CARDIOVASCULAR PHYSIOLOGY

CAPILLARY CIRCULATION

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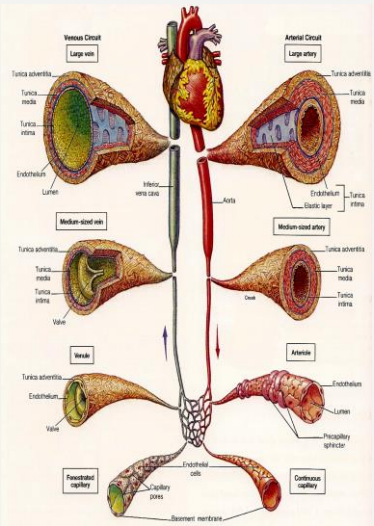
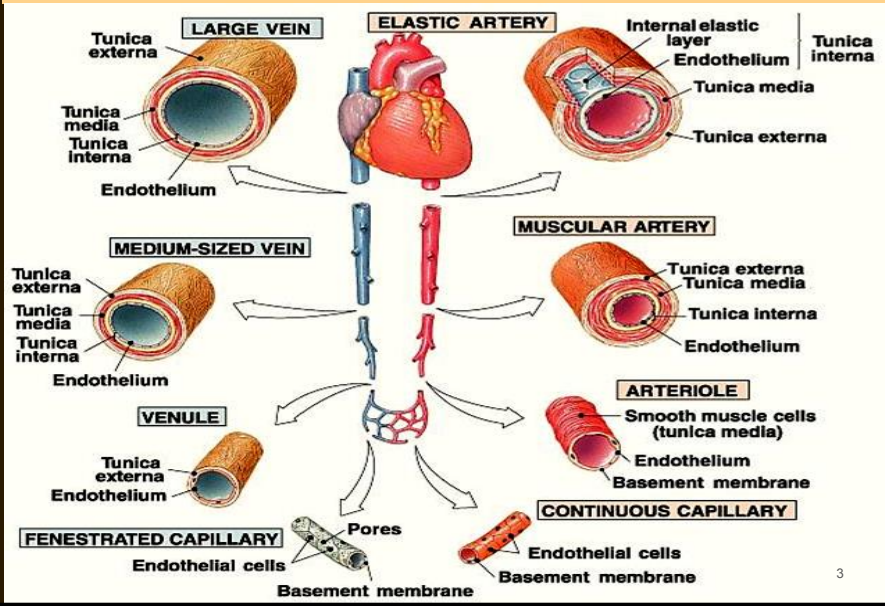
CLASSIFICATION OF THE VASCULAR SYSTEM

1. **Aorta**
   … (elastic recoil)
2. **Arteries**
   … (muscular, low resistance vessels)
3. **Arterioles**
   … (high resistance vessels)
4. **Capillaries**
   … (exchange vessels)
5. **Venules**
6. **Veins**
   … (capacitance vessels)



BLOOD VESSEL COMPARISON



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Structure of vasculature changes in response to different needs

	Mean diameter	Mean wall thickness	Endothelium	Elastic tissue	Smooth muscl	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					

