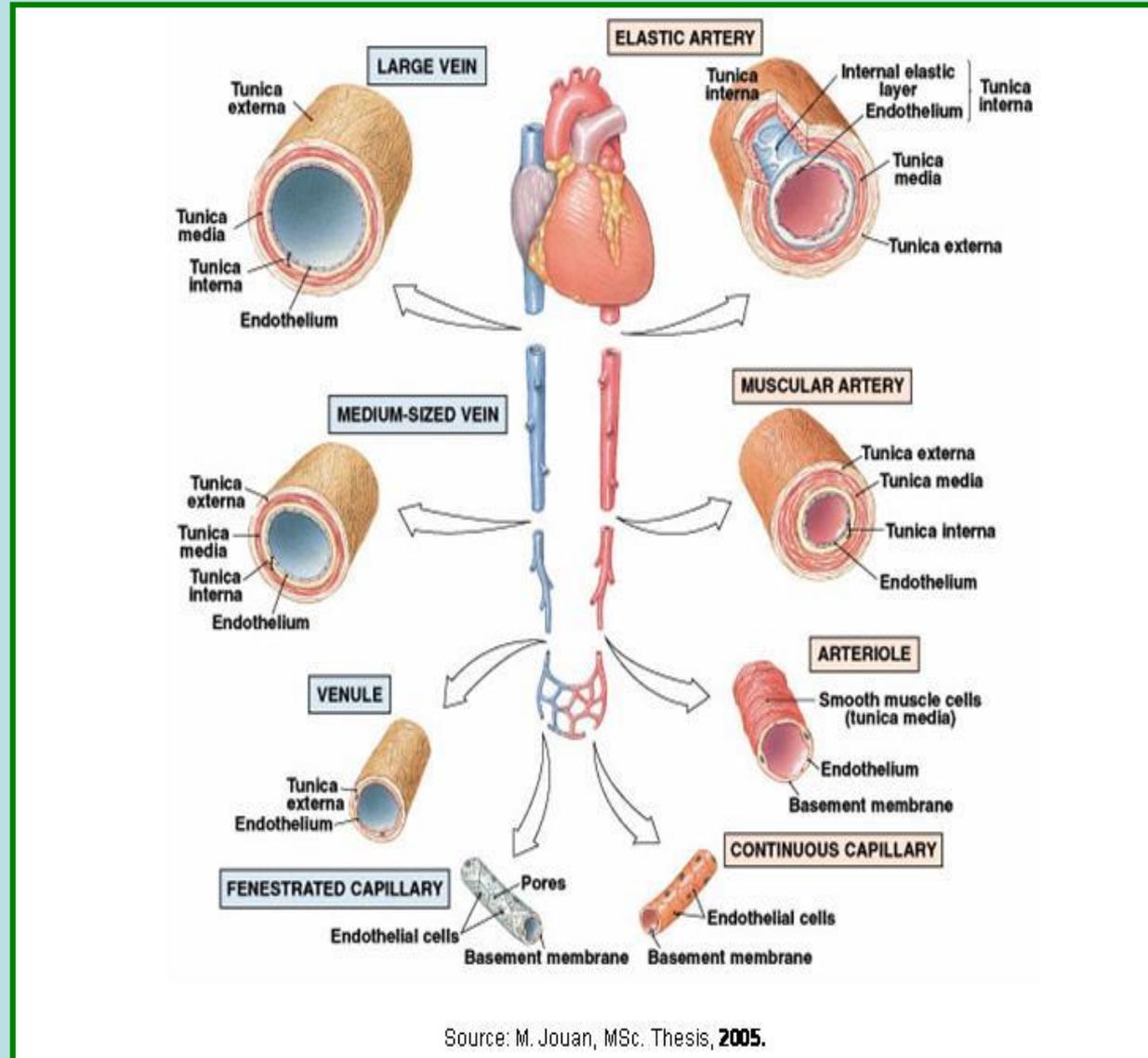


CARDIOVASCULAR SYSTEM

- heart
- macrocirculation,
- microcirculation
- lymph vascular system.



THE HEART

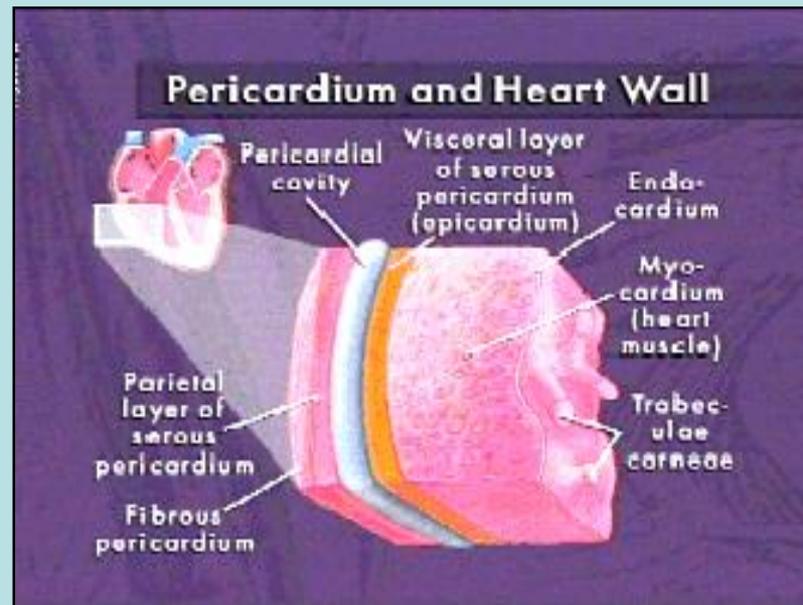
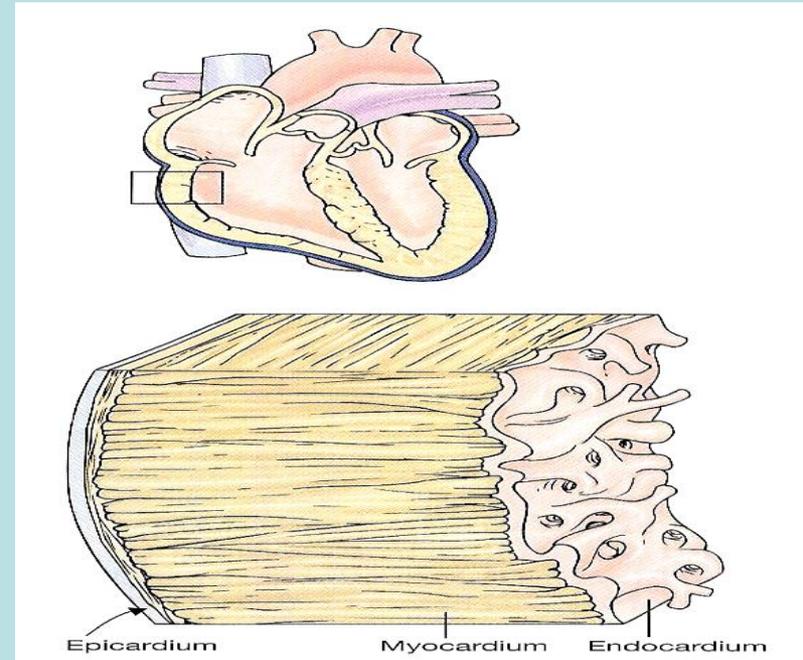
Pericardium

1. **Parietal pericardium** outer membrane
 - **fibrous layer** tough, white fibrous, anchorage
 - **serous layer** a thin fibrous layer on top of a simple squamous mesothelium

2. **Visceral pericardium** =
epicardium = **serous layer**

Pericardial cavity filled with **pericardial fluid** preventing friction

Pericarditis



**The Heart Wall - three layers:
A. The Epicardium**



B. The Myocardium

1- cardiac muscle

2- fibrous connective tissue

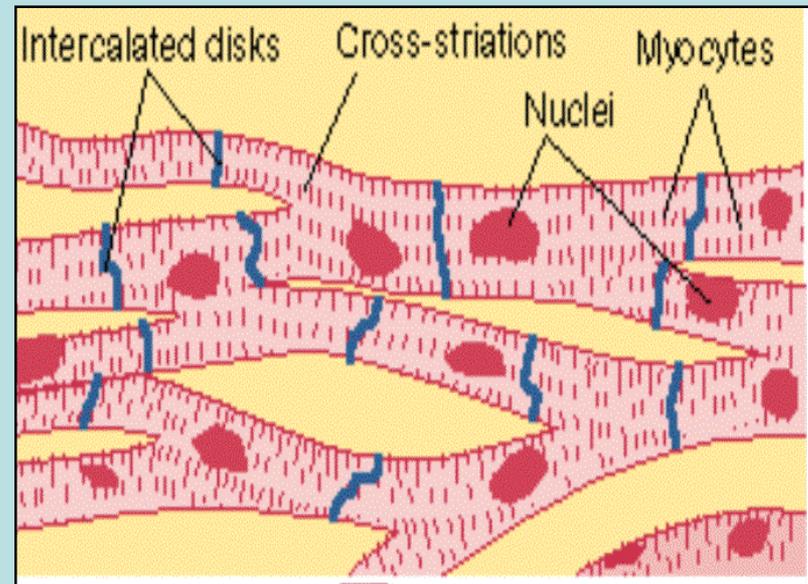
"skeleton of the heart"

- **anchorage** for the cardiac muscle and the atrioventricular valves.
coronary trigone.
- **The elastic component for the recoil** that assists in filling the chambers



Cardiac muscle

- Striated.
- Shorter than skeletal muscle
- Rich in mitochondria (up to 40% of cell volume)
- Branched.
- Has one nucleus in the center of the cell.
- **No nerves** are involved in the spread of contraction through the muscle.
- Adjacent cells are interconnected end-to-end by **intercalated discs**.



