

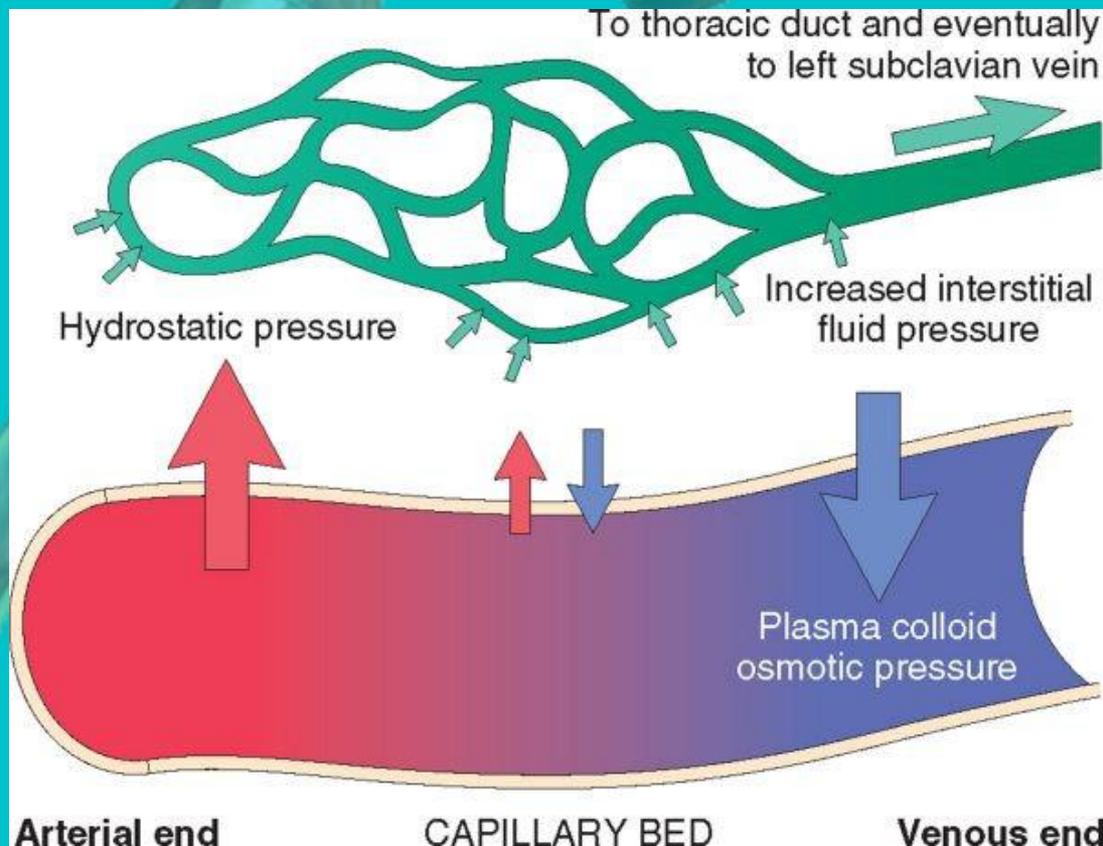


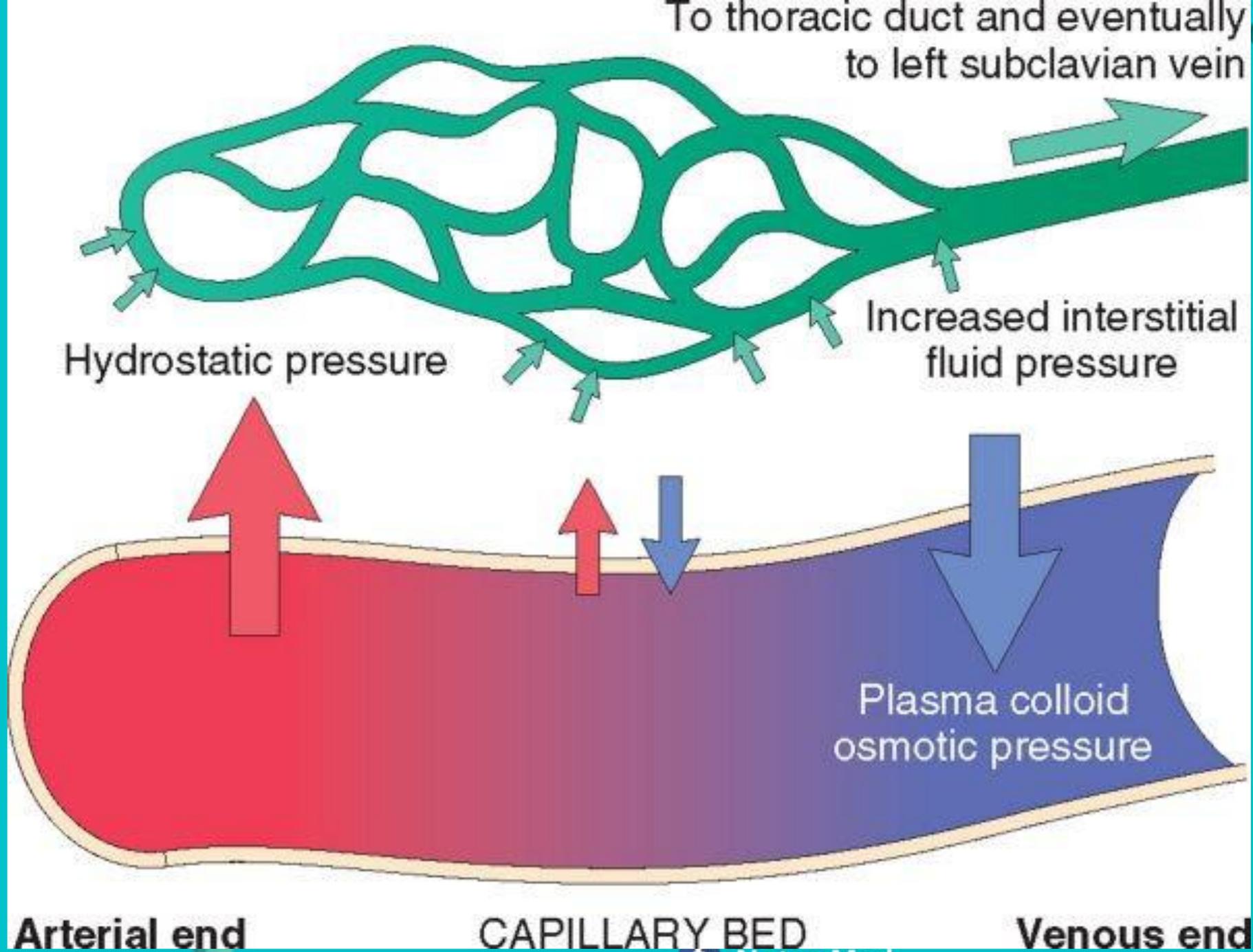
Edema



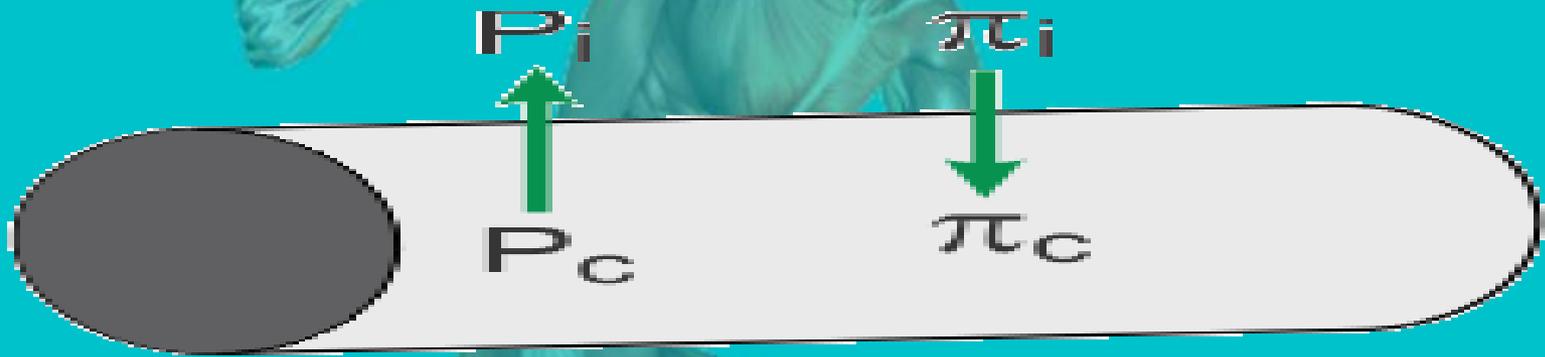
Edema

- Edema is define as the excessive collection of fluid within interstitial space and/air body cavities.





