



437

PHYSIOLOGY TEAM



MED437
KING SAUD UNIVERSITY

Females & Males Slides

Only Found in Males' slides

Only Found in Females' slides

Very Important Notes

Notes

Extra Information

PHYSIOLOGY

غيداء آل مصمغ
عبدالرحمن الحيسوني

Revised by

Edema

وهي الجزء الثاني من محاضرة الأولاد 2 homeostasis

Objectives:

- Define Edema and describe its different types.
- Discuss and describe the Starling forces governing fluid exchange across capillary walls.
- Link changes of hydrostatic and osmotic pressure to the pathogenesis of edema.

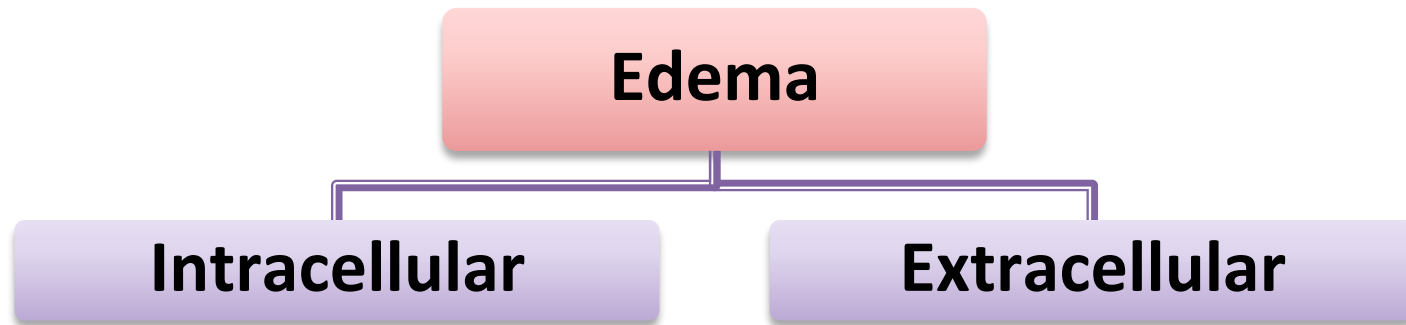
Edema



- ▶ Edema = Swelling
- ▶ It is the presence of abnormally large amounts of fluid in the intercellular tissue spaces of the body.
- ▶ It is excessive accumulation of fluid in the tissues.

Types of Edema

- ▶ Edema occurs mainly in ECF compartment, but it can involve the ICF compartment as well.



Due to intracellular swelling.

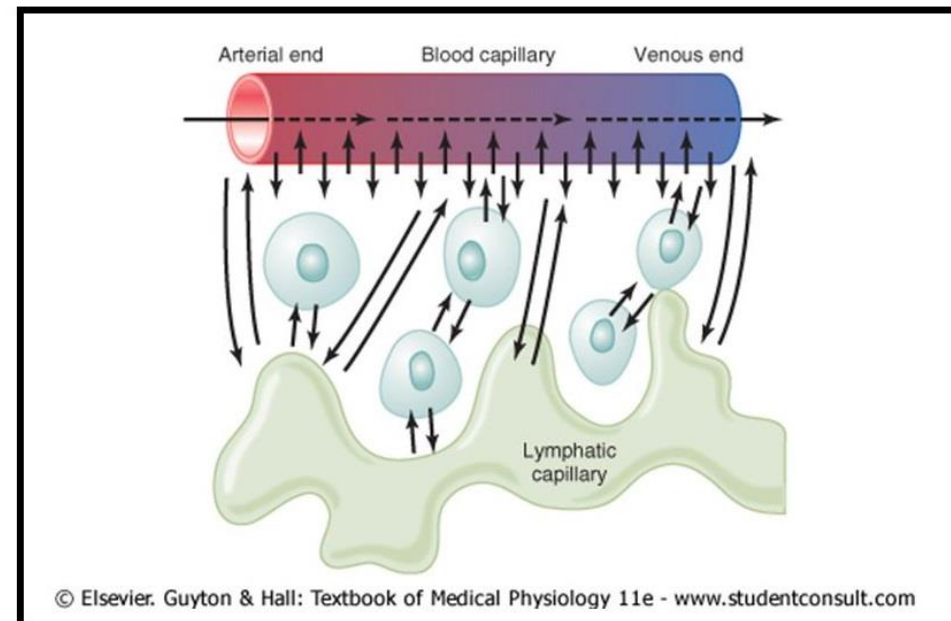
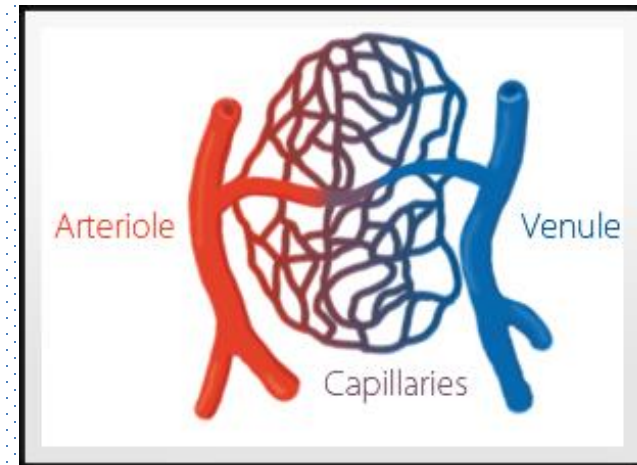
Caused by:

- Hyponatremia.
- Depressed metabolism
- Lack of nutrition to the cells.
- Inflammation.

- More common clinically
- Due to abnormal accumulation of fluid in the extracellular space.
(I.e. interstitial space)
- Can be caused by many conditions.
- A common clinical cause is excessive capillary fluid filtration

Fluid Exchange Between Blood & Interstitial Fluid

- . Normally, fluid is constantly moving in & out of the interstitial space to allow ECF to distribute between plasma and IF.
- . This process happens without fluid accumulating between the cells.
- . Fluid exchange between blood and tissue cells occurs at the level of the capillaries.
- . The capillaries are the smallest blood vessels in our vascular tree.
- . These vessels are very small and have a very thin wall allowing easy exchange of fluid across the walls.