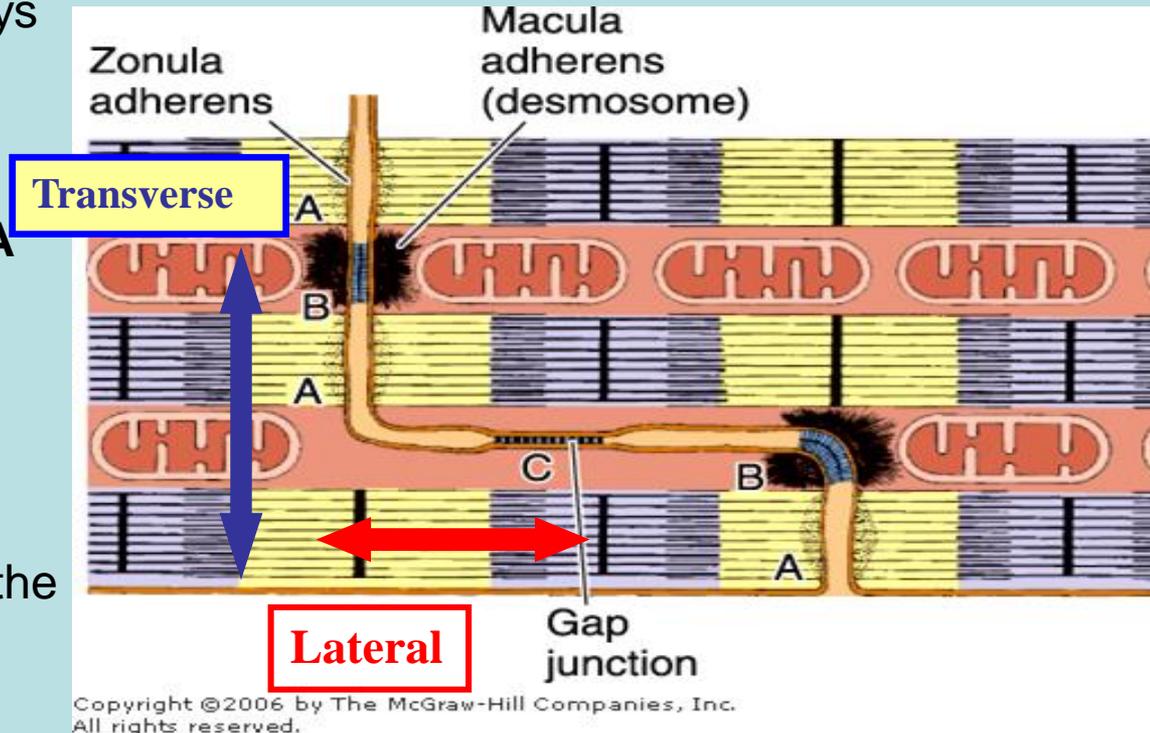
Intercalated discs where fibres interdigitate, function as a **syncytium (unit)**, which obeys 'all or none law'.

Transverse Part:
zonula (fasciae) adherents; A

*hold cardiac muscle cells
*anchor thin filaments

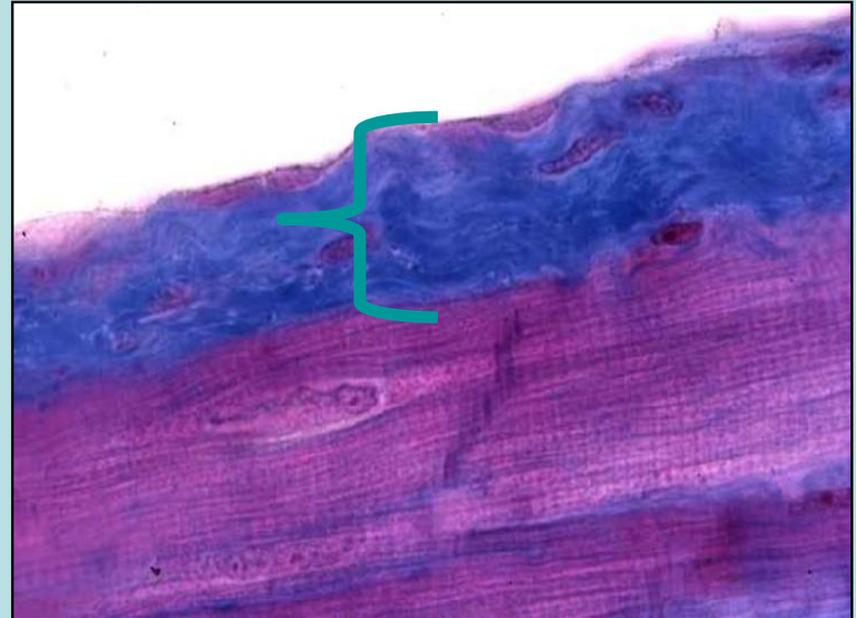
Desmosomes (macula adherentes) rivets to prevent the cells from pulling apart **B**

Lateral Part:
Gap junctions (nexus) - for impulse transfer providing **C** (electrical communication between cardiac muscle cells)



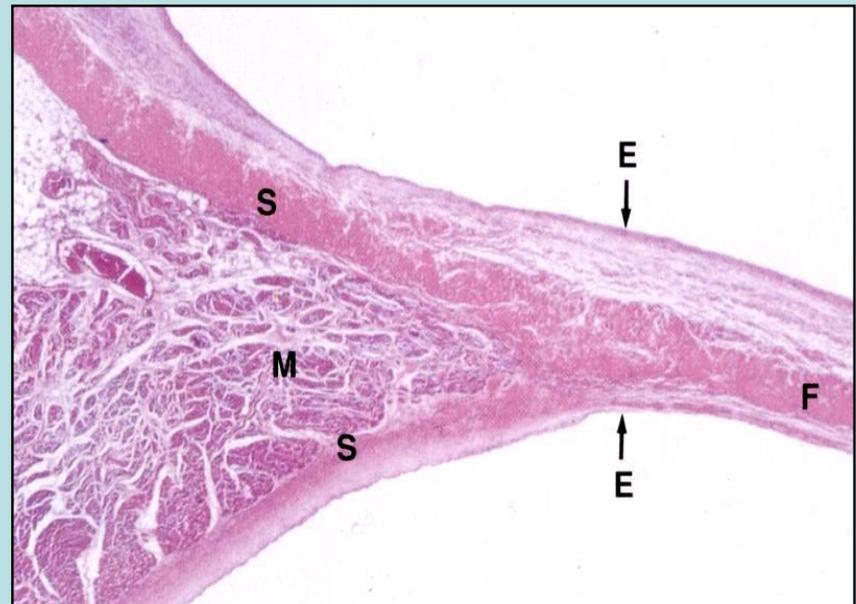
C. The Endocardium

- simple squamous endothelium
- loose connective tissue
- continuous** with the endothelium of the blood vessels
- Endocarditis.**



Cardiac Valves

- fibrous trigone**
- lamina fibrosa**, collagen fibers with elastic fibers)
- endothelium**



♥ Conduction pathway:

Specialized muscle fibres
without any direct stimulus from the nervous system,

consisting of

- **Sinoatrial (SA) node** located near the junction of the superior vena cava and the right atrium which **initiates** the beating action (called the **pacemaker**).

- **Internodal pathways (tracts)**

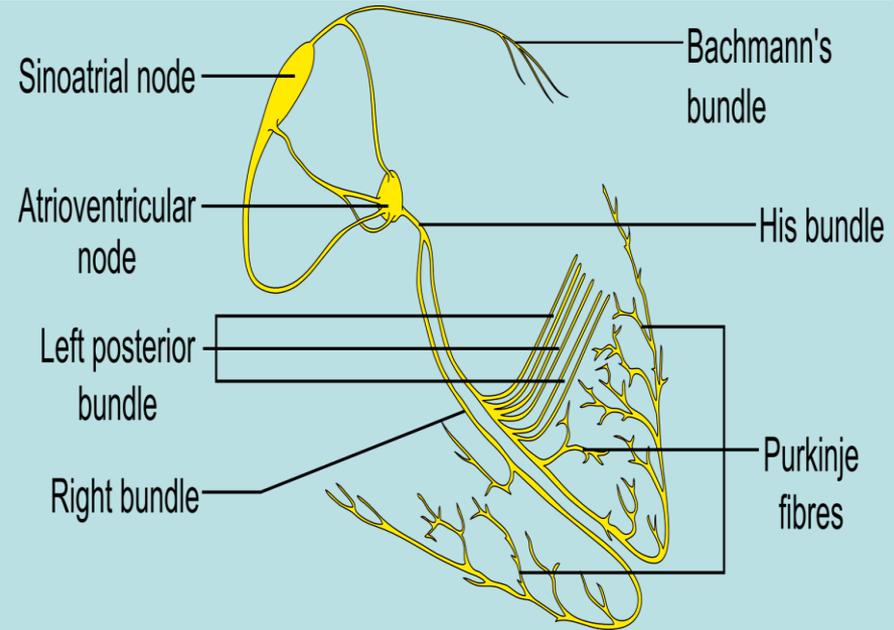
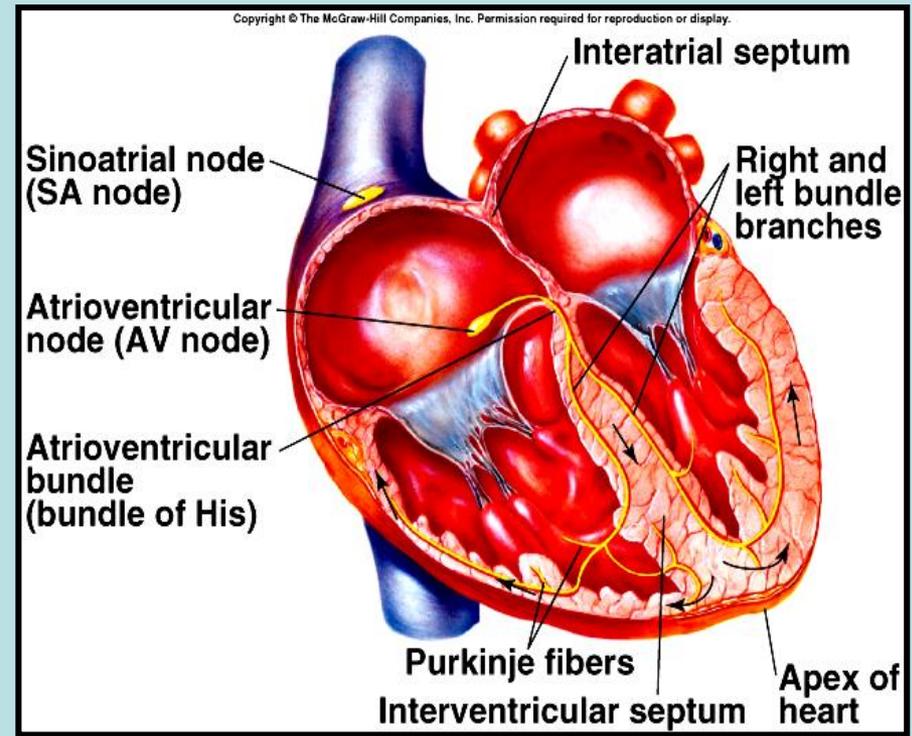
- **Atrioventricular (AV) node**