Net movement of fluid between plasma and interstitium governed by hydrostatic pressure and plasma oncotic pressure



RK 11

$$NDF = (P_c - P_i) - \sigma(\pi_c - \pi_i)$$

Filtration: $NDF > 0$
Reabsorption: $NDF < 0$

- P_c = capillary hydrostatic pressure
- P_i = tissue interstitial pressure
- π_c = capillary oncotic pressure
- π_i = tissue interstitial pressure
- σ = reflection coefficient

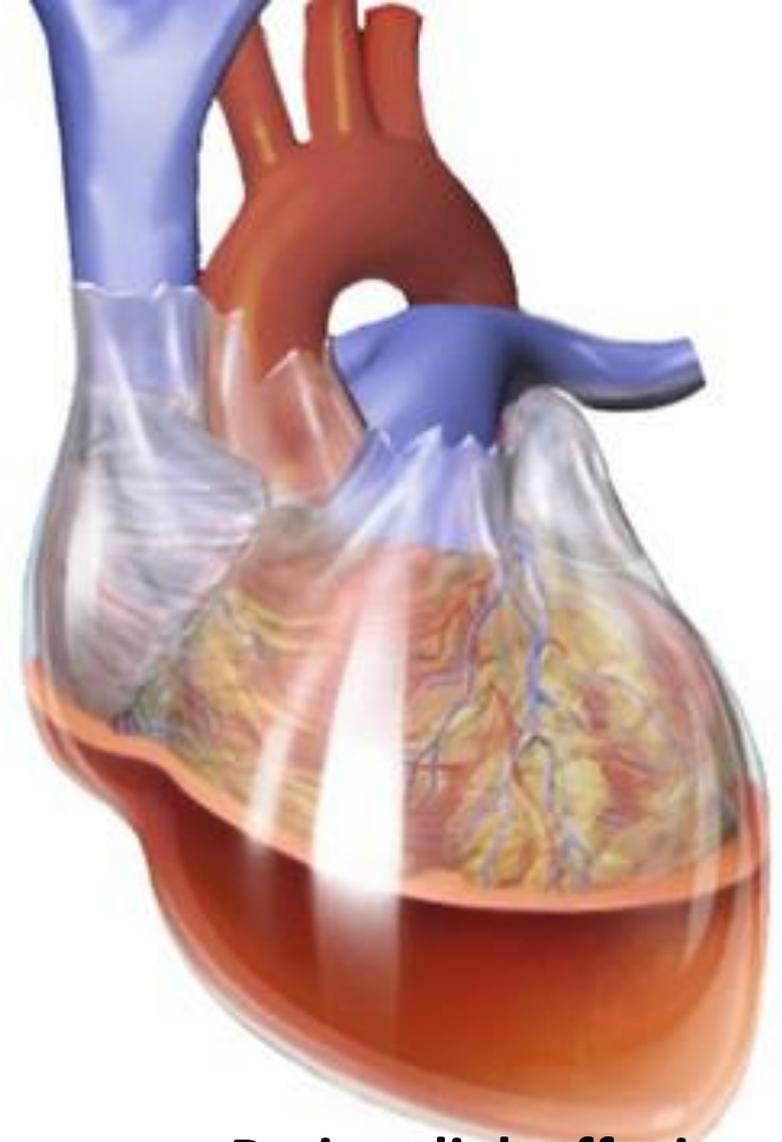
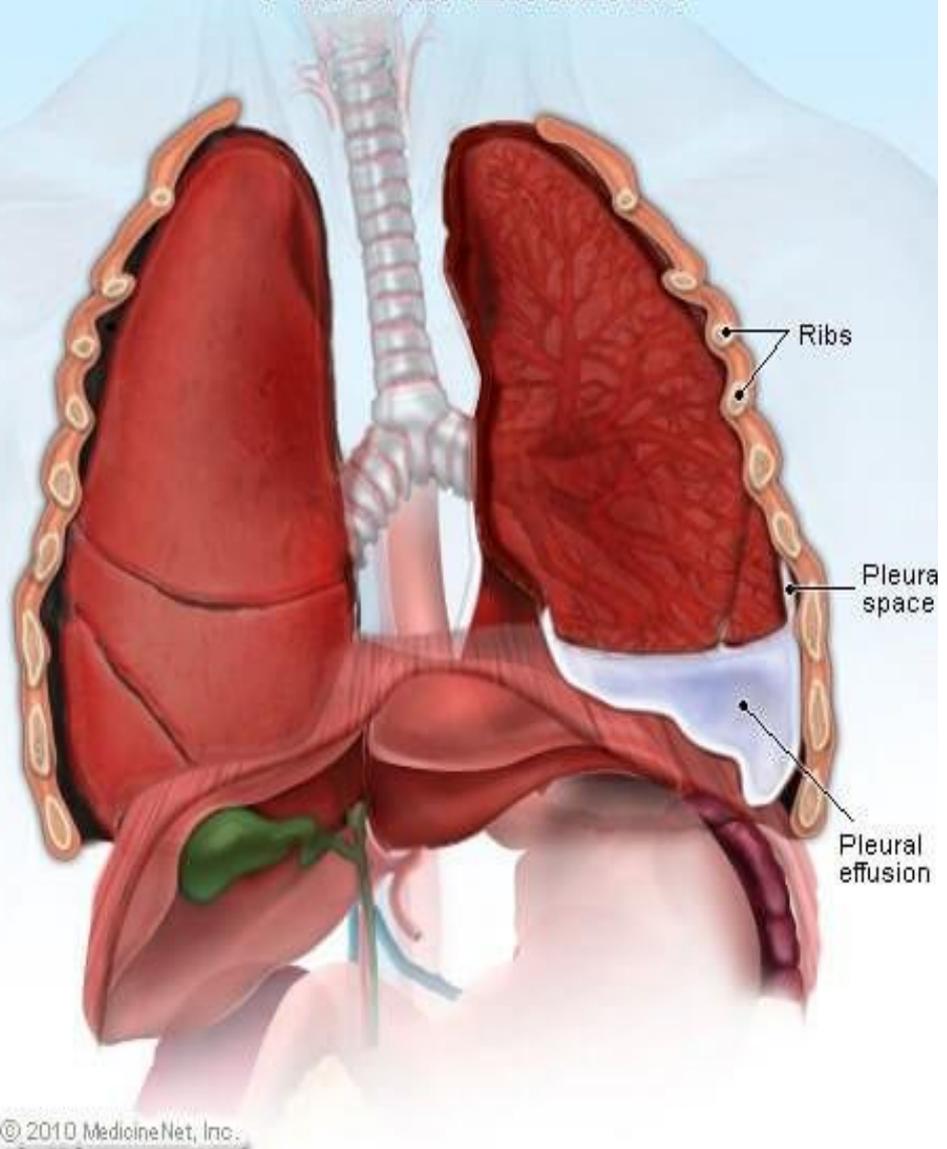
Hemodynamic Disorders

- In edema, approximately 60% of lean body weight is water, **2/3rd of which is intracellular** and the remainder is in **extracellular** compartments, mostly as interstitial fluid; **only 5%** of total body water is in **blood plasma**.

