

Cardiovascular system

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- vascular system is **transport system** of body, through which **nutrients** are conveyed to places where they are utilized **and waste products** are then conveyed to appropriate place from where they are excreted.
- it is a closed system of tubes made up of parts:
 - Heart,
 - Arteries,
 - veins & capillaries.

- **Heart**—four chambered muscular organ which pumps blood to various parts of the body.
- each half has a receiving chamber called atrium and a pumping chamber called ventricle.
- **arteries**- distributing channels which carry blood away from heart,
- they branch like trees on their way to different parts of the body.
- the large arteries are rich in elastic tissue but as branching progress there is smooth muscle in their walls.the minute branches visible to naked eye are called arterioles.

- **veins**—draining channels which carry blood from different parts of body to heart.
- The venules(small veins) join together to form larger veins which In turn unite to form great veins called venae cavae.
- **Capilleries**—network of microscopic vessels which connect arterioles with venules.,they are in intimate contact with tissues for a free exchange of nutrients and metabolites across their walls b/w the blood and tissue fluid.,they are replaced by sinusoids in **liver** and **spleen**.

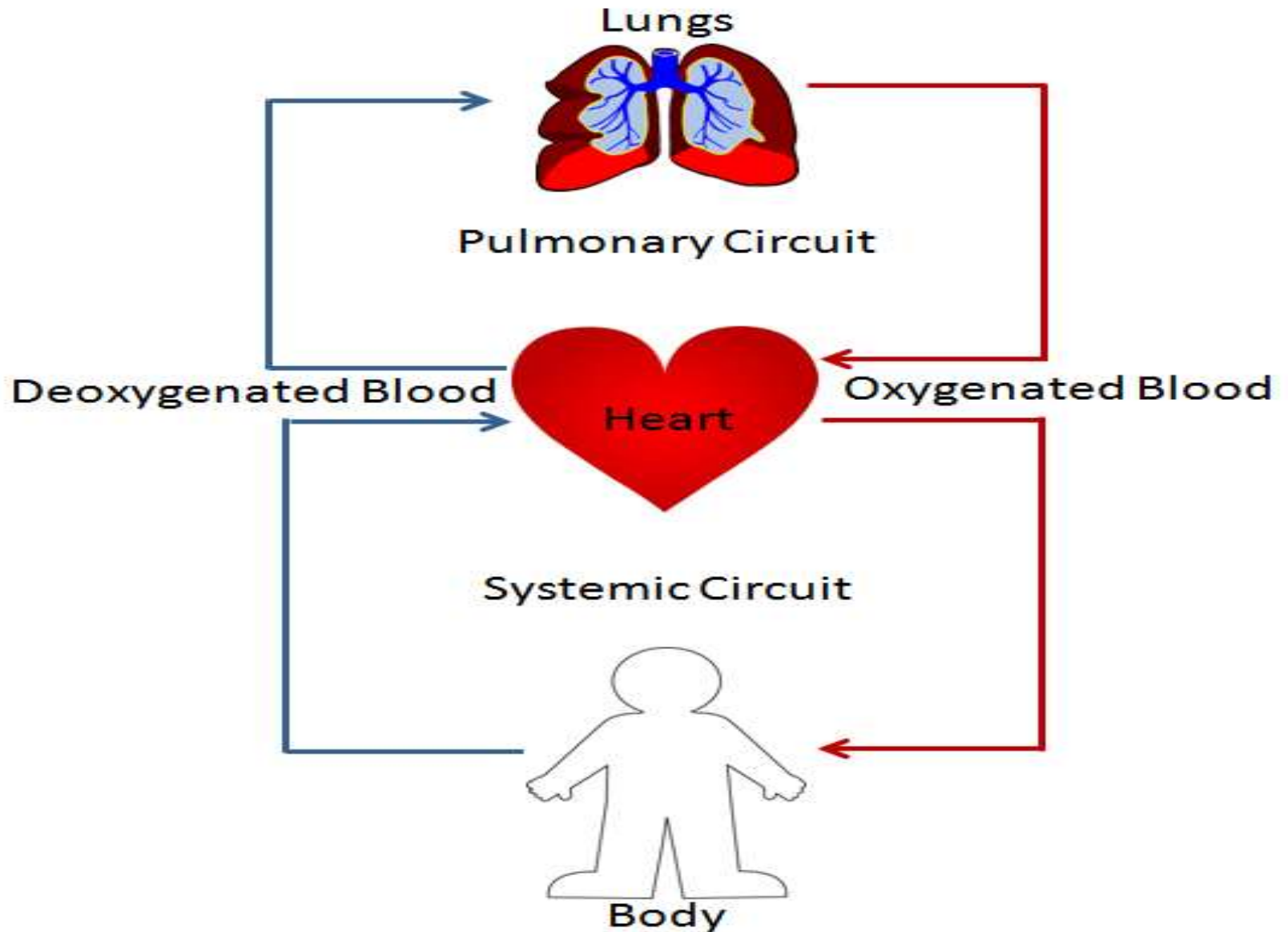
- functionally classified into five groups:
- distributing vessels—arteries
- resistance vessels—arterioles, precapillary sphincters,
- exchange vessels—capilleries, sinusoids, post capillary venules.
- reservoir vessels—large venules,veins
- shunts—various type of anastamosis.

