HAEMODYNAMIC DISORDERS, THROMBOEMBOLIC DISEASE, and SHOCK

TOPIC 1
EDEMA & EFFUSION

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HOD, Pathology
MCWH

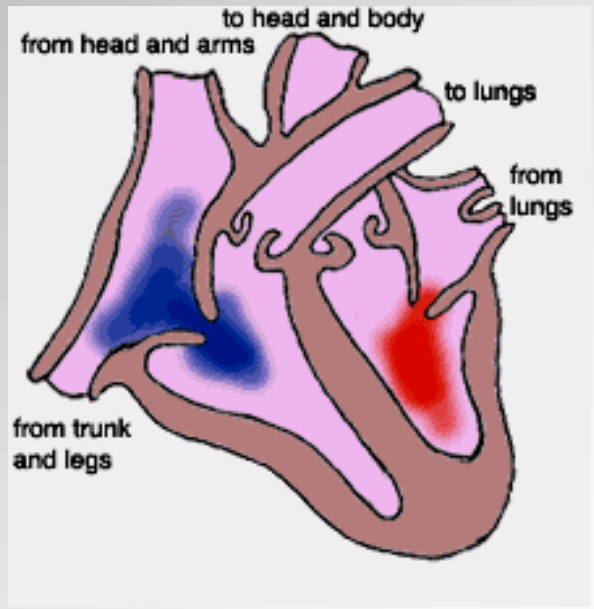
References:

- Robbins & Cotran Pathologic Basis of Disease- 9th edition
- Davidson's Principles and Practice of Medicine-23rd edition
- IMAGES- Above mentioned books & internet

TOPICS

1. EDEMA & EFFUSION
2. THROMBOSIS
3. EMBOLISM
4. INFARCTION
5. SHOCK
6. HYPEREMIA & CONGESTION
7. HEAMORRHAGE
8. DISSEMINATED INTRAVASCULAR COAGULATION (DIC)

HAEMODYNAMIC DISORDERS



- **Haemo**- related to **blood**
- **Dynamics**- concerned with the **motion** of bodies under the action of forces.
- **Haemodynamics** -Is the study of dynamics of blood flow or the circulation

HAEMODYNAMIC DISORDERS

- The health and well being of cells and tissues depends not only on the circulation of blood which delivers oxygen but also on normal fluid balance
- Alteration of any of these results in some disorders known as **haemodynamic disorders**

HAEMODYNAMIC DISORDERS, THROMBOEMBOLIC DISEASE and SHOCK

Disorders of haemodynamics

- Edema & Effusion
- Hyperemia & Congestion
- Shock

Disorders of abnormal bleeding and clotting

- Hemorrhage
- Thrombosis
- Embolism
- Infarction

EDEMA & EFFUSION

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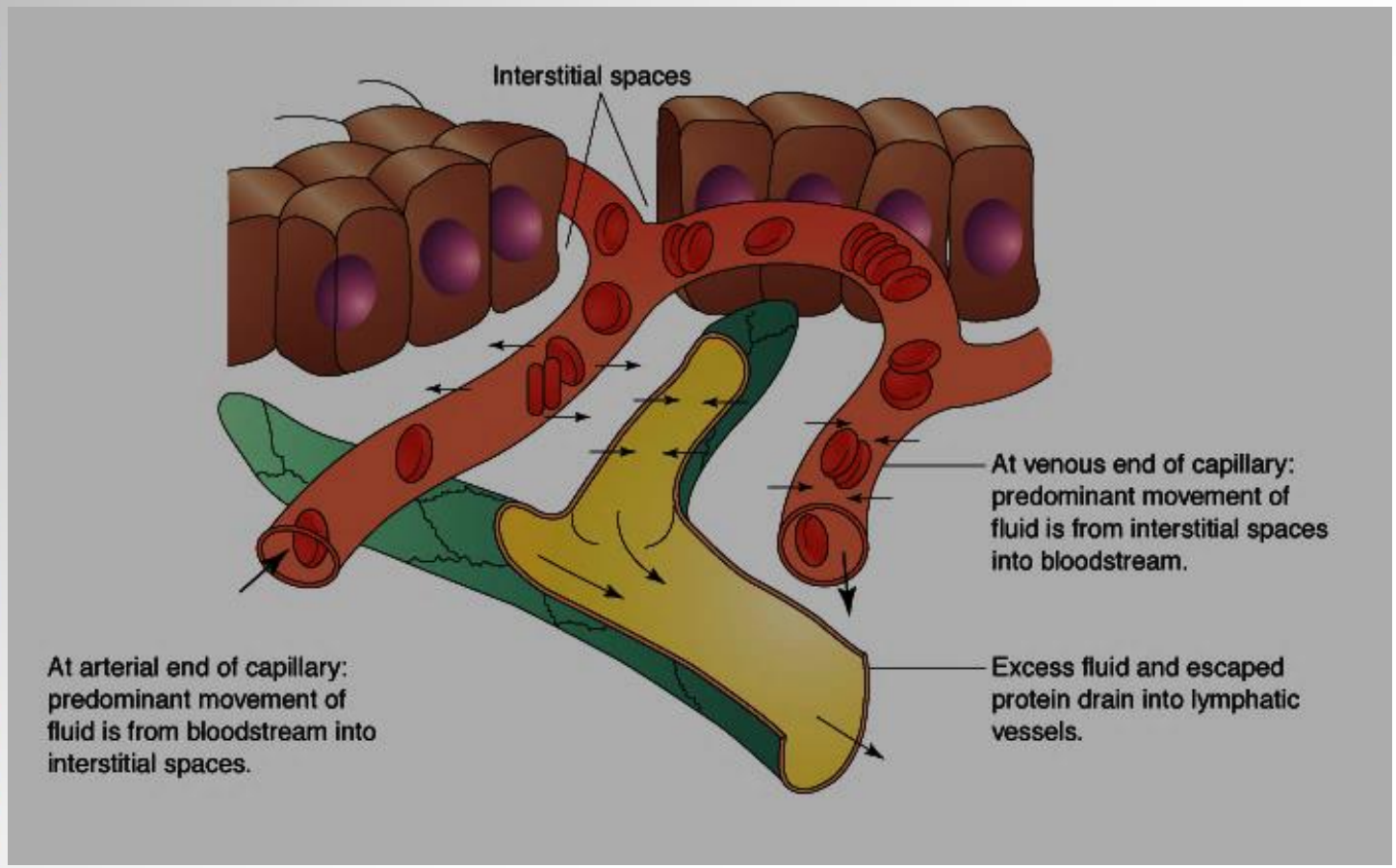
TOPICS

- Definition
- Pathophysiology
- Types and examples
- Morphology
- Clinical significance
- *Renal edema*
- *Cardiac edema*
- *Hepatic edema*
- *Pulmonary edema*
- *Cerebral edema*

EDEMA- DEFINITION

Accumulation of fluid in the interstitial tissue spaces

Interstitial Tissue Space



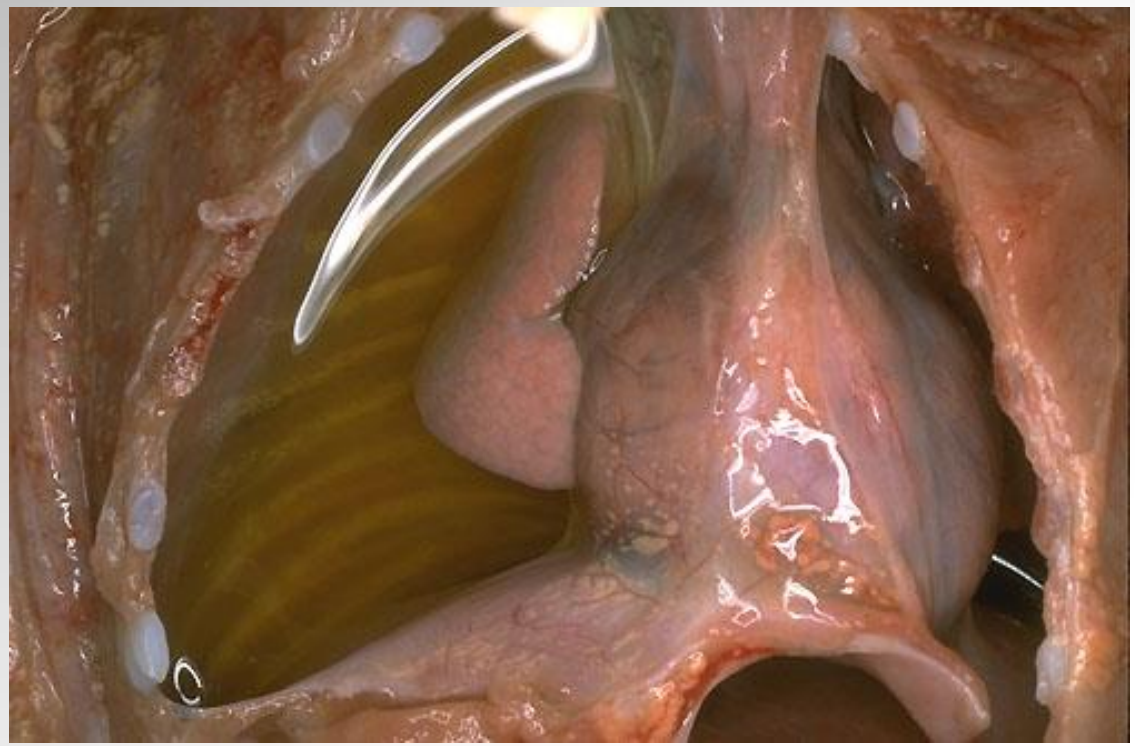
EFFUSION DEFINITION

Accumulation of fluid in the body cavities

EFFUSION

- *Hydrothorax (pleural effusion)*
- *Hydropericardium*
- *Hydroperitoneum (ascites)*