Hemodynamic Disorders

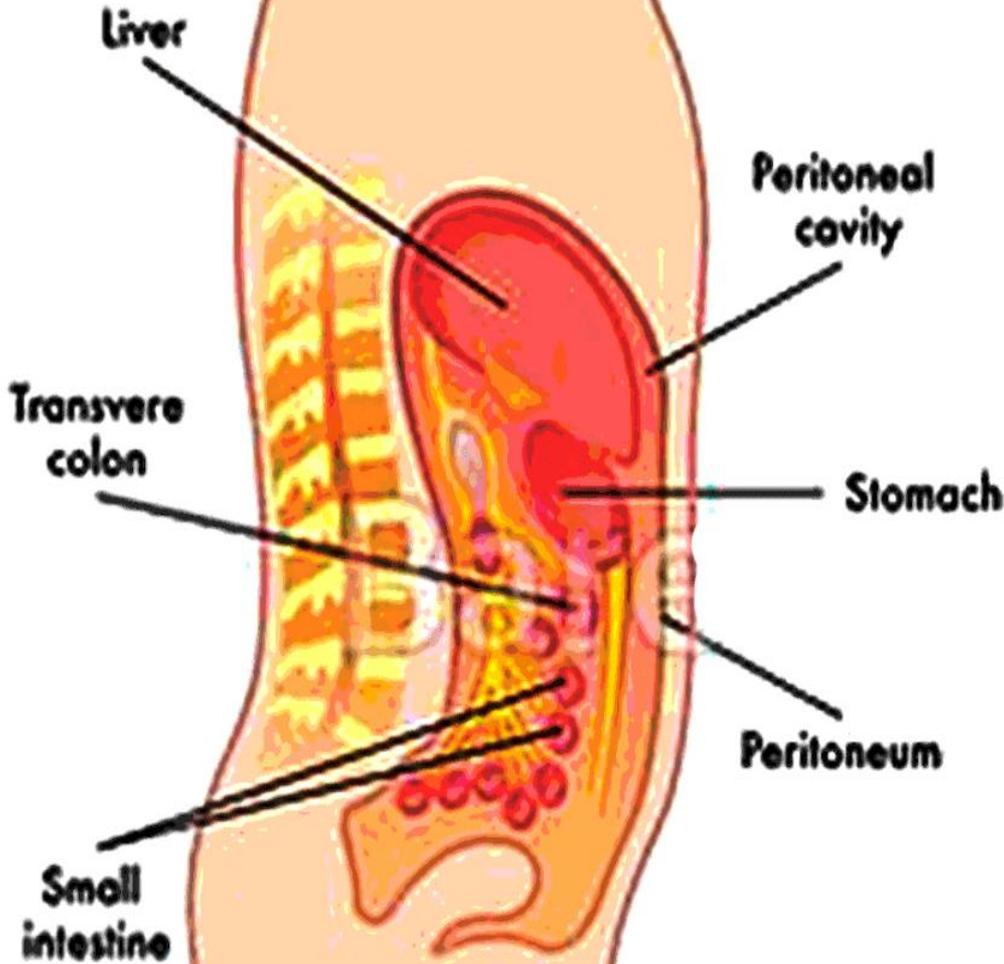
- Edema in different body cavities are variously designated;
 - In pleural cavity: **Hydrothorax (pleural effusion)**
 - In pericardium: **Hydropericardium (pericardial effusion)**
 - In peritoneum: **Hydroperitoneum (ascites)**
- **Anasarca** is a severe and **generalized edema** with profound subcutaneous tissue swelling.

Pleural Effusion

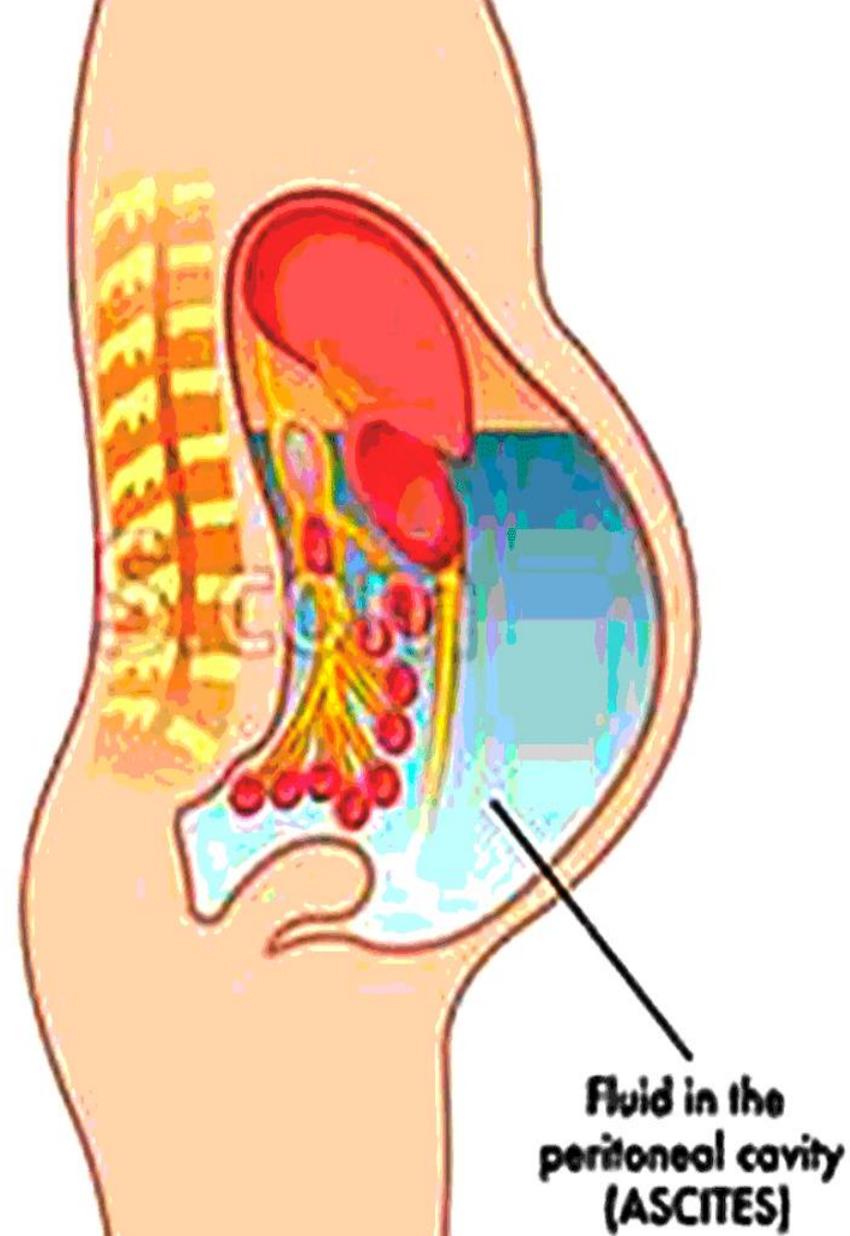


Pericardial effusion

Normal



Ascitis





Types of edema

Transudate

- Protein poor edema fluid and low LDH
- Specific Gravity- 1.012
- Clear
- Causes
 - Increased hydrostatic pressure and decreased osmotic pressure
 - It seen in patients suffering from heart failure, renal failure, hepatic failure, and certain forms of malnutrition

Exudate

- Protein rich edema fluid and high LDH
- Specific gravity-1.020
- Cloudy due to presence of white cells
- Causes
 - Increased vascular permeability (Inflammation)



Light's criteria

Pleural fluid is an exudate if one or more of the following criteria are met:

Pleural fluid protein divided by serum protein is > 0.5

Pleural fluid LDH divided by serum LDH is > 0.6

Pleural fluid LDH is $> 2/3$ than the normal top value of serum LDH

LDHs: Lactate dehydrogenases.