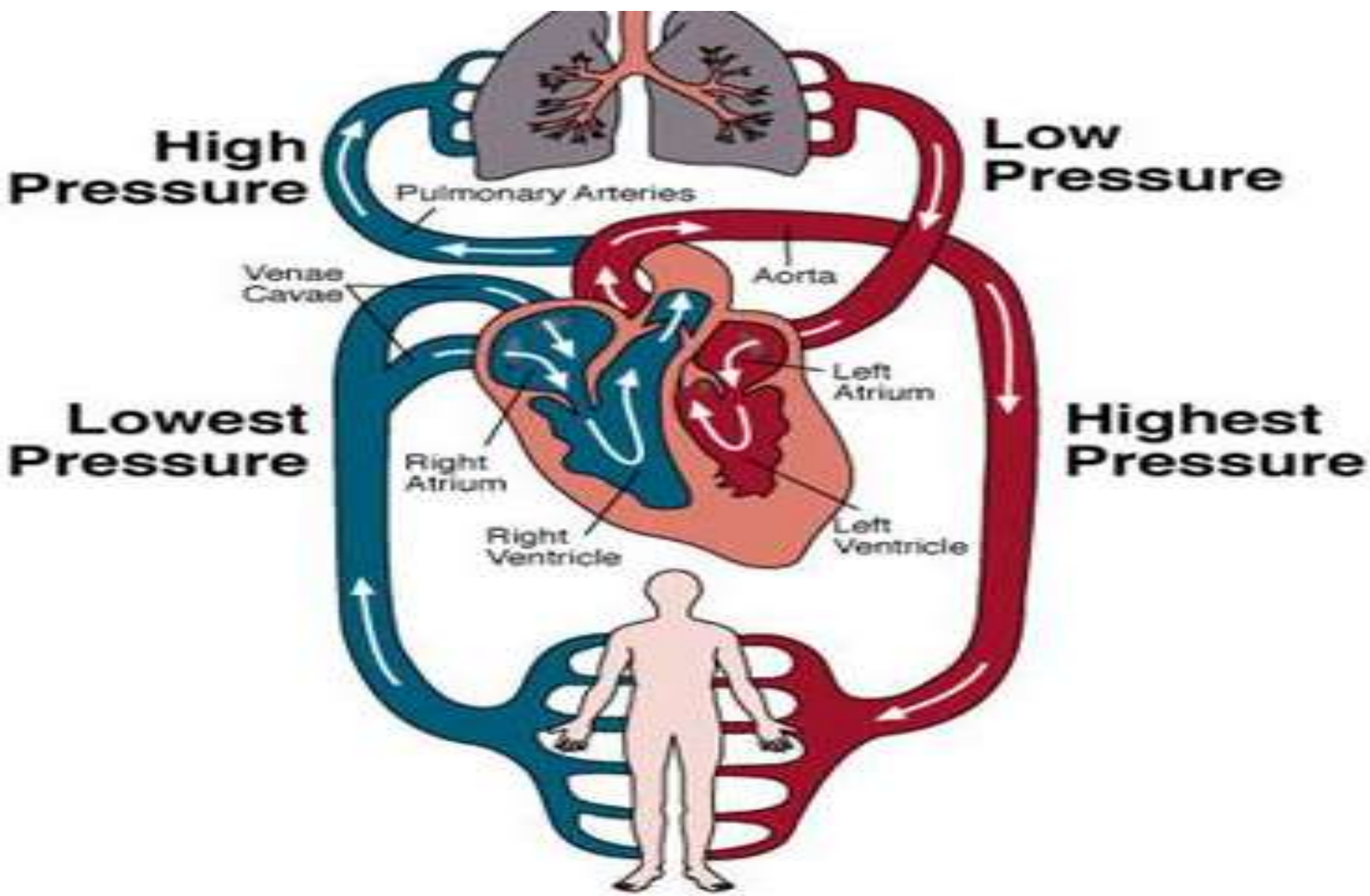
Types of circulation

- systemic circulation
- pulmonary circulation
- Portal circulation

Systemic circulation

- left atrium ---- left ventricle ---to remote capilleries of body through aorta & its branches.-----**as nutrition & oxygen pass from blood to tissues** ----through them waste products and co2 return from tissues to blood.-----blood is then returned to heart through venules, vein, superior vena cava and inferior vena cava.





Pulmonary circulation

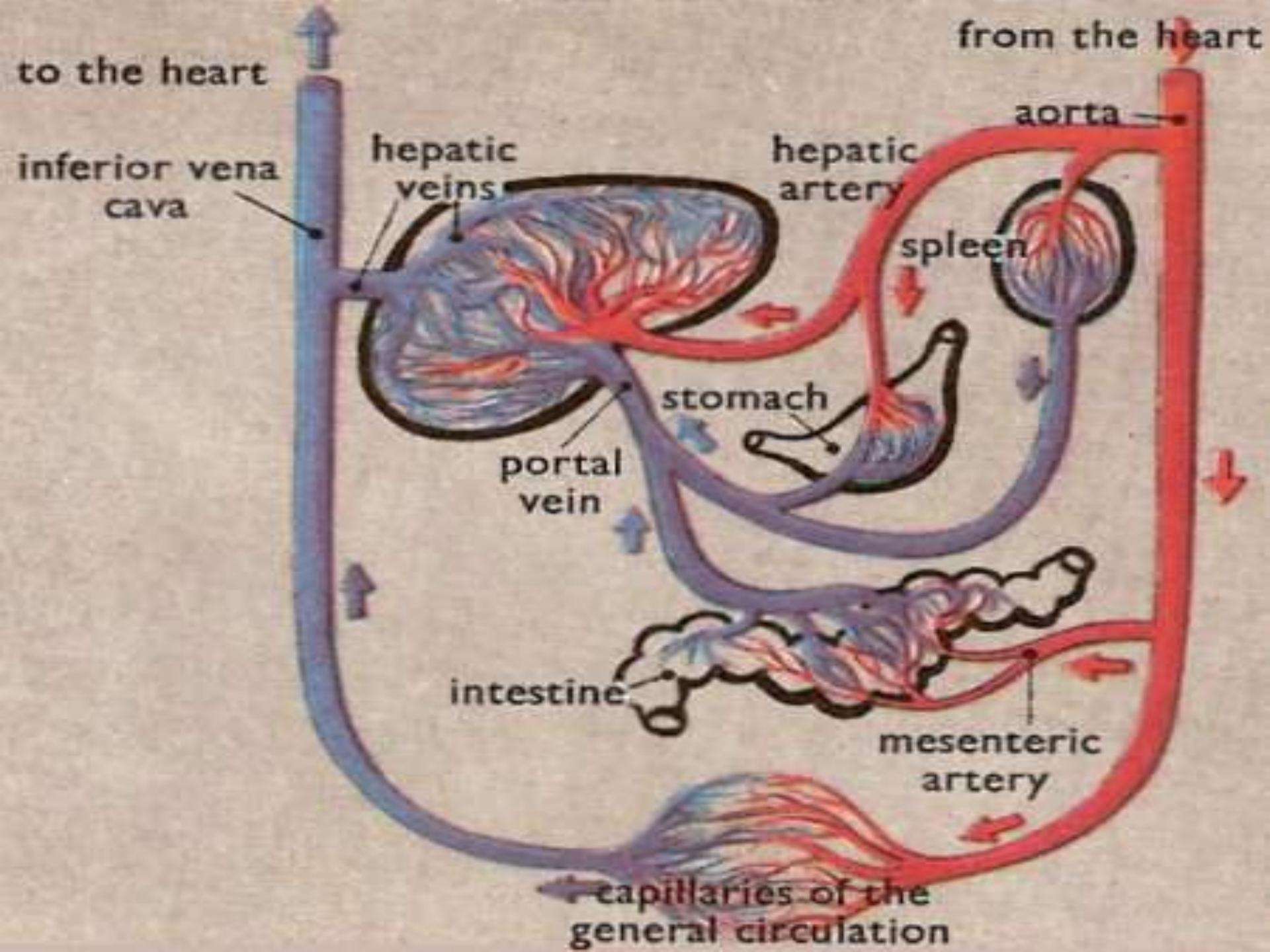
- SVC , IVC , CORONARY SINUS-----RA-----

