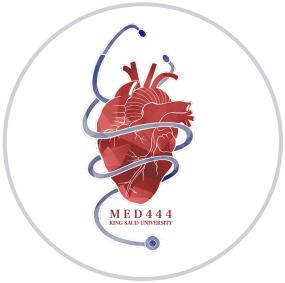


Capillary circulation

Editing File

Main text Female's slide Male's slide Important text Doctor's note Extra

Objectives:

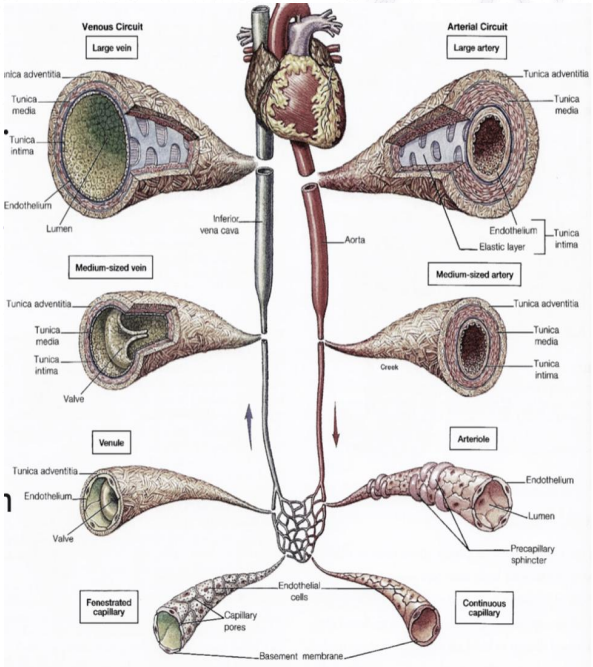
We highly Recommend you to watch it!

- Learn the components of the microcirculation & to understand their important role .
- To identify capillaries & their different types.
- To understand regulation of flow in capillary beds.
- To understand the formation of interstitial fluid & mechanism of edema formation.
- To understand the role of lymphatics.

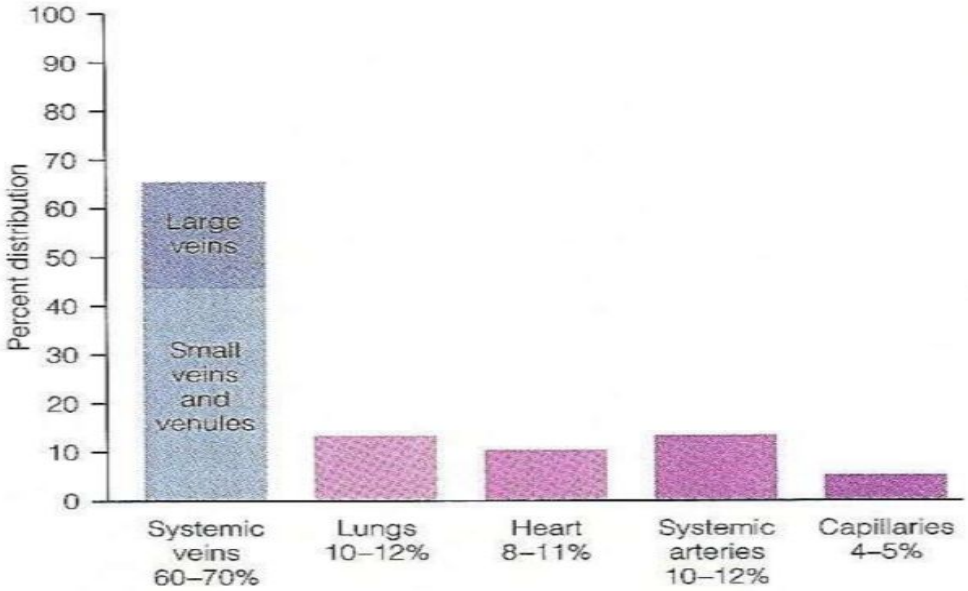
Components of microcirculation (vascular system)

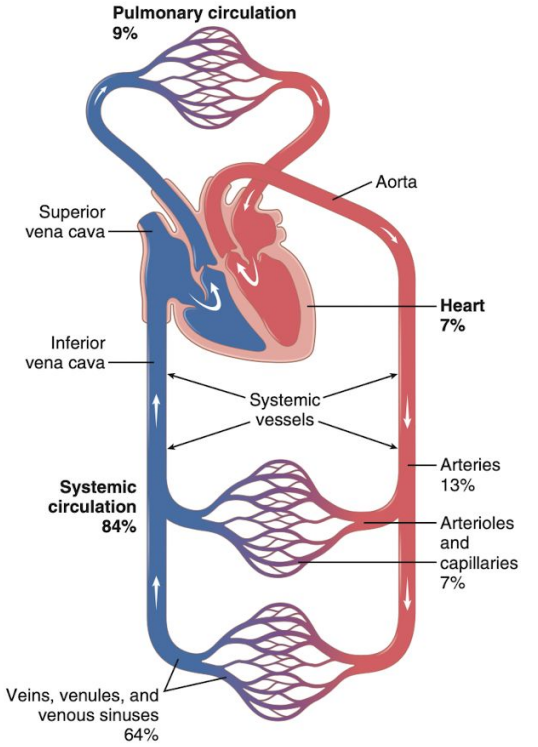
وَسُبْحَانَ اللَّهِ رَبِّ الْعَالَمِينَ

1. Aorta: Elastic recoil.
2. Arteries: Muscular, low resistance vessels.
3. Arterioles: High resistance & high muscular vessels
4. Capillaries are Exchange vessels: Exchange nutrients & waste materials between blood & tissues.
5. Venules: larger than arterioles with much waker muscular coat.
6. Veins & venules: Capacitance vessels.