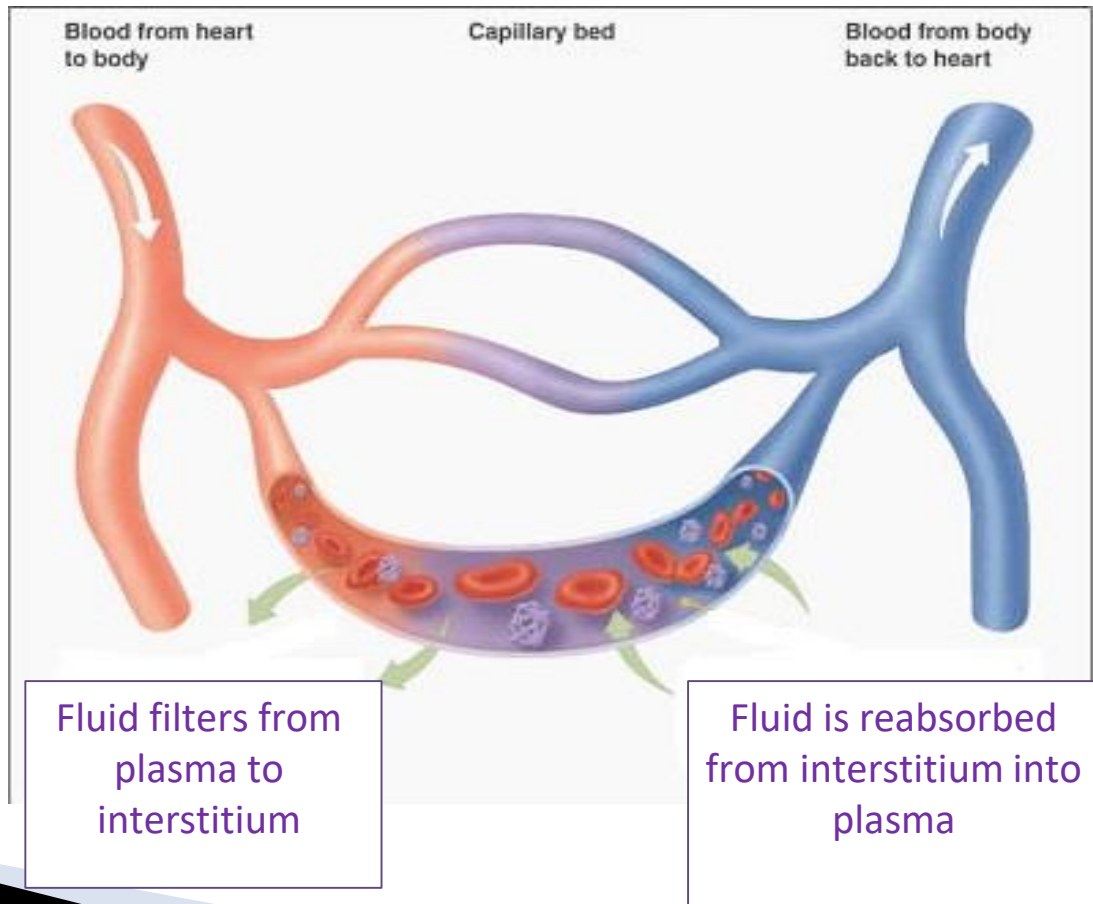


Fluid Filtration Across Capillaries

▶ Excessive capillary fluid filtration is a common cause for Extracellular Edema.

- The rate of diffusion through the capillary membrane is proportional to the concentration difference of the substance between two sides of the membrane, for example: Oxygen in the capillary is greater than in the ISF, but CO₂ is greater in the ISF than in the capillary—so the excess CO₂ will move into blood and the O₂ will move into ISF

As blood passes through capillaries...



- Substances are primarily transferred between the plasma and the interstitial fluid by diffusion
- Water-soluble substances and some proteins pass through capillary membrane through capillary pores

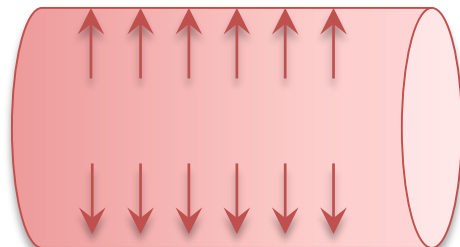
Factors controlling fluid filtration across capillary walls

Movement of fluids across capillary walls depends on the balance of Starling forces acting across the capillary walls.

Starling forces
Forces that control the movement of fluid in/out of the capillary

Hydrostatic pressure P

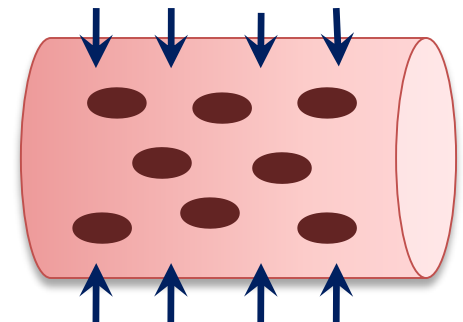
The pressure exerted by blood (water) on the walls of the blood vessel.



Colloid osmotic (oncotic) pressure π

The osmotic pressure created by the non-diffusible plasma proteins inside the blood vessel.