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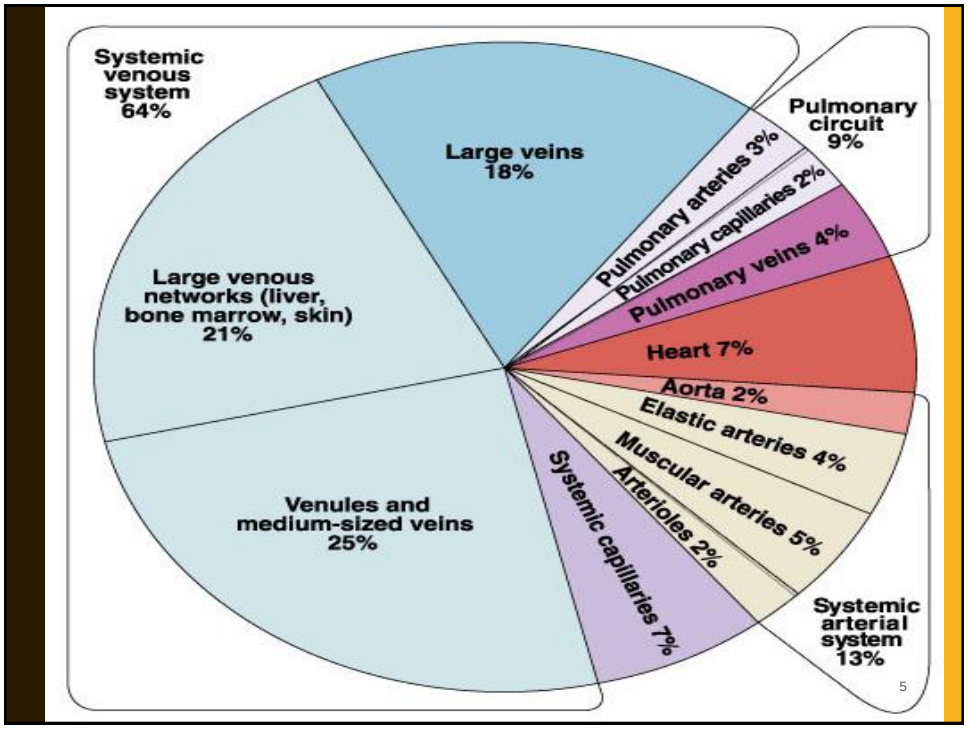
Systemic venous system 64%
Large veins 18%
Large venous networks (liver, bone marrow, skin) 21%
Venules and medium-sized veins 25%
Pulmonary circuit 9%
Pulmonary arteries 3%
Pulmonary capillaries 2%
Pulmonary veins 4%
Heart 7%
Systemic arterial system 13%
Aorta 2%
Elastic arteries 4%
Muscular arteries 5%
Arterioles 2%
Systemic capillaries 7%