Distribution Of Blood In The Different Parts Of Circulatory System: At rest

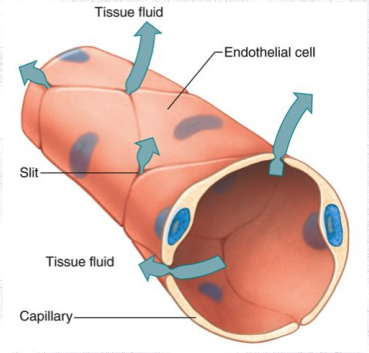


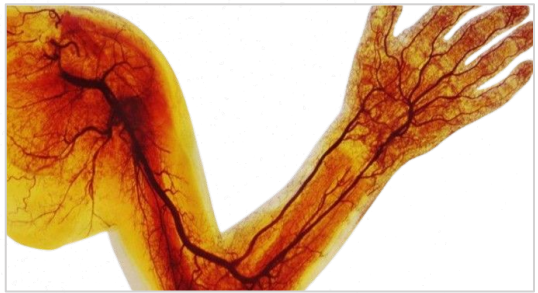


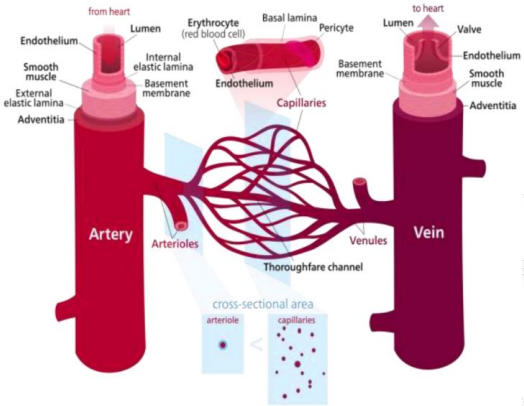
At rest, 4-5% of circulating blood is present in capillaries.

Capillaries (Microcirculatory Vessels)

- The most purposeful function of the circulation occurs in the microcirculation Provide direct access to the cells & Most permeable.
- Capillaries are the **smallest blood vessels** in the vascular system. And the larger in number (over 10 billion) in the body.
- Capillaries are extremely thin, constructed of a SINGLE layer of highly permeable endothelial cells.
- Capillaries are the site of exchange: transport of oxygen & nutrients to the tissues with removal of waste products from the tissues back to circulation





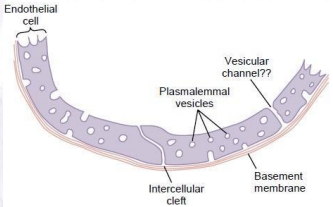


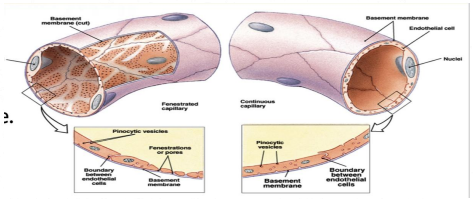
Capillary Wall & Cross-Sectional area

Female's slide

Capillary Wall

- composed of a SINGLE-layer of simple squamous highly permeable epithelial cells.
- The wall is of 0.5 micrometers in thickness.
- Have very thin basement membrane.
- The membrane is having pores, plasmalemmal vesicles, & vesicular channels.
- It regulates transfer of fluid from blood to the interstitial fluid space & vice versa.



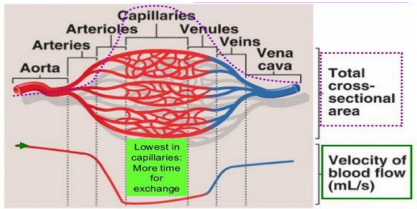


Capillaries Cross-Sectional Area

- The total surface area ranges from 700-1000 m2 of surface area (>3 tennis courts).
- Capillary is of 0.5 - 1 mm in length and very small diameter (4-9 microns).
- As the diameter of blood vessel decreases, the total cross-sectional area increases & the velocity of blood flow decreases.
- The velocity of blood flow within each segment of the circulatory system is inversely proportional to the total cross-sectional area of the segment. Because the aorta has the smallest total cross-sectional area of all circulatory segments, it has the highest velocity of blood flow.

$$V = \frac{Q}{A}$$

V= Velocity
Q= Flow
A= Cross sectional area.

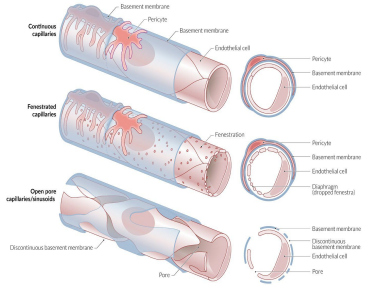


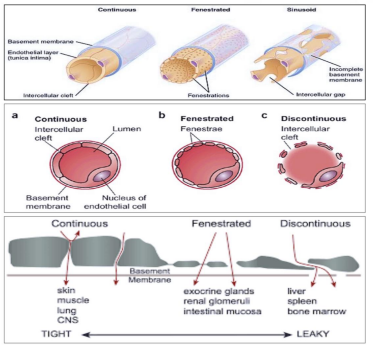
As diameter of vessels ↓, the total cross-sectional area ↑ & velocity of blood flow ↓

Types of Capillaries

Capillaries are classified into (3) types according to their wall permeability.
Wall permeability is affected by the size & diameter of the pores (intercellular clefts).