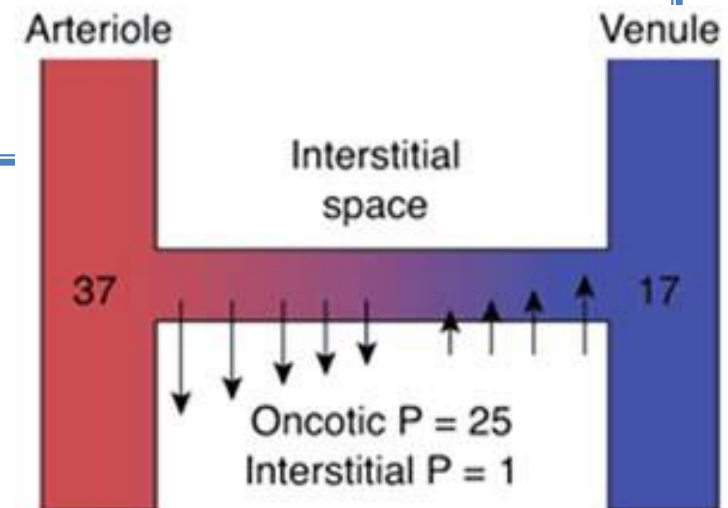
(especially albumin)



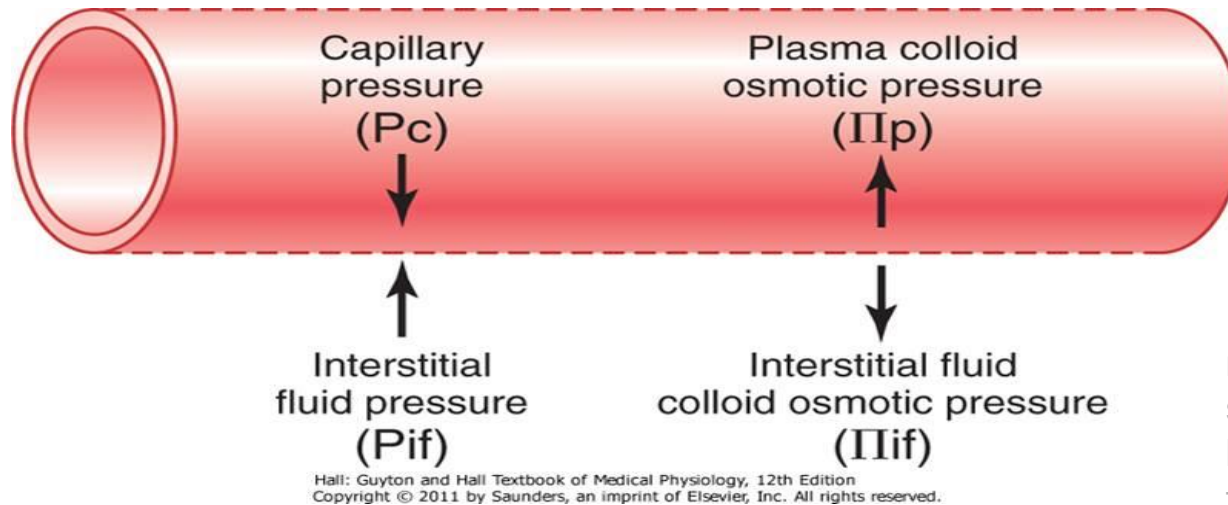
Starling forces acting across capillary membrane

Starling's equation: states that the rate of leakage of fluid is determined by the difference between two forces and also by the permeability of the vessel wall to water, which determines the rate of flow for a given force imbalance.

$$\text{Net Filtration Pressure} = P_c - P_{if} - \pi_p - \pi_{if}$$



Starling forces acting across capillary membrane



P_{if}=lower than atm (so negative) causing a light suction in tissues that helps hold tissues together

Four primary forces determine whether fluid moves in or out of blood “Starling forces”:

- capillary “hydrostatic” pressure → out of blood.
- IF “hydrostatic” pressure → into blood.
- Plasma “colloid osmotic” pressure → into blood
- IF “colloid osmotic” pressure → out of blood.

Arteriolar end: Hydrostatic pressure > Oncotic pressure ⇒ Fluid passes into interstitium

Venule end: Oncotic pressure > Hydrostatic pressure ⇒ Fluid returns capillary bed

| Colloid osmotic pressure (oncotic)(π_p) | Hydrostatic pressure (P_c) |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| <ul style="list-style-type: none"> • Formed by plasma proteins (especially albumin) • It tries to keep the fluid in the capillary | It forces the blood fluid pass into the tissues through the capillary wall. |
| 25mmHg | Arterial end = 37 mmHg |
| 28mmHg | Venous end = 17 mmHg |
| Colloid osmotic pressure (oncotic)(π_{if}) | Arterial end = 30 mmHg |
| 8 mmHg | Venous end = 10 mmHg (usually 15–25 mmHg less than arterial end) |

*IF hydrostatic pressure (P_{if}) is usually subatmospheric in loose connective tissue (~ - 3 mmHg)

The increase of pressure at the venule end \Rightarrow Fluid cannot return capillary and stay at the interstitium.

*Negative charge means sucking or absorption

$$P_c + \pi_{if} - P_{if} - \pi_c =$$

قد تكون قيمة P_{if} موجبة حسب المعطى

Edema

- Increase capillary filtration

1. **Increased capillary pressure**

- Kidney failure
- Heart failure.
- Venous obstruction

2. **Decreased plasma oncotic pressure**

- Loss of proteins (nephrotic syndrome, burns).
- Inability to synthesize proteins (liver failure, malnutrition).

3. **Increased capillary permeability**

- Inflammation
- Infection.
- Immune reactions.

- Decrease lymph uptake

Lymphatic obstruction

- Infection (filaria).
- Surgery.
- Congenital absence.
- Cancer.