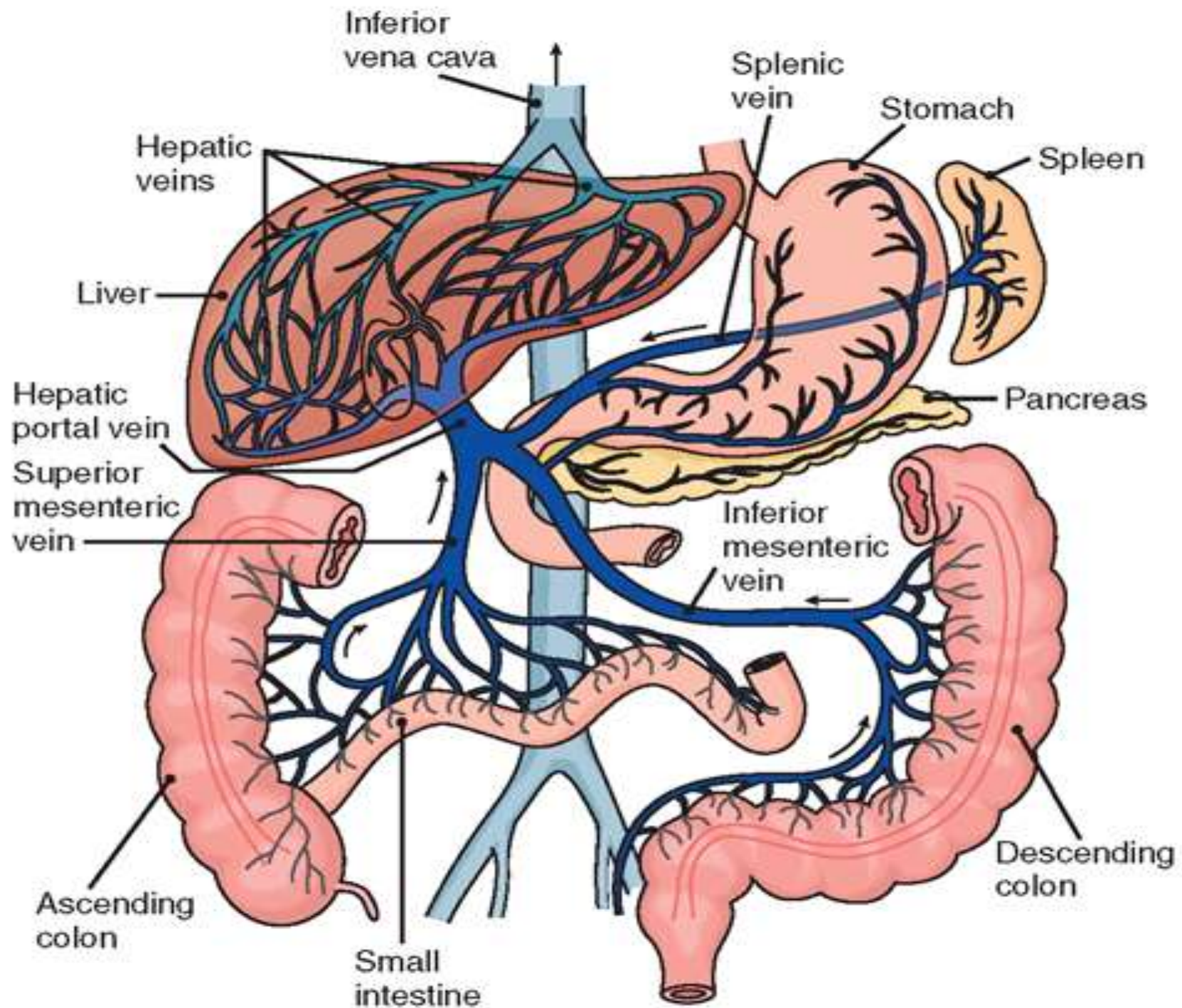
-----RV-----PUMPS blood to capillary plexus
of lungs via PULMONARY TRUNK.

- HERE CO₂ IS EXCHANGED FOR O₂.
- THE OXYGENATED blood reaches left atrium
via pulmonary veins.

Portal circulation

- part of systemic circulation which has following characteristics---
- blood passes through two sets of capilleries before draining into a systemic vein.
- vein draining first capillary network is known as portal vein ,which branches like a artery to form second set of capilleries /sinusoids --- hepatic portal circulation, hypophyseal portal circulation & renal portal circulation.





Classification of blood vessels

- arteries
- arterioles
- capilleries
- sinusoids & cavernous tissues
- Venules and veins

Arteries

- **thick walled** , uniformly thicker than accompanying veins ,**except arteries with in the cranium and vertebral canal,where they are thin.**
- their **lumen is thinner** than accompanying veins.
- they **have no valves.**
- usually accompanied by vein and nerve(neurovascular bundle).