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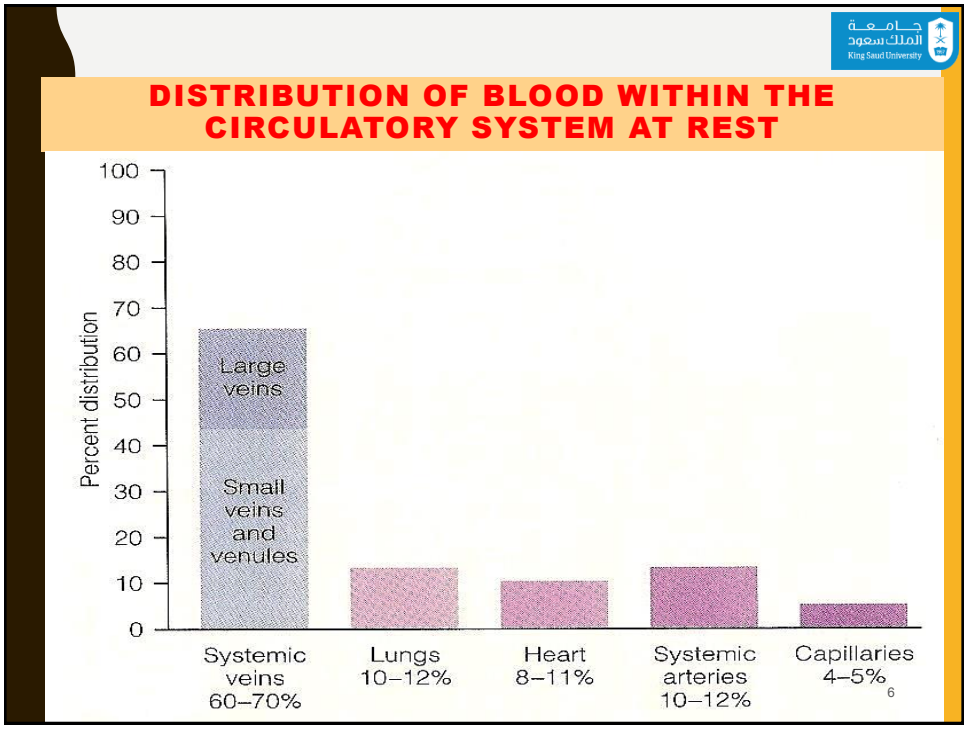
DISTRIBUTION OF BLOOD WITHIN THE CIRCULATORY SYSTEM AT REST
Percent distribution
100
90
80
70
60
50
40
30
20
10
0
Large veins
Small veins and venules
Systemic veins 60–70%
Lungs 10–12%
Heart 8–11%
Systemic arteries 10–12%
Capillaries 4–5%
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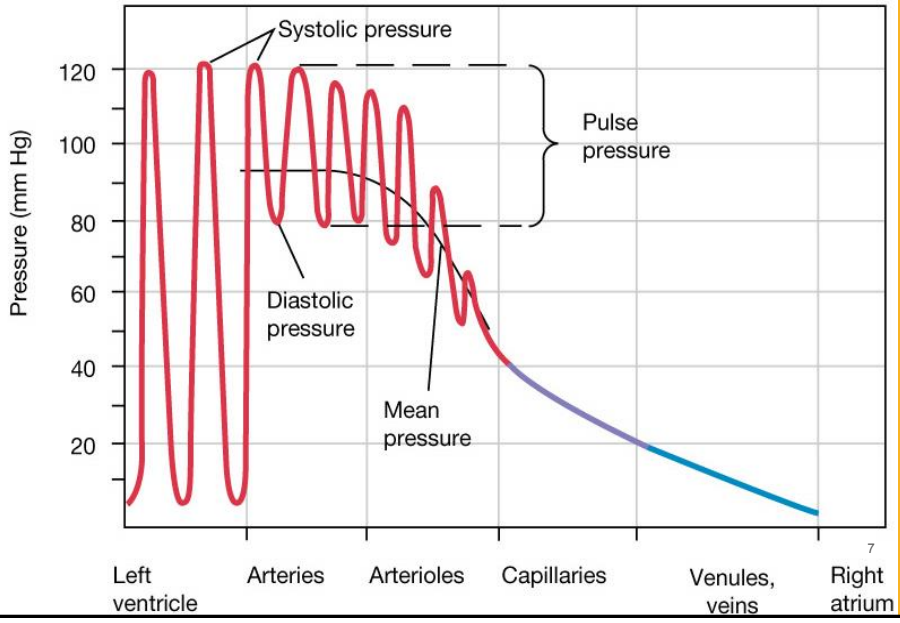
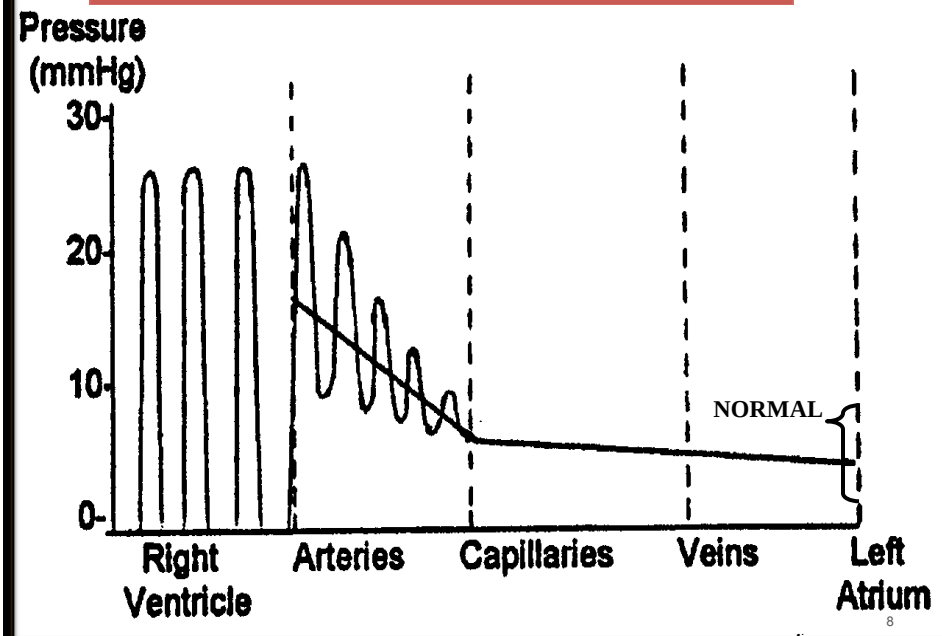
PRESSURE THROUGHOUT THE SYSTEMIC CIRCULATION