Continuous/True	• Tight junction & do not have fenestrae/pores. • Allow passage of only very small molecules. • Found in brain, muscles, lungs & adipose tissue.
Fenestrated	• Have wider pores. • Allow large substances to pass but not plasma proteins. • Found in kidney glomeruli, small intestines & endocrine glands.
Sinusoidal/ Discontinuous	• Large diameter with large fenestrae (wider gaps between the cells). • The endothelium is discontinuous. • Found in liver, spleen, bone marrow, lymphoid tissue, &some endocrine glands.





Variability of permeability and filtration in organ

Permeability differ in organs due to the alternation in the size of pores/clefts between cells.

1-Brain 2-Liver 3-Kidney glomeruli	1-Tight junction 2-Wide open 3- Small oval fenestrae	1-Allow passage of water, O2, & Co2). 2-Allow passage of large molecules even plasma proteins. 3-Allow passage of ionic substances but not PP.

Why is there such a difference?
Due to their permeability.

How does the permeability change?
By alteration of pores/clefts size between the cells.

Pores/fenestration of capillary depends on the organ :

1-Brain & muscle 2-Subcutaneous Tissue 3-Intestines 4-Liver & Spleen	1-Small 2-Moderate 3-Large 4-Extremely large

How does the permeability change?

Factors that mediates pore size change :

1-Histamine:

- If little = will increase the flow (distends vessel).

- If a lot = will decrease the arterial blood pressure (anaphylaxis). (massive vasodilation)

2-Cytokines:

- Alters flow/pressure & permeability.

3-Nerves:

- Sympathetic stimulation

4-Drugs:

- Any drug influencing contraction or dilation of smooth muscle & endothelial permeability.

5-Inflammation:

- Stretches the cells apart & increases the cleft size.
- If too much, can compress the vessels as well.

Female's slide

Functions of Capillaries

Exchange vessels between blood & tissues (main function)

1-Provide direct access to the cells & Most permeable.
2-Remove CO_2 & cellular waste products from the tissues to the blood.

3-Transport nutrients & Oxygen from blood to the tissues.

Play a metabolic role

1-Capillaries produce:

- PgI2 (prostacyclin); Growth factors for blood cells, fibroblast GF, platelet GF (growth factor), and produce ACE (angiotensin converting enzyme) in the lung

2-Antithrombotic function.

3-Inactivation of intercellular messengers.

Play a role in temperature regulation

1-Blood vessel constriction (vasoconstriction) which lead to heat conservation across epidermis.

2-Blood vessel dilatation (vasodilatation) which lead to increase heat loss across epidermis.

Capillary tone

Capillary tone refers to the degree of constriction or relaxation of the walls of the capillaries. Changes in capillary tone can affect the distribution of blood flow within tissues and organs and can also impact the exchange of nutrients, gases, and waste products between the blood and surrounding tissues. For example, increased capillary tone can reduce blood flow to a tissue, while decreased capillary tone can increase blood flow.

Structure & blood flow in capillary beds (Network)

Arterioles divides into a number of Metarterioles, which do not have a continuous smooth muscle coat(to give time for exchange).

Blood flows from Arterioles through **Metarterioles**, then to enter Capillary bed network via precapillary sphincters.

Capillaries are arranged in capillary beds and they consist of two types of vessels:

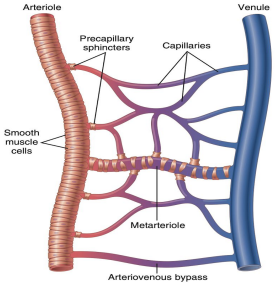


Figure 16-1. Components of the microcirculation.

Vascular shunt: Directly connects an Arteriole to a Venule.

True capillaries (Exchange vessels):

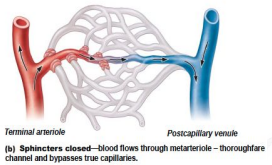
- Cross of O_2 & nutrients to cells.
- Cross of CO_2 & metabolic waste products into blood.

Possibly come SAQ:

Blood flow from arterioles to the capillary bed is intermittent (not continuous). contraction of arteriolar smooth muscles, metarterioles, precapillary sphincters, & O_2 concentration in the tissues will regulate the capillary blood flow through the capillary bed network.then Venules drain the network.

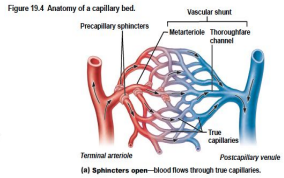
Precapillary sphincters open in response to activity & Vasodilation

At rest



(b) Sphincters closed—blood flows through metarteriole – thoroughfare channel and bypasses true capillaries.

In high metabolism



(a) Sphincters open—blood flows through true capillaries.