- **Bundle of His (AV bundle)**

- **Rt & Lt bundle branches.**

- **Purkinje fibers**

- generate electrical impulses
- conduct electrical impulses through the myocardium
- synchronize the heartbeat
- are found along the innermost layer of the myocardium



BLOOD VESSELS

vasoconstriction /vasodilatation

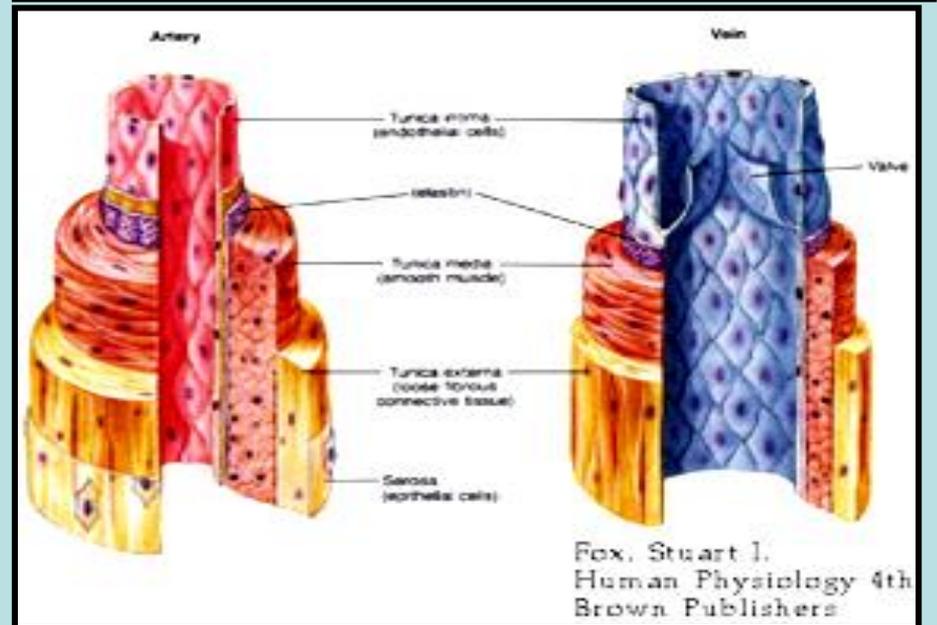
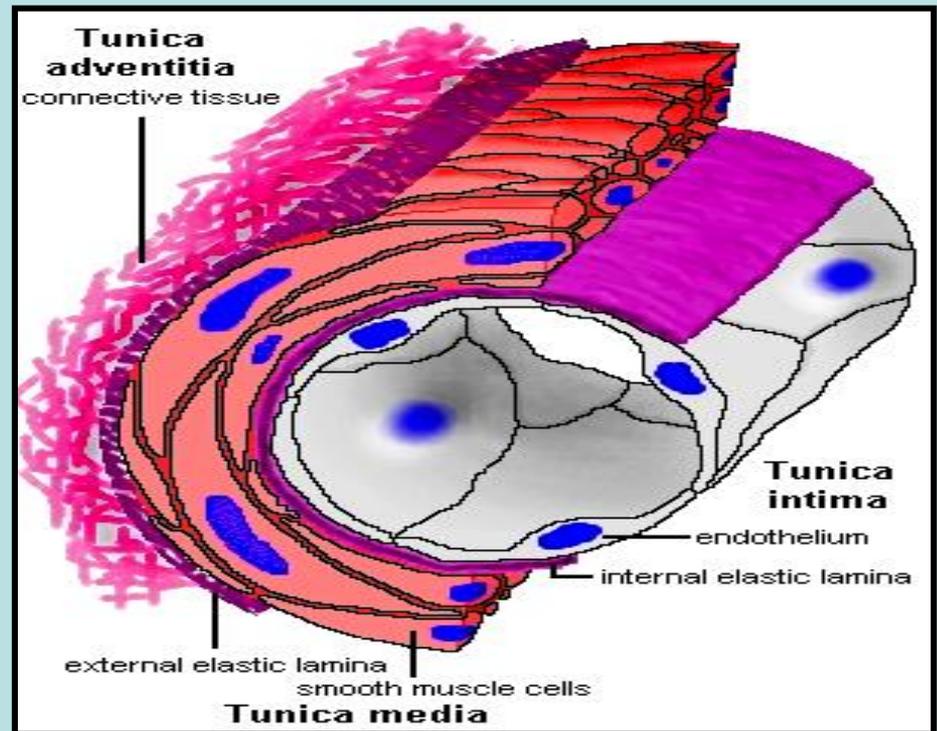
- Regulate **arterial** blood **pressure**
- Adjust blood **flow** within organs
- Regulate **capillary** blood **pressure**
- Distribute blood **volume** within the body

arteries, arterioles, capillaries, venules and veins.

General Structure of Blood Vessels

three major layers or tunics

- Tunica intima** simple squamous endothelial, subendothelial connective tissue, **internal elastic lamina**
- Tunica media** circumferential smooth muscle, the **external elastic lamina**
- Tunica adventitia** connective tissue, nerves, vasa vasorum



Fox, Stuart I.
Human Physiology 4th
Brown Publishers

ARTERIES

- I. Conducting or Elastic Arteries (large arteries) >1cm
- II. Distributing or Muscular Arteries (medium arteries) 0.1-10mm
- III. Arterioles (small arteries) <0.1mm

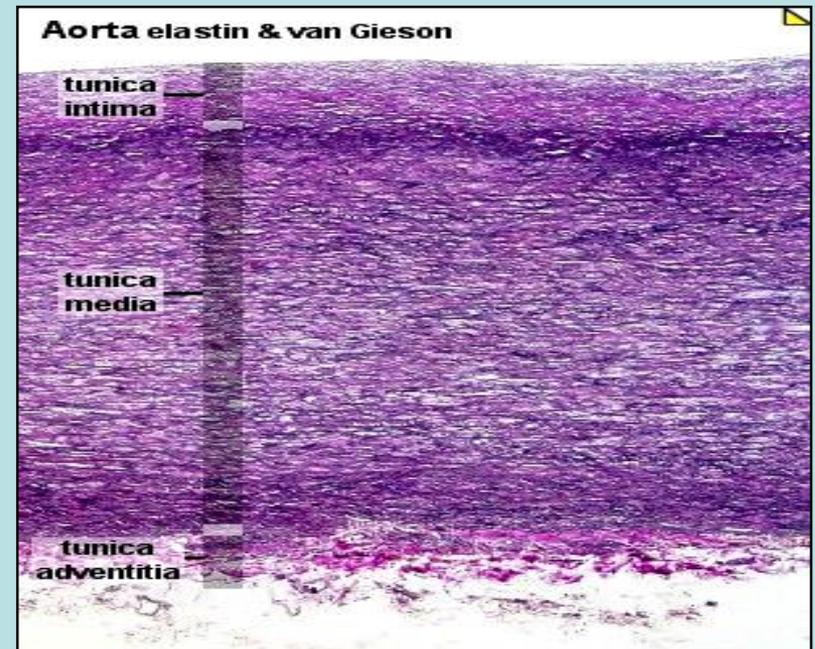
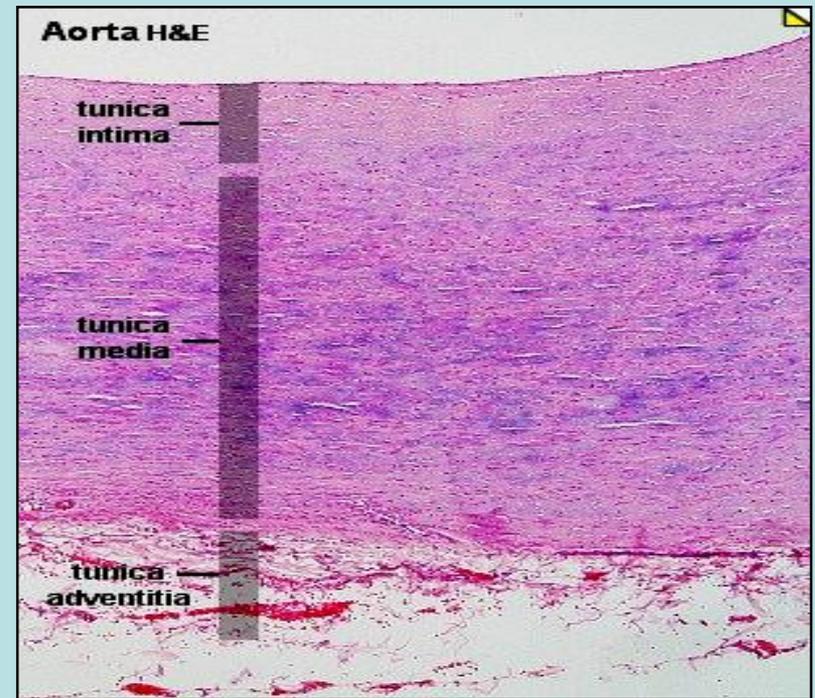
Elastic Arteries (large arteries)