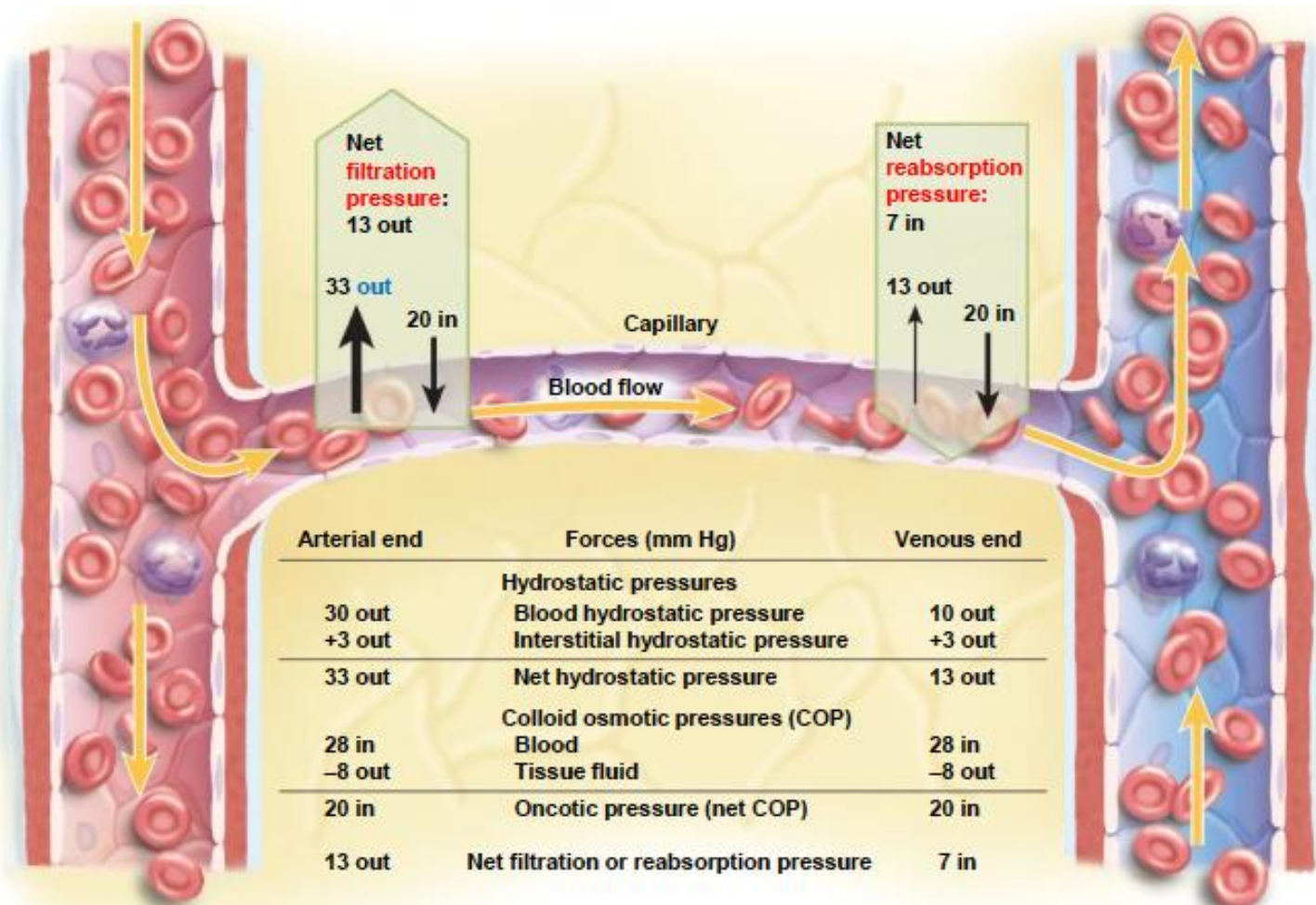
Oncotic pressure:

Plasma proten content > Interstitial protein content →

Plasma oncotic pressure > interstitial oncotic pressure

- Effective oncotic pressure = Plasma oncotic pressure – Interstitium oncotic pressure
- Effective oncotic pressure **DECREASES**:
 - As the decreasing of plasma oncotic pressure (cirrhosis, malnutrition, nephrotic syndrome)
 - As the increasing of interstitium oncotic pressure (Increasing of permeability – inflammatory / allergy)

Forces that determine fluid movement through capillary membrane

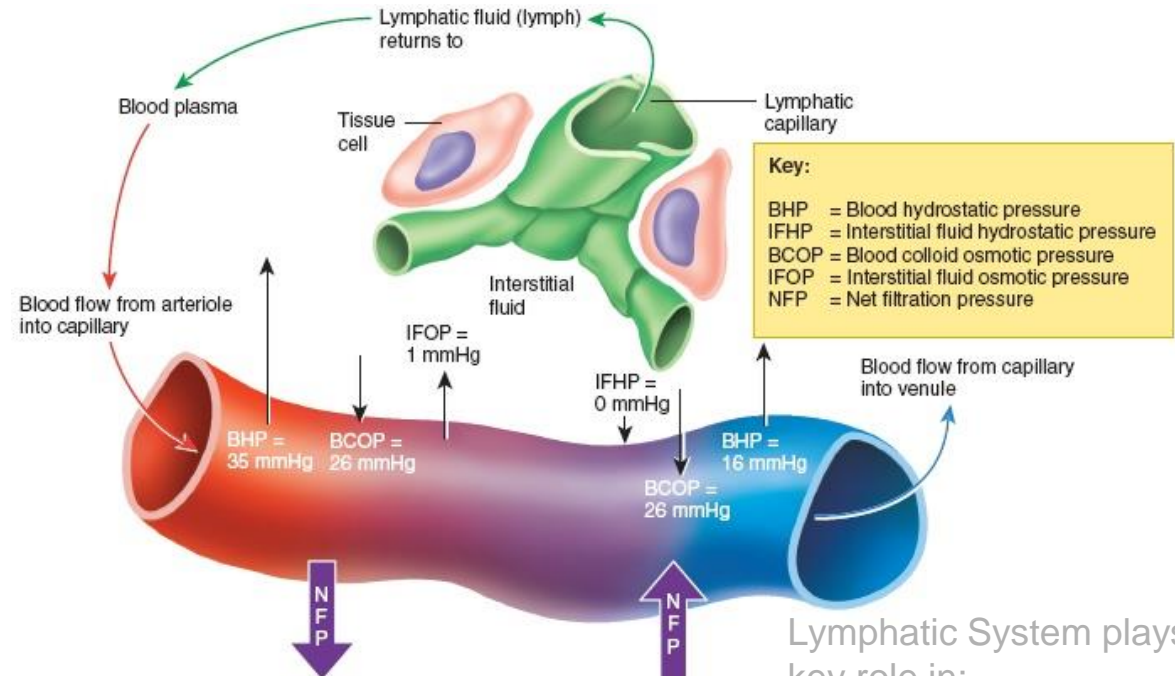


The lymphatic system

- ▶ The reabsorption pressure causes 9/10 of the filtered fluid to be reabsorbed while 1/10th remains in the interstitial fluid.