Types of arteries

- large arteries/elastic arteries— aorta, pulmonary artery.
- muscular artery-temporal, occipital, radial
- arterioles (smallest artery of muscular type)
- side branches from terminal **arterioles-metaarterioles**.
- the terminal narrow end is surrounded by a **precapillary** sphincter, which regulates the blood flow into capillary bed.
- the muscular arterioles are responsible for generating peripheral resistance and thereby regulating the **diastolic blood pressure**.

histologically

- all arteries are made of three coat—
- A) **tunica intima** (inner coat)—
- Layer of flattened endothelial cells which are supported by subendothelial aerolar tissue and fenesterated internal elastic lamina.
- B) **tunica media**(middle coat) –
- thickest of all coats,made of smooth muscle and elastic tissue arranged circularly ,
- limited externally by a fenestrated external elastic lamina.

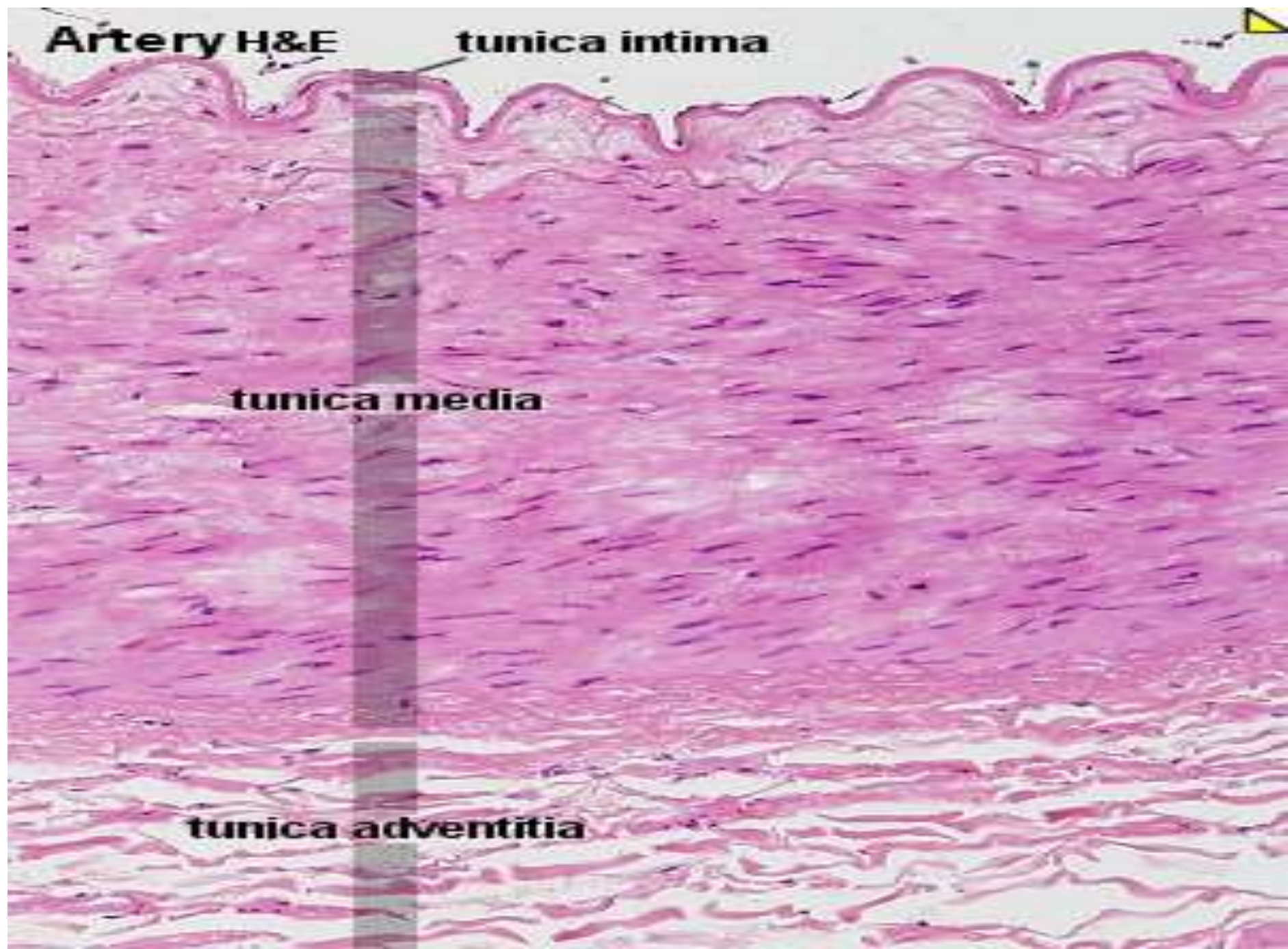
- c) **tunica adventitia**(external coat)—thin but strongest of all coats.
- made of longitudinally arranged fibers of both collagen and elastic tissue making it fibroelastic.