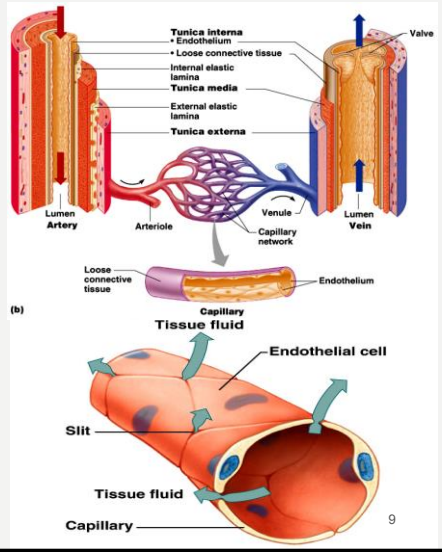


Pressure In The Pulmonary Circulation



CAPILLARIES

- Smallest blood vessels.
  - One endothelial cell thickness.
- Exchange vessels.
  - Provide direct access to cells.
  - Most permeable.
  - Permits exchange of nutrients & wastes.



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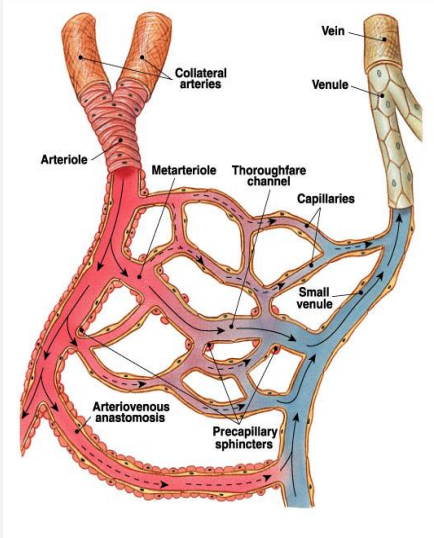
CAPILLARY NETWORK



- Blood flows from arterioles through metarterioles, then through capillary network
- Venules drain network
- Smooth muscle in arterioles, metarterioles, precapillary sphincters regulates blood flow