Mechanisms of Trans-Capillary exchange

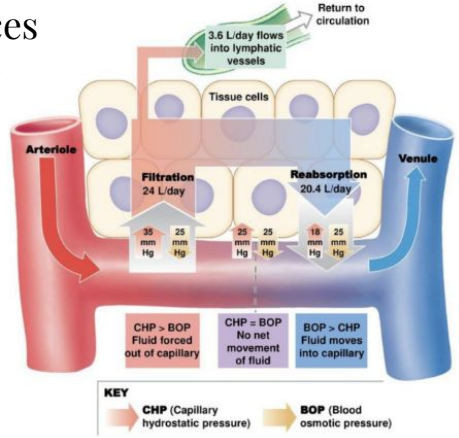
Simple diffusion through 1- cell membrane 2-intercellular pores	1-for lipid soluble gases (O_2 & CO_2) according to concentration gradient 2-Water-soluble, non-lipid-soluble substances .
Filtration	Bulk flow for fluid transfer by starling's forces according to pressure gradient. (Bulk flow refers to the movement of fluid and solutes across the capillary wall through a non-selective process that occurs due to the balance between hydrostatic pressure and colloid osmotic pressure across the capillary wall. This process is driven by a pressure gradient and allows the movement of both small and large molecules based on their concentration gradients. Explained in more details later..)
Vesicular transport	Transcytosis (Transcytosis involves the formation of vesicles at the luminal surface of the endothelial cell, which then transport the macromolecules across the cell and release them on the abluminal surface. This allows the macromolecules to be transported from the blood into the surrounding tissues)
Mediated (Membrane) Transport	Occurs only in capillaries of the brain & involves secondary active transport, e.g, transport of glucose by co-transporters in cell membrane.
Trans-Capillary Fluid Transfer	• Trans-capillary fluid transfer refers specifically to the movement of fluid across the capillary wall, which separates the blood from the surrounding tissues. This process is regulated by the Starling forces, the lymphatic system, and the glycocalyx layer. Trans-capillary fluid transfer is a selective process that allows the exchange of fluid and solutes between the blood and the tissues. • Trans-capillary transfer occurs either by diffusion, or by filtration vesicular transport. • Diffusion occurs through: - Cells: for lipid soluble molecules. - Intercellular clefts between cells: for non - lipid soluble molecules • Filtration (Bulk Flow): - Fluid movement is affected & influenced by the concentration gradients, cleft size (permeability) & hydrostatic pressure (varies by organ & situation).

Important slide

Formation of Interstitial Fluid (IF)

The Interstitial Fluid (IF) formation is **regulated by** the **net filtration pressure** force at the two vascular ends (arteriolar & venular) of the capillary bed.

Net filtration pressure is **affected by the net balance** between the two forces (hydrostatic & oncotic pressures) found in the plasma capillaries & in the interstitial fluid.



Movement of fluid from Capillaries is affected by the:

- Blood pressure
- Capillary permeability
- Osmosis

Excessive fluid gained by tissues is removed by the Lymphatic system

Moving of fluid from capillary to tissue ›› filtration

Moving of fluid from tissue to capillary ››reabsorption

Important slide

Hydrostatic & oncotic pressures

It's really important to know the **forces**

Capillaries Hydrostatic Pressure forces the fluid & its dissolved substances outward through the capillary pores into the interstitial spaces.

Osmotic pressure caused by plasma proteins(colloid pressure)causes inward movement of fluid by osmosis from interstitial spaces into blood, preventing significant loss of fluid from blood into interstitial spaces.

	Hydrostatic Pressure (Outward Force)	Oncotic (Osmotic / Colloid) Pressure (Inward Force)
Interstitial space	- Interstitial hydrostatic pressure (PIF) is almost 0 mmHg. - The interstitial fluid pressure which is caused by pumping of lymphatic system is negative 3 mmHg in most tissues. - Encapsulated organs have positive interstitial pressures (+5 to +10 mmHg). PIF varies from one organ to another: - Subcutaneous tissues: -2 mmHg. - Liver, Kidney: +1 mmHg. - Brain: As high as +6 mmHg.	- Colloid osmotic pressure is caused by presence of large proteins. - There is almost no colloid osmotic pressure in the interstitial space.
Capillary (plasma)	- Normal Capillary hydrostatic pressure ranges from **30-35 mmHg** at the **arterial end**, & from 10-15 mmHg at the **venous end.**	- Colloid osmotic pressure is caused by presence of large proteins. - High content of proteins in plasma accounts for its higher osmotic pressure compared to that of the Interstitial fluid (IF). - Plasma osmotic pressure: Is high (**25-28 mmHg**) & will attract fluid & dissolved substances from tissue spaces into the circulation.

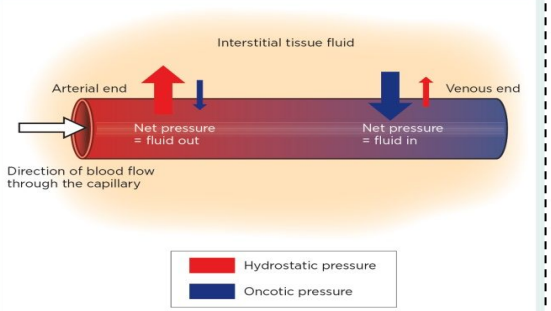
How Does Fluid Filtrate at The Capillary Bed?

- Fluid transfer depends on the relative balance & equilibrium between the hydrostatic & osmotic pressures found in capillary plasma & interstitial space.

- Any loss of plasma colloids will result in an increase loss of fluid from the vasculature to the interstitial space.

  Osmotic pressure caused by the plasma proteins (also called colloid osmotic pressure) tend to cause fluid movement by osmosis from the interstitial spaces into the blood, so this osmotic pressure exerted by the plasma proteins prevents significant loss of fluid volume from the blood into the interstitial spaces.