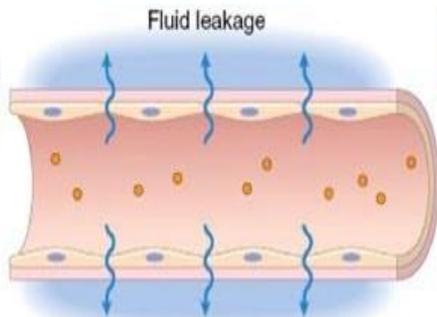
Transudate

Exudate

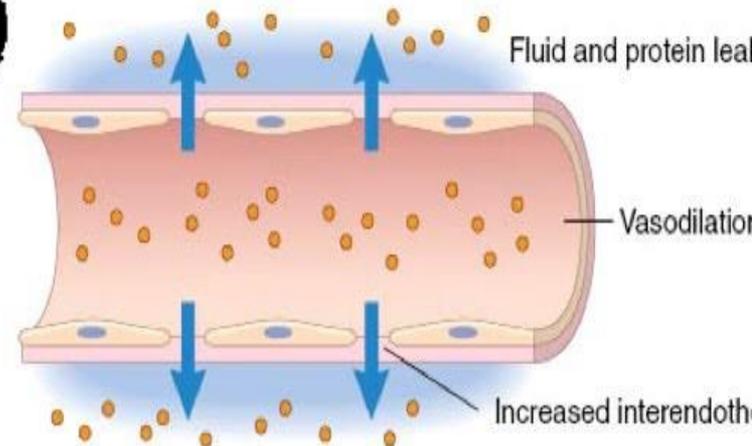


VS

↑
Increased hydrostatic pressure (e.g., heart failure)



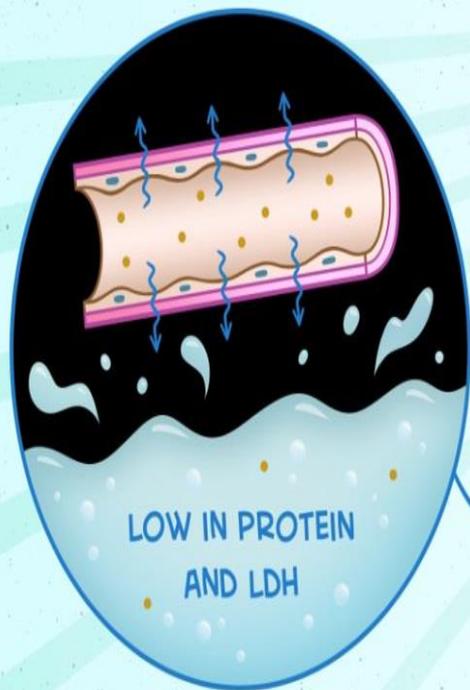
↓
Decreased colloid osmotic pressure (decreased protein synthesis, e.g., liver disease) or increased protein loss, e.g., kidney disease



TRANSUDATIVE

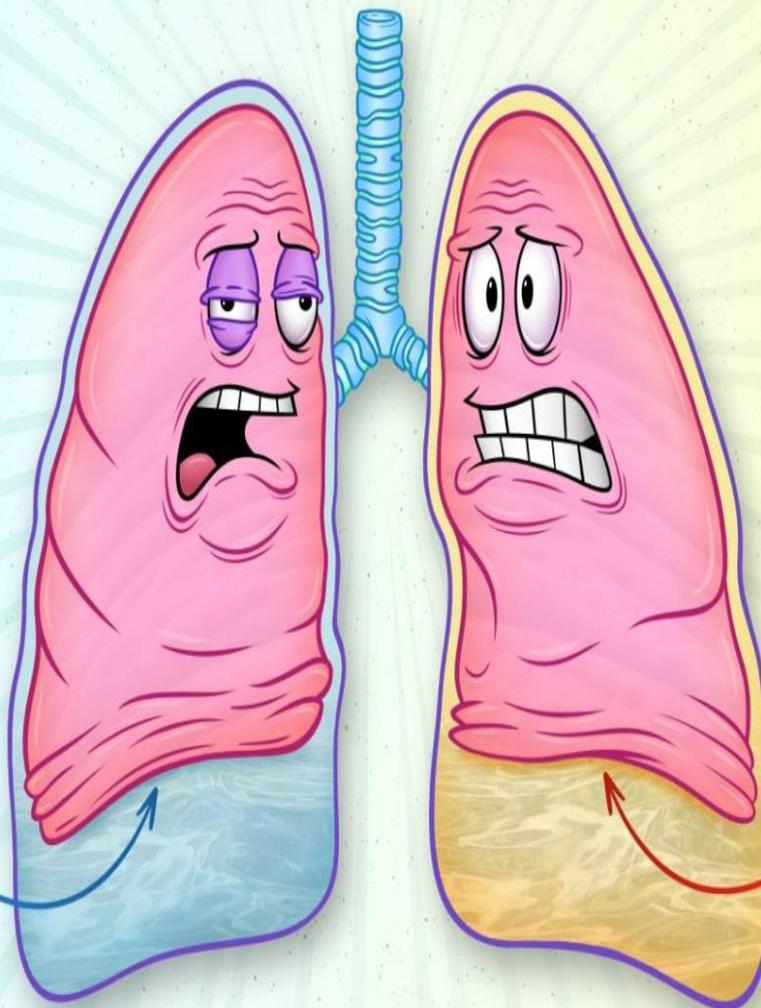
OCCURS DUE TO INCREASED HYDROSTATIC PRESSURE OR LOW PLASMA ONCOTIC PRESSURE

E.G., CHF, CIRRHOSIS, NEPHROTIC SYNDROME, PE, HYPOALBUMINEMIA



PLEURAL EFFUSION

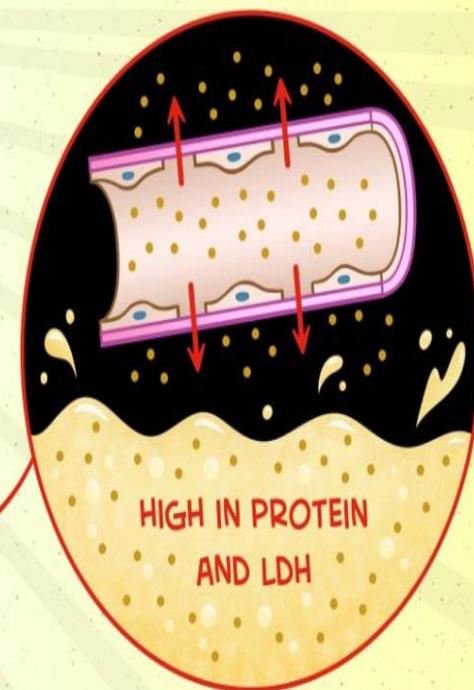
ACCUMULATION OF FLUID WITHIN THE PLEURAL SPACE