- ▶ The lymphatic cells return the 1/10th of the remaining fluid to the blood vessel.

- ▶ The total quantity of lymph \approx 2-3L/day



Lymphatic System plays key role in:

- Controlling concentration of proteins in interstitial fluids
- the volume of interstitial fluid
- the interstitial fluid pressure

Net filtration at arterial end of capillaries (20 liters per day)

Net reabsorption at venous end of capillaries (17 liters per day)

Net filtration pressure (NFP)

$$= (BHP + IFOP) - (BCOP + IFHP)$$

Pressures promoting filtration

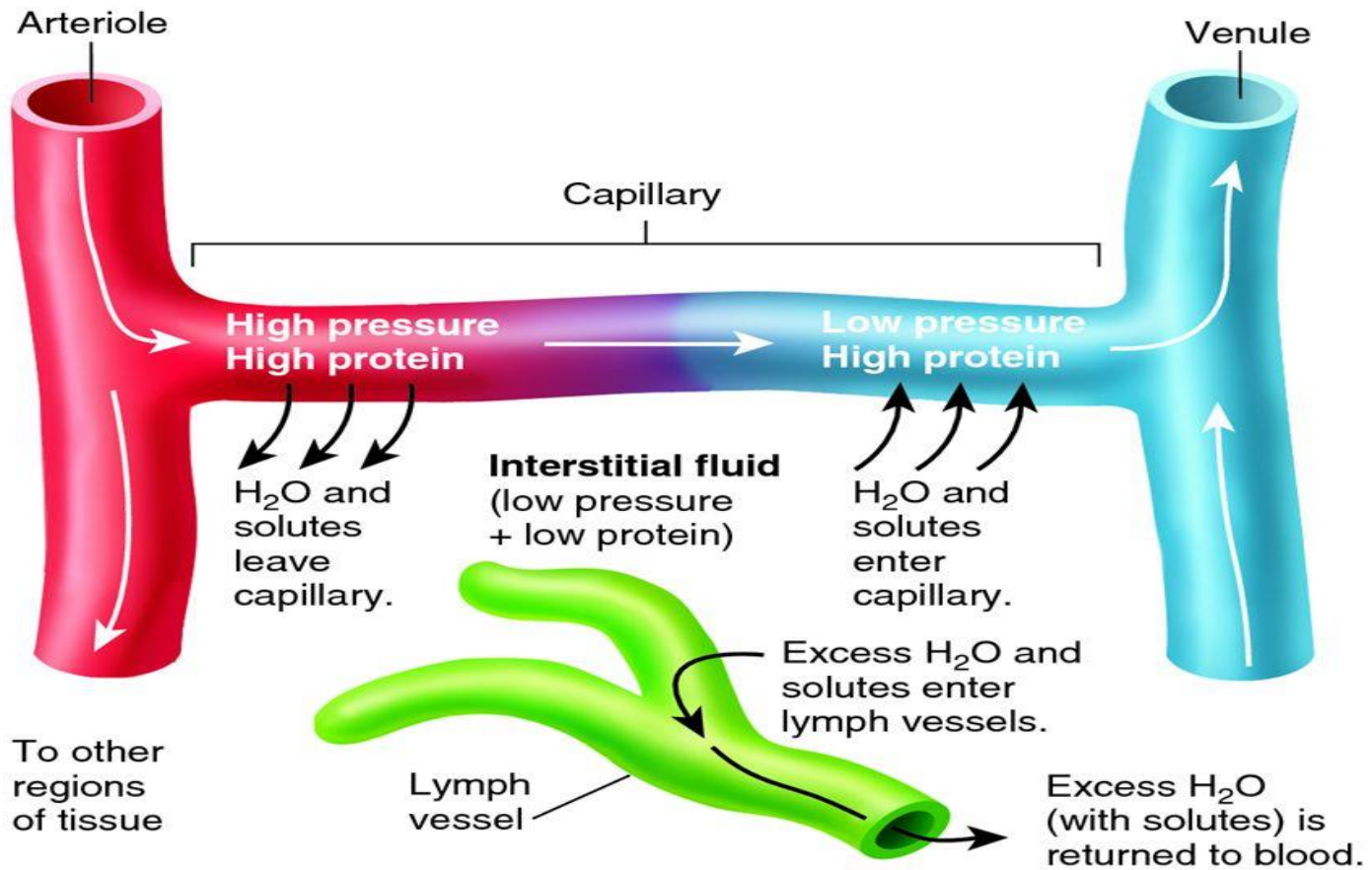
$$= (BCOP + IFHP) - (BHP + IFOP)$$

Pressures promoting reabsorption

| Arterial end |
|----------------------------------------------------|
| $NFP = (35 + 1) - (26 + 0)$ $= 10 \text{ mmHg}$ |
| Result: Net filtration |

| Venous end |
|----------------------------------------------------|
| $NFP = (16 + 1) - (26 + 0)$ $= -9 \text{ mmHg}$ |
| Result: Net reabsorption |