e.g. aorta, pulmonary, branches of the aorta

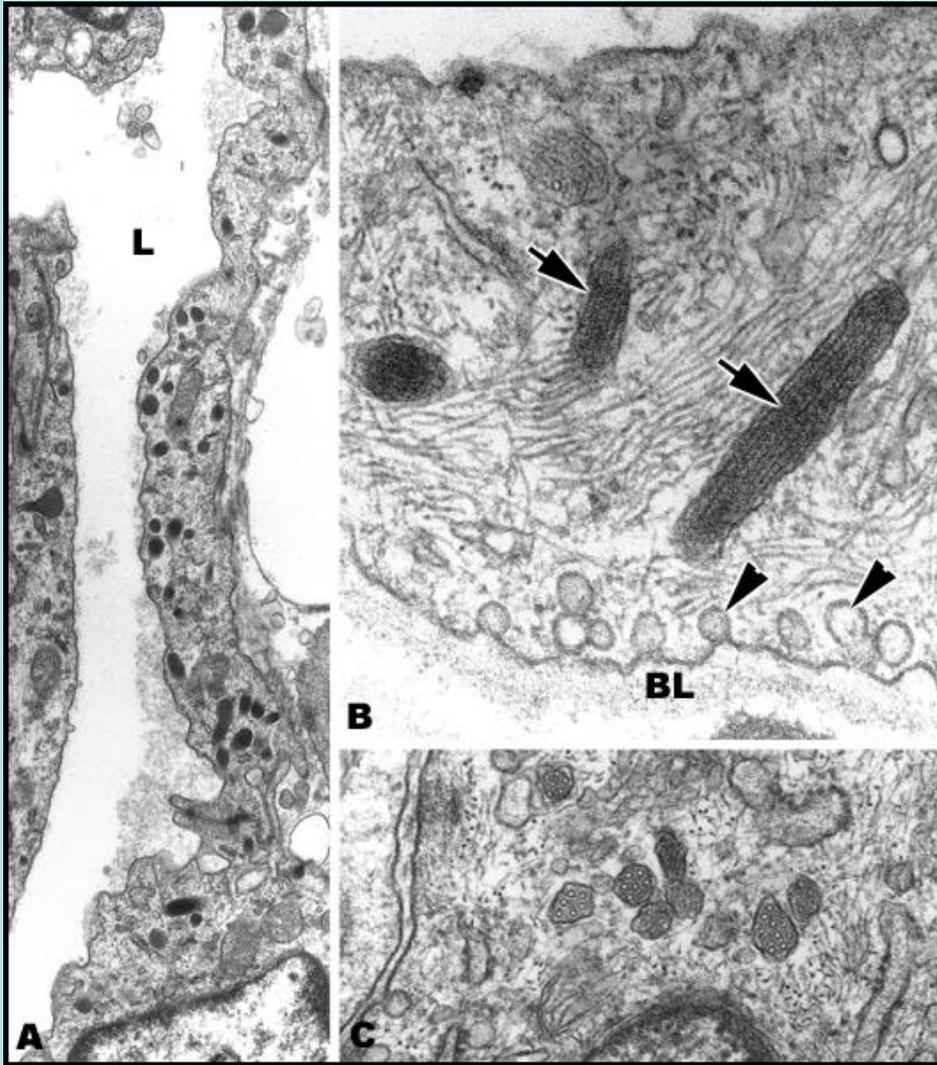
tunica intima thick, **Endothelium** with **Weibel-Palade** bodies/ **von Willebrand factor** (platelets coagulation), **less prominent Internal elastic lamina**

tunica media most of the wall, **concentric fenestrated lamellae of elastic fibers** (50 elastic lamellae). **Smooth muscle** and **collagen fibres (type III)**
Indistinct external elastic lamina

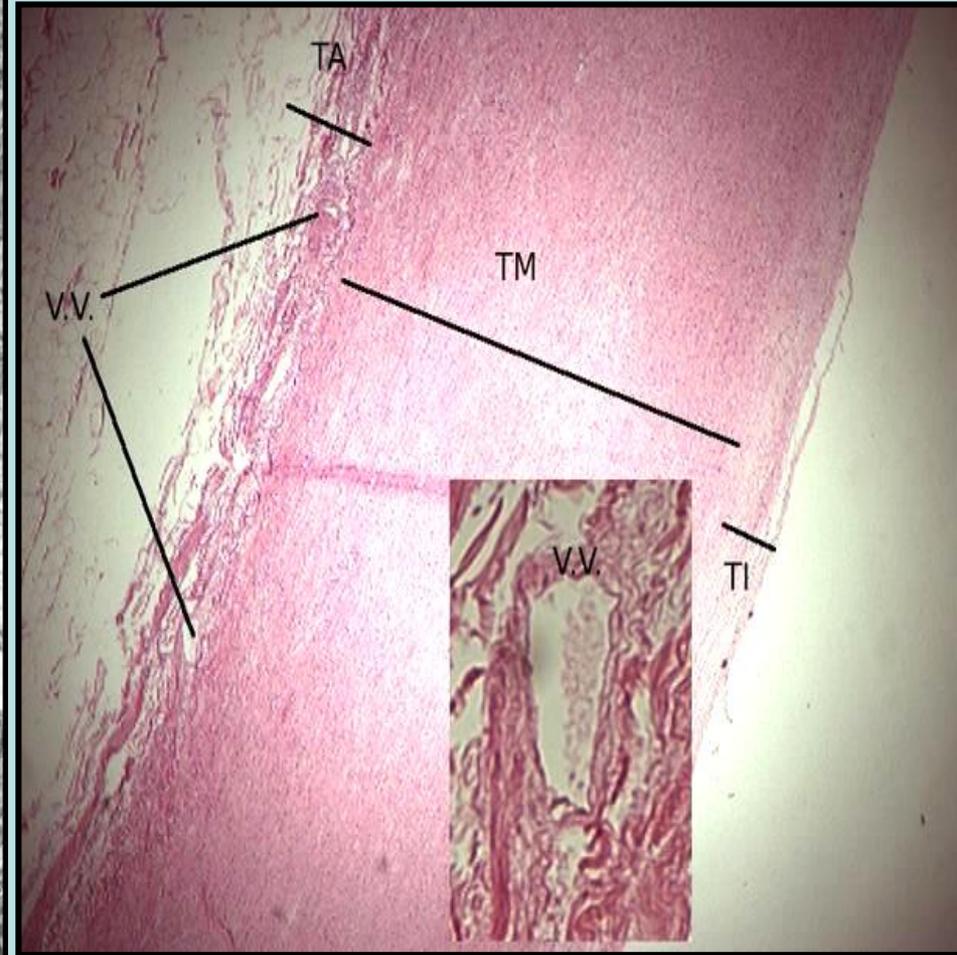
tunica adventitia elastic, **collagen fibres** and is **vasa vasorum**



Weibel-Palade bodies



Vasa vasorum



Muscular Arteries

Tunica intima

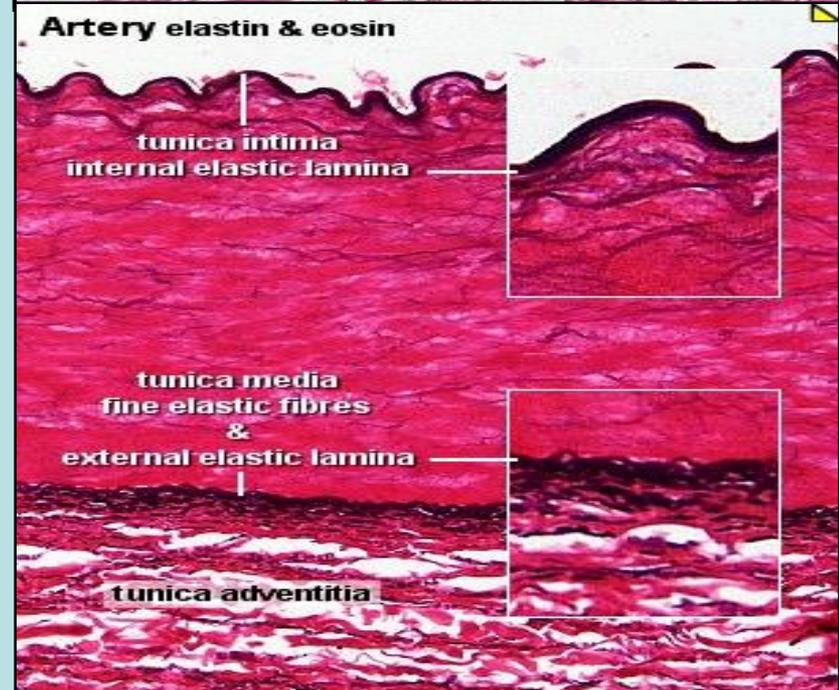
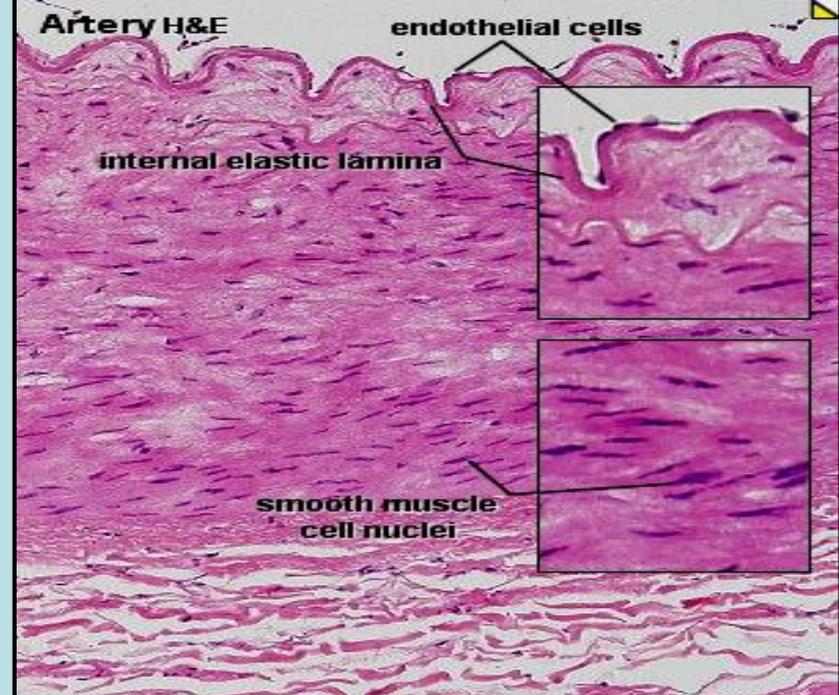
- **thinner** than in elastic arteries
- **endothelium** and **Weibel-Palade** bodies
- **well defined internal elastic lamina** wavy pink line

Tunica media

- **concentric layers** of smooth muscle cells.
- elastic and collagen fibres
- the **external elastic lamina** can be **clearly distinguished**

Tunica adventitia

- **variable** thickness and appearance



Arterioles (small arteries)