EXUDATIVE

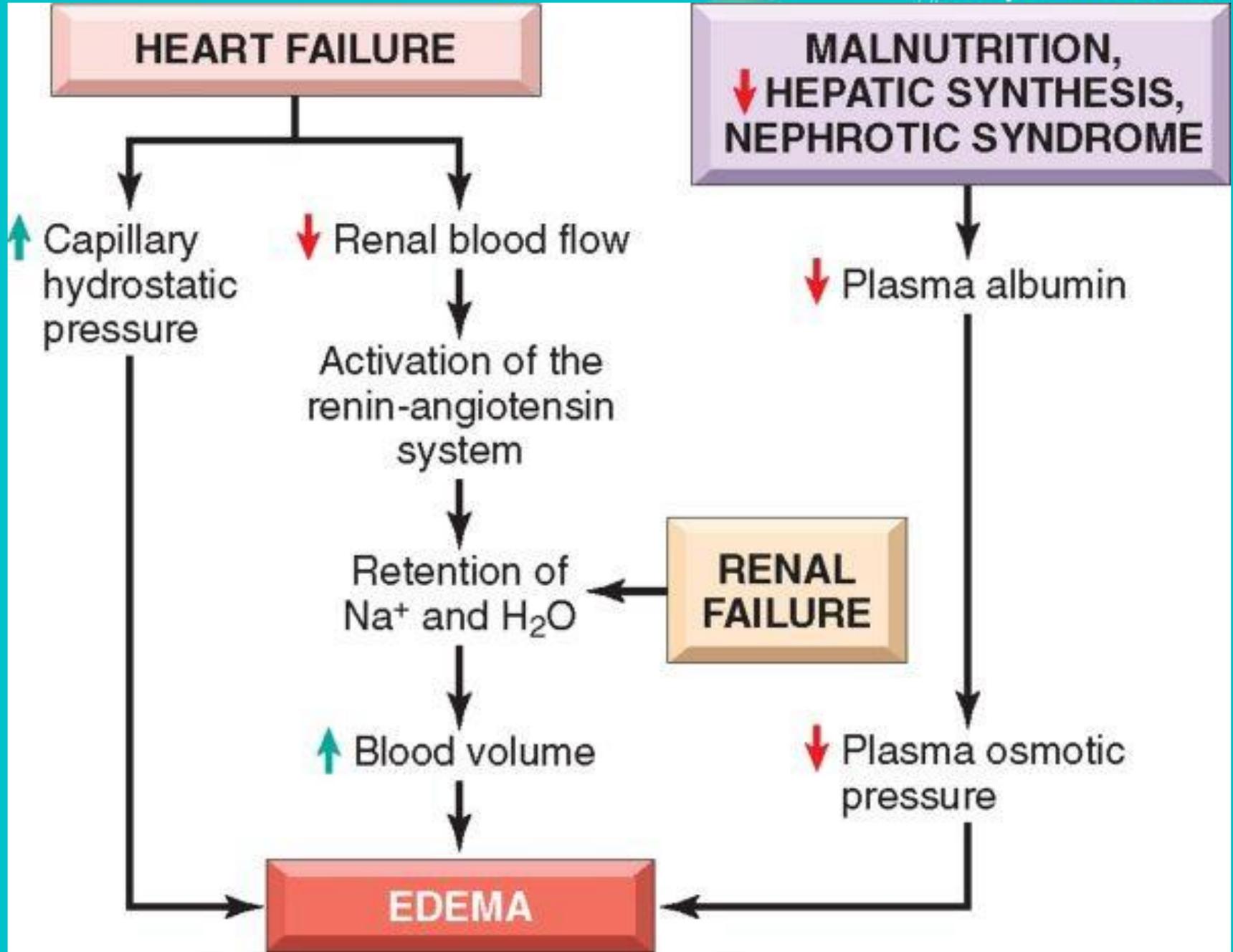
OCCURS DUE TO INFLAMMATION AND INCREASED CAPILLARY PERMEABILITY

E.G., PNEUMONIA, CANCER, TB, VIRAL INFECTION, PE, AUTOIMMUNE



Causes of edema

- Increased hydrostatic pressure
- Reduced plasma osmotic pressure (hypoproteinemia)
- Lymphatic obstruction
- Sodium and water retention
- Inflammation



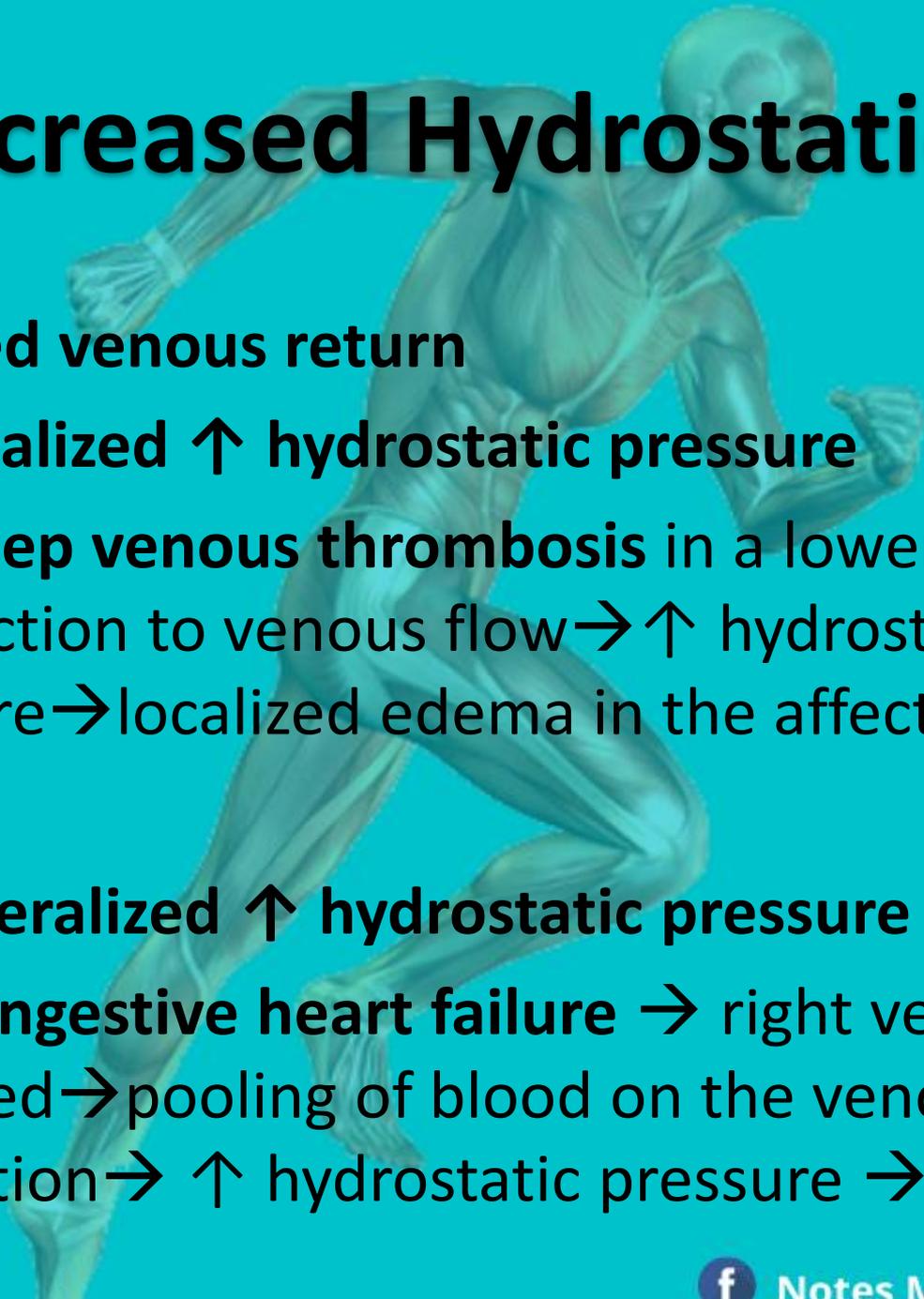
Increased hydrostatic pressure

- Impaired venous return
- Congestive heart failure
- Constrictive pericarditis
- Liver cirrhosis
- Venous obstruction or compression
- Thrombosis
- External pressure (e.g. mass)
- Lower extremity inactivity with prolonged dependency
- Arteriolar dilation
- Heat
- Neurohumoral dysregulation

Increased hydrostatic pressure

- Focal impairment in venous return:
 - It is regional increases in hydrostatic pressure, for example: deep vein thrombosis in a lower extremity-localized edema in the affected leg.
- Generalized increased in venous pressure
 - It is resulting systemic edema for example: congestive heart failure