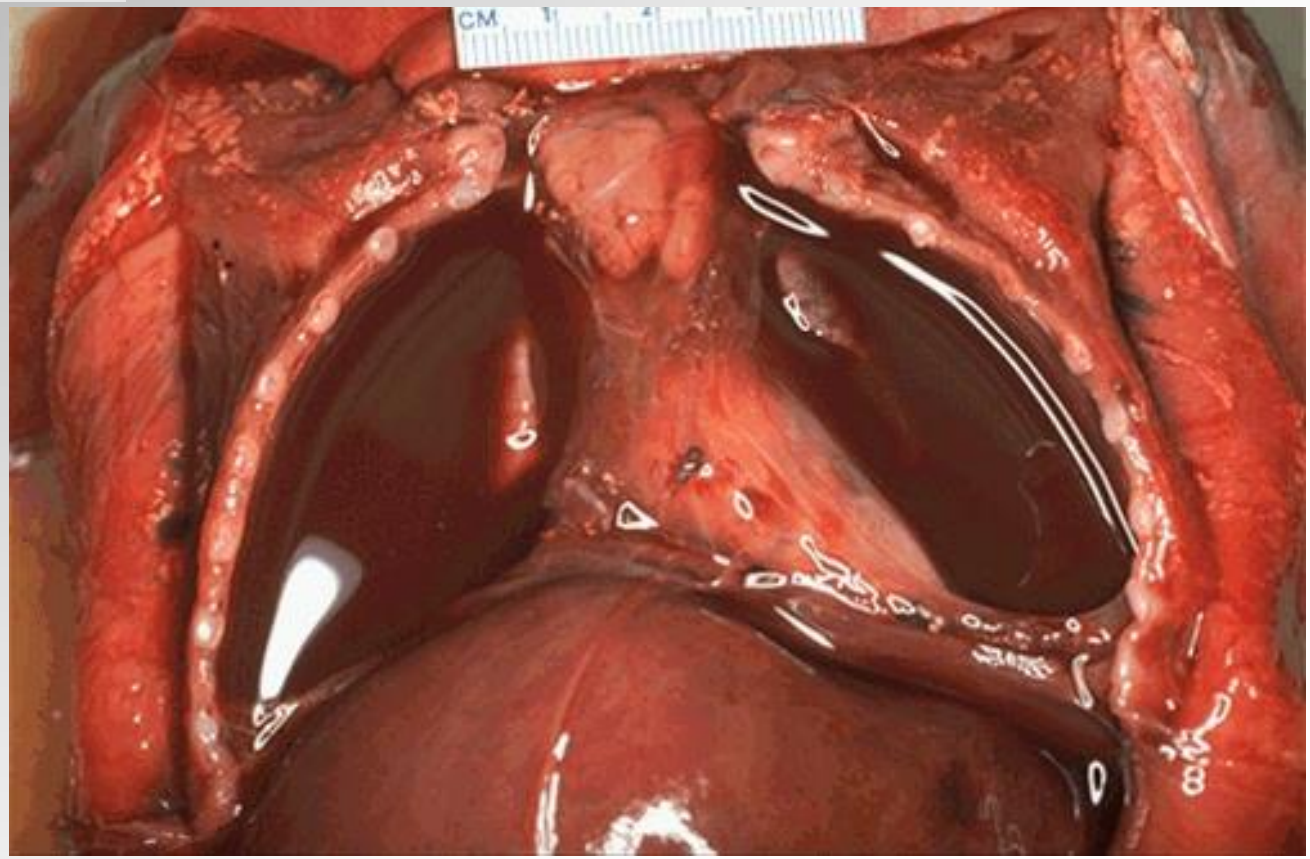
Pleural effusion



This is a right sided pleural effusion (in a baby)

The fluid is clear, pale yellow in appearance (serous effusion)

Pleural effusions



Bilateral pleural effusions.

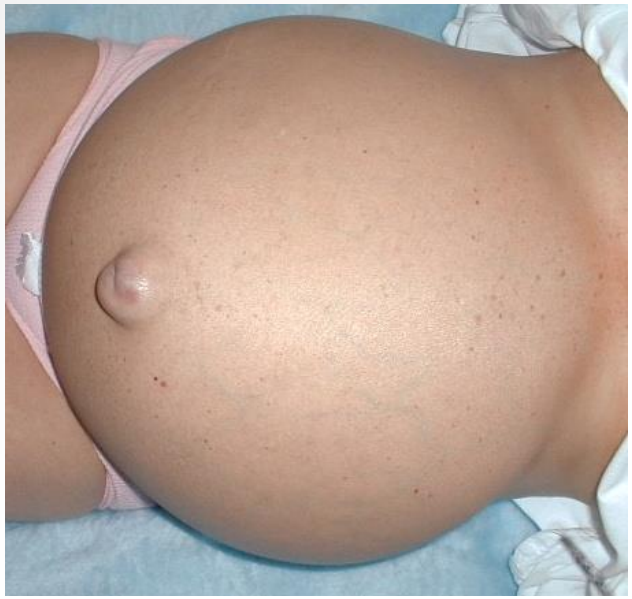
The fluid appears reddish, because there has been hemorrhage into the effusion

ASCITES

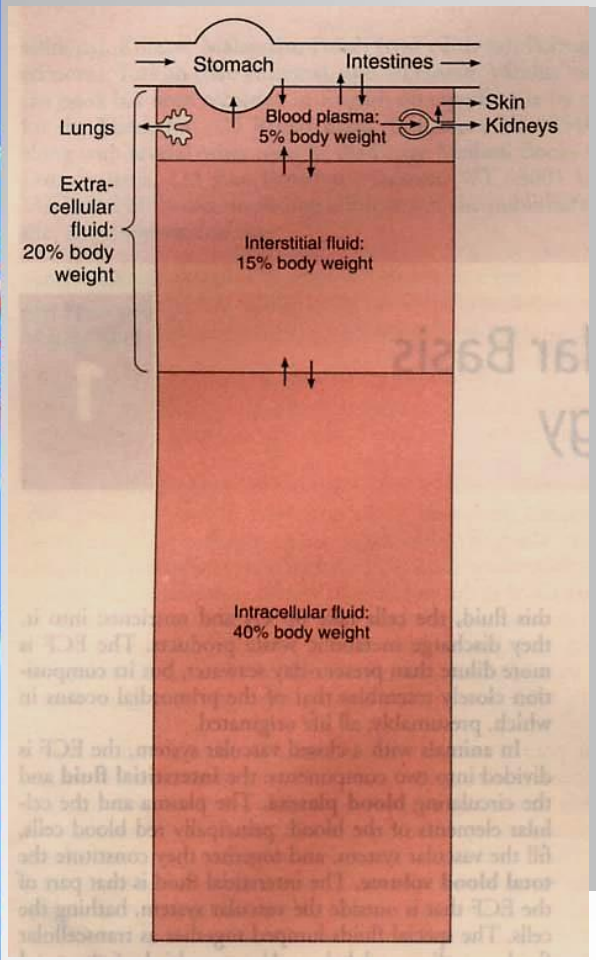
- It is clinically detectable when **at least 500 mL** have accumulated

CAUSES:

- Malignant disease
- Cardiac failure
- **Hepatic cirrhosis**



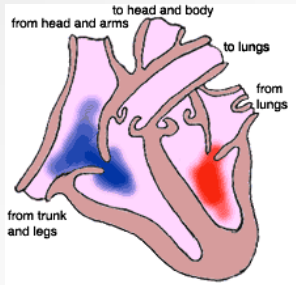
Body fluid compartments



Three major fluid compartments

- **Intravascular**
- **Interstitial and**
- **Intracellular**

- **60% of body weight is water (in a healthy adult)**
- **2/3rd (40%) is *INTRACELLULAR***
- **15% is *INTERSTITIAL***
- **Only 5% is *INTRA-VASCULAR* (plasma)**