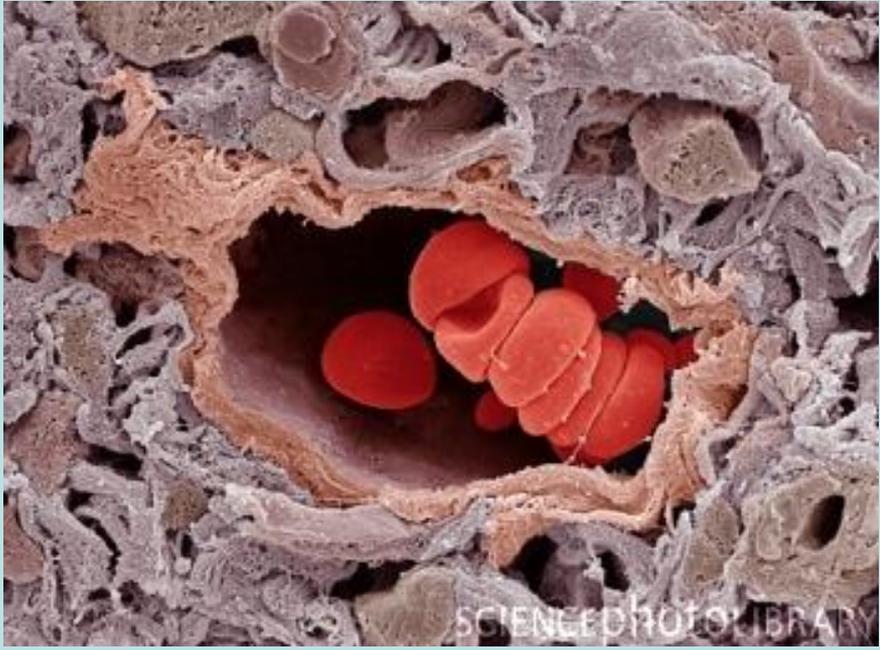
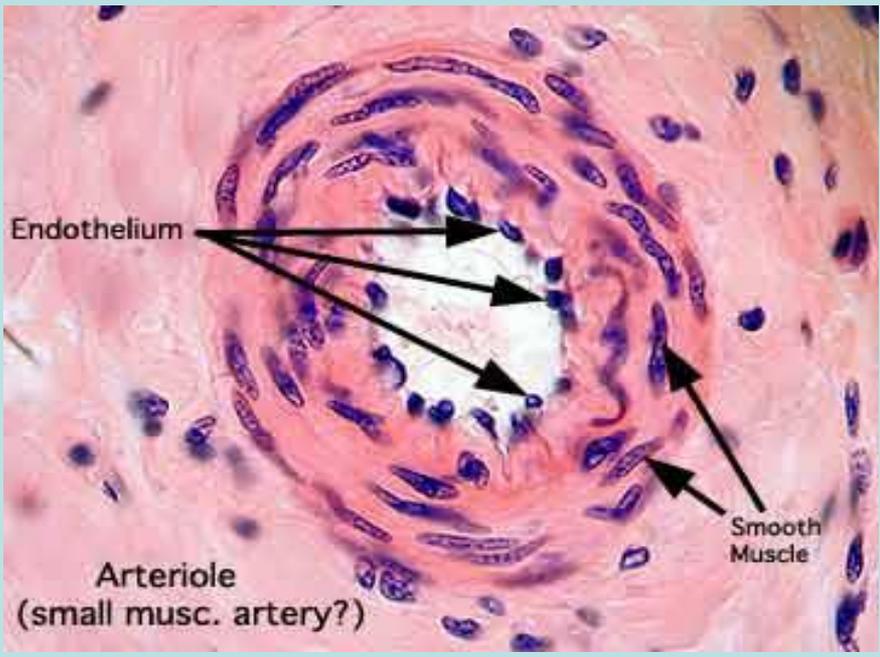
Tunica intima smaller with **endothelium** and **incomplete** or **absent** internal elastic lamina

Tunica media **circular smooth muscles** i.e. single to few layers

Tunica adventitia

autonomic nerve fibres lumen size
peripheral resistance control **arterial**
blood pressure

Arterioles are the **major resistance vessels** they branches into several arterioles with diameters **small** enough to offer considerable **resistance** to flow.

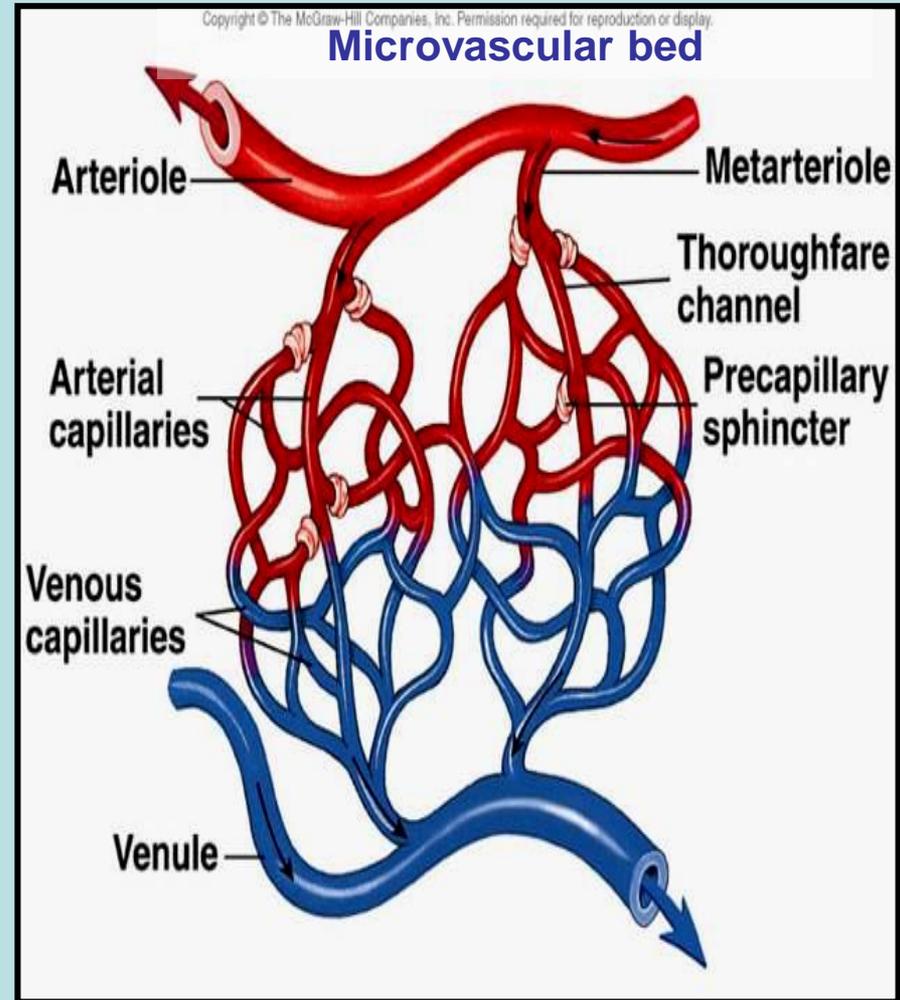


Microvascular bed

Metarterioles communication between arterioles and venules and are important in bypassing the blood flow through the capillaries. **True capillaries branch mainly from metarterioles**

Precapillary sphincters smooth muscles rings at the origin of true capillaries to **regulate blood flow** into true capillaries and tissues

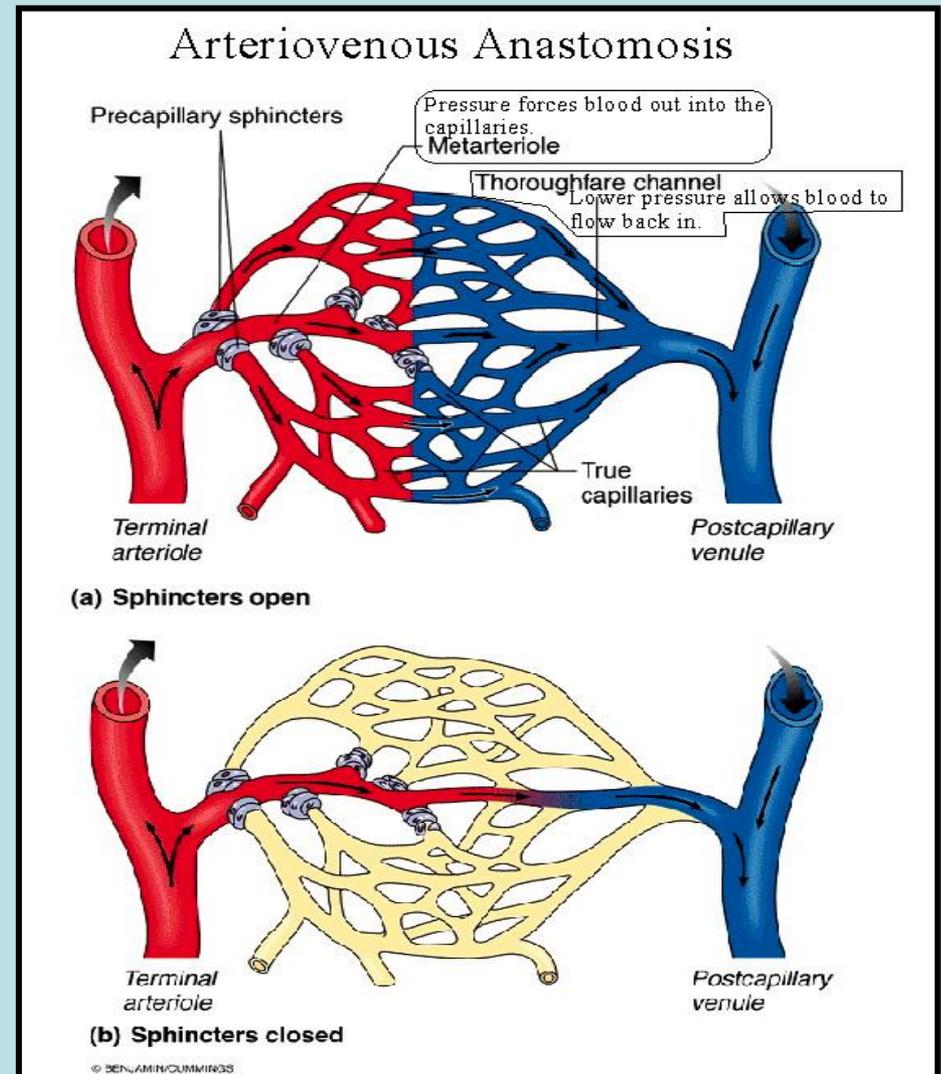
Thoroughfare channel NO Precapillary sphincters



Arteriovenous anastomosis (arterial-venous-shunt)

- **direct connections** between **arterioles** and **venules** allow blood to **bypass** the capillary bed very common in the dermis of the skin, lips, nose and GIT

- **Functions as backup routes** in case of blockage and assist in **temperature regulation**



CAPILLARIES

- Only the tunica intima
- endothelium, its basal lamina and the pericytes (perivascular cells).