Fig 2. **Fluid movement between capillary and tissue**



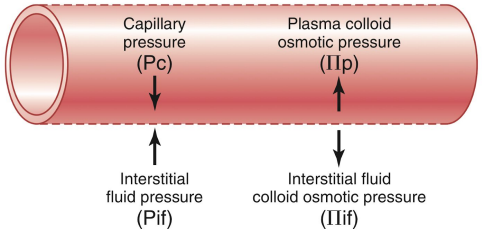


Figure 16-5. Fluid pressure and colloid osmotic pressure forces operate at the capillary membrane and tend to move fluid either outward or inward through the membrane pores.

Total Starling Forces& Filtration at Capillary Beds

- **The Capillary Pressure(Pc)**:Forces the fluid & it Dissolved Substances Outward through capillary membrane into the interstitial spaces.
- **The Interstitial Fluid Pressure(Pif):**Forces the fluid inward through the capillary membrane when it is positive but outward when it is negative.
- **The Capillary Plasma Colloid Osmotic Pressure (pc)**:Causes Osmosis Of Fluid Inward through the capillary membrane.
- **The Interstitial Fluid colloid osmotic pressure(pif)**:Causes Osmosis Of Fluid Outward through the capillary membrane.

The net filtration pressure (NFP) is calculated as:

NFP=(Pc-Pif)–(pc-pif)

✯If NFP = positive, then fluid is lost from capillary (filtration)the capillary membrane into the interstitial spaces.

✯If NFP = negative, then fluid is gained by capillary (reabsorption)from the interstitial spaces into the capillaries.

How Do We Calculate The Net Movement at The Capillary Bed?

- The rate of fluid filtration at the Capillaries is determined by:the starling forces, the number & size of pores in each capillary, as well as the number of capillarie in which the blood is flowing:

Filtration Rate = Kf X NFP

-Net Filtration Pressure (NFP)

- Filtration Coefficient(Kf): is a product of surface area time the hydraulic conductivity of membrane "membrane permeability"

Dr: This is the the most important thing you have to memories in this slide

Starling's Forces

443: it's for your information
44:Dr did not focus on it

Starling's Equation for Capillary Filtration:

Flux (net driving pressure) =
Kf [(Pc – Pif) – σ (pc – pif)]

-Fluid transfer depends on the relative balance between hydrostatic pressure & osmotic pressure.

- Kf = Capillary filtration coefficient (surface area & permeability)
- Pc = Capillary hydrostatic pressure
- Pif = Interstitial hydrostatic pressure
- σ = Capillary reflection coefficient (o to 1)
1 = impermeable to proteins
- pc = Capillary colloid osmotic pressure
- pif = Interstitial colloid osmotic pressure

وَسُبْحَانَ اللَّهِ رَبِّ الْعَالَمِينَ

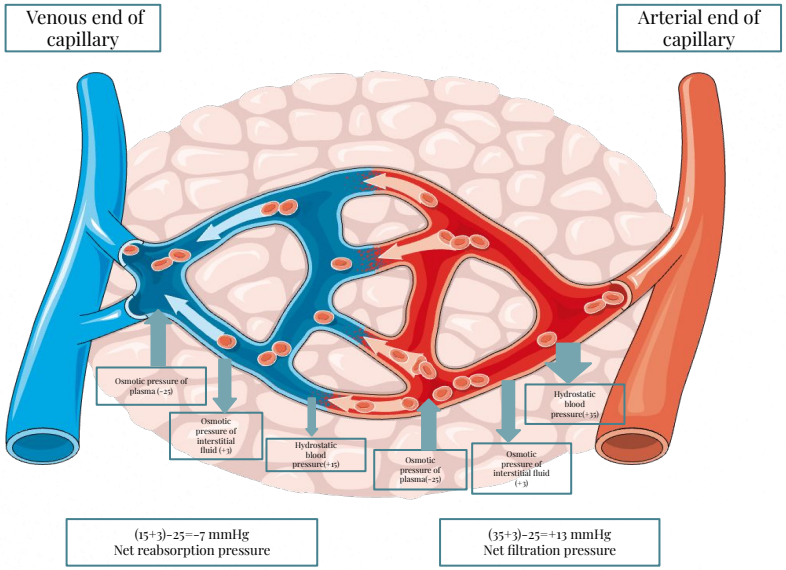
Female's slide

Starling's Forces & Filtration at Capillary Beds

Fluid Balance: Net Filtration & Absorption of Fluid Across The Capillary Membrane

At venous end of capillary	
Outward forces:	Value
Capillary blood pressure	Pc=10~15 mmHg
Negative interstitial free fluid pressure	PIF=-3 mmHg
Total outward forces	15 - (-3) = 18 mmHg
Inward forces:	Value
Plasma colloid/osmotic pressure	Pc=25~28 mmHg
Total inward force	25 - 0 = 25 mmHg
Net inward force	18-25=-7 mmHg

Reabsorption (gained)



At arterial end of capillary	
Outward forces:	Value
Capillary blood pressure	Pc=30~35 mmHg
Negative interstitial free fluid pressure	PIF=-3mmHg
Total outward forces	35 - (-3) = 38 mmHg
Inward forces:	Value
Plasma colloid/osmotic pressure	Pc=25~28 mmHg
Total inward force	25 - 0 = 25 mmHg Interstitial osmotic pressure =0
Net outward force	38-25=+13 mmHg

Filtration (lost)