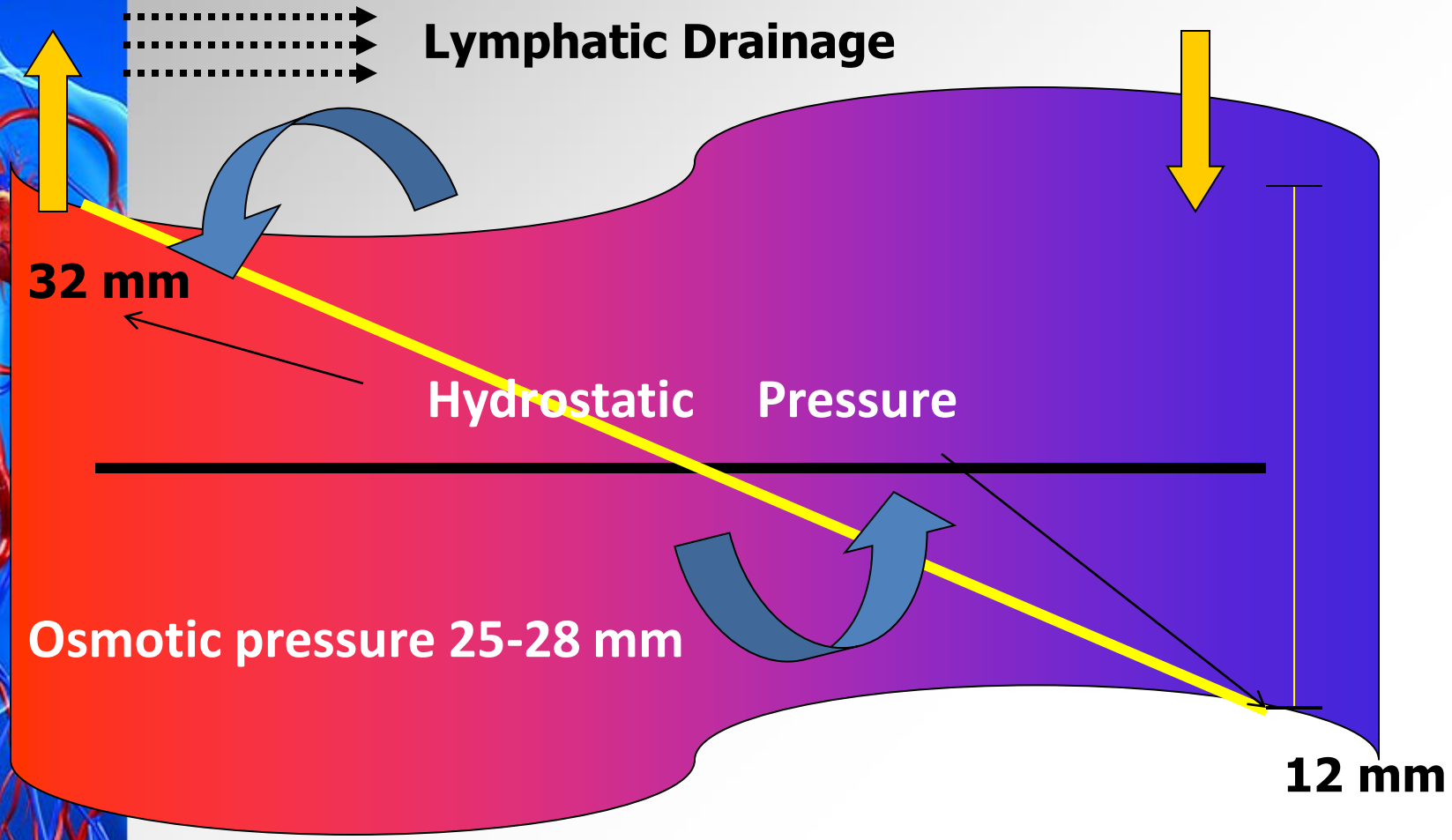


MECHANISM OF NORMAL CONTROL IN SYSTEMIC CIRCULATION

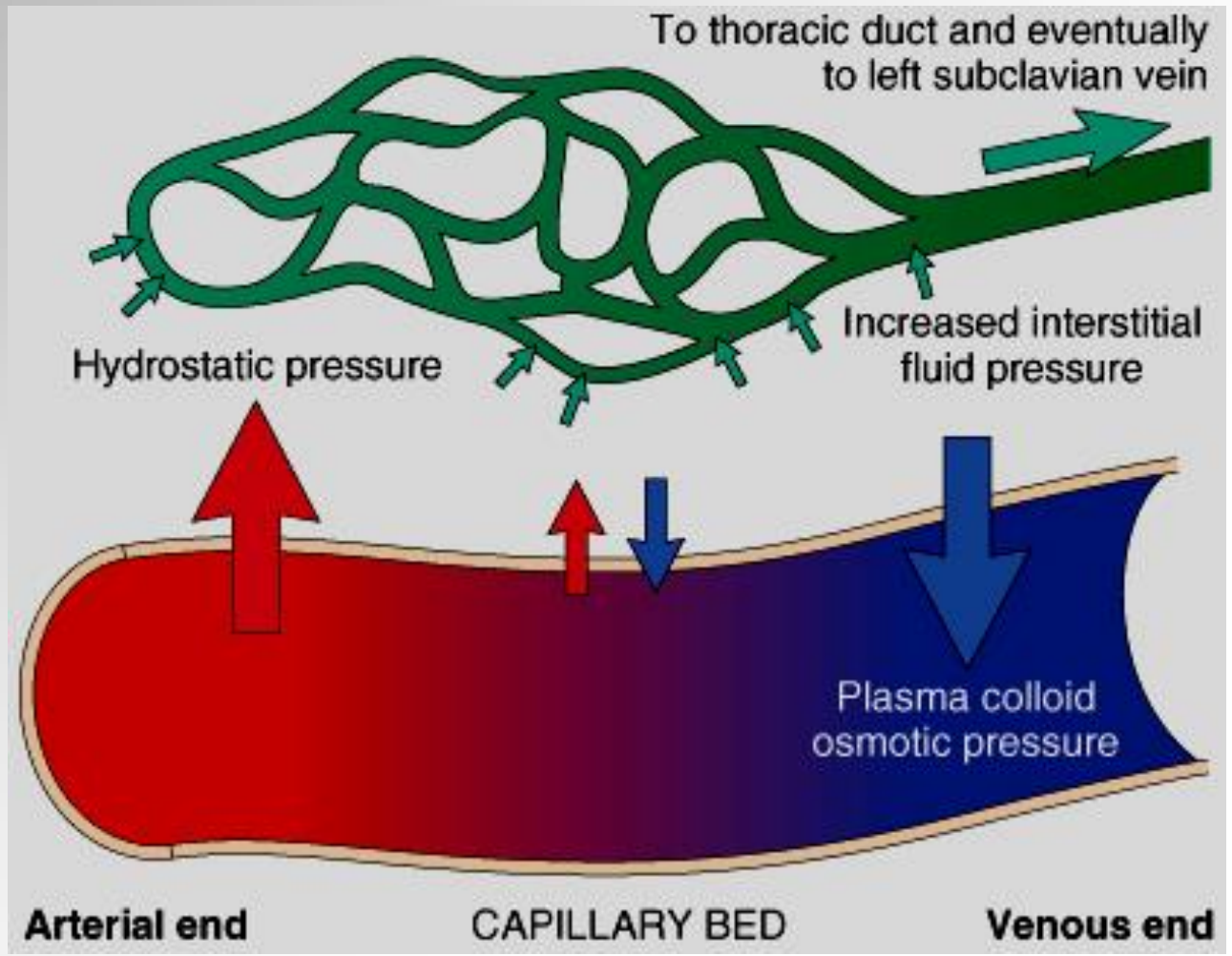
Starling's Hypothesis

- states that the fluid movement across the **capillary** wall is dependent on the balance between
- the **hydrostatic pressure gradient** and
- the **oncotic pressure gradient** across the **capillary**

Fluid balance across capillary wall

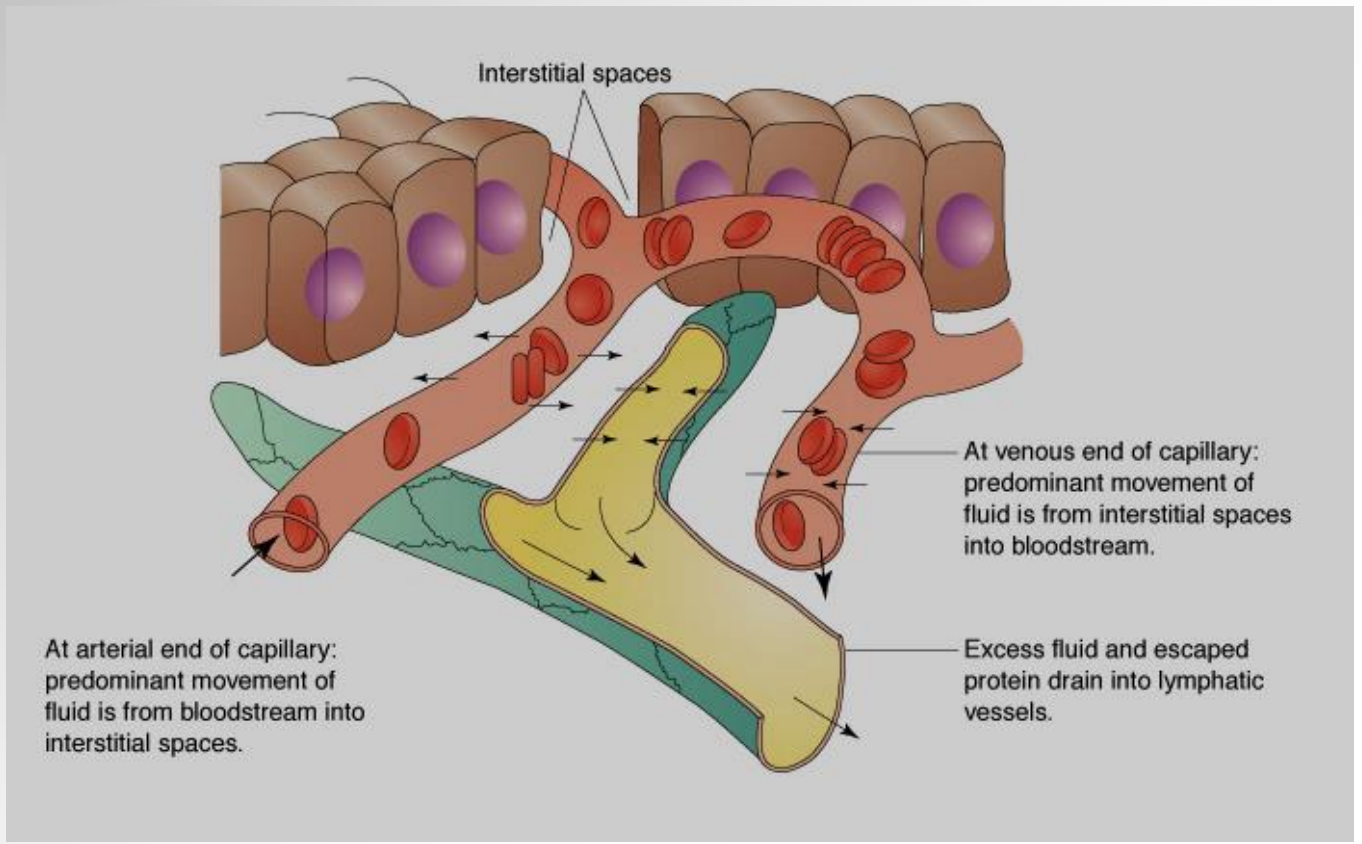


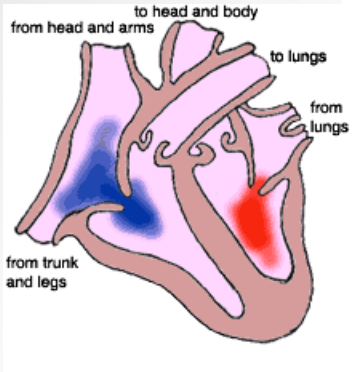
Factors affecting fluid balance across capillary wall



Factors affecting fluid balance across capillary wall

INTERSTITIAL SPACES

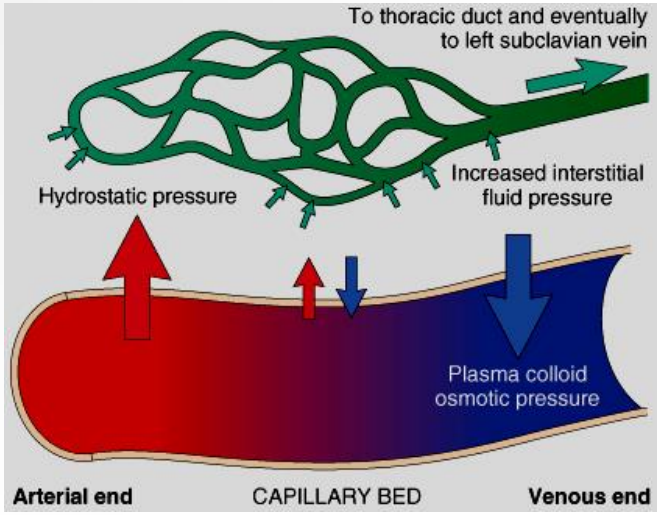




PATHOPHYSIOLOGIC CATEGORIES OF EDEMA

PATHOPHYSIOLOGIC CATEGORIES OF EDEMA

I. Increased Hydrostatic Pressure
II. Reduced Plasma Osmotic Pressure (Hypoproteinemia)
III. Lymphatic Obstruction
IV. Sodium Retention
V. Inflammation



PATHOPHYSIOLOGIC CATEGORIES OF EDEMA

I. Increased Hydrostatic Pressure

A. *Impaired venous return*

- i. Congestive heart failure
- ii. Constrictive pericarditis
- iii. Ascites (liver cirrhosis)
- iv. Venous obstruction or compression
  - a. Thrombosis
  - b. External pressure (e.g., mass)
  - c. Lower extremity inactivity with prolonged dependency