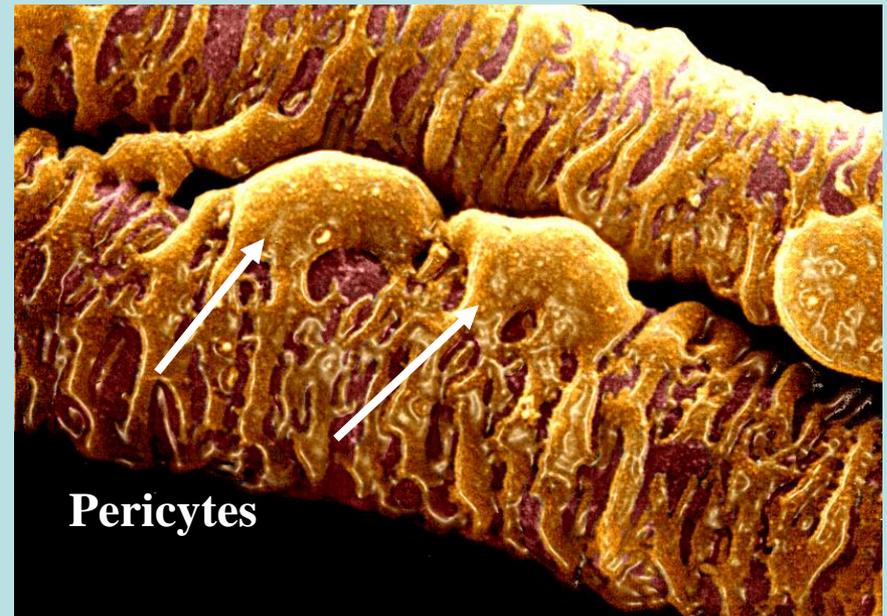
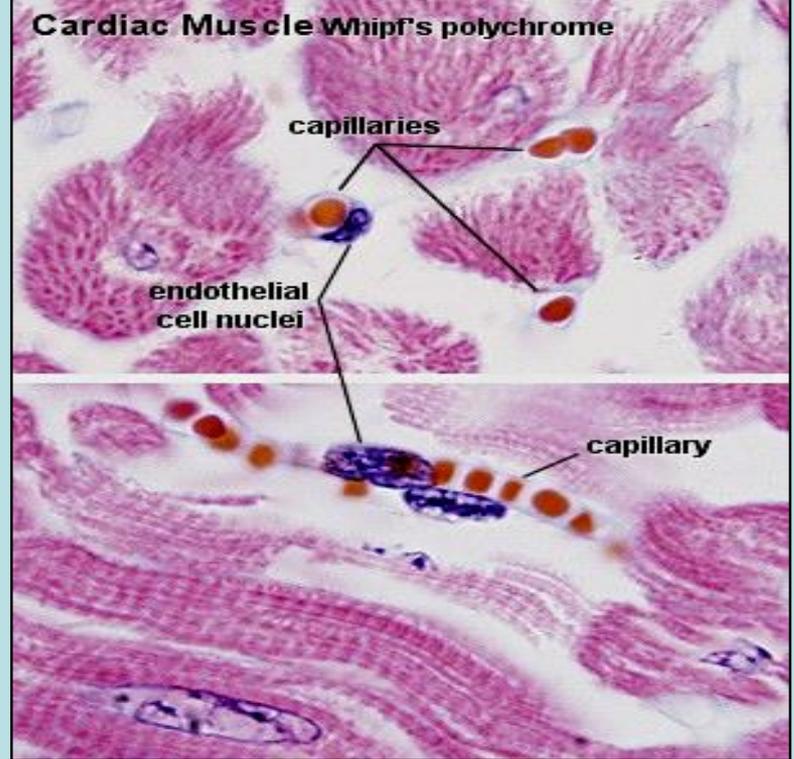
- contractile
- blood flow
- repairing
- phagocytic

- Pinocytotic vesicles for transporting materials across endothelium in both directions

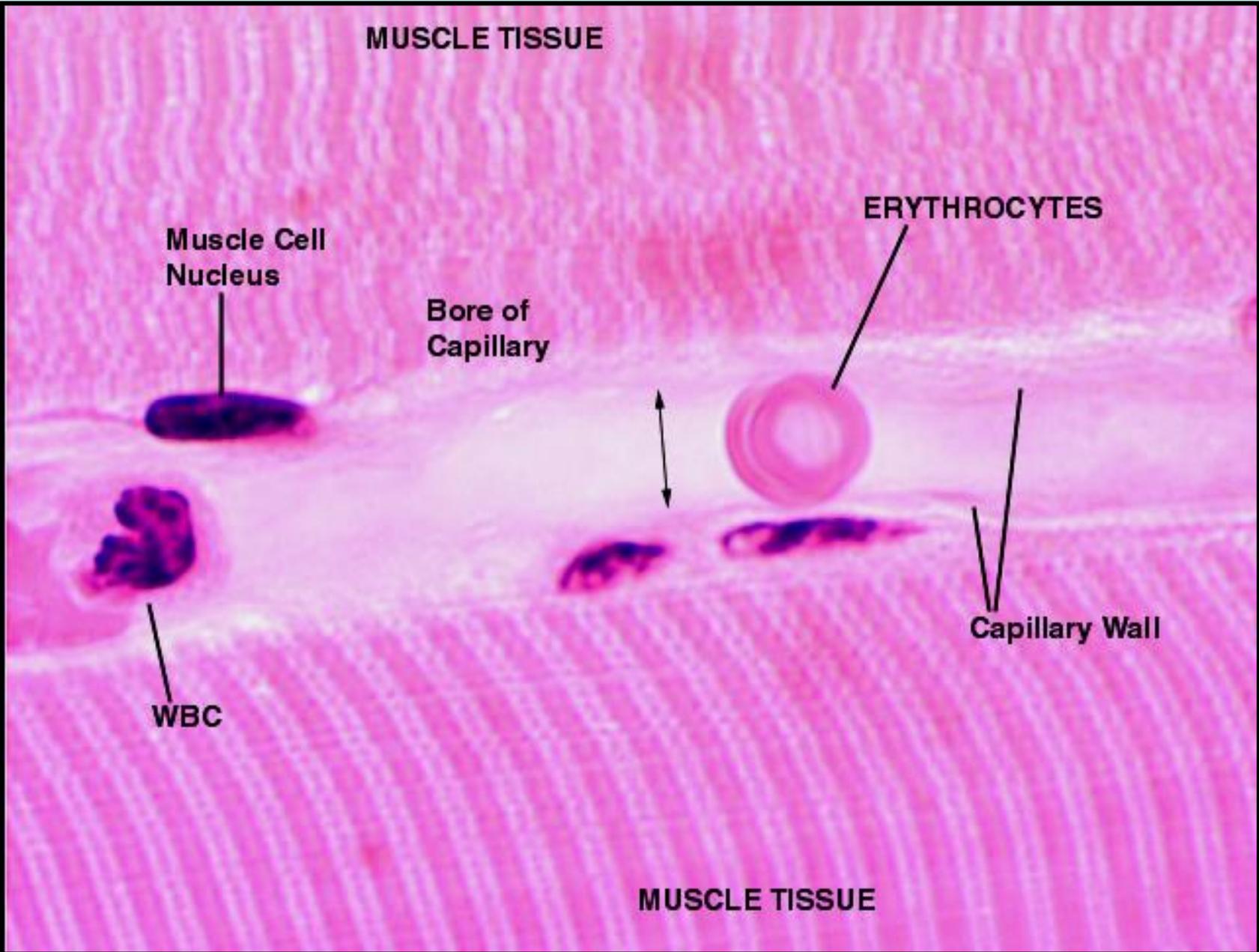
- Ultrastructurally **three** different types of capillaries

- Continuous capillaries
- Fenestrated capillaries
- Sinusoids (discontinuous capillaries)

-



MUSCLE TISSUE



Muscle Cell
Nucleus

Bore of
Capillary

ERYTHROCYTES

WBC

Capillary Wall

MUSCLE TISSUE

Continuous capillaries and fenestrated capillaries

continuous endothelium lining

continuous basal lamina

▪ **fenestrated** capillaries there are a **tiny pores (fenestrae)** <100 nm in diameter

control access of substances

▪ **Continuous capillaries** strict control on access of the substances e.g.