Normal Forces at The Arterial & Venous Ends of The Capillary

Tissue Hydrostatic Pressure= 0 mmHg

+10 جت من ناتج طرح الي طالع والي داخل بدون IFFP
HP-POP=35-25=+10
بعدين البوستف ثلاثة جت لما عكسنا السهم و غيرنا الاشارة

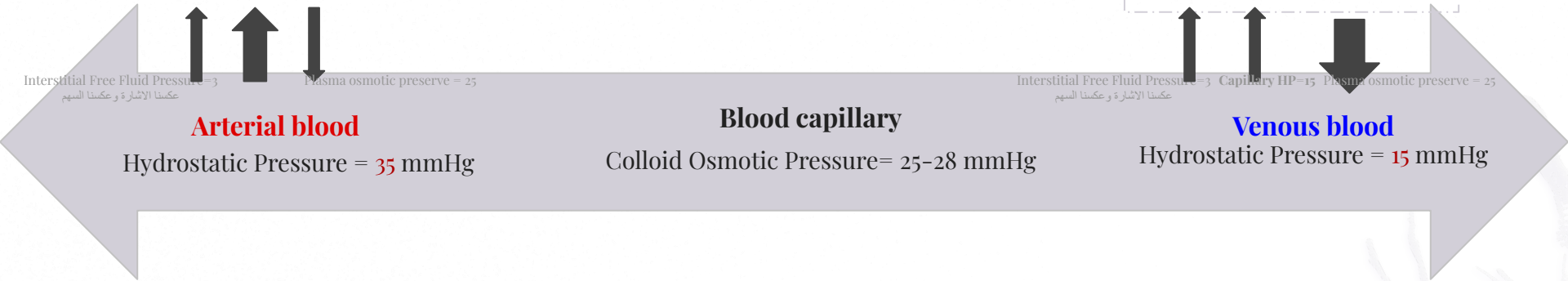
Interstitial Free Fluid Pressure= -3 mmHg

-10 جت من ناتج طرح الي طالع والي داخل بدون IFFP
HP-POP=15-25=-10
بعدين البوستف ثلاثة جت لما عكسنا سهم و غيرنا اشارة IFFP

NFP = (+10+3)= +13 mmHg
38-25=+13

Interstitial fluid

NFP = (-10 +3) = - 7 mmHg
18-25=-7



Arterial blood
Hydrostatic Pressure = 35 mmHg

Blood capillary
Colloid Osmotic Pressure= 25-28 mmHg

Venous blood
Hydrostatic Pressure = 15 mmHg

السهم العريض يدل على الحركة النهائية

Normal Forces at The Arterial & Venous Ends of The Capillary

Male slide only

At arterial end:

- Hydrostatic pressure dominates at the arterial end, as a net sum of pressure forces=38 (Capillary hydrostatic pressure 35mmHg plus inward Interstitial free fluid pressure -3mmHg minus Capillary osmotic pressure 25mmHg).
flow fluid out of the circulation through capillary pores

- The net force will result in fluid flow out of the capillary with a net filtration pressure (NFP) of +13 mmHg

- 13 mmHg filtration pressure NFP causes an average of 1/200 of plasma in flowing blood to filter out of arterial end of the capillary into the interstitial space.

At venous end:

- Oncotic pressure dominates at the venous end, as a net sum inward pressure forces= -7 (Capillary osmotic pressure 25mmHg minus Capillary hydrostatic pressure 15mmHg plus inward Interstitial free fluid pressure -3mmHg).

-The net force will result in fluid flow moves into the capillary with a NFP of -7 mmHg.

At arterial end of capillary	
Outward forces:	Value
Capillary blood pressure	Pc= 30 mmHg
Negative interstitial free fluid pressure	PIF= -3mmHg
Interstitial fluid colloid osmotic pressure	8
Total outward forces	(30+8) - (-3) = 41 mmHg
Inward forces:	Value
Plasma colloid/osmotic pressure	Pc= 28 mmHg
Total inward force	28 - 0 = 28 mmHg Interstitial osmotic pressure =0
Net outward force	41 - 28= +13 mmHg

Filtration (lost)

Extra slide

Starling's Forces Explanation

Fluid Balance: Net Filtration & Absorption of Fluid Across The Capillary Membrane

Thanks to 443!

The movement of fluids and solutes across the walls of capillaries is regulated by a balance of forces known as Starling's forces. There are four main forces involved in this balance: capillary hydrostatic pressure (CHP), interstitial fluid hydrostatic pressure (IFHP), plasma oncotic pressure (POP), and interstitial fluid oncotic pressure (IFOP).

- Capillary hydrostatic pressure (CHP) is the force exerted by the blood against the walls of the capillary. This force tends to push fluid out of the capillary and into the surrounding tissues. This pressure is generated by the pumping action of the heart and tends to push fluid out of the capillary and into the surrounding tissues. CHP varies depending on the location in the body, but it is typically around 25-30 mmHg at the arteriolar end of the capillary and around 15-18 mmHg at the venular end.

- Interstitial fluid hydrostatic pressure (IFHP) is the force exerted by the interstitial fluid against the walls of the capillary. This force tends to push fluid from the surrounding tissues into the capillary. This pressure tends to push fluid from the surrounding tissues into the capillary. IFHP is usually very low, around 0-5 mmHg, because the lymphatic system helps to drain excess interstitial fluid.