B. *Arteriolar dilation*

- i. Heat
- ii. Neurohumoral dysregulation

PATHOPHYSIOLOGIC CATEGORIES OF EDEMA

II. Reduced Plasma Osmotic Pressure (Hypoproteinemia)

A. Protein-losing glomerulopathies (nephrotic syndrome)

B. Liver cirrhosis (ascites)

C. Malnutrition

D. Protein -losing gastroenteropathy

PATHOPHYSIOLOGIC CATEGORIES OF EDEMA

III. Lymphatic Obstruction

A. Inflammatory

B. Neoplastic

C. Postsurgical

D. Post irradiation

PATHOPHYSIOLOGIC CATEGORIES OF EDEMA

IV. Sodium Retention

A. Excessive salt intake with renal insufficiency

B. Increased tubular reabsorption of sodium

   i. Renal Hypoperfusion

   ii. Increased secretion of renin- angiotensin- aldosterone

PATHOPHYSIOLOGIC CATEGORIES OF EDEMA

V. Inflammation

A. Acute inflammation

B. Chronic inflammation

C. Angiogenesis

TYPES OF EDEMA

I. Pathophysiology
II. Extent of involvement
III. Clinical basis

TYPES OF EDEMA

I. On the basis of pathophysiology

- **INFLAMMATORY - Due to increased vascular permeability *(exudate)***

- **NON-INFLAMMATORY - Due to alterations in haemodynamic forces across the capillary wall *(transudate)***

TYPES OF EDEMA

II. On the basis of extent of involvement

- LOCAL – pulmonary, cerebral, effusions
- GENERALISED- anasarca

TYPES OF EDEMA

III. On clinical basis

- **PITTING**
- **NON PITTING**

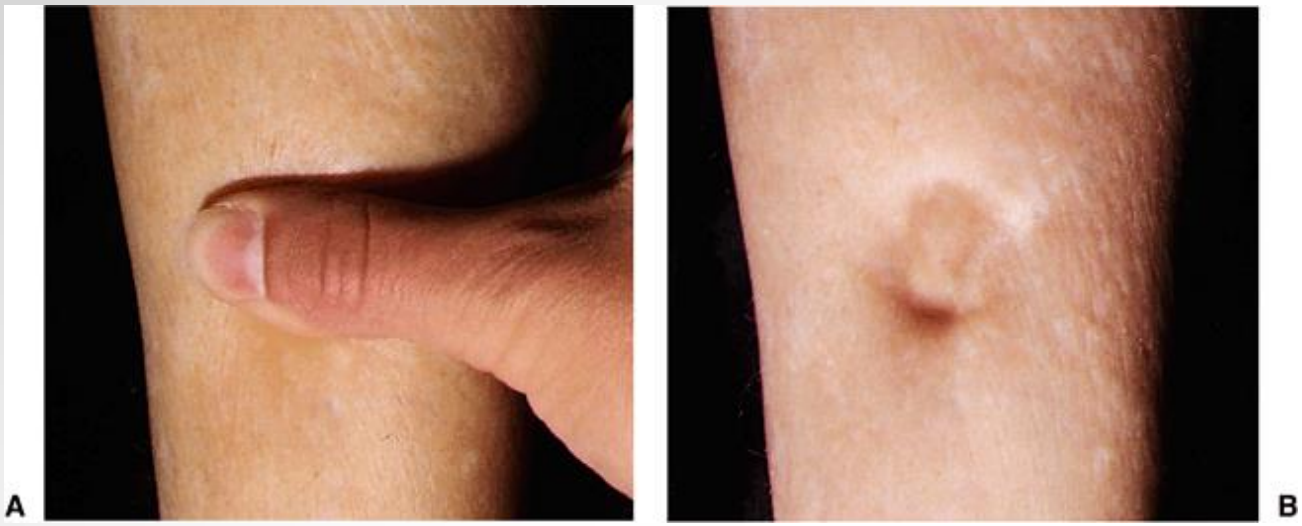
Comparison of an exudate with a transudate

	EXUDATE	TRANSUDATE
Total protein content	High, as in plasma>3g/dl	Low, <3 g/dl
Distribution of protein	As in plasma	Nearly all albumin
Fibrinogen	Present, as it clots spontaneously	Not present. No tendency to coagulate
Specific gravity	High (over 1.018)	Low (about 1.012)
Inflammatory cells	Plentiful; (poly,lympho)	Few present; nearly all mesothelial cell

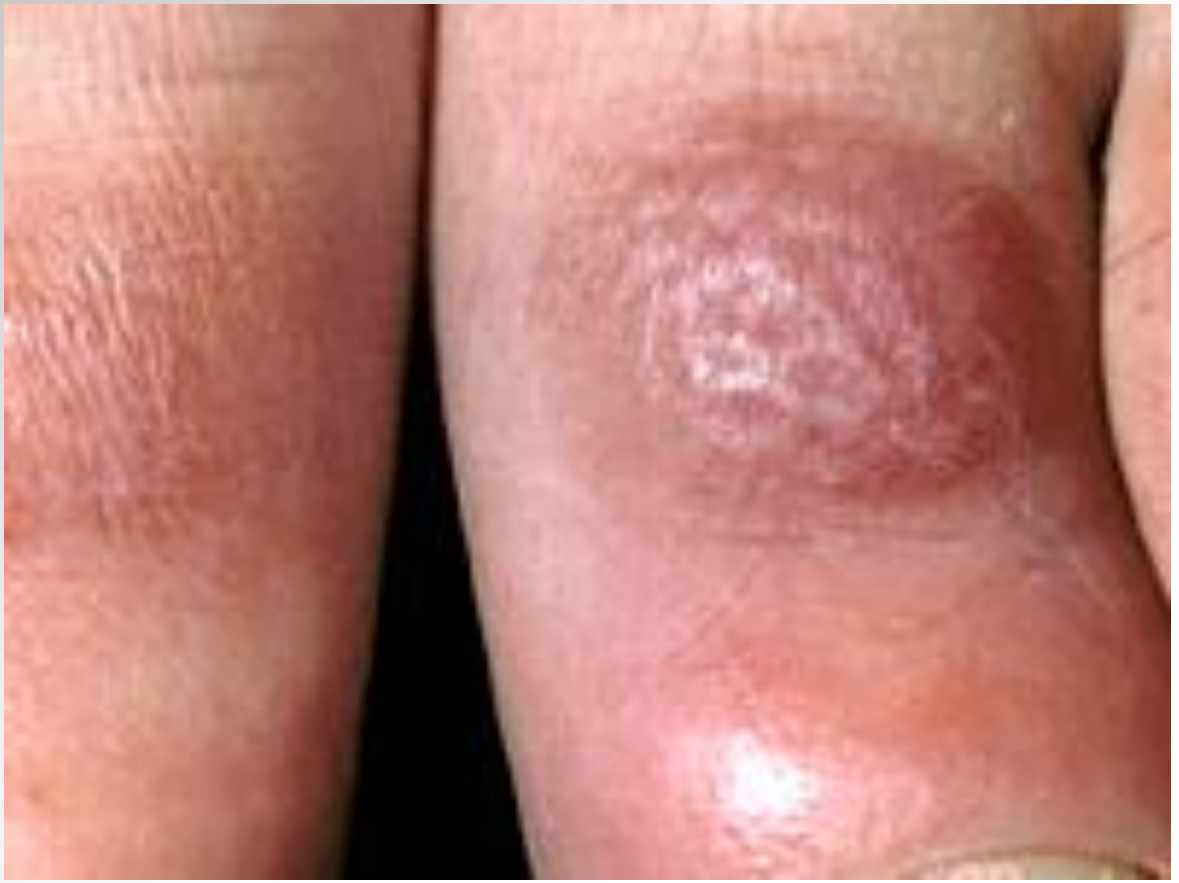
Pitting edema of the leg

A. In a patient with congestive heart failure, severe edema of the leg is demonstrated by applying pressure with a finger.

B. The resulting “pitting” reflects the inelasticity of the fluid-filled tissue.



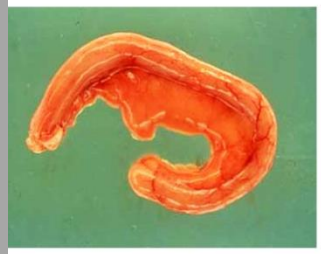
Non pitting edema (Pretibial myxedema)



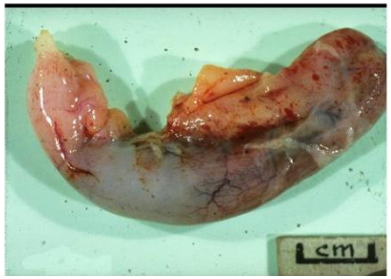
MORPHOLOGY OF EDEMA

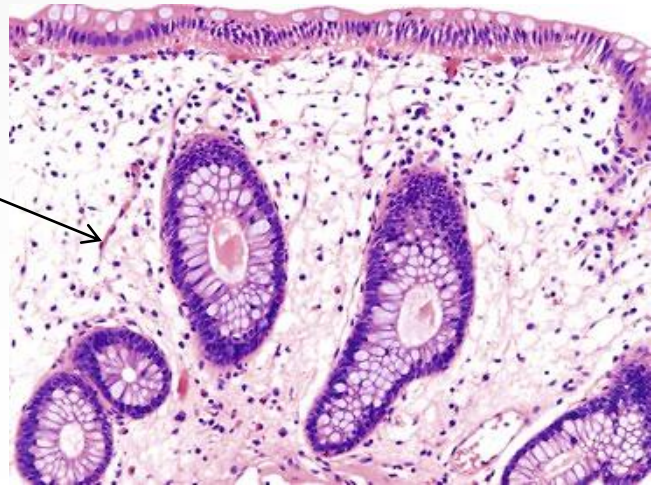
- Edema is most easily recognized grossly
- Microscopically, **clearing and separation of the extracellular matrix elements.**

• Normal appendix



• Appendicitis





MORPHOLOGY OF EDEMA

- Although any organ or tissue in the body may be involved,
- Most commonly encountered in
  - **subcutaneous tissues**
  - **the lungs and**
  - **the brain**

MORPHOLOGY OF EDEMA

Subcutaneous

Variable distribution

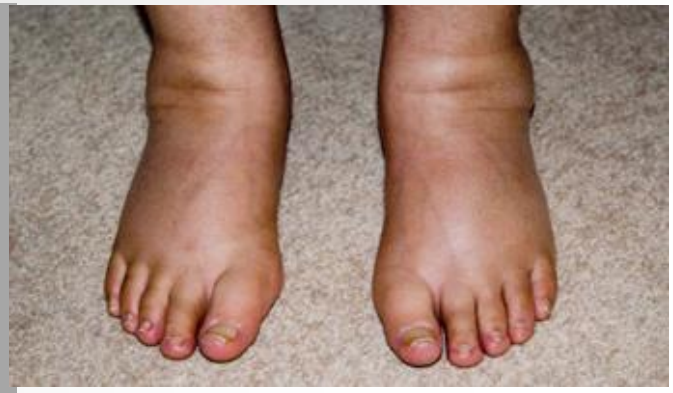
- ***Diffuse***
- ***Dependent*** **:**

Cardiac failure

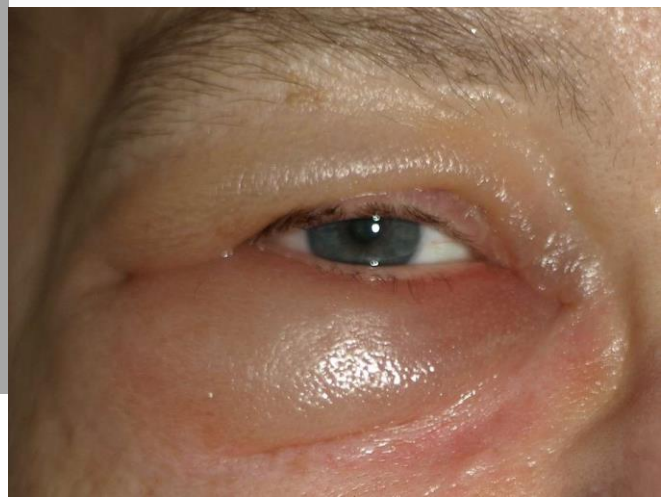
(legs and sacral area)