summary



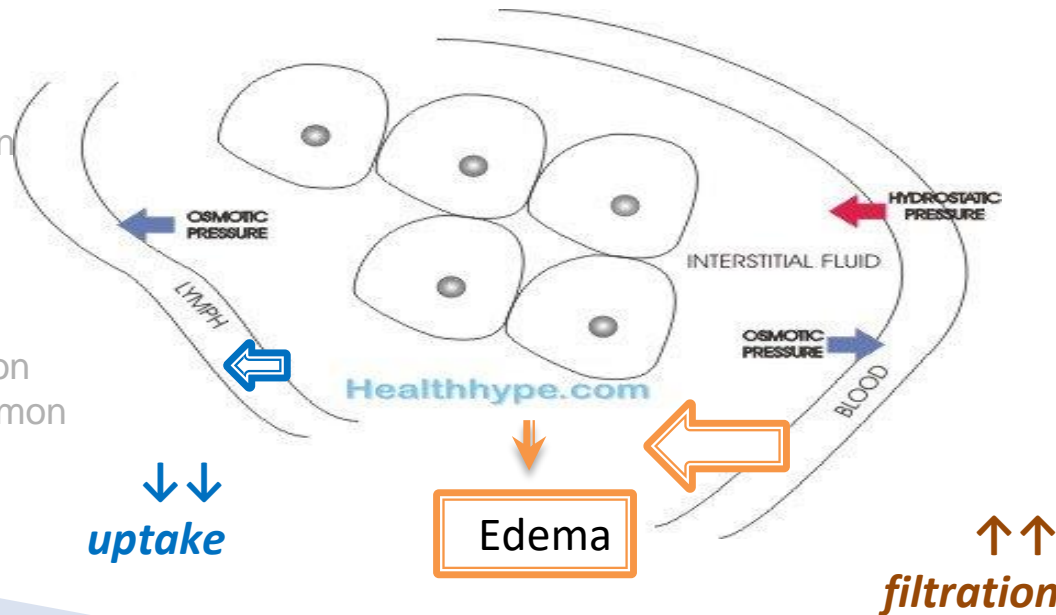
Edema

excessive accumulation of fluid in the EC fluid

Two main reasons

- Failure of lymphatic uptake.

- Abnormal leakage of fluid from plasma to interstitial space.

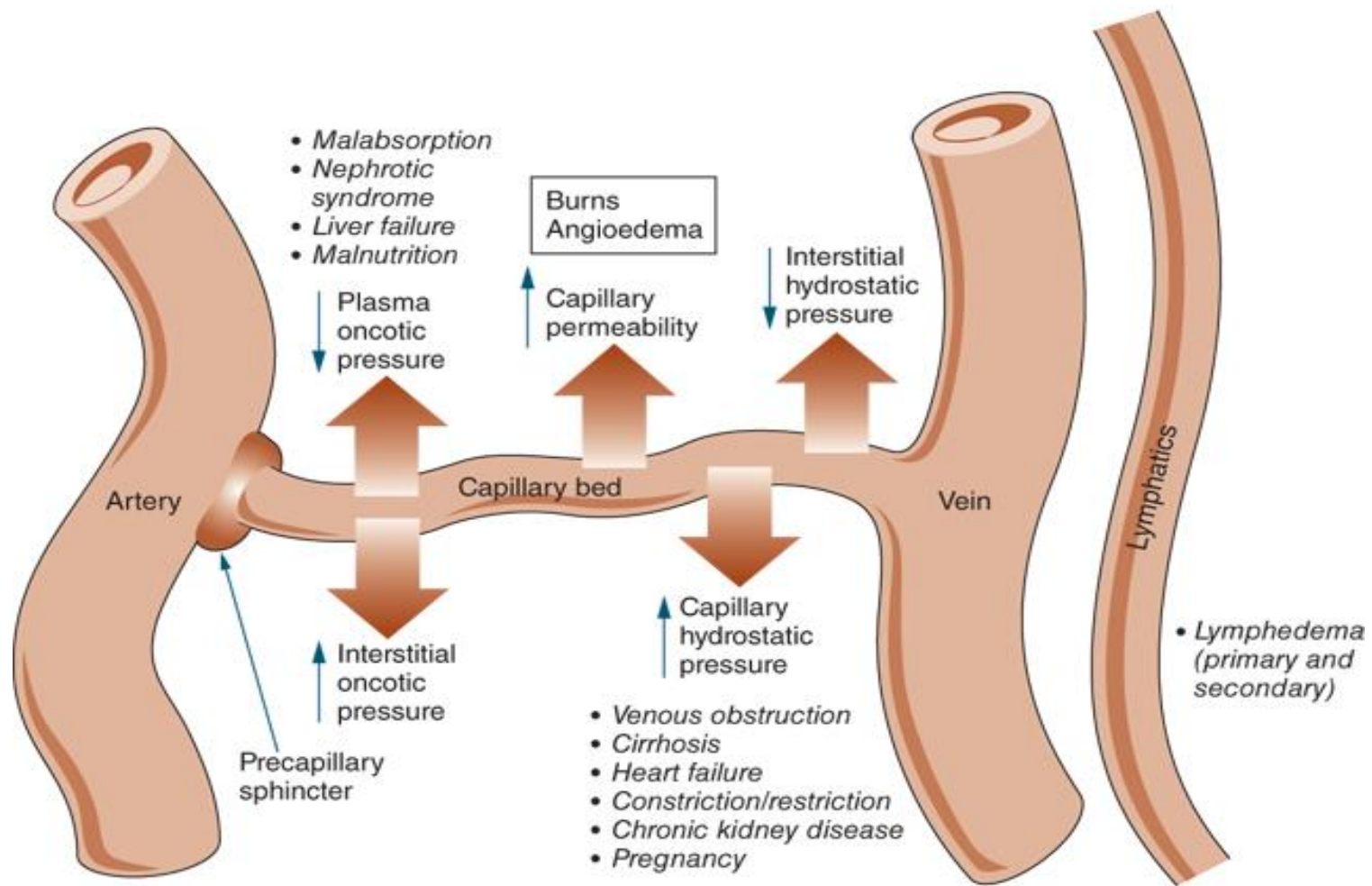


Capillary filtration = $K_f(\text{coefficient of capillary filtration}) \times \text{NFP}(\text{net filtration pressure slide 7})$ so:

- increased K_f
- Increased P_c
- Decreased π_p

can cause \uparrow capillary filtration rate which is the most common clinical cause of IF accumulation

$\uparrow\uparrow$
filtration



Intracellular Edema:

inflammation of tissues.