Artery H&E

tunica intima

tunica media

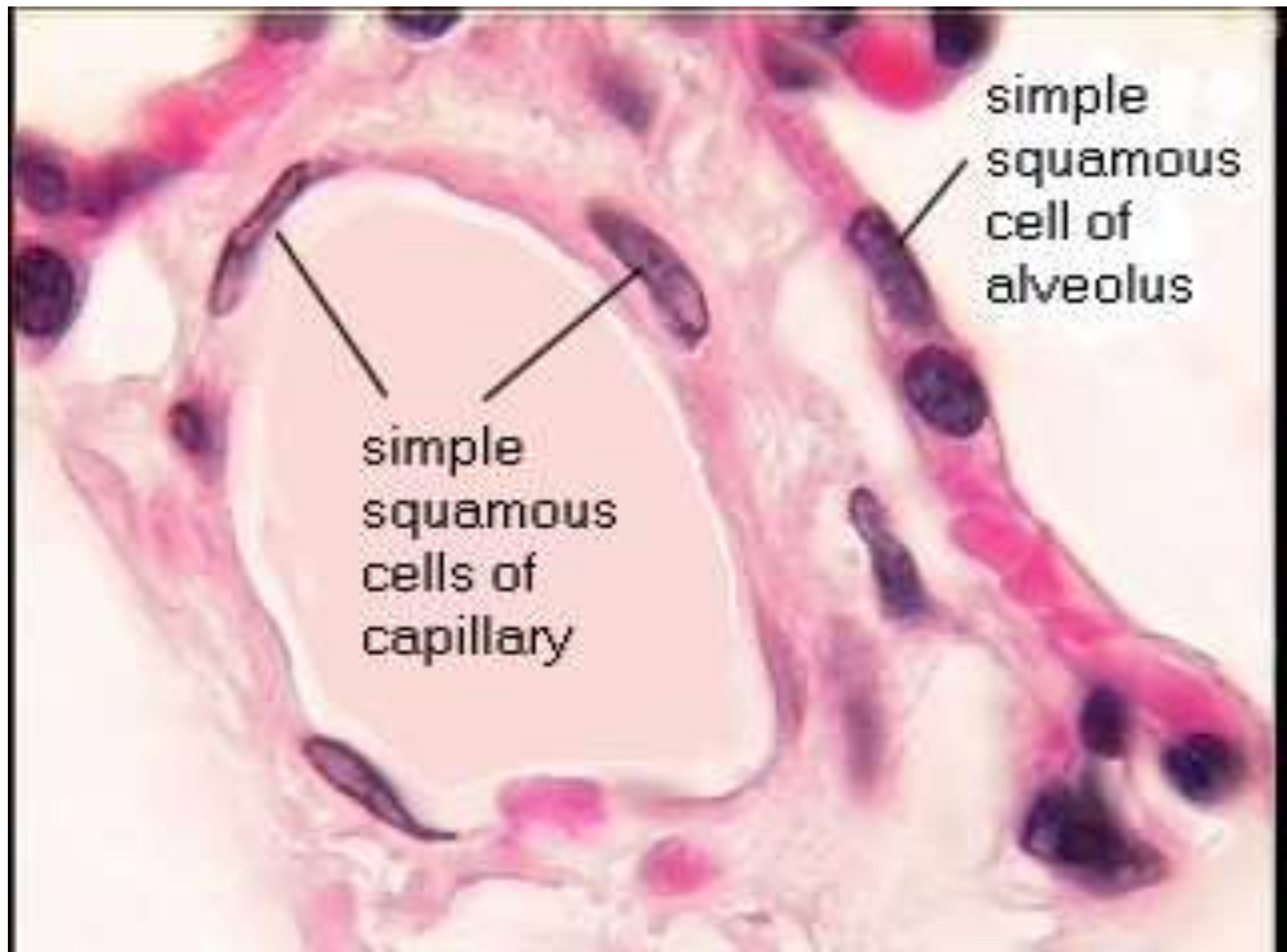
tunica adventitia



- **Blood supply of arteries—**
- the **nutrient vessels** are called vasa vasorum form a dense capillary network in t. adventitia, **supply adventitia and outerpart of tunica media.**
- **rest of vessel** wall is nourished directly by **diffusion from luminal** blood.
- fenestrations in elastic lamina facilitate diffusion.
- nerve supply is by **nonmyelinated, sympathetic** fibers, vasoconstrictor in function.

capilleries

- are networks of microscopic endothelial tubes interposed b/w metaarterioles and venules.
- True capilleries are without any smooth muscle.,begin beyond precapillary sphincters.
- replaced by cavernous (dilated) space in sex organs , splenic pulp and placenta.,
- average diameter is 6-8 microns ,allow red blood cells to pass in single file.
- size smallest in brain & intestine, largest (20microns) in skin & bone marrow.