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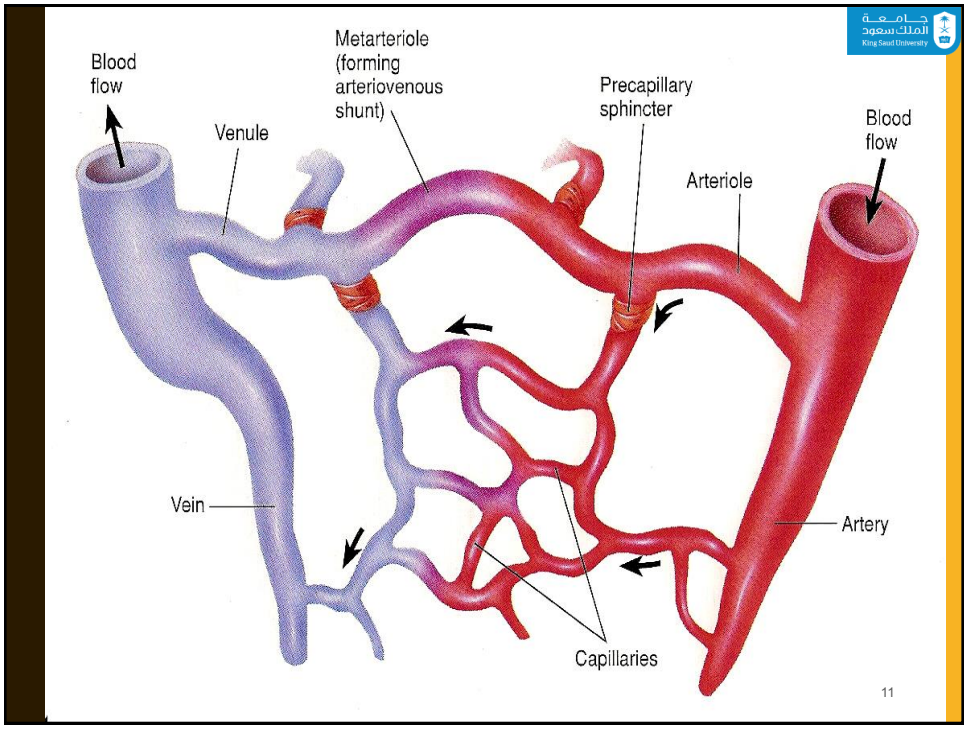
Blood flow
Metarteriole (forming arteriovenous shunt)
Venule
Precapillary sphincter
Arteriole
Blood flow
Vein
Artery
Capillaries
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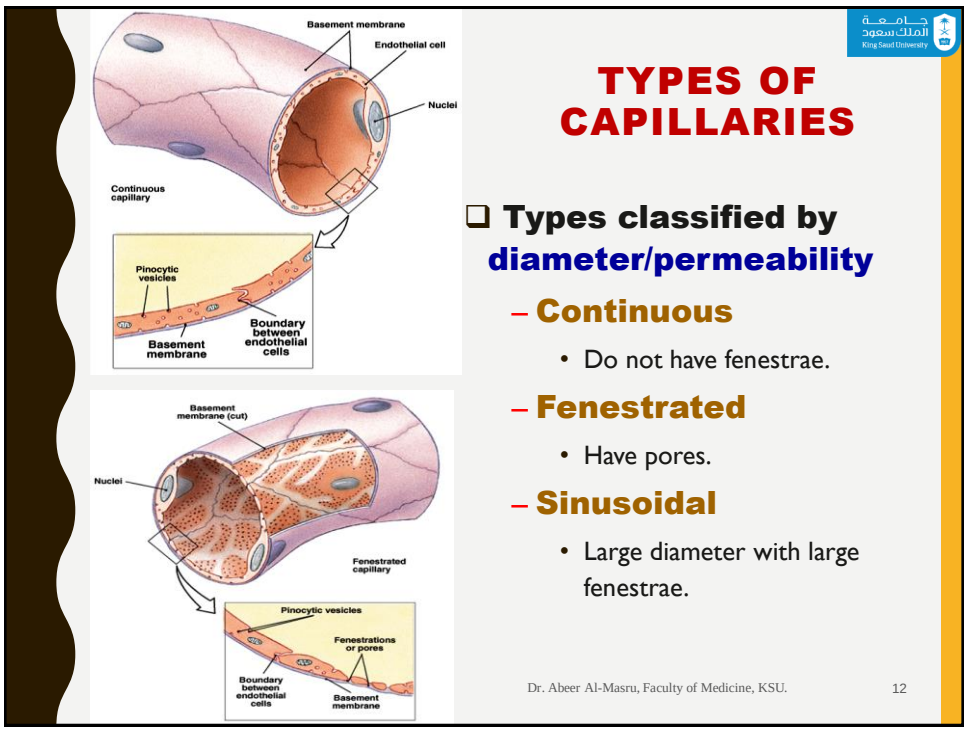
Basement membrane
Endothelial cell
Nuclei
Continuous capillary
Pinocytic vesicles
Basement membrane
Boundary between endothelial cells
Basement membrane (cut)
Nuclei
Fenestrated capillary
Pinocytic vesicles
Fenestrations or pores
Boundary between endothelial cells
Basement membrane
TYPES OF CAPILLARIES
Types classified by diameter/permeability
– Continuous
• Do not have fenestrae.
– Fenestrated
• Have pores.
– Sinusoidal
• Large diameter with large fenestrae.
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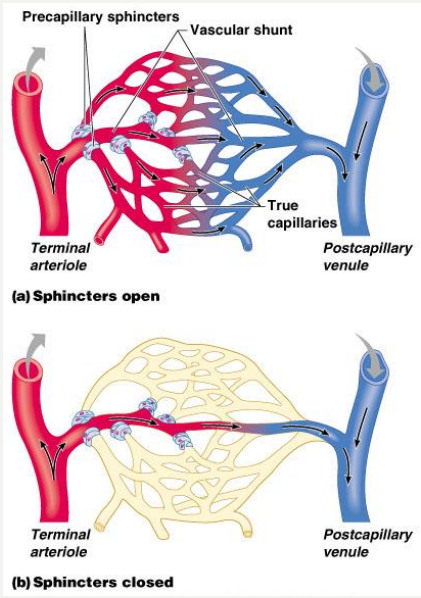
Capillary Beds

