



HISTOLOGICAL ORGANIZATION OF THE CARDIOVASCULAR APPARATUS

Obimbo MM,

MBChB, MSc, Dip Felasa C (Uppsala Uni), MMed (Obs/Gyn), PhD (UoN),

Postdoc- University of California San Francisco

Obstetrician and Gynecologist,

Human Anatomy and Translational Science Scholar

LECTURE OBJECTIVES

- At the end of this session, the student should be able to:
 - Review the structure of the heart and identify the cardiac muscle
 - Describe the organization of arteries, arterioles, veins, venules and capillaries
 - Identify the layers of muscular and elastic arteries
 - Identify the layers of the veins and structure of the capillaries
 - Describe the mechanism of regulation of blood flow

Preamble

- Concerned with transport of blood and lymph
- Four major components:
 - The heart
 - Macrocirculation ; arteries and veins
 - Microcirculation
 - Lymphatics

General structure of the heart

- **Has three layers**

- Epicardium
- Myocardium
- Endocardium

- **Epicardium**

- Mesothelium
- Composed of dense fibrocollagenous tissue, adipose and coronary neurovasculature

- **Myocardium**

- Has cardiac myocytes
- Striated in nature; state other characteristics of cardiac myocytes
- Extensive capillary network-for perfusion

- **Endocardium**

- Composed of three layers

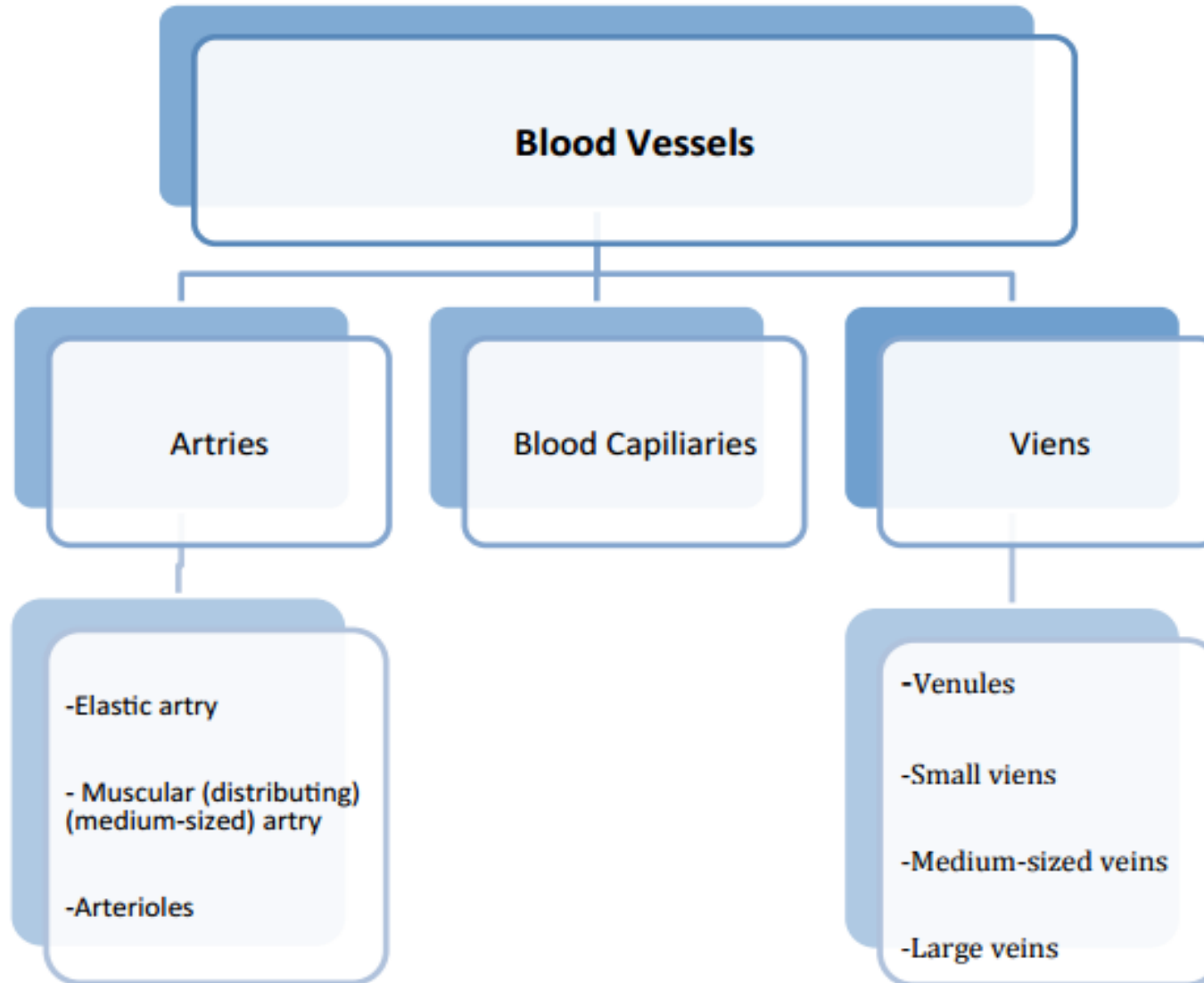
3 layers of the endocardium

- Luminal endothelial cell layer with subendothelial connective tissue
- Middle layer composed of some smooth muscles and loose connective tissue
- Deep subendothelial layer made of loose connective tissue, nerves, arteries and veins
 - Cardiac conduction system is also found here

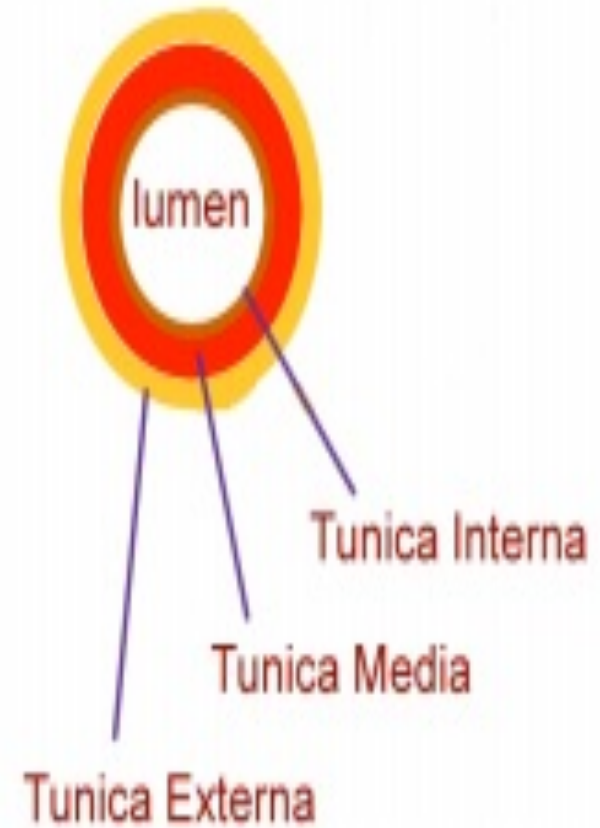
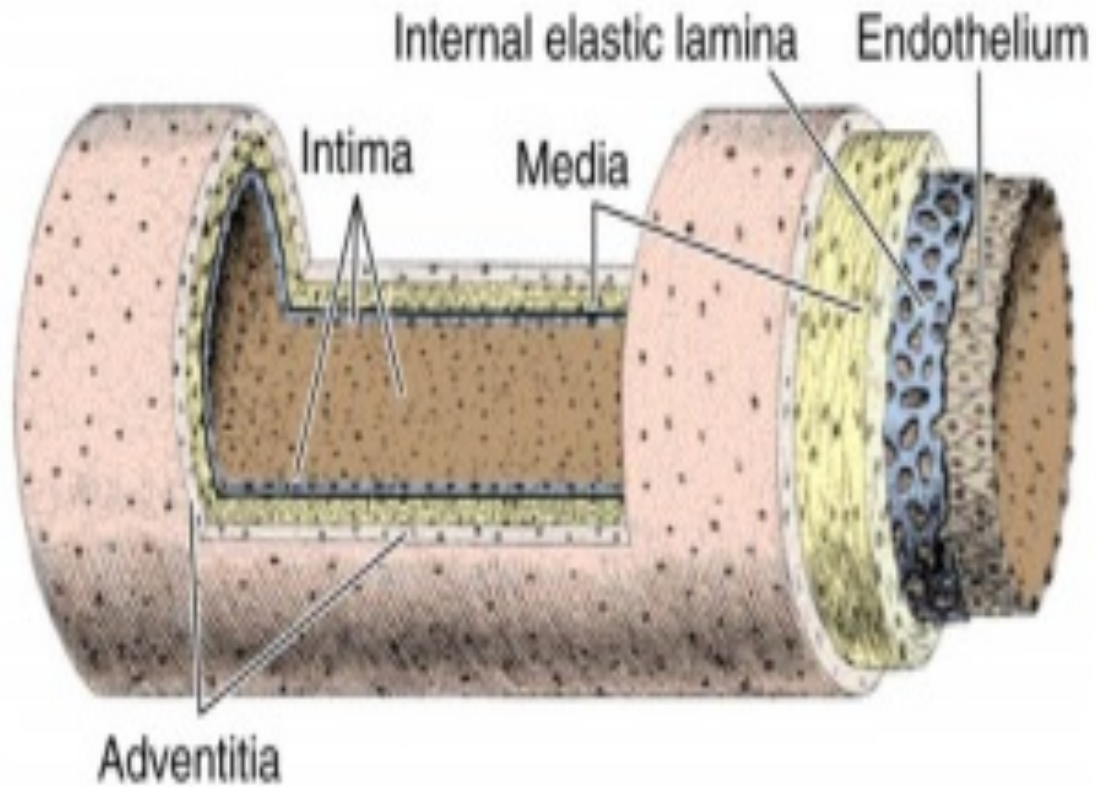
Semilunar valves