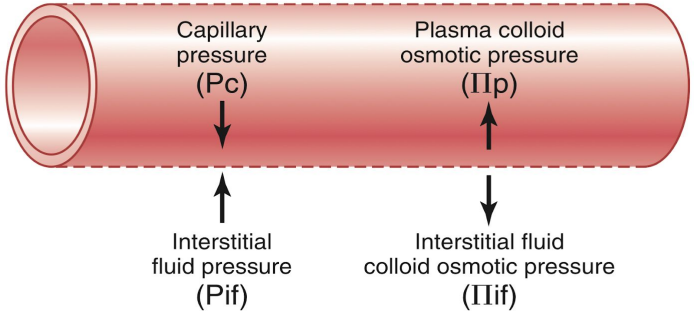
- Plasma oncotic pressure (POP) is the force created by the presence of proteins in the blood plasma. These proteins tend to draw water into the capillary and prevent it from leaking out into the surrounding tissues. the pressure created by the presence of proteins in the blood plasma, specifically albumin. These proteins are too large to cross the capillary walls and tend to draw water back into the capillary, preventing it from leaking out into the surrounding tissues. POP is typically around 25 mmHg in healthy individuals.

- Interstitial fluid oncotic pressure (IFOP) is the force created by the presence of proteins in the interstitial fluid. These proteins tend to draw water out of the capillary and into the surrounding tissues. However, the concentration of proteins in the interstitial fluid is much lower than in the plasma, so IFOP is usually negligible.

- Filtration refers to the movement of fluid and small solutes from the capillary into the interstitial space. This movement is driven by the difference between the capillary hydrostatic pressure (CHP) and the interstitial fluid hydrostatic pressure (IFHP) and plasma oncotic pressure (POP). At the arteriolar end of the capillary, CHP is higher than IFHP and POP, so fluid and solutes are pushed out of the capillary and into the interstitial space. This process is aided by the presence of small gaps between the endothelial cells that make up the capillary walls, which allow fluid and solutes to pass through.

Once the fluid and solutes are in the interstitial space, they may be taken up by the surrounding tissues, or they may be absorbed by the lymphatic system. The lymphatic system helps to drain excess interstitial fluid and return it to the bloodstream, which helps to maintain the balance of fluids in the body.

- Absorption refers to the movement of fluid and solutes from the interstitial space into the capillary. This movement is driven by the difference between the plasma oncotic pressure (POP) and the interstitial fluid oncotic pressure (IFOP) and the capillary hydrostatic pressure (CHP). At the venular end of the capillary, POP is higher than IFOP and CHP, so fluid and solutes are drawn back into the capillary from the interstitial space. This process is aided by the presence of proteins in the blood plasma, which create an osmotic pressure that draws water back into the capillary.



بالعربي المختصر

فيه اربع قوات

١- (Interstitial Hydrostatic Pressure) هذي طالعه برا من الـtissue (يعني باتجاه انها تدخل للـcapillary) ولكن lymphatic يسحبها

لكن سحب lymphatic ينتج لنا قوة الي هي (interstitial fluid pressure) وهي تقريباً 3- (معلومة : ممكن تلقونها بمواقع اخرى 3+ ولكن اتجاهها بيكون بالمعاكس، هي بالسالب راح تكون داخله الكابيليري، لكن لو نعكس الاشارة وتصير بالموجب راح تصير طالعة برا من الكابيليري)

٢- (interstitial oncotic pressure) هذي تجي من البروتين الذائب فقط، بما ان في الـtissue البروتين تكون مرتبطة فقيمتها تعتبر 0 تقريباً

٣- (capillary hydrostatic pressure) هذي تجي من pumping of the heart وهي جالسة تحاول تطلع السوائل خارج الـ capillary وقيمتها تختلف حسب مكانها هل في artery end او في venous end لان هي راح تطلع fluid وشوي شوي تقل (لان fluid بدت تقل) لين توصل عند Venules وهي قليلة مرة

٤- (capillary oncotic pressure) وهذي زي ماقلنا هي بسبب البروتينز الذائبة ، وبما ان بالكابيليري بروتين كثير فهي قيمتها ثابته (25)، ايش فايدتها ؟ proteins تحب fluid فهي راح تسحب الـ fluid لجهتها (يعني تسحب من برا لداخل الـ capillary)

كذا عرفنا القوات واتجاهها، الحين نحسب الفرق بين كل القوات الي داخله والي طالعة من الـ capillary ونشوف، لو موجب معناته = filtration ، ولو سالب معناتها = reabsorption

Factors Affecting Capillary Filtration & Clinical Conditions

Factors Affecting Capillary Filtration :

- Blood pressure
- Permeability
- Organ Structure
  (Encapsulated or not?)
- Osmotic pressure

1 Clinical Conditions Associated with an Increase in Capillary Filtration:

In case of congestive heart failure: Venous pressure rises → will build-up of blood in capillaries → ↑capillary hydrostatic pressure → ↑filtration → edema.

In case of hypoproteinemia (Starvation, liver disease, renal disease):
↓ plasma protein colloid osmotic pressure → loss of fluid from capillaries → edema.

In case of inflammation: The gaps between the endothelial cells increase because of the inflammatory mediators → ↑ movement of proteins into the interstitial space → edema.

2 Clinical Conditions Associated with a Decrease in Capillary Filtration:

In case of blood loss: Vasoconstriction of arterioles → will decrease the capillary hydrostatic pressure. The osmotic pressure of plasma proteins favours absorption of interstitial fluid → ↑ Blood volume. (Capillary) - Shift mechanism(↓blood volume then ↓blood pressure so blood will shift ti interstetial Fluid as intermediate regulatory mechanism

Lymphatic System

Lymphatic vessels present between capillaries. Begin as blind ended tubes And it's Parallel to the venous system.