- Capillary beds consist of two types of vessels:
  - Vascular shunt – directly connects an arteriole to a venule.
  - True capillaries – exchange vessels.
    - Oxygen & nutrients cross to cells
    - Carbon dioxide & metabolic waste products cross into blood



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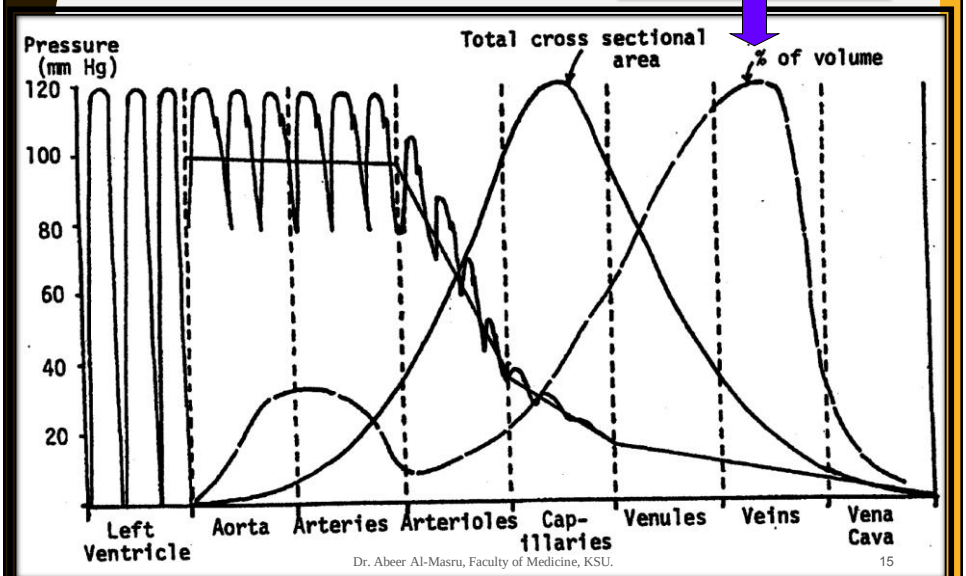
Total Cross Sectional Area