- Aortic
- Pulmonary
 - Lined by endothelial cells with a core of dense fibrous connective tissue

Blood vessels - Scheme



Walls of a blood vessel



Tunica Intima

- Composed of three parts:
 - Endothelial cells – simple squamous epithelium
 - Subendothelial layer – loose connective tissue
 - Internal elastic lamina – fenestrated elastic sheet

- Functions of the endothelium:
 - Regulate passage of gases, fluids and various molecules
 - Act as receptors eg. Leucocyte adhesion molecules
 - Synthesis of factor VIII (vWF)
 - Responsive to local factors such as histamines

Tunica media

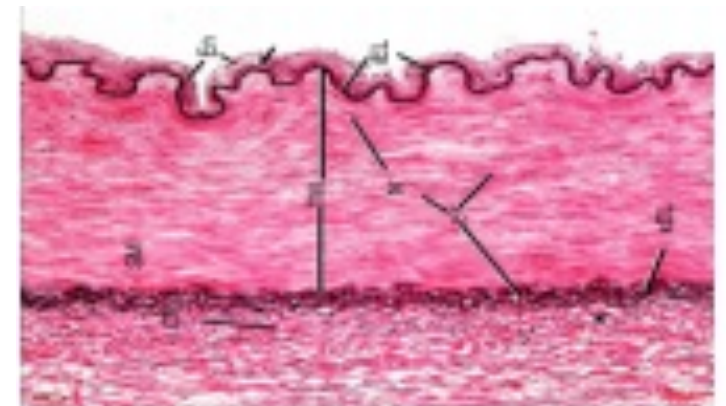
- This is layer between the intima and adventitia
- Has four main components:
 - Smooth muscles,
 - Elastic fibres
 - Type III collagen
 - Type I collagen
- Larger arteries may have tunica externa

Tunica adventitia

- Has connective tissue with vasa vasorum and nerva vasorum
- Some of the vasa extent to the media

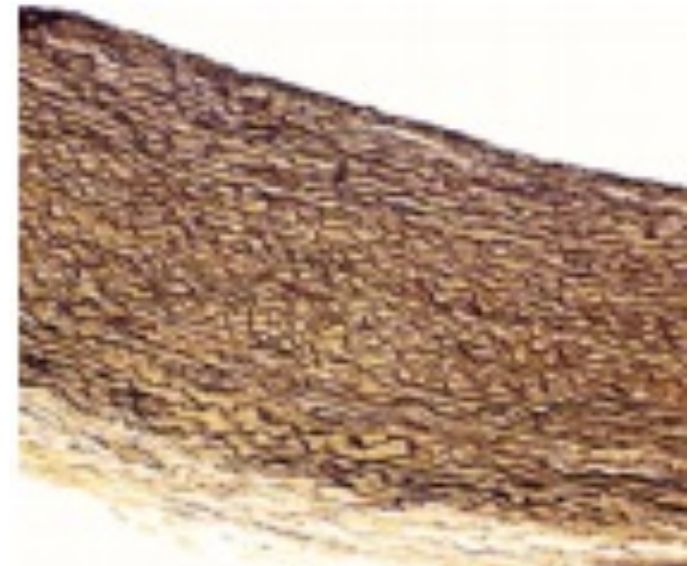
Arteries – Muscular (examples??)