Increased Hydrostatic Pressure



- **Impaired venous return**

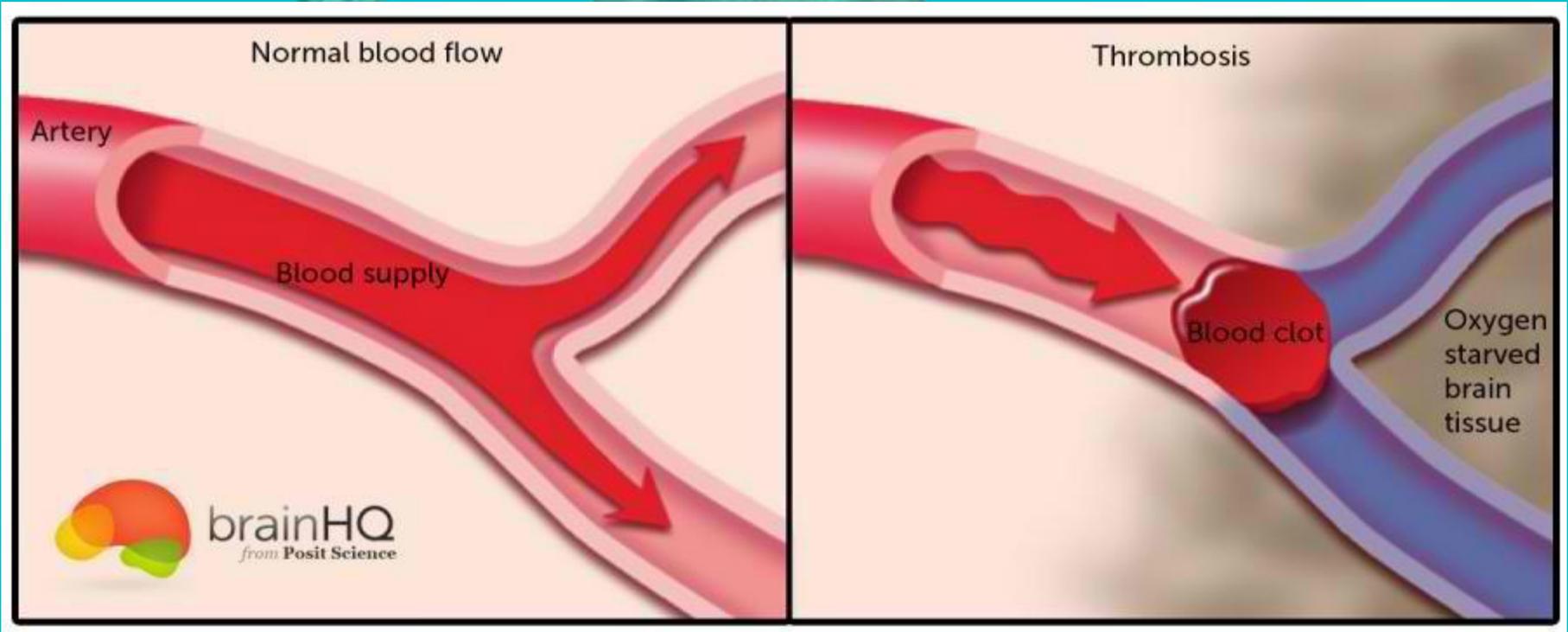
- A. Localized \uparrow hydrostatic pressure**

- e.g. **Deep venous thrombosis** in a lower extremity \rightarrow obstruction to venous flow \rightarrow \uparrow hydrostatic pressure \rightarrow localized edema in the affected leg

- B. Generalized \uparrow hydrostatic pressure**

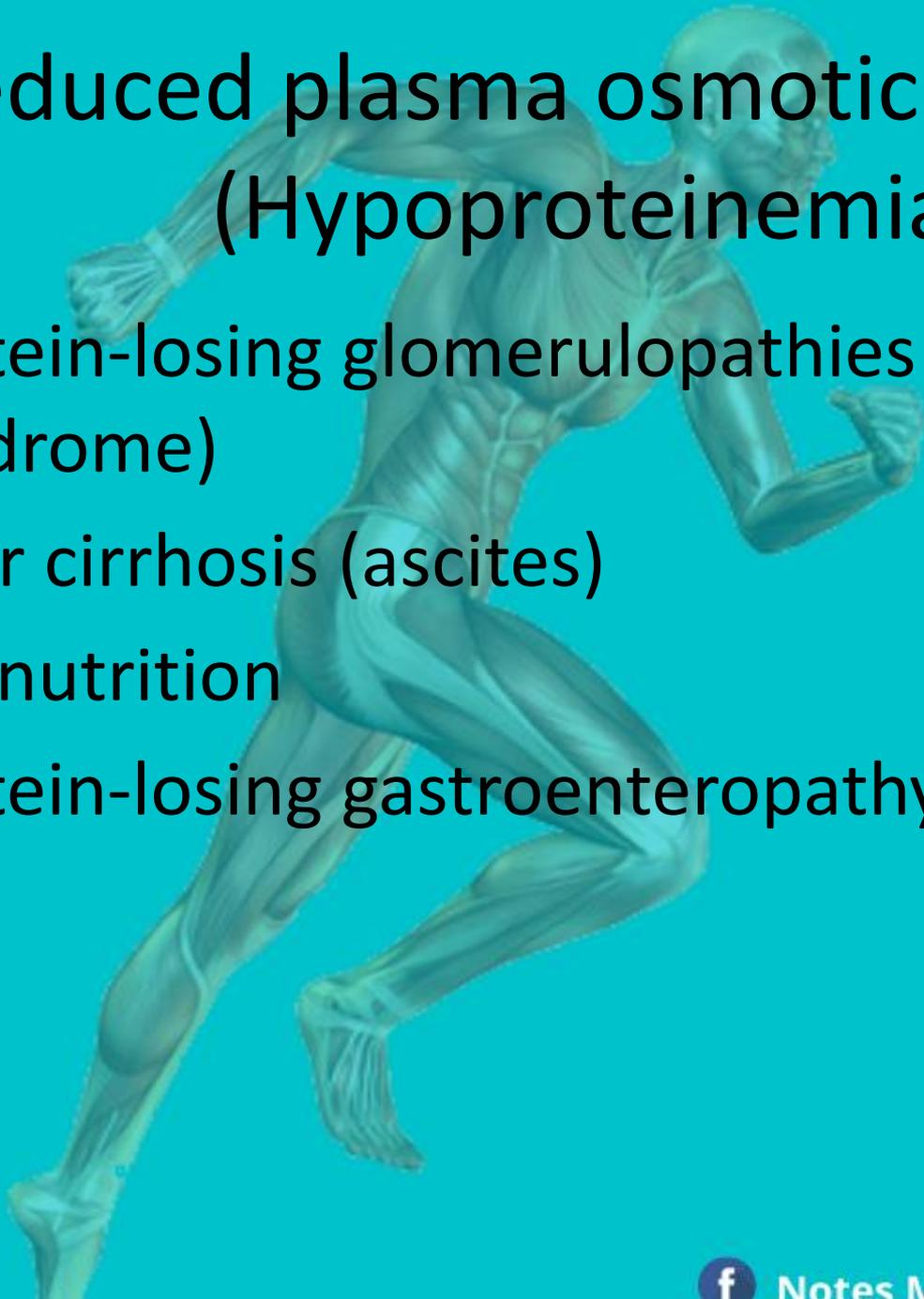
- e.g. **Congestive heart failure** \rightarrow right ventricular function impaired \rightarrow pooling of blood on the venous side of the circulation \rightarrow \uparrow hydrostatic pressure \rightarrow Generalized edema

- In addition other mechanism also play role in edema formation in CHF
 - ↓ Cardiac output
 - ↓ Renal blood flow
 - Activation of **renin-angiotensin-aldosterone system** →
 - ↑ Tubular reabsorption of sodium salt and water retention
 - ↑ **ADH** secretion → ↑ water retention
- ↓
- ↑ Plasma volume and hydrostatic pressure → **edema**



Reduced plasma osmotic pressure (Hypoproteinemia)

- Protein-losing glomerulopathies (nephrotic syndrome)
- Liver cirrhosis (ascites)
- Malnutrition
- Protein-losing gastroenteropathy



Reduced plasma osmotic pressure (Hypoproteinemia)

- It occurs when albumin, the major plasma protein, it is not synthesized in adequate amounts as in severe liver diseases (e.g., cirrhosis or protein malnutrition)
 - It is lost from the circulation as in nephrotic syndrome
 - It reduced plasma osmotic pressure when fluid goes to interstitial tissues