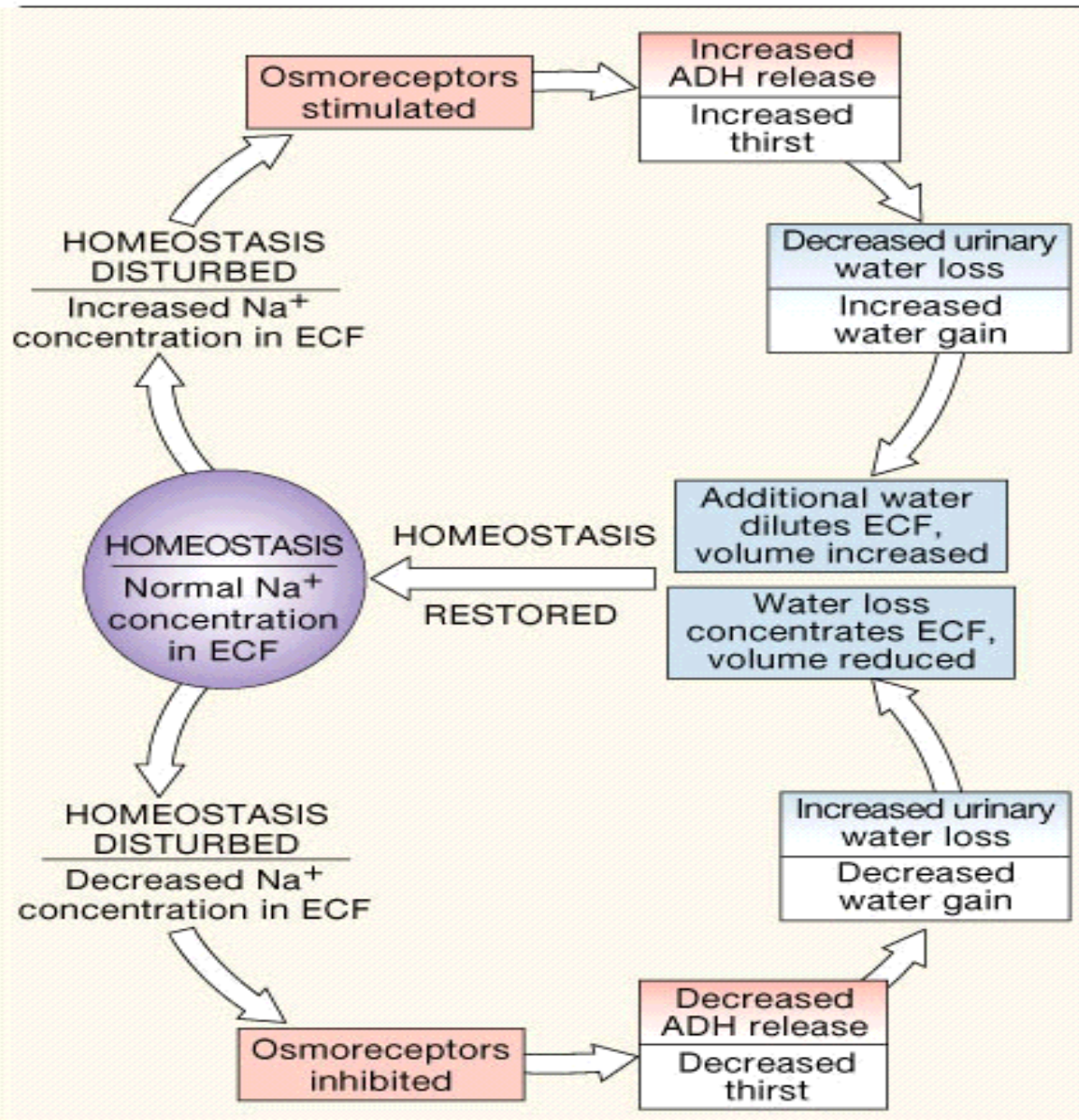
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graph TD; A[inflammation of tissues.] --> B[↑ membrane permeability.]; B --> C[Na inside cells.]; C --> D[water]; D --> E[edema]
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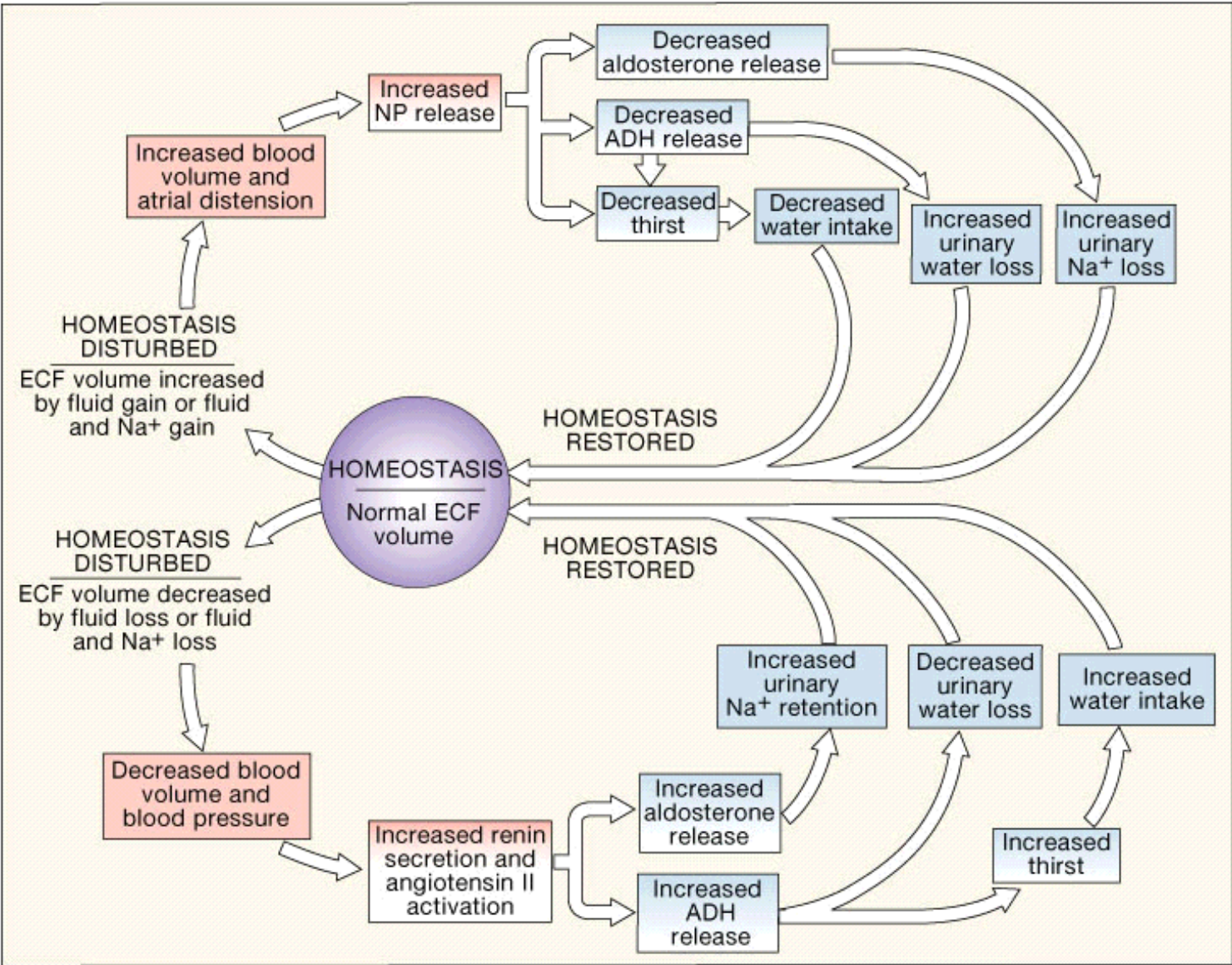
↑ membrane permeability.