- Tunica intima
 - Endothelium , subendothelial connective tissue
 - Prominent internal elastic lamina
- Tunica media
 - Smooth muscle cells predominate (several layers 25-40)
 - Sparse elastic fibres, type III and I collagen
 - External elastic lamina may be present
- Tunica adventitia
 - Mainly loose connective tissue



Arteries – Elastic (examples?)

- Tunica intima
 - Endothelium, subendothelial connective tissue
 - Internal elastic lamina – indistinct
- Tunica Media
 - Fenestrated elastic lamellae (importance of fenestrations?)
 - Number of layers 40 – 70 (age?)
 - Sparse
 - Smooth muscle
 - Type I and III collagen fibres
 - Elastic fibres
- Tunica adventitia
 - Loose connective tissue with vasa vasora



Arterioles

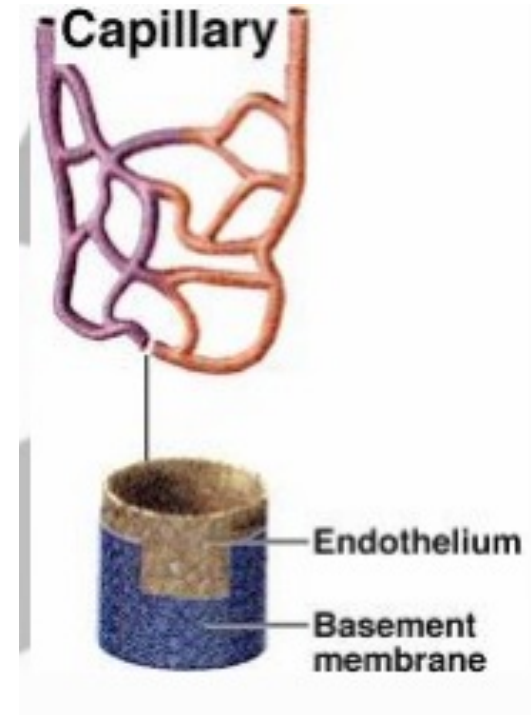
- Less than 0.1mm-0.5mm in diameter
- Tunica intima has endothelium only smaller in size cf larger arteries
- Tunica media has 2-3 layers of SMCs and adventitia is thin
- SMC regulate blood flow to target tissues
- Receive both sympathetic and parasympathetic innervation

Veins

- 4 types of veins:
 - Venule
 - Small veins
 - Medium sized veins
 - Large veins
- Tunica intima forms valves with a core of elastic CT
- No to distinguishable internal elastic lamina
- Tunica media SMCs and type I and III collagen
- Tunica adventitia is thicker than T media

Capillaries

- Diameter range 7-9 μm
- Arranged in networks
- Endothelium
 - Polygonal in shape
 - Cell borders wavy held together via tight junctions
 - Centrally located nuclei
 - Rest on basal lamina
 - Thin layer of delicate connective tissue and pericytes surround the basal lamina



Types

- Continuous
- Fenestrated
- Sinusoidal

- Continuous capillaries
 - Walls are continuous without gaps
 - Pinocytotic vesicles in cytoplasm
 - Examples:
 - In muscular, nervous and connective tissues



- Fenestrated

- Numerous circular pores 60-80nm in their wall
- Pores have diaphragm spanning over them except the renal glomerulus
- Continuous basal lamina
- Examples: In intestines, pancreas and endocrine glands, glomerulus

- Sinusoidal

- Enlarged diameter (30-40 um)
- Irregular and tortuous with multiple pores without diaphragm
- Incomplete basal lamina
- Examples: Red bone marrow, spleen, certain endocrine glands

Regulation of blood flow

- Regulations of blood flow locally via:
 - SMCs contraction
 - Hormones..list
 - Oxygen tension.. in lungs
 - pH changes
- Main regulation site at arteriole level
- Mechanosensation/mechanotransduction
 - Fluid shear stress on endothelium
 - Repeated stress leads to vascular remodeling to maintain perfusion
 - Transduction through PECAM1, VE-Cadherin, VEGFR2

Applied Histology

- Arteriosclerosis; atherosclerosis
- Thrombosis
- Hypertension
- Congenital vascular diseases
- Varicose veins

END



THANK YOU