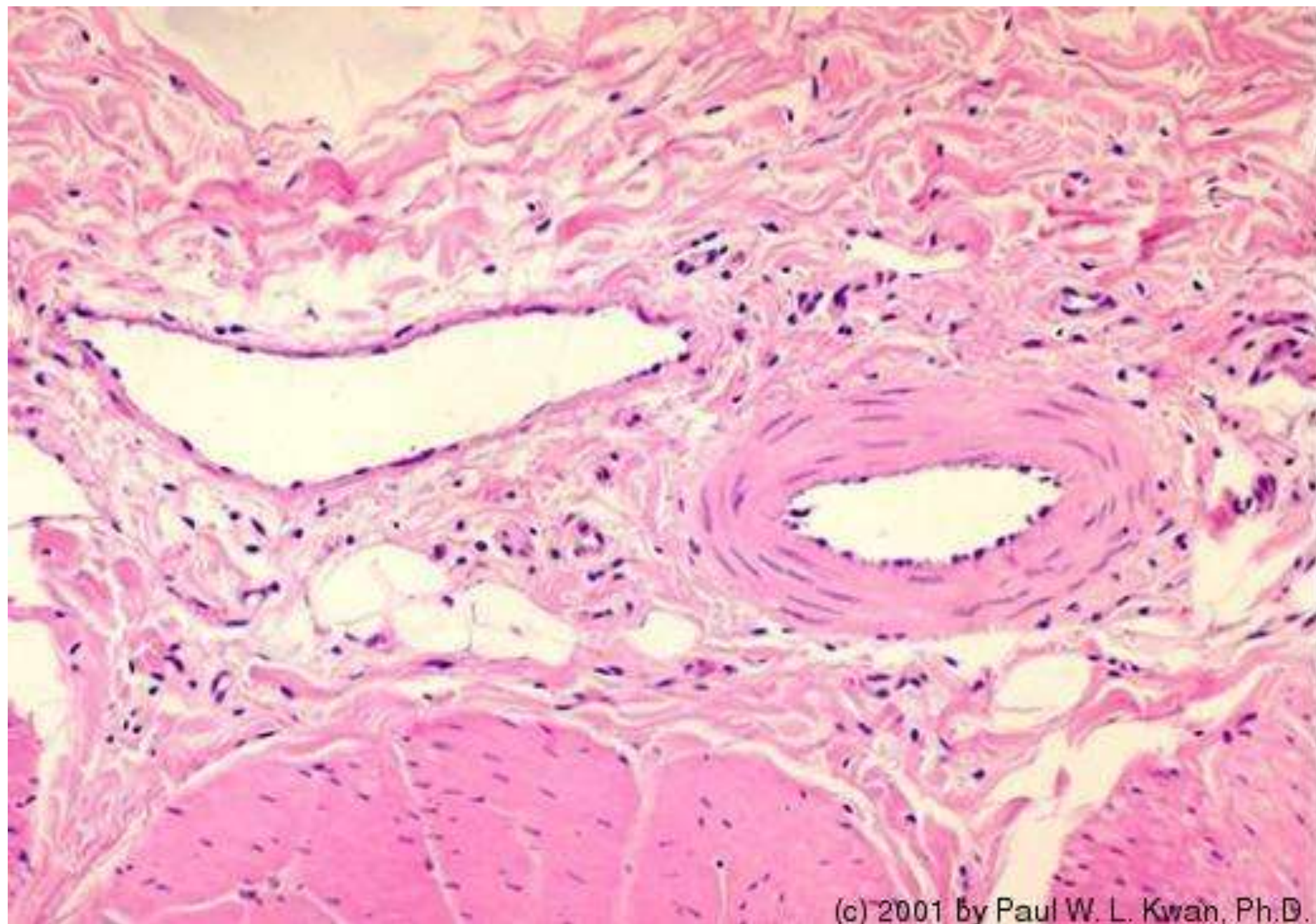


Types of capillary

- a) continuous capillaries –
- found in skin , connective tissue , skeletal and smooth muscles, lung and brain.
- allow passage of small molecules across their walls (upto 10 micron in size)

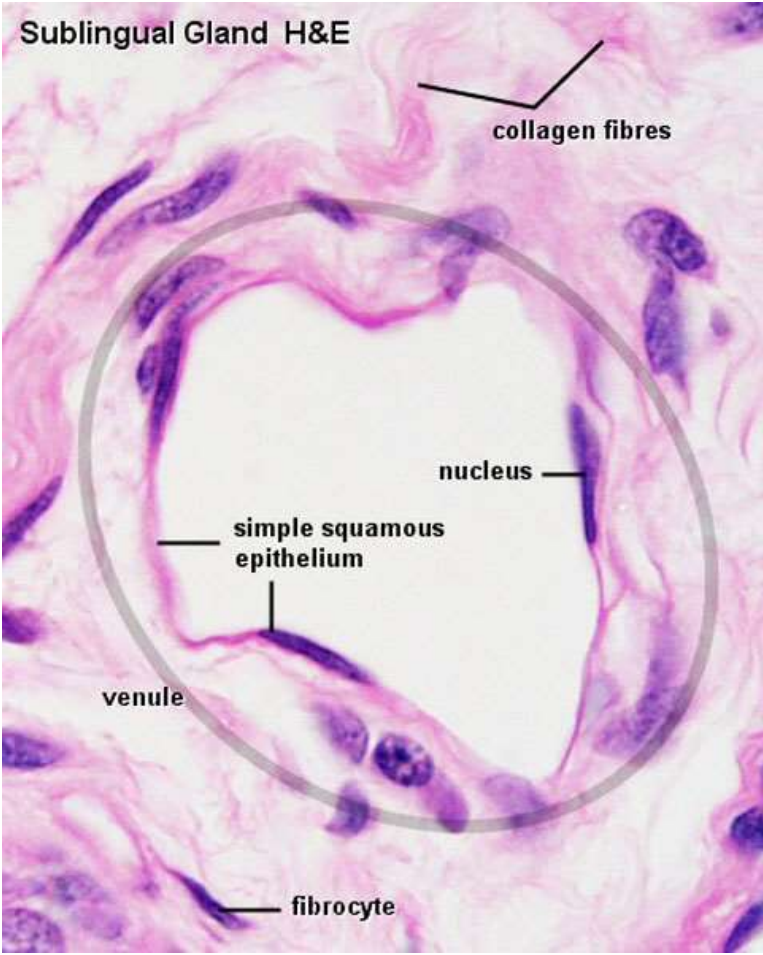
- fenestrated capillaries—
- found in –renal glomeruli , intestinal mucosa, endocrine glands and pancreas.
- allow passage across their walls of larger molecules (upto 20-100 nm size)
- **capillary wall is composed** of –
- - single layer of endothelial cells,
- - basal lamina of glycoprotein which surrounds the endothelial cells and splits to enclose pericapillary cells **called pericytes.**
- - a pericapillary layer of connective tissue cells & fibers.

- the capillary bed & post capillary venules form an enormous area for exchange of – nutrients, gases, metabolites and water, b/w the blood and interstitial fluid.
- capillaries also allow migration of leukocytes out of vessels.