Reduced Plasma Osmotic Pressure

↓ synthesis of albumin
e.g. Cirrhosis of liver
Protein malnutrition

Hypoalbuminemia

Protein loss
e.g. Nephrotic Syndrome (heavy proteinuria due to leaky glomeruli)

↓ Plasma osmotic pressure

Generalized edema

↓ Intravascular volume

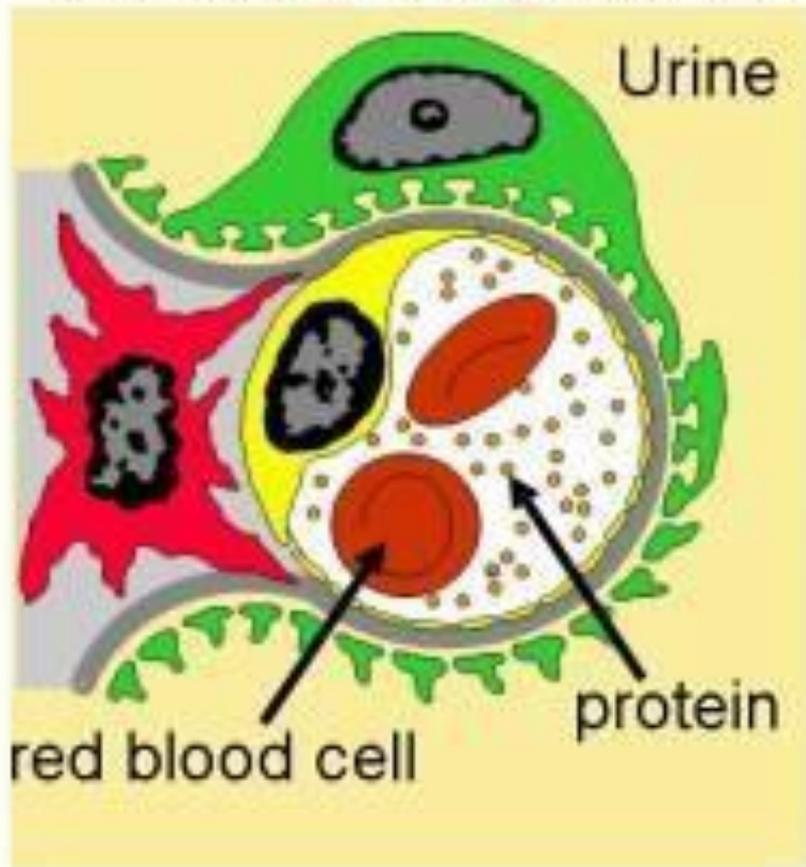
Renin-angiotensin-aldosterone System activation

Renal hypoperfusion (↓ GFR)

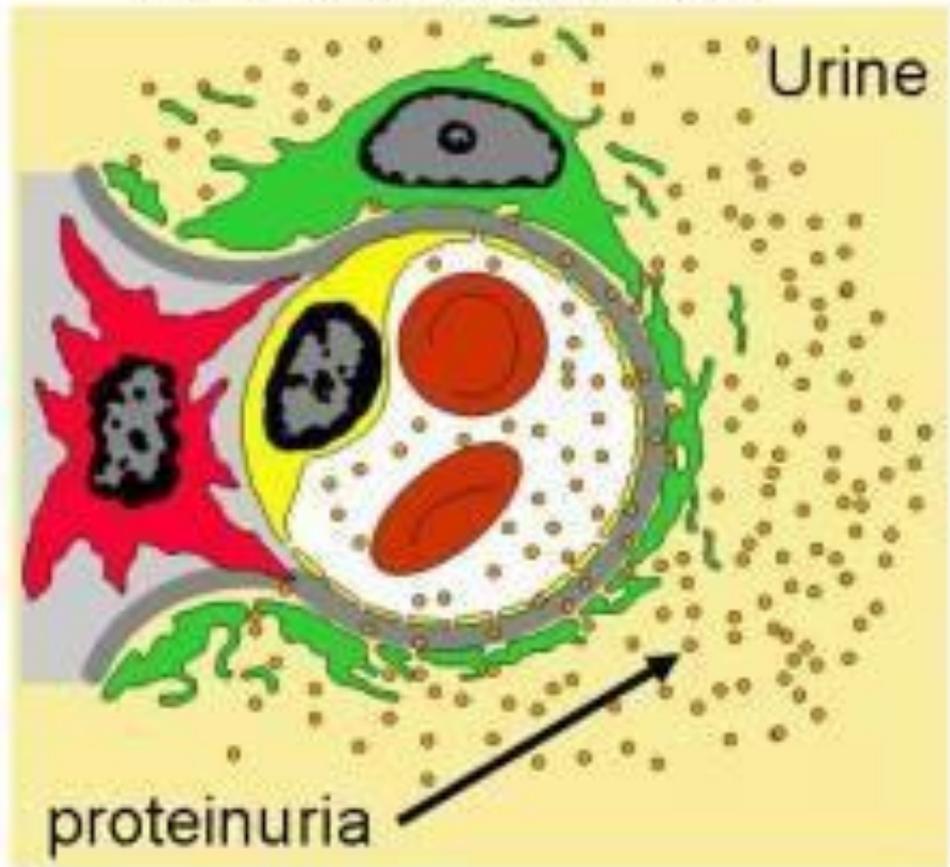
Low osmotic pressure persists

Salt and water retention

Normal glomerular capillary



Capillary with proteinuria



NEPHROTIC SYNDROME



**PRESENTED BY:
KIRANDEEP RANDHAWA**

Lymphatic obstruction

- Inflammatory– parasitic infestation- elephantiasis
- Neoplastic condition
- Postsurgical (e.g. modified radical mastectomy for carcinoma of breast)
- Post-irradiation

Lymphatic obstruction

- Impaired lymphatic drainage results in lymphedema that is typically localized;
 - The causes include:
 - Chronic inflammation with fibrosis
 - Invasive malignant tumors
 - Physical disruption
 - Radiation damage
 - Certain infectious agents

Lymphatic obstruction

- In filariasis:
 - Lymphatic obstruction due to extensive inguinal lymphatic and lymph node fibrosis → edema of the external genitalia and lower limbs → elephantiasis
- Invasive malignant tumors
- Post surgical and radiation damage e.g. Breast cancer → severe edema of the upper extremity due to removal of axillary lymph nodes



Sodium and water retention

- Excessive salt intake with renal insufficiency
- Increased tubular reabsorption of sodium
- Renal hypoperfusion
- Increased renin-angiotensin-aldosterone secretion

Sodium and water retention

- Increased salt retention and associated water retention
 - It is caused by both increased:
 - Hydrostatic pressure (due to intravascular fluid volume expansion)
 - Diminished vascular colloid osmotic pressure (due to dilation).
- It is seen in conditions with:
 - Impaired renal function such as primary disorders of the kidney and disorders that decrease renal perfusion.