- ***Periorbital*** **:**

Nephrotic syndrome



Dependent edema



Periorbital edema

MORPHOLOGY OF EDEMA

- **Severe, generalized edema is called anasarca**

CLINICAL FEATURES

Merely annoying to fatal

CLINICAL FEATURES

Subcutaneous edema

- In cardiac & renal failure subcutaneous edema signals underlying disease
- May **impair wound healing** & **clearance of infection**

CLINICAL FEATURES

Pulmonary edema

- Interferes with normal ventilatory function
- Favours bacterial infection

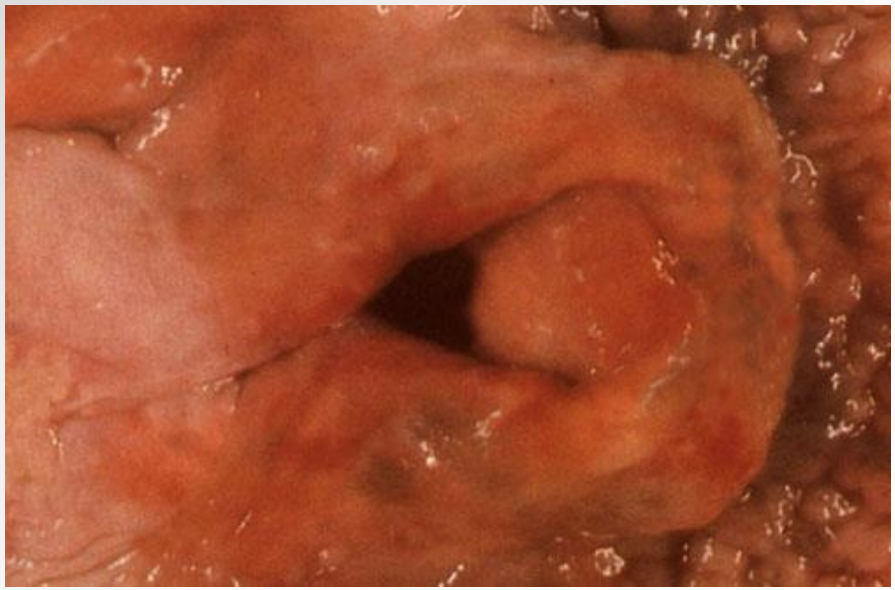
CLINICAL FEATURES

Brain edema

- Can be rapidly *fatal*
- Brain substance can herniate through foramen magnum
- Brain stem vascular supply can be compressed
- Both the conditions can injure medullary centre & cause death

Laryngeal edema

Fatal



LOCAL EDEMA

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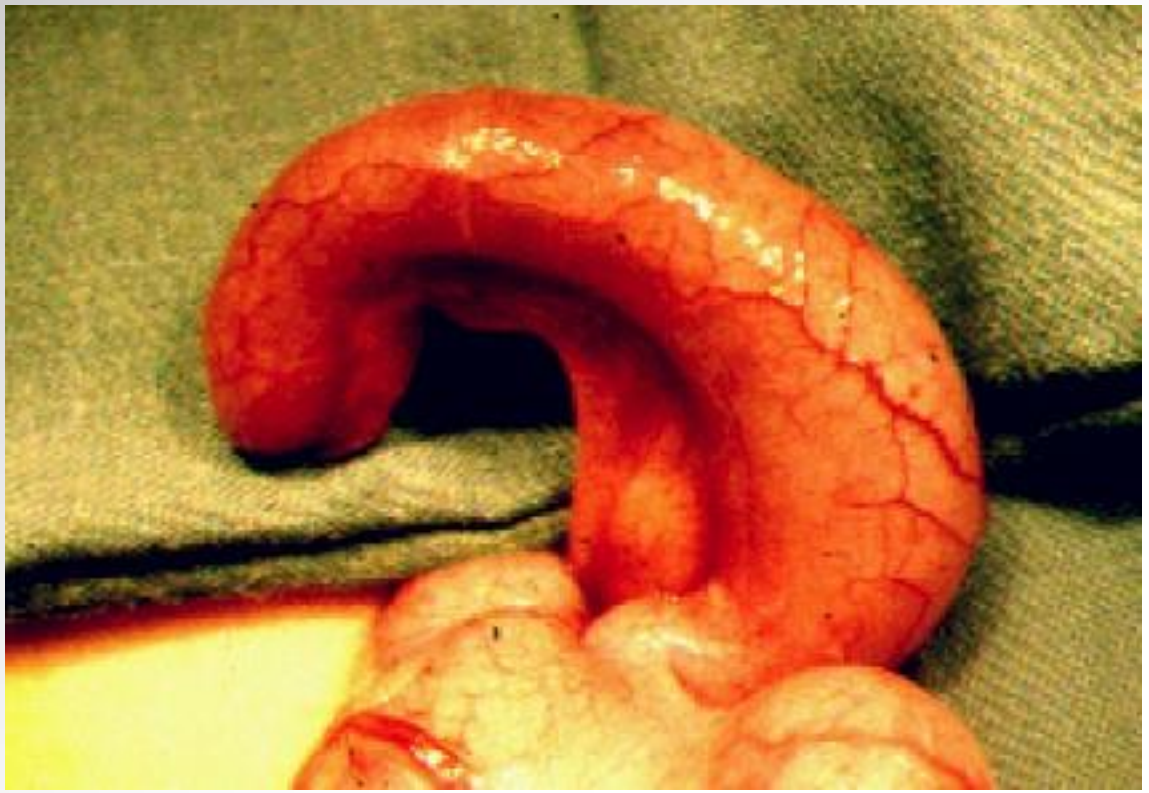
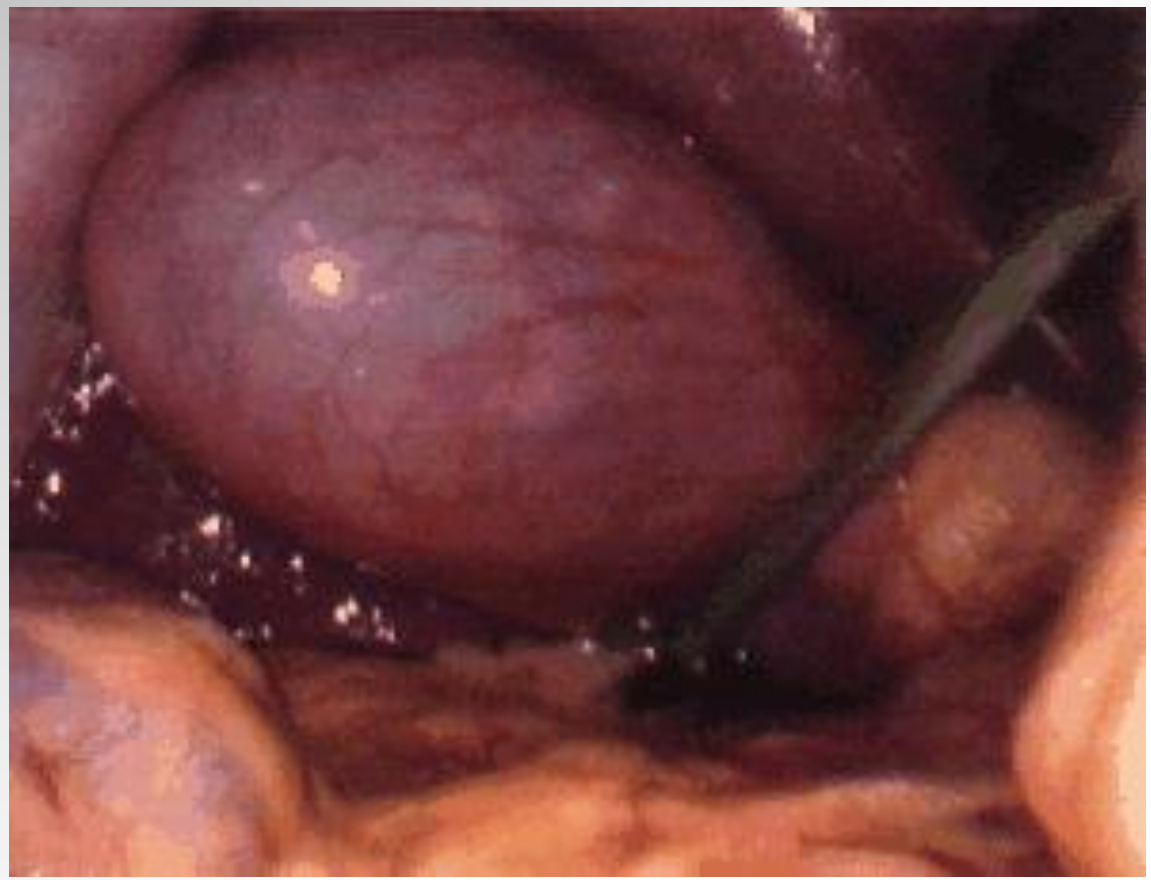
Local edema- causes

- Acute Inflammation
- Hypersensitivity reaction
- Venous obstruction
- Lymphatic obstruction

Acute inflammation acute appendicitis (local edema)



Acute inflammation acute cholecystitis (local edema)



Local edema (Cont)

Hypersensitivity edema

↑ Vascular permeability seen in

- type I
- type III &
- type IV hypersensitivity reaction

Local edema

Edema due to venous obstruction

Examples

- **Venous thrombosis**
- **A tumour / growth compressing a vein**

Increased hydrostatic pressure proximal to the obstruction

Local edema (Cont)