blood-brain-barrier,

the "**blood-thymus barrier**,

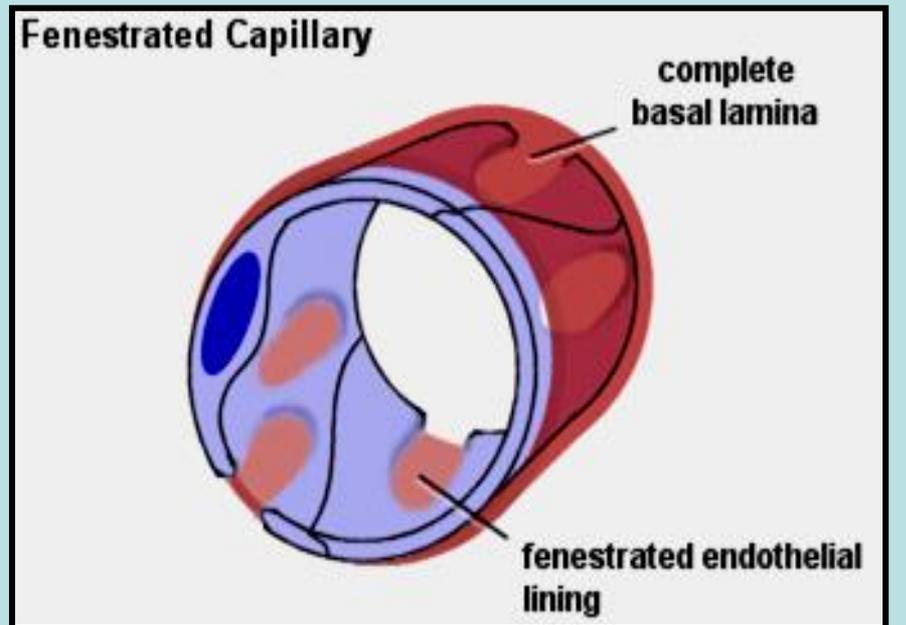
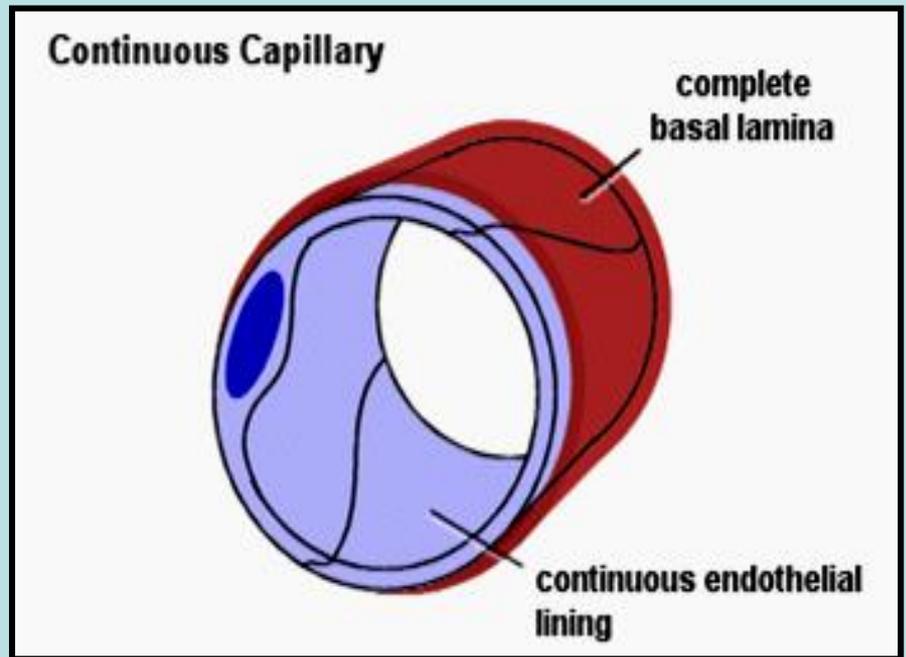
muscle and **connective tissues**

▪ **Fenestrated capillaries** e.g.

the **endocrine glands**,

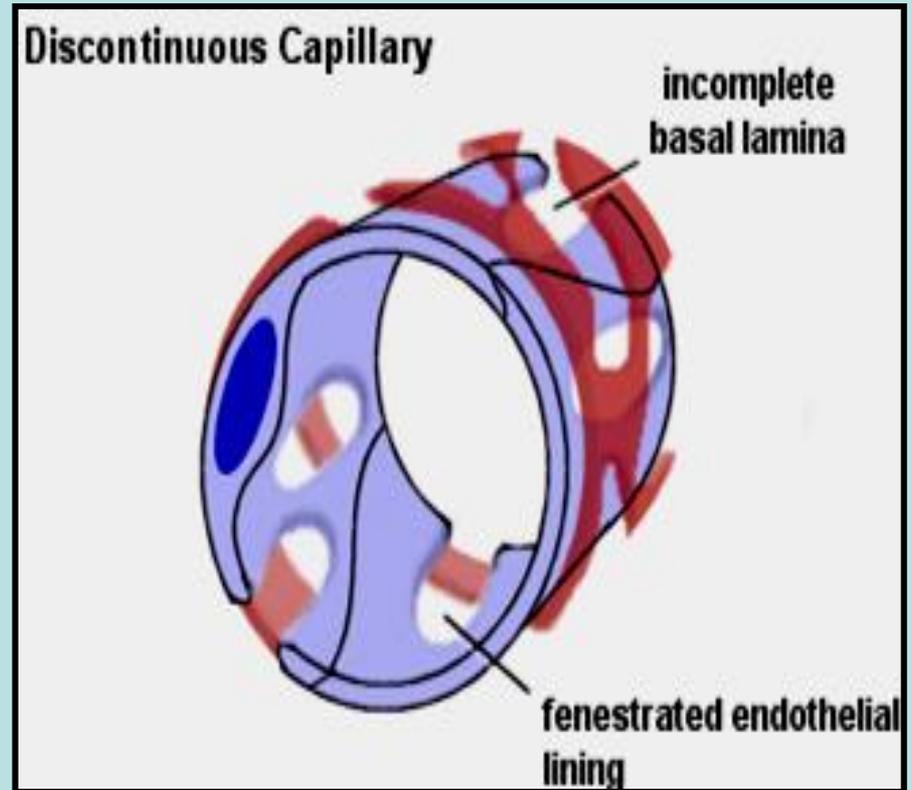
renal glomeruli

intestinal villi

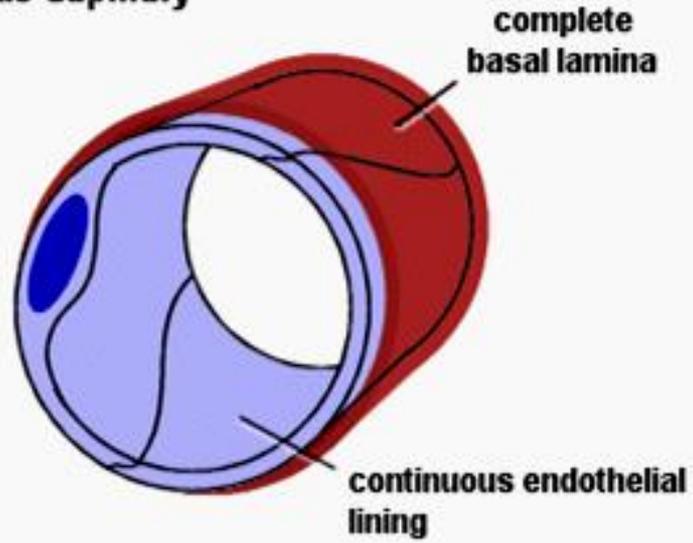


Discontinuous capillaries (Sinusoid)

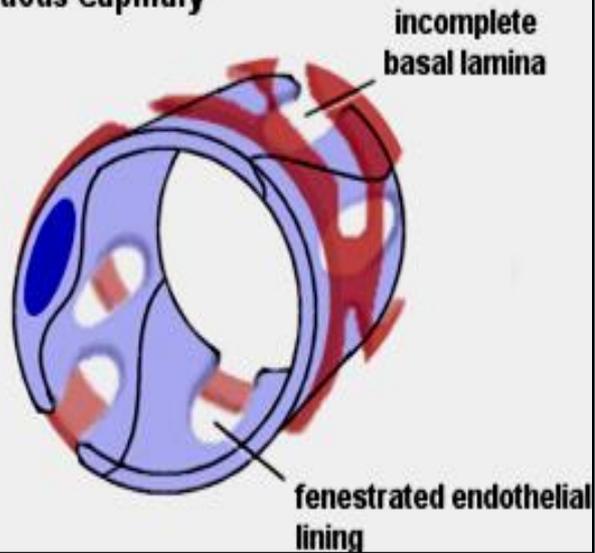
- **irregular vessels** with large diameters
- endothelium with **gaps** and **discontinuous** basal lamina
- found where a very **free exchange** of substances e.g.
 - liver
 - hematopoietic organs (**bone marrow, spleen**)
 - endocrine glands



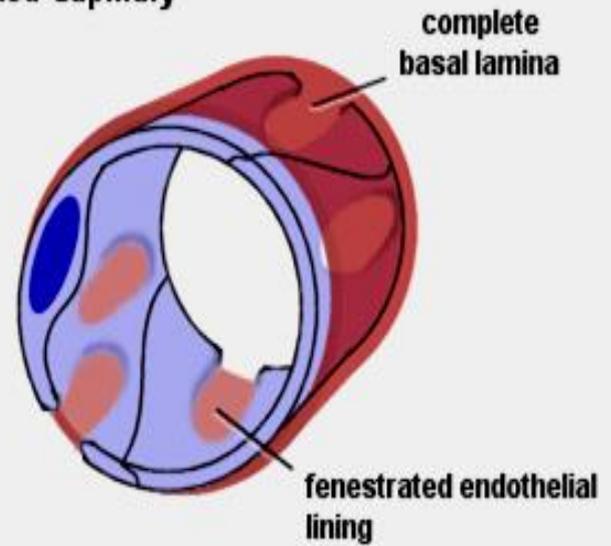
Continuous Capillary



Discontinuous Capillary



Fenestrated Capillary

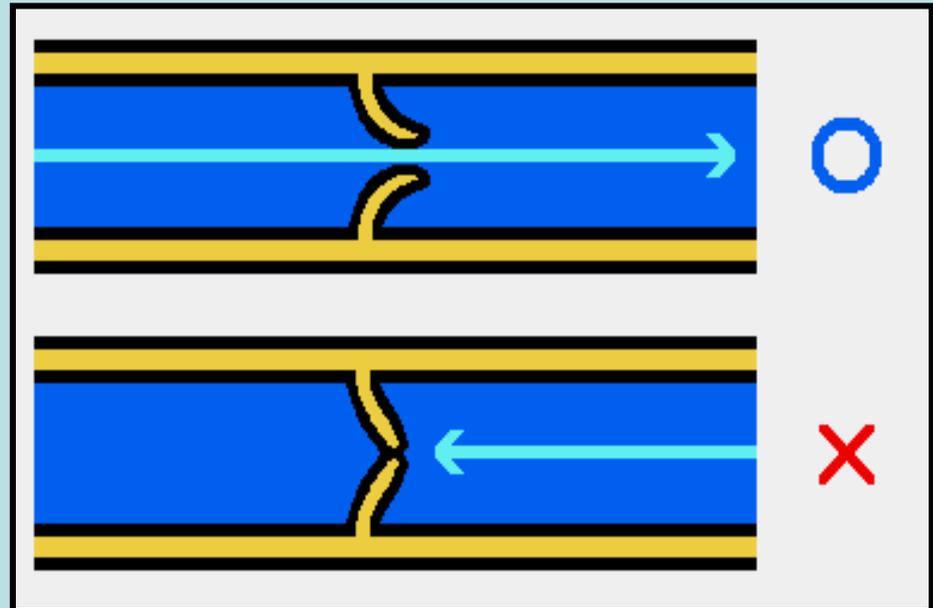


VEINS

large, medium or small veins
(venules)