Capacity Vessels



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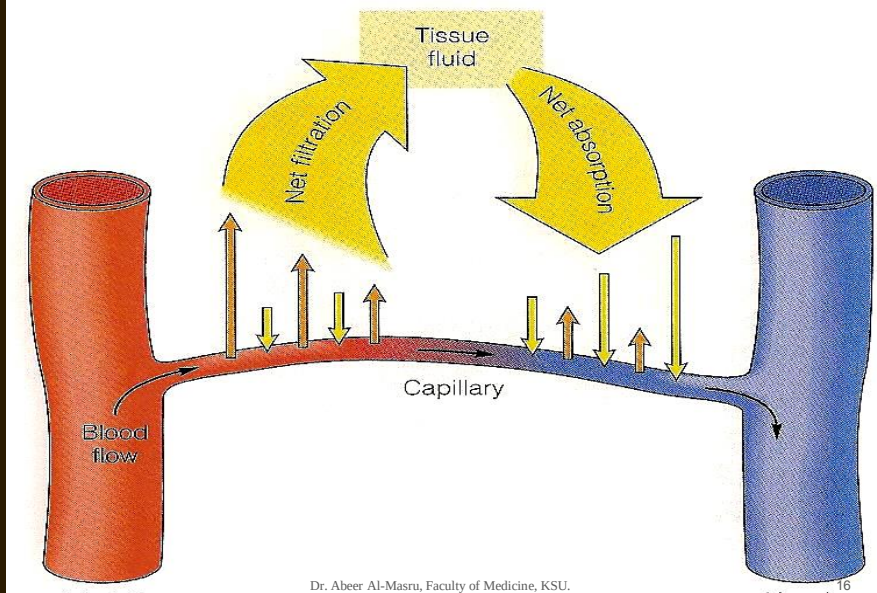
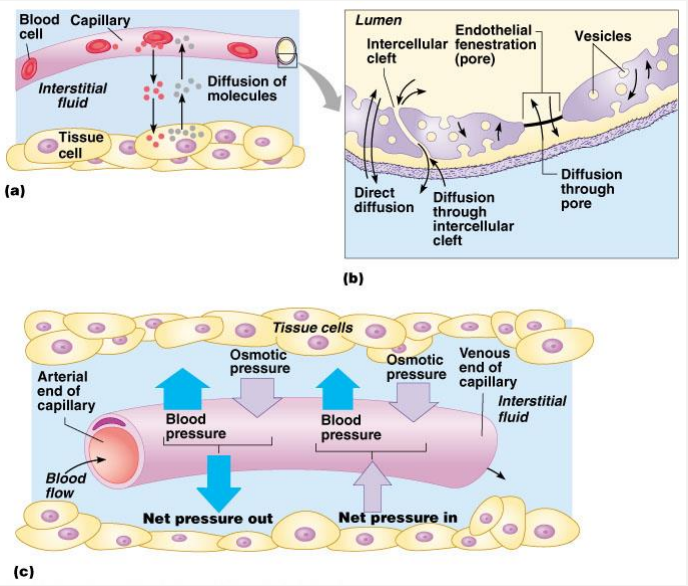
EXCHANGE OF FLUID BETWEEN CAPILLARIES AND TISSUES



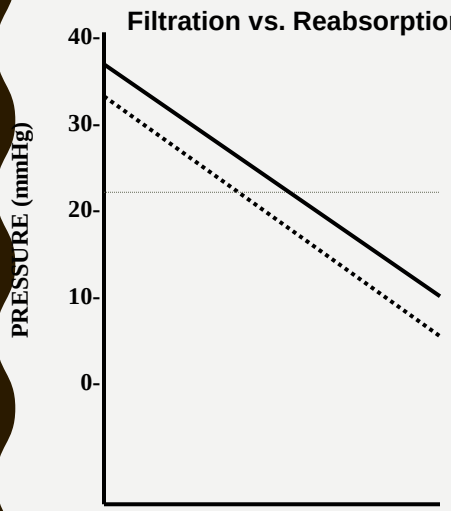
CAPILLARY EXCHANGE AND INTERSTITIAL FLUID VOLUME REGULATION

- Blood pressure, capillary permeability, & osmosis affect movement of fluid from capillaries.
- A net movement of fluid occurs from blood into tissues.
- Fluid gained by tissues is removed by lymphatic system.

Diffusion at Capillary Beds



FLUID BALANCE



Outward Forces:

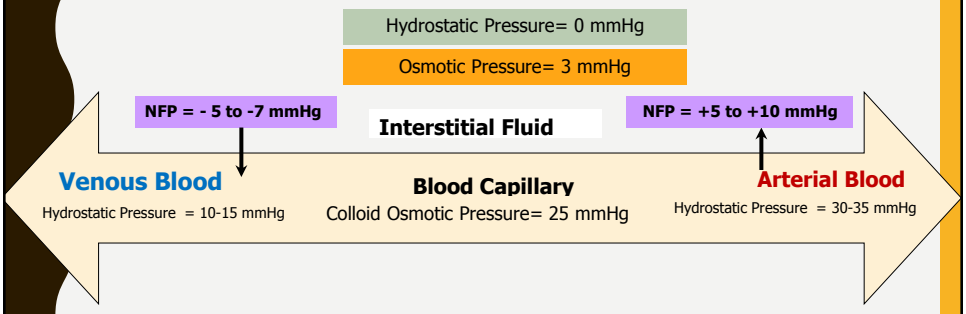
1. **Capillary blood pressure** (P_c = 30-35 to 10-15 mmHg)
2. **Interstitial fluid pressure** (P_{IF} = 0 mmHg)
3. **Interstitial fluid colloidal osmotic pressure** (μ_{IF} = 3 mmHg)