Edema due to lymphatic obstruction

Examples :-

(a) Filariasis

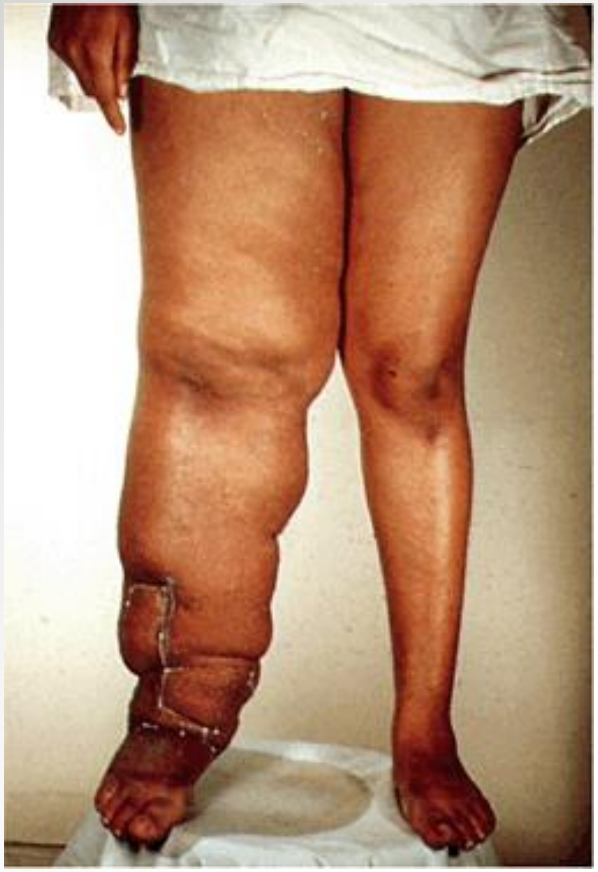
(b) Recurrent bacterial lymphangitis

(c) Lymphatic edema of arm & peau d' orange appearance of the breast in breast carcinoma

Filariasis

- **W. bancrofti** parasites are mainly transmitted by Culex quinquefasciatus mosquitoes and some species of Anopheles
- **Brugia** parasites are mainly transmitted by Mansonia mosquitoes

Edema secondary to lymphatic obstruction. Massive edema of the right lower extremity **(elephantiasis)** in a patient with obstruction of lymphatic drainage.



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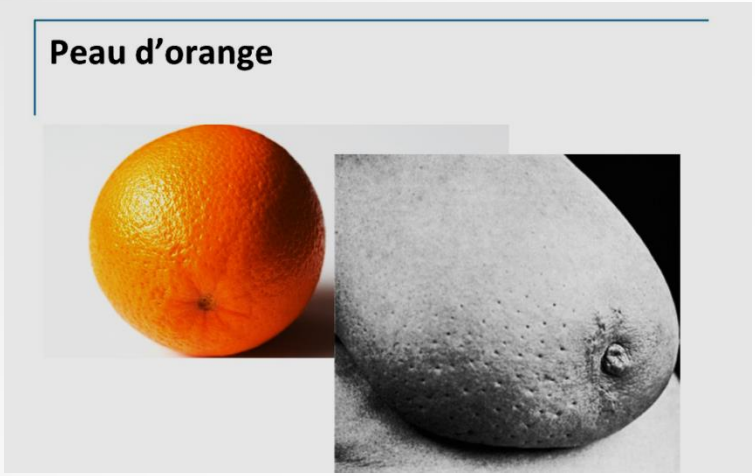
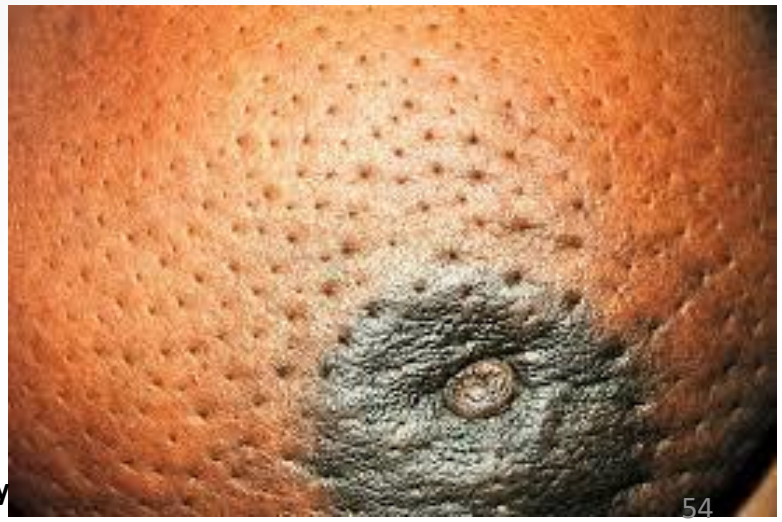
Peau d' orange appearance in breast carcinoma

- Peau d Orange is a French term, which means "skin of an orange."





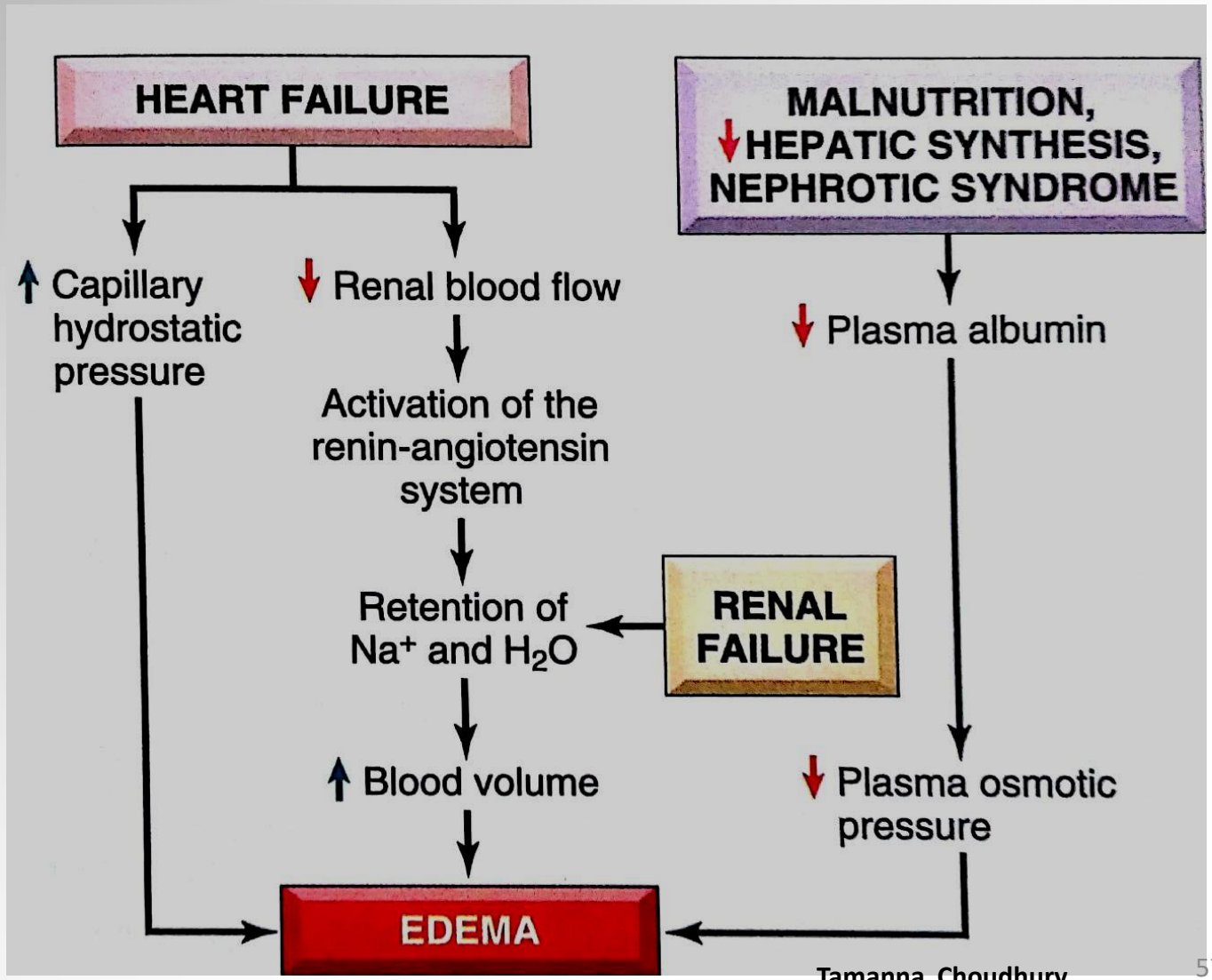
GENERALIZED EDEMA

Generalized edema

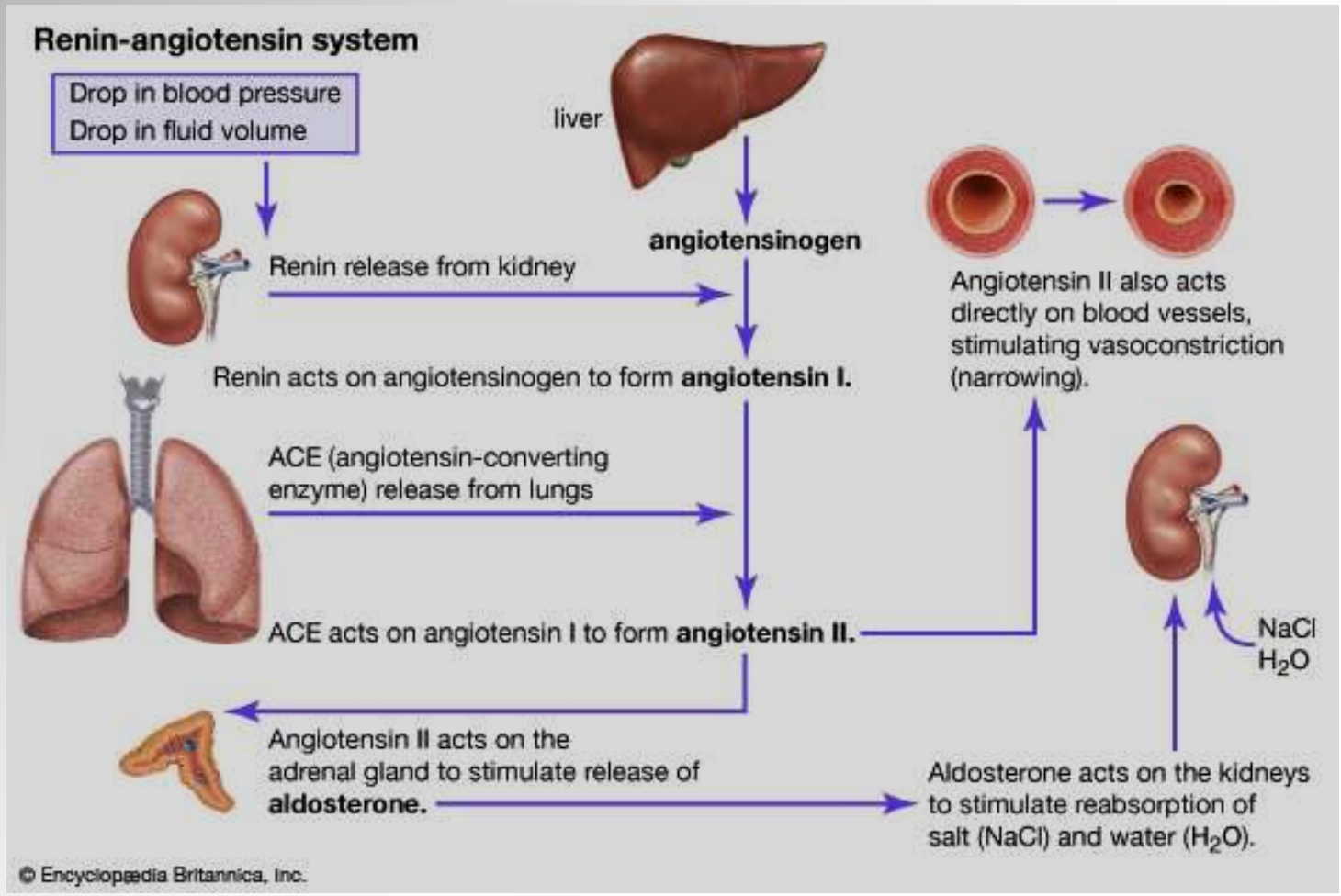
CAUSES:

