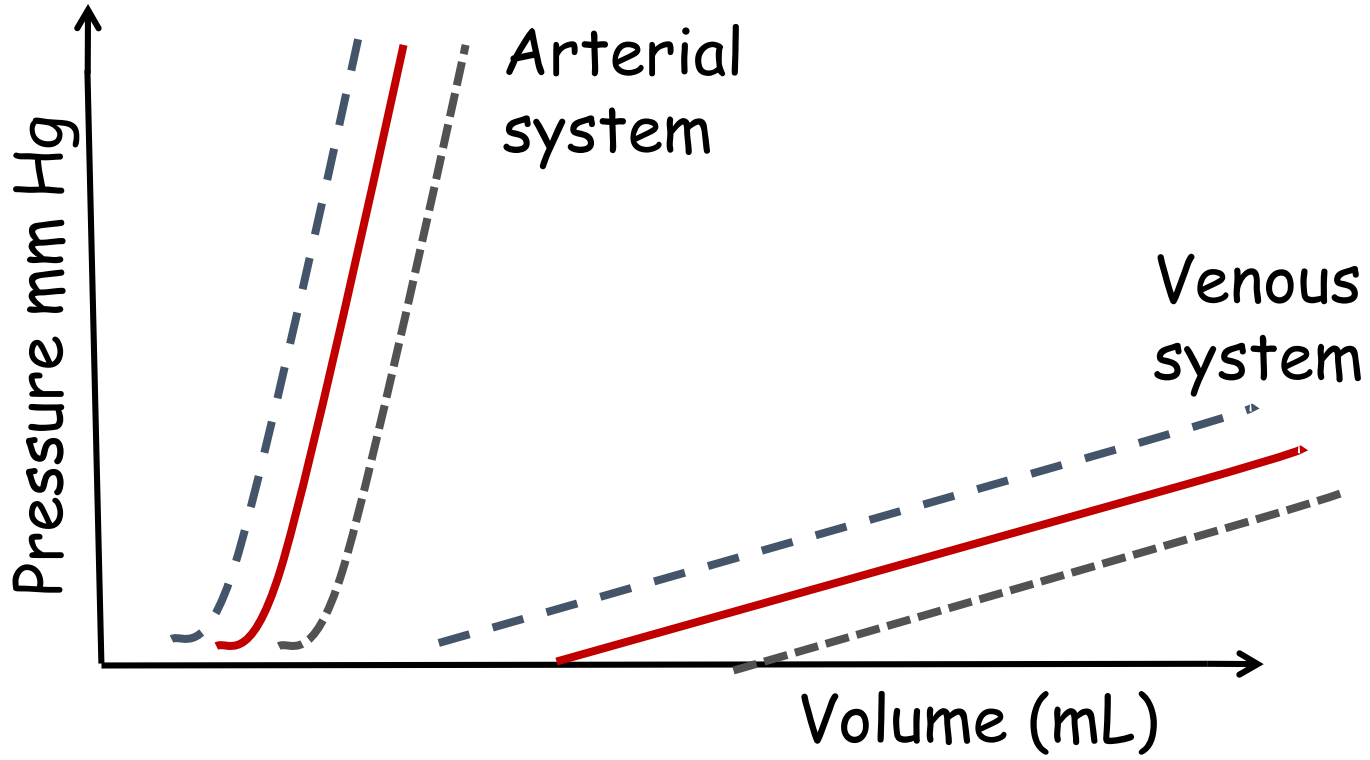
- Can distend with blood – act as *capacitance vessels* (reservoirs)
  - Veins can increase volume without a rise in the pressure
  - With excessive stretching of veins (e.g. heart failure), their pressure rises

- Contraction of veins increases venous return to heart
  - Aided by the muscle and respiratory pumps

Characteristics of Blood vessels

Vessel	Lumen diameter	Wall Thickness	Cross sectional area (Total) cm^2	% of blood contained
Aorta	2.5cm	2mm	4.5	2
Artery	0.4cm	1mm	20	8
Arteriole	30μm	20μm	400	1
Capillary	5μm	1μm	4500	5
Venule	20μm	2μm	4000	
Vein	0.5cm	0.5mm	40	54
Vena cava	3cm	1.5mm	18	

Volume pressure relationship in vessels



Normal resting

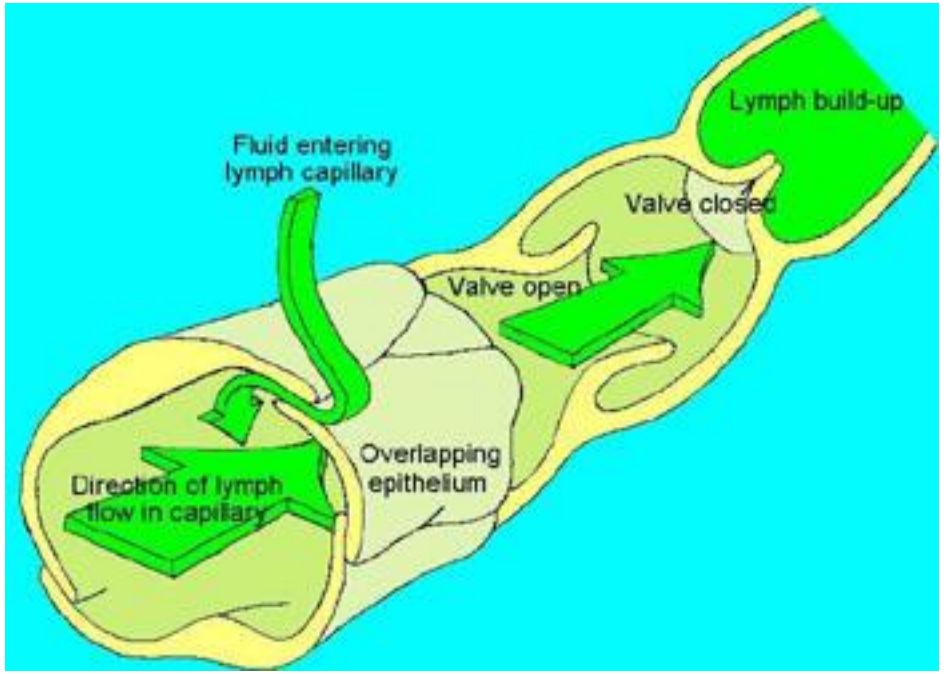
Sympathetic Stimulation ↑

Sympathetic stimulation ↓

Lymphatics

- Drain interstitial spaces
- Vessels eventually drain to right and left subclavian veins

- Vessels contain valves
- Go through lymph nodes
- Differ from capillaries
  - No fenestrations
  - Wide gaps between endothelial cells
  - ‘No’ basal lamina




POSEIDON