In comparison with arteries

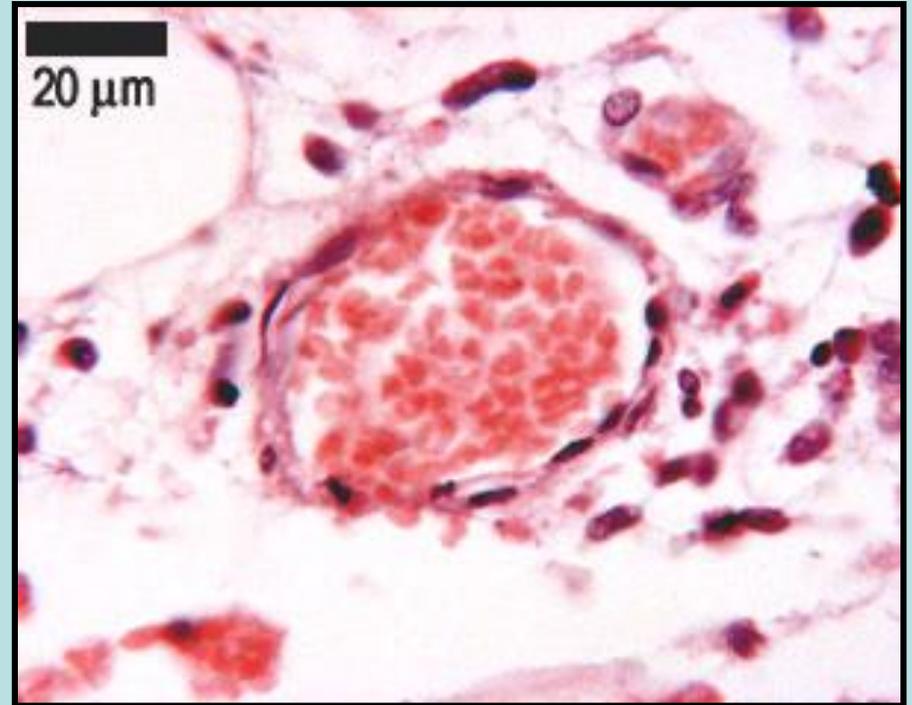
- Subjected to structural **variation**
 - more **numerous**
 - diameter **larger** than that of adjacent arteries
- walls are **thinner** and **less elastic** i.e. **little elastic recoil**
 - veins are highly **stretchable** i.e more **compliant (less resistance)**
 - the **vasa vasorum** are **greater** in the veins (necessary as the vessels have much **less oxygenated** blood)
 - **valves** are found in veins.
 - Veins have **less** smooth muscles than arteries



Venules

Postcapillary venules and muscular venules

- Postcapillary venules receive blood from capillaries and possess an **endothelial lining** with its **basal lamina** and **Pericytes**.
- They are **larger** than capillaries.
- Muscular venules are distinguished from postcapillary venules by the presence of a **tunica media** (which is **present in muscular venules**)



Medium veins

The **three tunics** of the wall are most evident in medium sized vein

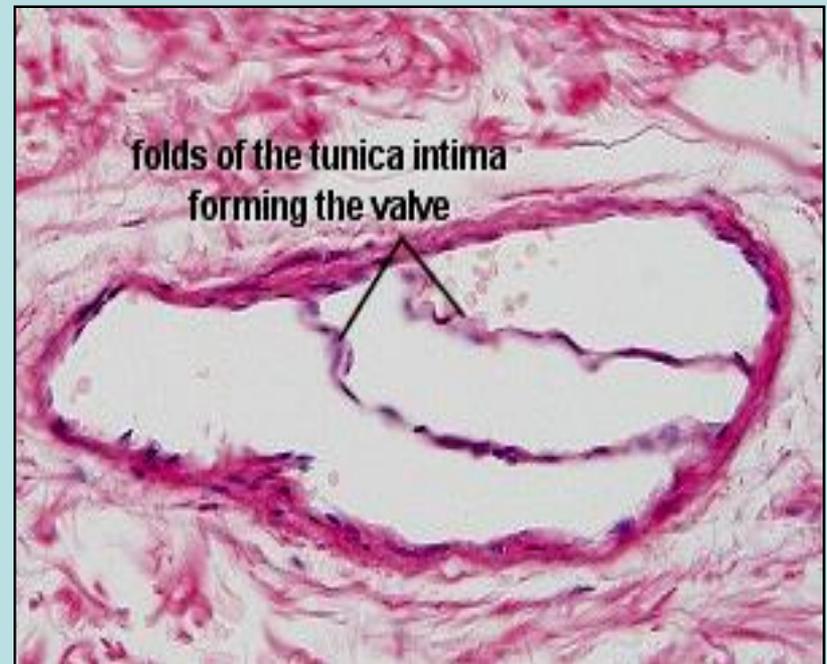
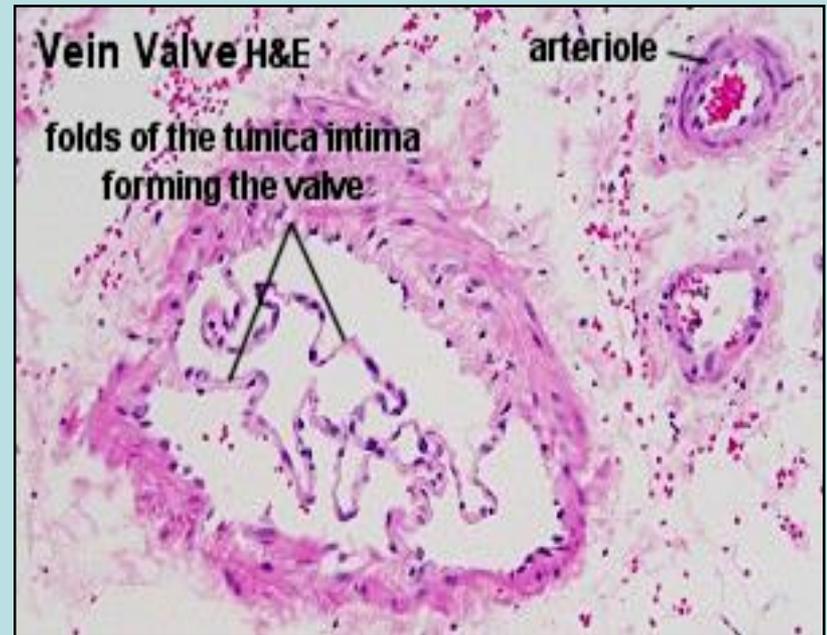
Tunica intima consists of **endothelium** with its **basal lamina**

Valves formed by loose, pocket-shaped folds of the **tunica intima**, **endothelium /elastic fibres** prevent the **backflow** of blood.

varicose veins

Tunica media thinner circularly arranged smooth muscles

Tunica adventitia thicker than the tunica media and have **longitudinal bundles** of smooth muscles, collagen and elastic fibres

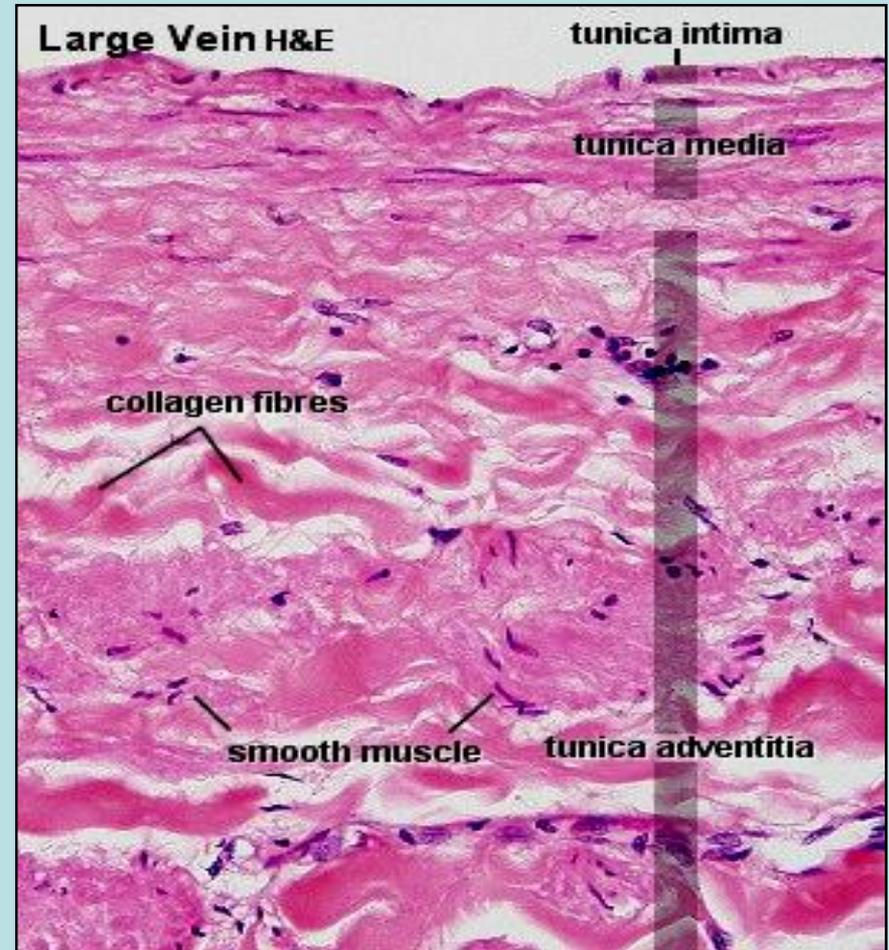


Large veins

Tunica intima consists of **endothelium/ basal lamina** and **subendothelial** connective tissue. Often the boundaries with tunica media is **not** clear

Tunica media thin and contains **smooth muscle** cells, collagen fibres

Tunica adventitia is the **thickest** layer it has bundles of **longitudinal** smooth muscle cells, collagen and elastic fibres.



Lymphatic Vessels

unidirectional flow, the lymph.

Three types

Lymph capillaries

larger than blood capillaries and **irregularly**

absent basal lamina

no tight junctions → **entry of liquids** into the lymph capillary

temporary openings → **larger particles** (lipid droplet) e.g. villi of the ileum and jejunum

Lymph collecting vessels

similar to lymph capillaries but **larger** and with **valves**

empty into **lymph nodes**

The lymph is moved by the **compression** of the lymph vessels by **surrounding tissues**

Lymph ducts

smooth muscle cells

They also form **valves** which may give a **beaded appearance** to the lymph
the right lymphatic duct and the **thoracic duct** → **subclavian veins**

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