- **Heart failure**
- **Renal failure**
- **Nephrotic syndrome**
- **Cirrhosis of liver**
- **Malnutrition**

Mechanism of systemic edema in heart failure, renal failure, malnutrition, hepatic failure and nephrotic syndrome



Renin Angiotensin Aldosterone axis



Nephrotic Syndrome

- Massive **proteinuria** (daily loss of 3.5gm or more of protein)
- **Hypoalbuminaemia**- plasma albumin level less than 3gm/L
- **Generalized edema**
- **Hyperlipidemia and lipiduria**

Edema in Nephrotic Syndrome

- Nephrotic syndrome is caused by a derangement in glomerular capillary walls resulting in **increased permeability to plasma proteins**

NEPHROTIC SYNDROME- pathogenesis

Leaky glomerular capillary wall

↓

Heavy proteinuria

↓

Hypoproteinaemia

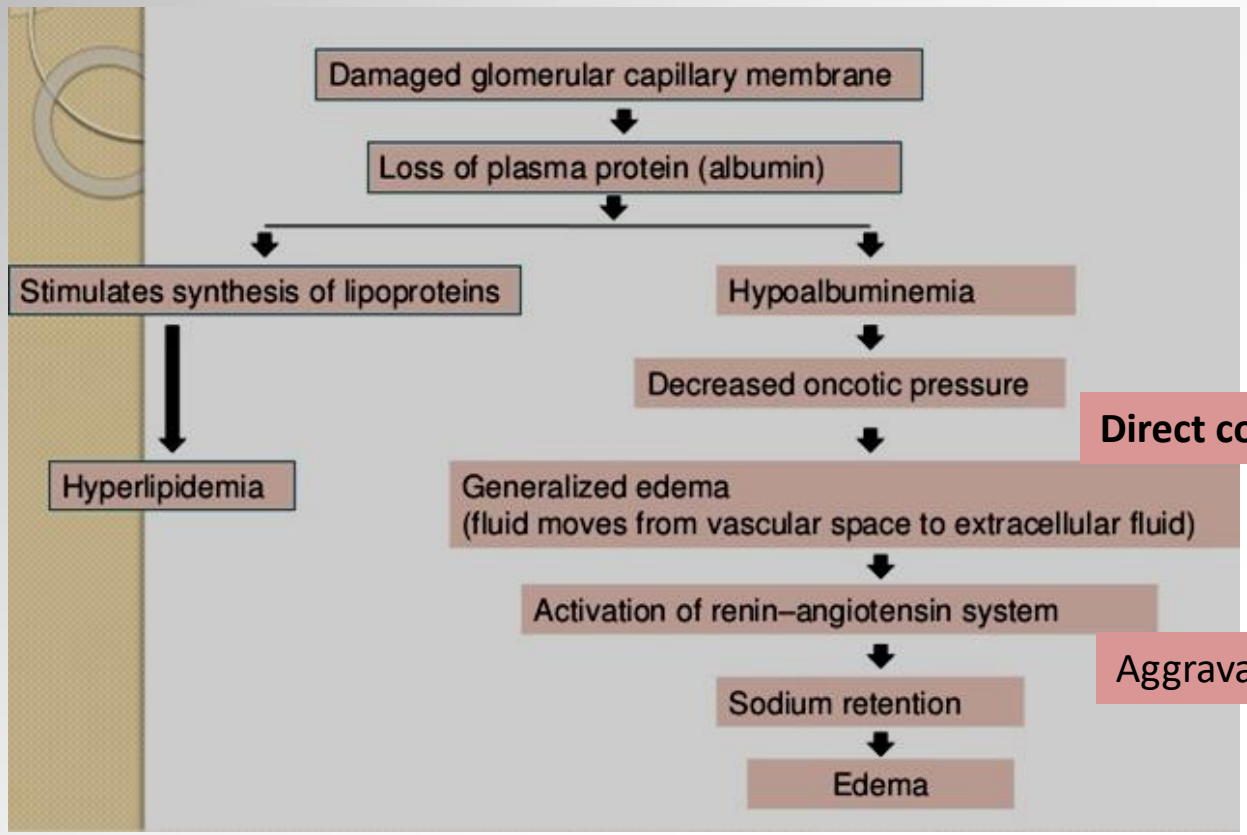
↓

Decreased colloidal osmotic pressure

↓

EDEMA

Edema in Nephrotic Syndrome



Direct consequence

Aggravates edema

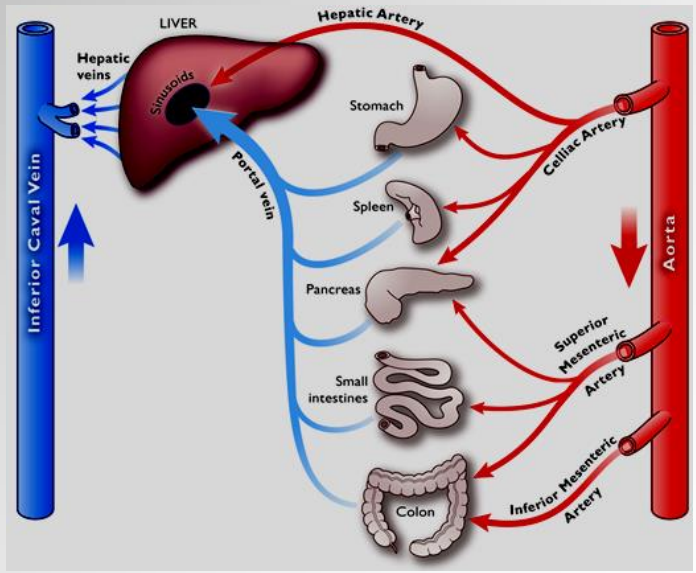
EDEMA IN CIRRHOSIS OF LIVER

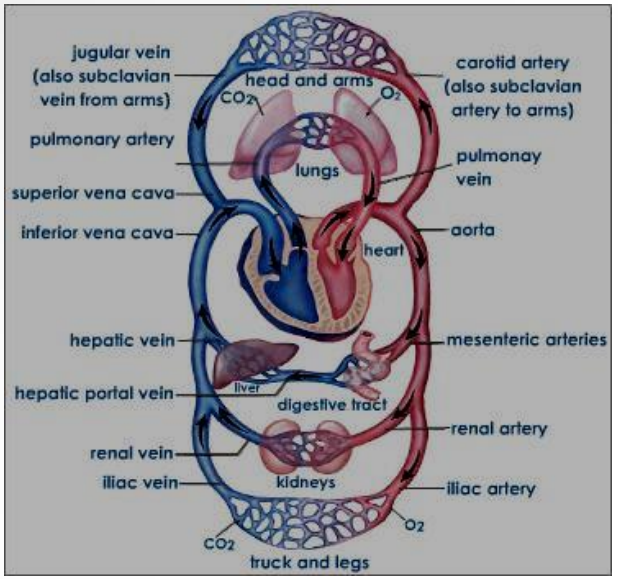
EDEMA (ascites) IN LIVER CIRRHOSIS

- **Increased hydrostatic pressure**: elevated pressure in the veins running through the liver (**sinusoidal hypertension)**
- **Percolation of hepatic lymph into the peritoneal cavity**
- **Splanchnic vasodilation and hyperdynamic circulation**
- **Hypoalbuminemia:** a decrease in liver function **caused** by scarring of the liver, i.e., **cirrhosis**.
- **Failure in hepatic inactivation of aldosterone**