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Sublingual Gland H&E



sinusoids

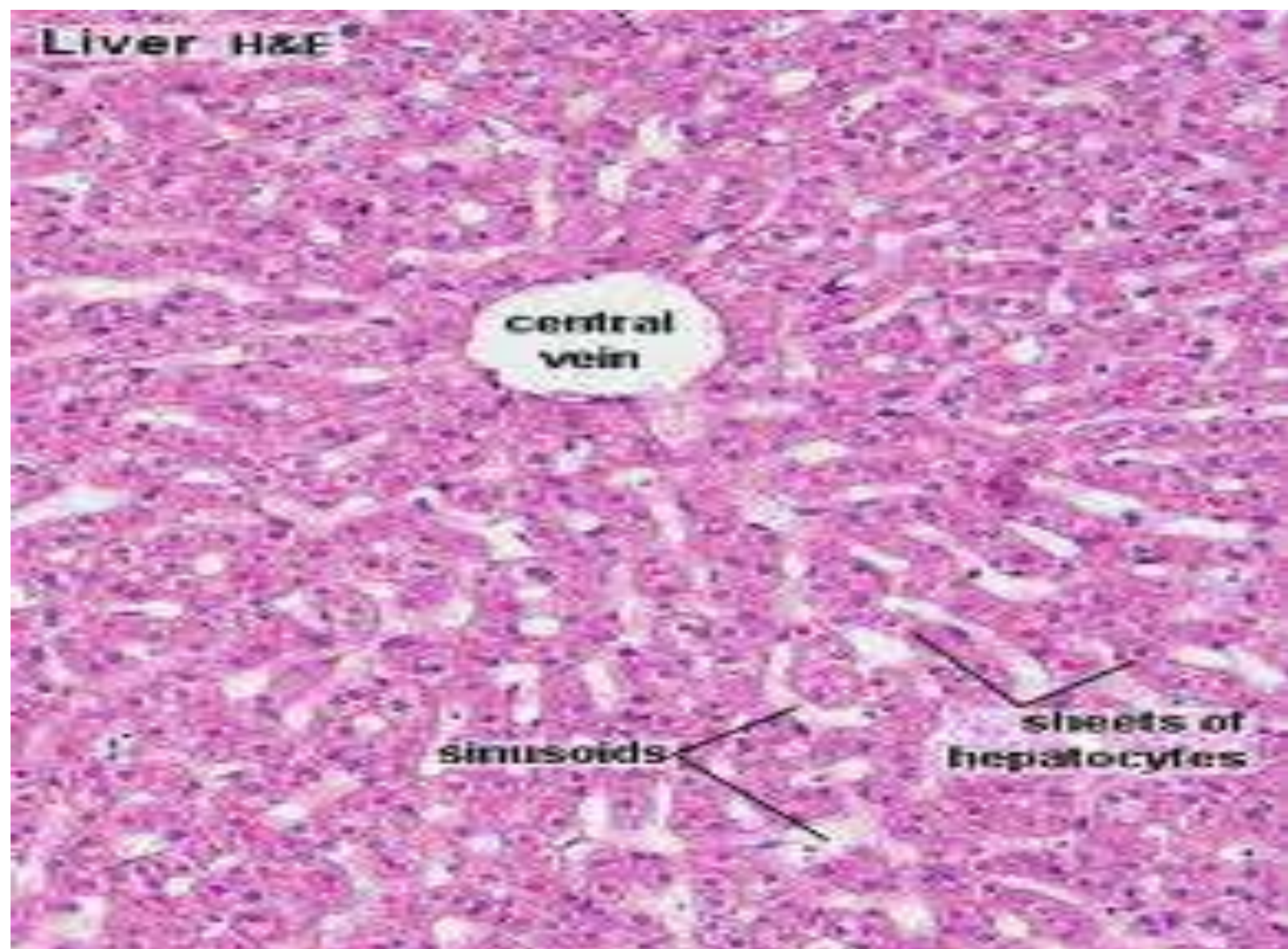
- found in –liver, spleen, bone marrow, suprarenal glands, parathyroid glands, carotid body.
- they are large irregular vascular spaces which are closely surrounded b parenchyma of the organ.

Liver H&E

central
vein

sinusoids

sheets of
hepatocytes



Difference of capillary and sinusoid

- **in sinusoid** the lumen is wider (upto 30 microns) and irregular .
- their walls are thinner and may be incomplete.they are lined by endothelium in which phagocytic cells (macrophages) are often disturbuted.the adventitial support is absent, and basal lamina is replaced by a thin layer of reticular fibers.
- may connect arteriole with venule (spleen, bone marrow) or venule with venule (liver).