Na inside cells.

water

edema





Quiz :

- True or False

(1) The lack of nutrition to the cells can cause Extracellular Edema. (True / False)

(2) Fluid is reabsorbed from plasma to interstitium (True / False)

(3) Increased capillary pressure can lead to Kidney failure and heart failure. (True / False)

MCQ:

(1) Starling forces : are forces that control movement of fluid in / out of a :

(A) Capillary (B) Vessels (C) Cell membrane

(2) Capillary with a “hydrostatic “ pressure moves fluid :

(A) Out of blood (B) Into blood (C) Both A&B

(3) Edema occurs mainly in the.....Compartment but it can involve the.....Compartment as well.

(A) EFC , IEF (B) ECF , ICF (C) ECF, IFC

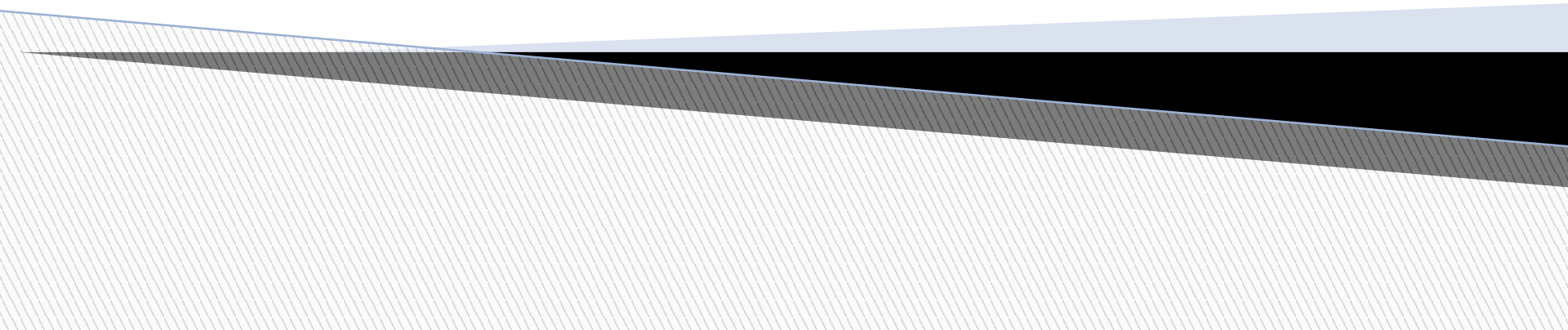
Answers :

- True and False

(1)False (2) False (3) True

- MCQ

(1)A (2) A (3) B



Thank you & good luck

Boys team members: ▶

- ▶ هشام الشايع
- ▶ محمد الحسن
- ▶ محمد الصويغ
- ▶ محمد المنجومي
- ▶ معاذ الحمود
- ▶ خالد العقيلي
- ▶ عبدالجبار اليماني
- ▶ عمر الفوزان
- ▶ فهد الحسين
- ▶ سعد الهداب
- ▶ نواف اللويمي
- ▶ انس السيف
- ▶ سيف المشاري
- ▶ سعود العطوي
- ▶ نايف المطيري
- ▶ عبدالرحمن العقيلي

Girls team members: ▶

- ▶ مها العمري
- ▶ هديل عورتاني
- ▶ ريما العنزي
- ▶ روتانا خطيب
- ▶ لجين عزيز الرحمن
- ▶ العنود المفرج
- ▶ ريم القرني
- ▶ عهد القرين
- ▶ العنود المنصور
- ▶ مها النهدي
- ▶ بلقيس الراجحي
- ▶ سارة البلهد
- ▶ ميعاد النفيجي
- ▶ نورة البسام
- ▶ عبير العبدالجبار
- ▶ وجدان الشامري
- ▶ الجوهرة الشنفي

together everyone

TEAM

achieves more

Team Leaders:

-طارق العميم

-مها بركة