Muscle activity pumps fluid in lymph vessels, then the lymph Collect the excess interstitial fluid & return it to blood vessels in the subclavian vein, Approximately 120 ml/day is returned to the blood vessels.

Interstitial fluid enter the lymphatic capillaries through loose junctions between endothelial cells. Then flow back to the thoracic duct with the help of contraction of both the lymphatic vessel walls smooth muscle & the surrounding skeletal muscle.

Failure of lymphatic drainage can lead to edema.

Lymphatic capillaries are small, thin-walled, micro-vessels located in the spaces between cells except CNS. Serve to drain and process ECF, then carries lymph into lymphatic vessels, connects to a lymph node to the venous circulation .

Lymphatic capillaries are slightly larger in diameter than blood capillaries, allow interstitial fluid to flow into them but not out.

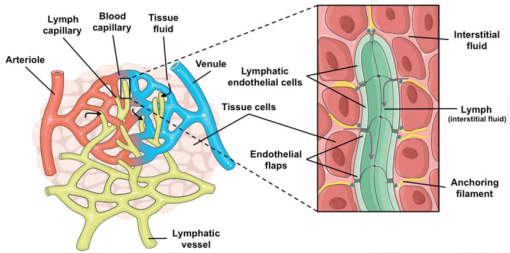
Functions of Lymphatic System:

- 3 basic functions :

1. Drain excess interstitial (tissue) fluid back to the blood, in order to maintain original blood volume.

2. Transports absorbed fat from small intestine to the blood.

3. Helps provide immunological defenses against pathogens.

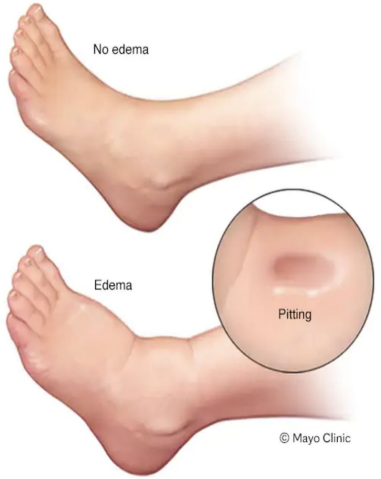


Edema

The term "Edema" is used to describe unusual accumulation of interstitial fluid.

Loss of fluid from the vascular space into the extravascular or interstitial space will result in:

- Low blood volume which will result in low blood pressure.
- Loss of fluid from capillaries into the tissue which will result in edema.



Causes:

1. **Alteration in Starling's forces balance due to:**
   - A decrease or loss in Plasma protein (colloids) concentration, will lead to a decrease in plasma osmolarity, allowing fluid to escape from circulation to the interstitial space.
   - An increase in Capillary hydrostatic pressure.
2. **Failure of Lymphatic drainage.**
3. **An increase in capillary permeability or in pores size secondary to:**
   - Histamine release, Bradykinin or certain drugs administration.
   - Inflammation & release of cytokines.
4. **Involvement of some types of hormones.**
   - Activation of Renin-Angiotensin-Aldosterone System which will result in secondary Hyperaldosteronism, leading to sodium (Na^+) & water retention.
   - Activation of Anti-diuretic hormone (ADH)/Vasopressin, leading to water retention.

MCQs:

Important slide

For more question check our summary file!

Answers

1/B
2/D
3/C

1

Under normal circumstances, Which of the following has the greatest influence on capillary fluid exchange ? From female slides.

A	Permeability	B	Hydrostatic pressure of plasma.	C	Lymphatic pressure.	D	Osmotic pressure

2

Which of the following is altered by the body to increase capillary filtration? From Female slides.

A	Osmotic pressure.	B	Lymphatic pressure.	C	Permeability.	D	Hydrostatic pressure of plasma.

3

The hydrostatic & osmotic pressure of tissue is? From boys dr.

A	Hydrostatic = reabsorption Osmotic = reabsorption	B	Hydrostatic = filtration Osmotic = filtration	C	Hydrostatic = reabsorption Osmotic = filtration	D	Hydrostatic = filtration Osmotic = reabsorption

MCQs:

All the questions are from boys dr.

Important slide

For more question check our summary file!

Answers

4/B
5/D
6/C

4 Which of the following can lead to open of the capillary?

A	Vasoconstrictor	B	Exercise, vasodilator, mediators as histamine	C	Both A and C	D	Sitting position

5 The hydrostatic & osmotic pressure of capillary is?

A	Hydrostatic = filtration Osmotic = filtration	B	Hydrostatic = reabsorption Osmotic = reabsorption	C	Hydrostatic = reabsorption Osmotic = filtration	D	Hydrostatic = filtration Osmotic = reabsorption

6 Which of the following has the smallest radius ?

A	Aorta	B	Arteriole	C	Capillary	D	Veins

SAQ

What is the filtration forces? And what is the reabsorption forces?	SLIDE:14
What regulate the blood flow in the capillary network?	SLIDE:11
The tendency for edema to occur will be by?	SLIDE:24
Name the factors that affect the capillary filtration?	SLIDE:22

Finally you have arrived , we have been waiting for you !!

Meet our team !

Team leaders

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Did you like the lecture ? we mean our work :)

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