Splanchnic circulation

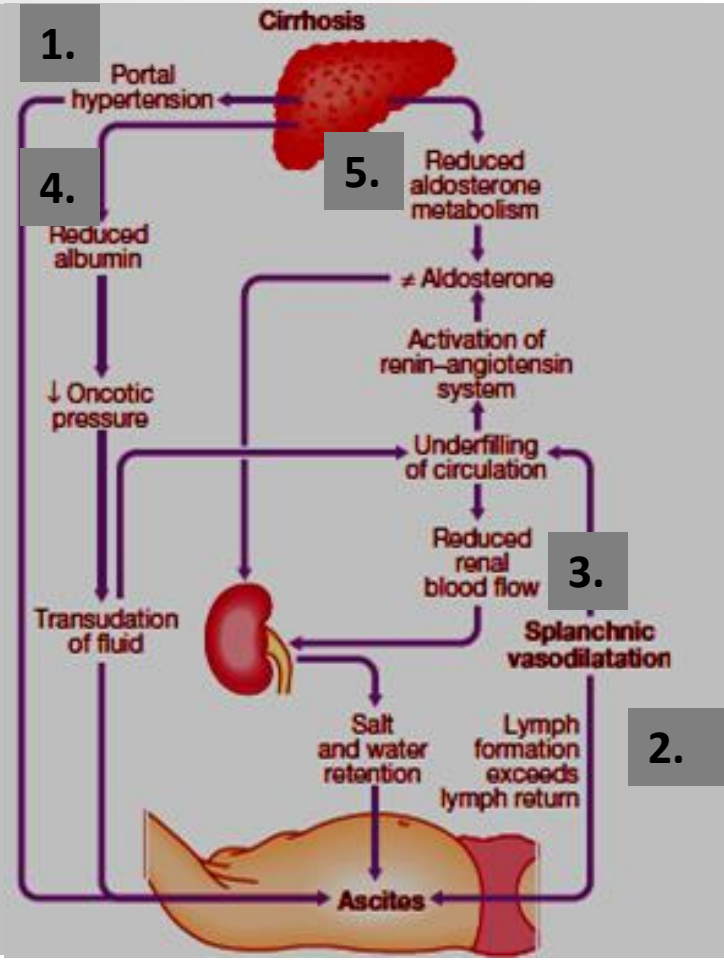
Systemic, portal, hepatic circulation



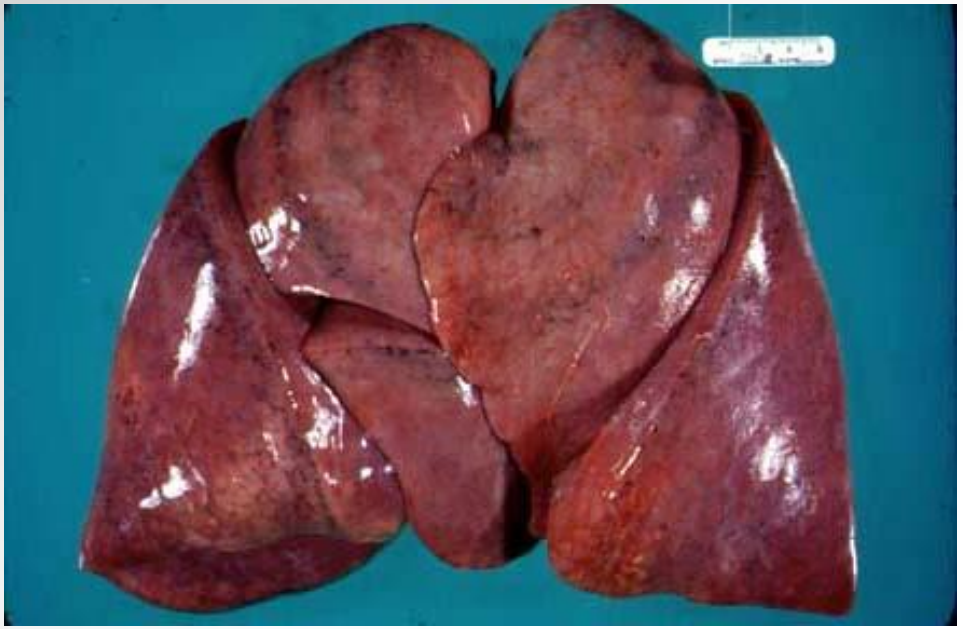


EDEMA IN CIRRHOSIS OF LIVER

1. Increased hydrostatic pressure
2. Percolation of hepatic lymph into the peritoneal cavity
3. Splanchnic vasodilation and hyperdynamic circulation
4. Hypoalbuminemia
5. Failure in hepatic inactivation of aldosterone



PULMONARY EDEMA



CLASSIFICATION OF PULMONARY OEDEMA

- A. HEMODYNAMIC EDEMA
- B. EDEMA DUE TO MICROVASCULAR INJURY
- C. EDEMA OF UNDETERMINED ORIGIN

CAUSES OF PULMONARY OEDEMA (Cont)

EDEMA DUE TO HAEMODYNAMIC CAUSE

Increased Hydrostatic pressure

- **Left heart failure**
- **Volume overload**

Decreased oncotic pressure

- **Nephrotic syndrome**
- **Liver disease**

Lymphatic obstruction

CAUSES OF PULMONARY OEDEMA(Cont)

EDEMA DUE TO MICROVASCULAR INJURY

- **Infectious agents :** viruses, mycoplasma, other
- **Inhaled gases :** oxygen, sulfur dioxide, cyanates, smoke
- **Liquid aspiration :** gastric contents, near-drowning
- **Drugs and chemicals:**

CAUSES OF PULMONARY OEDEMA(Cont)

EDEMA OF UNDETERMINED ORIGIN

- High altitude
- Neurogenic

Pulmonary edema

Grossly: Weight ⇧

Frothy, blood tinged fluid – on section

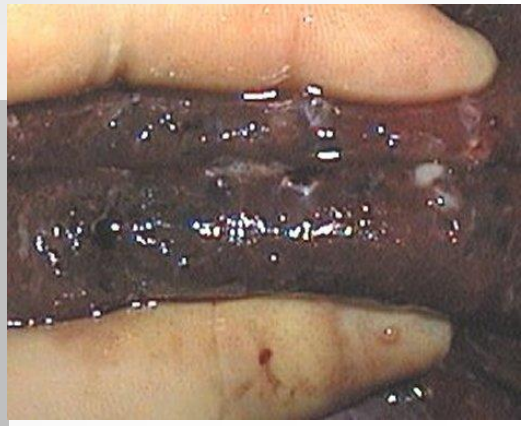
M/E : Alveolar capillaries engorged

Intra-alveolar precipitate

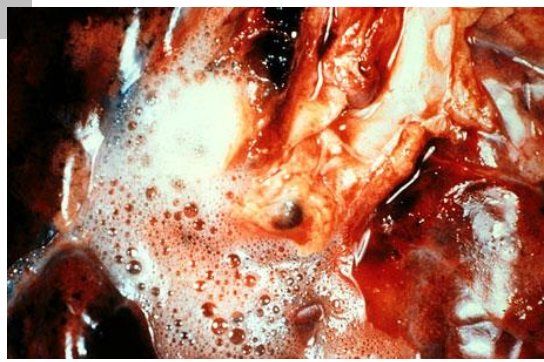
Alveolar microhaemorrhage

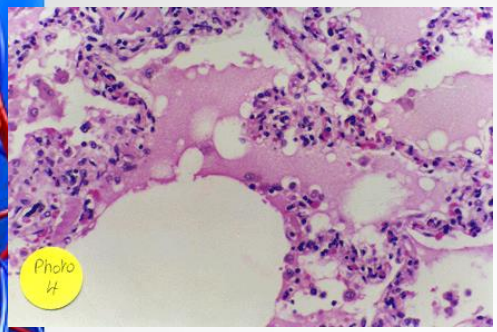
Hemosiderin laden macrophages

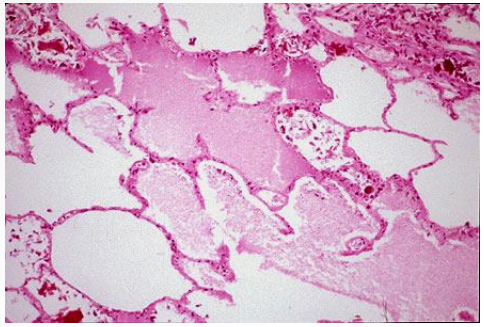
(heart failure cell)



Fluid is expressed from the cut surfaces of both







CEREBRAL EDEMA

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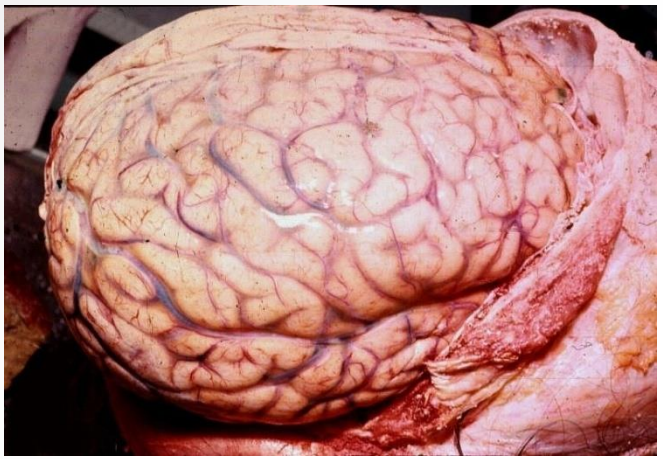
Cerebral edema- causes

- Primary or metastatic tumour
- Infarction
- Contusion
- Abscess
- Encephalitis

MORPHOLOGY OF CEREBRAL EDEMA

Cerebral edema:

- Swollen
- Softer
- Gyri – Flattened
- Sulci – Narrowed
- Ventricular cavities – compressed



What we have learnt in this class

- Definition- edema, effusion
- Pathophysiological categories of edema
- Types of edema
- Mechanism of edema- heart failure, renal failure, nephrotic syndrome, hepatic cause (Edema in cirrhosis)
- Morphology of edema
- Local edema- causes & examples
- Pulmonary edema
- Cerebral edema

Practice questions

1. **Define** edema.
2. What are the **types** of edema ? What is **anasarca**?
3. What are the **pathophysiological categories** of edema?
4. What are the causes of **generalized edema**?
5. What are the causes of **localized edema**? Give few examples of localized edema.
6. What are the differences between **exudates & transudates**?
7. What is the **clinical significance** of edema?
8. Discuss the mechanism of edema in **heart failure**.
9. Discuss the mechanism of edema in **nephrotic syndrome**.
10. What is the mechanism of edema in **liver cirrhosis?**
11. What are the causes of **pulmonary edema**? What is heart failure cell?
12. Mention few causes of **cerebral** edema.

MCQ

Edema occurs due to

a) Decreased hydrostatic pressure
b) Lymphatic obstruction
c) Increased plasma colloidal osmotic pressure
d) Sodium retention
e) inflammation

MCQ

Edema occurs due to

a) Decreased hydrostatic pressure F

b) Lymphatic obstruction T

c) Increased plasma colloidal osmotic pressure F

d) Sodium retention T

e) Inflammation T

MCQ

Exudate is associated with

a) Low protein content
b) Inflammation
c) Low specific gravity
d) Increased tendency to clot
e) High cellular content

MCQ

Exudate is associated with

a) Low protein content F

b) Inflammation T

c) Low specific gravity F

d) Increased tendency to clot T

e) High cellular content T

MCQ

Local edema occurs in

a) Inflammation
b) Neoplasia
c) Lymphatic obstruction
d) Hypersensitivity reaction
e) Malnutrition

MCQ

Local edema occurs in

a) Inflammation T

b) Neoplasia F

c) Lymphatic obstruction T

d) Hypersensitivity reaction T

e) Malnutrition F

MCQ

Edema due to sodium retention occurs in

a) Congestive cardiac failure
b) Nephrotic syndrome
c) Cirrhosis of liver
d) Filariasis
e) Increased tubular reabsorption of sodium

MCQ

Edema due to sodium retention occurs in

a) Congestive cardiac failure F

b) Nephrotic syndrome F

c) Cirrhosis of liver F

d) Filariasis F

e) Increased tubular reabsorption of sodium T

MCQ

Hypoproteinemia causes edema in

a) Congestive cardiac failure
b) Liver cirrhosis
c) Nephrotic syndrome
d) Protein losing enteropathy
e) Filariasis

MCQ

Hypoproteinemia causes edema in

a) Congestive cardiac failure F

b) Liver cirrhosis T

c) Nephrotic syndrome T

d) Protein losing enteropathy T

e) Filariasis F

Thank You