TOTAL = 38 to 18 mmHg

Inward Force:

1. **Plasma colloidal osmotic pressure (μ_C = 25- 28 mmHg)**

FLUID FILTRATION & REABSORPTION IN NORMAL MICROCIRCULATION



- **At arterial end:**
  - Water moves **out** of the capillary with a NFP of +5 mmHg.
  - Hydrostatic pressure dominates at the arterial end & net fluid flows out of the circulation.
- **At venous end:**
  - Water moves into the capillary with a NFP of -5 mmHg.
  - Oncotic pressure dominates at the venous end & net fluid will flow into the bloodstream

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LYMPHATIC SYSTEM

- Lymphatic vessels present b/w capillaries.
- **3 basic functions:**
  - Drain excess interstitial (tissue) fluid back to the bl, in order to maintain original bl volume.
  - Transports absorbed fat from small intestine to the bl.
  - Helps provide immunological defenses against pathogens.

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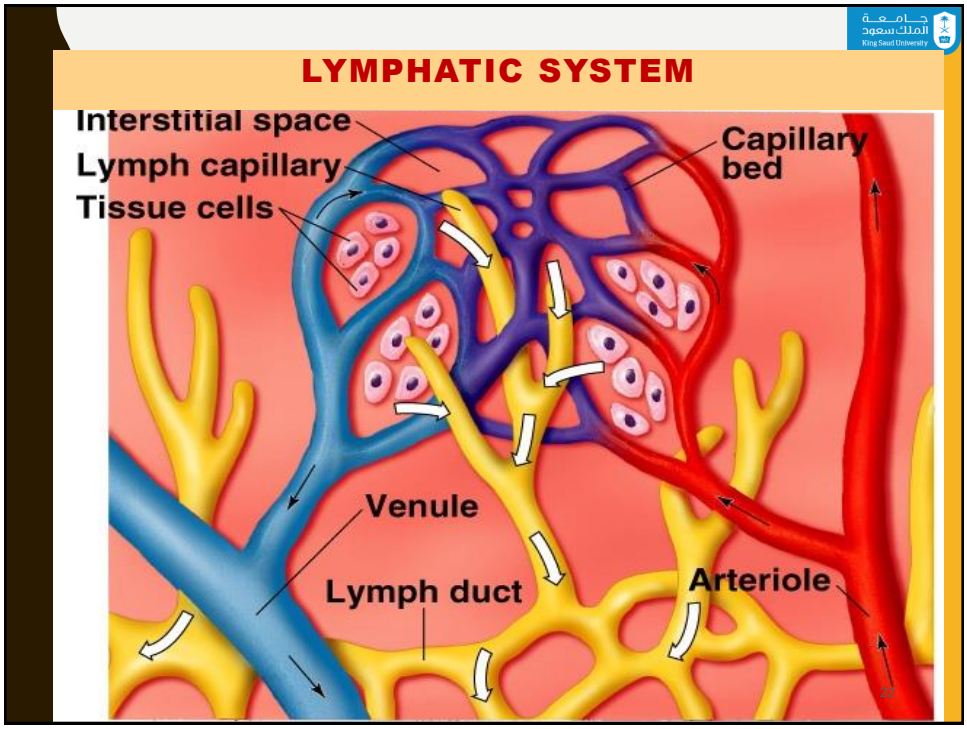
LYMPHATIC SYSTEM
Interstitial space
Lymph capillary
Tissue cells
Capillary bed
Venule
Lymph duct
Arteriole


Thank You
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