Sodium and Water Retention

•Primary causes

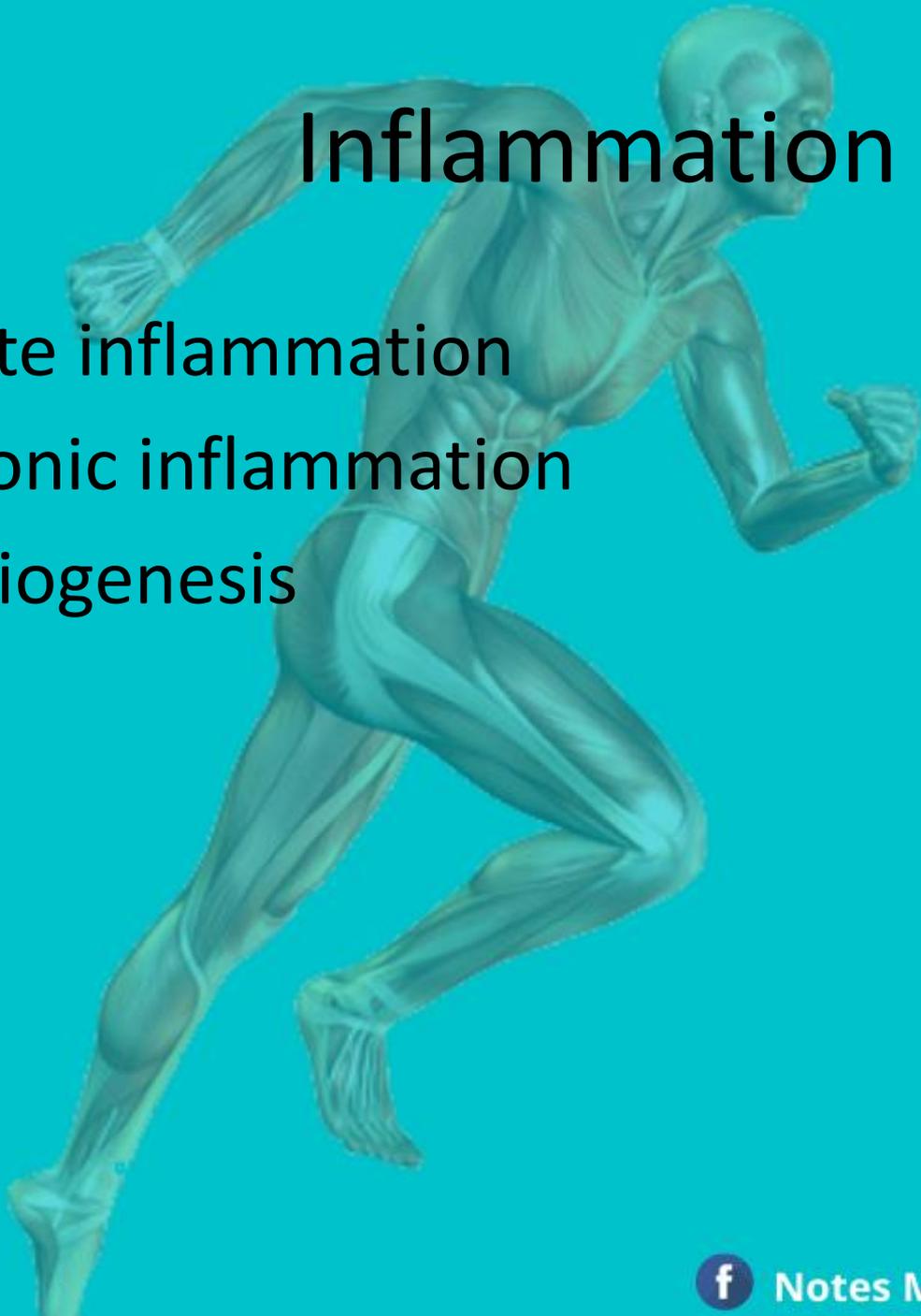
- Renal diseases—glomerulonephritis, acute renal failure
 - Renal hypoperfusion
 - Activation of renin angiotensin aldosterone system
 - Retention of salt and water
- SIADH e.g. lung malignancies and pituitary disorders → retention of water— cerebral edema

•Secondary causes

- Heart failure
- Cirrhosis of liver

Inflammation

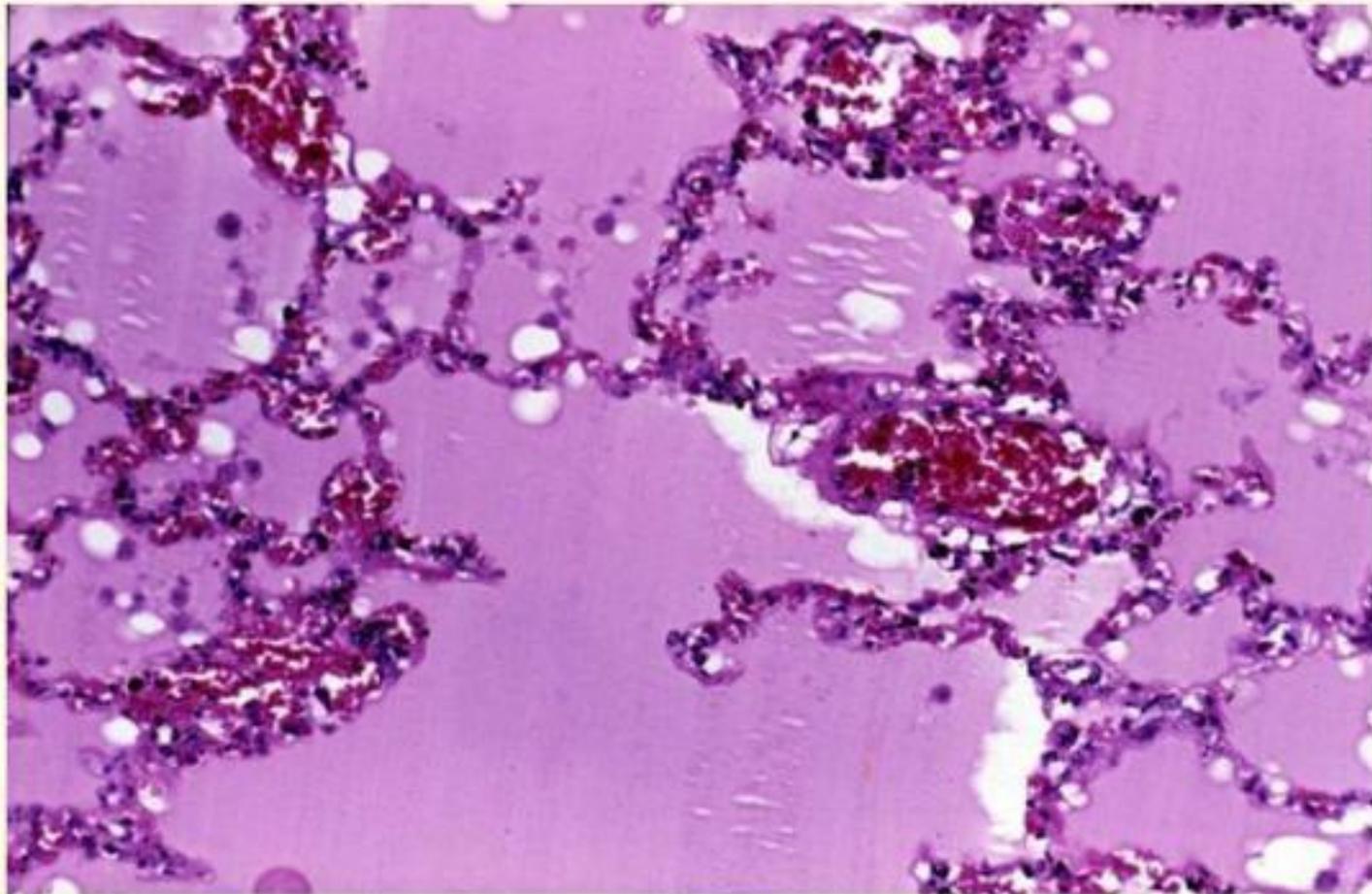
- Acute inflammation
- Chronic inflammation
- Angiogenesis



Morphology

- Gross:
 - Distribution is influenced by gravity
 - As in dependent edema (e.g. the legs when standing, the sacrum when recumbent)
 - Pitting edema
 - **Lungs (pulmonary edema)**– heavy boggy lungs, frothy blood tinged fluid on cut section
 - Brain- swollen with narrowed sulci and distended gyri
 - periorbital edema -- severe renal disease
- Microscopically:
 - Clearing and separation of extracellular matrix and subtle cell swelling

Pulmonary Edema



Clinical features

- Subcutaneous edema
 - Signal of underlying cardiac or renal disease; impair wound healing, clearance of infections
- Pulmonary edema
 - Left ventricular failure; Renal failure
 - Impaired oxygen diffusion
 - Favours bacterial infection
- body cavities effusion
 - Pleural effusion- collapse of lung parenchyma
 - Ascites- bacterial infection
 - Pericardial effusion- heart failure
- Cerebral edema
 - Herniation of brain substance thru' foramen magnum- injure medullary centers and death