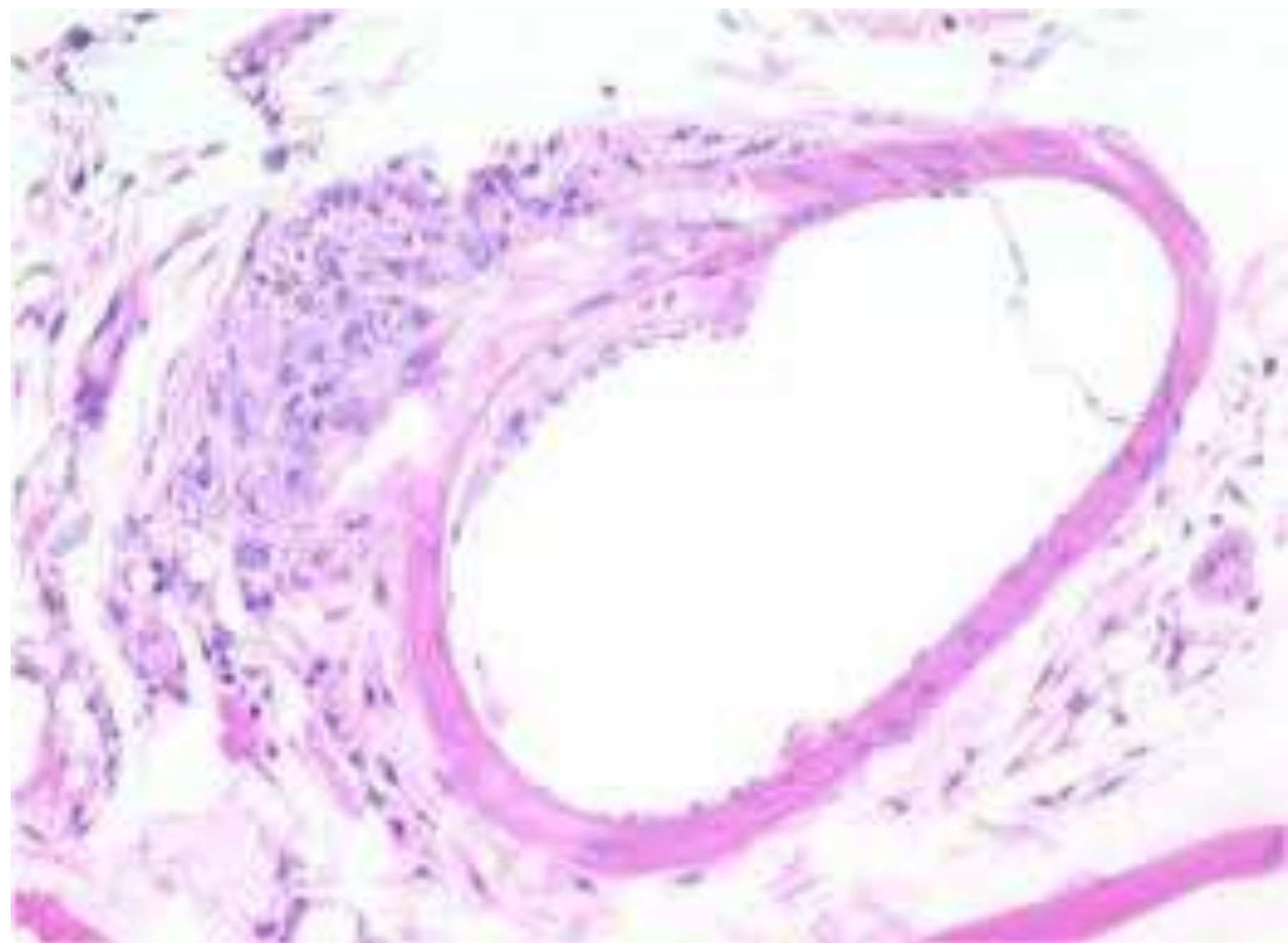
Cavernous tissues

- they are blood filled spaces lined by endothelium and surrounded by trabeculae. The latter contain smooth muscle fibers. The arterioles and venules directly open into these spaces.
- **e.g.**-----errectile tissues of penis or clitoris , in nasal mucous membrane.

veins

- they are thin walled, thinner than arteries,
- their lumen is larger than accompanying arteries.
- They have valves, to maintain unidirectional flow of blood,
- **Valves are absent in---****a)** veins of less than 2mm in diameter, **b)** in venae cavae **c)** in hepatic, renal, uterine, ovarian, cerebral, spinal, pulmonary and umbilical veins.

- Their muscular and elastic component is much less than of arteries,
- large veins have dead space around them for their dilatation during increased venous return.



Microscopically(veins)

- made of usual three coats which are found in arteries, but ill defined and muscle and elastic tissue content is poor,
- internal elastic lamina is absent,
- weak and poorly developed tunica media , amount of collagen fiber is more than elastic and muscle fibers.,
- thick and best developed adventitia,

- Smooth muscles are absent in
- veins of maternal part of placenta,
- cranial venous sinus and pial veins
- retinal veins
- veins of cancellous bone
- venous spaces of corpora cavernosa and spongiosum.

muscular
artery

nerve

vein



- larger veins like arteries are supplied with nutrient vessels called vasa vasorum, but in veins vessels may penetrate upto intima.
- nerves also distributed to veins in the same manner as to arteries,

Factors helping venous return

- **overflow** from capilleries, pushed from behind by arteries,
- **negative intrathoracic pressure** sucks blood into the heart from all over the body,
- **gravity** helps venous return in upper part of body,
- **arterial pulsation** press on venae comitantes intermittently and drive the venous blood towards the heart,
- **venous valves** prevent any regurgitation of luminal blood,
- muscular contractions press on vein and form a very effective mechanism of venous return. The calf muscles are known as **peripheral heart**.

Anastomosis of blood vessels

- **defination**
- **a precapillary or postcapillary** communication b/w neighbouring vessels is called anastomosis,
- circulation through the anastomosis is called collateral circulation.

types

- a) arterial anastamosis-
- communication b/w arteries , or branches of arteries,
- may be actual or potential,
- actual—(arteries meet end to end)
- E.g palmer arches, planter arc, circle of willis, intestinal arcade around stomach, labial branches of facial arteries, uterine and ovarian arteries,

- **potential anastomosis**—arterial anastomosis takes place b/w the terminal arterioles,
- such communication can dilate only gradually for collateral circulation,
- so on sudden occlusion of a main artery , the anastomosis may fail to compensate the loss,
- examples are seen **in coronary arteries around the limb joints , the cortical branches of cerebral arteries.**

Venous anastamosis

- comm. b/w the veins or tributeries of veins,
- e.g the dorsal venous arches of the hand and foot.

Arteriovenous anastamosis (shunt)

- comm. b/w artery or a vein.
- when organ is active these shunts are closed and bd circulates through the capilleries,
- when organ is at rest, the blood bypass the capillery bed and is shunted back through the arteriovenous anastamosis,
- the shunt vessel may be straight or coiled, with thick muscular coat, under influence of sympathetic system.

- e.g , **skin of nose**, lips, external ear, **mucous membrane of nose** , **alimentary cannal**.
- sp. Av shunts are found in **skin of digital pads** and **nail beds**.

End arteries

- arteries which do not anastomose with their neighbours arteries,
- e.g –central artery of retina is best example of an absolute end artery,
- central branches of cerebral arteries and vasarecta of mesentric arteries, arteries of spleen, kidney, lung & metaphyses of long bones.

Importance---

- occlusion of an end artery causes serious nutritional disturbances resulting in death of tissue supplied by it e.g **occlusion of central artery of retina results in permanent blindness.**

applied

- a) **blood pressure** is arterial pressure exerted by blood on the arterial walls,
- the max. pressure during ventricular systole is **called—systolic pressure**, due to force of contraction of heart.
- The minimum pressure during ventricular diastole is **diastolic pressure**. Due to arteriolar tone,
- normally the blood pressure is 120/80 mm of hg , the systolic pressure ranges from 110-140 mm of hg, & diastolic from 70-80 mm of hg. The diff. b/w systolic and diastolic pressure is **called pulse pressure**.

B) haemorrhage / bleeding is due to rupture of blood vessels-----

- venous ---oozing of blood,
- arterial—spurting of blood,

c) vascular catastrophies are ---

- thrombosis.
- embolism,
- haemorrhage,
- All of them result in a loss of blood supply to the area of distribution of the vessel involved , unless compensated by collateral circulation.

- d) arteritis, & phlebitis---inflammation of artery and vein.
- e) arteriosclerosis---occurs in old age due to arteries become stiff.,results in variable reduction in the blood supply to the tissues and a rise in systolic pressure.

Mcq -

- 1) capilleries are classified as ---
- A) distributing vessels,
- B) exchange vessels,
- c) resistance vessels,
- d) reservoir vessels,
- 2) in portal circulation blood passes through
- A) two set of capilleries
- b) one set of capilleries
- C) two set of sinusoids
- D) three set of capilleries

- side branches of terminal arterioles are called---
- A) capilleries
- B) meta arterioles
- C) sinusoids
- D)venules
- following is example of arteriovenous shunt—
- a) glomerulus
- B) dorsal venous arch of foot
- C) coronary arteries
- D) central arteries