



# NOVA

Charting New Horizons in Education

## Hemodynamics disorders I

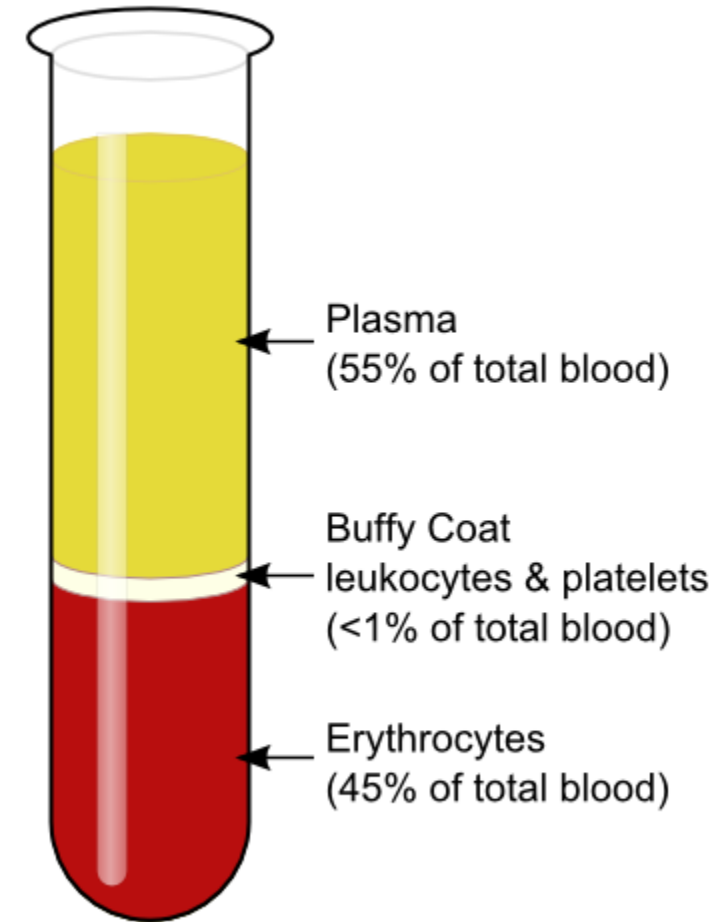
11  
Pathology



# VA Blood composition



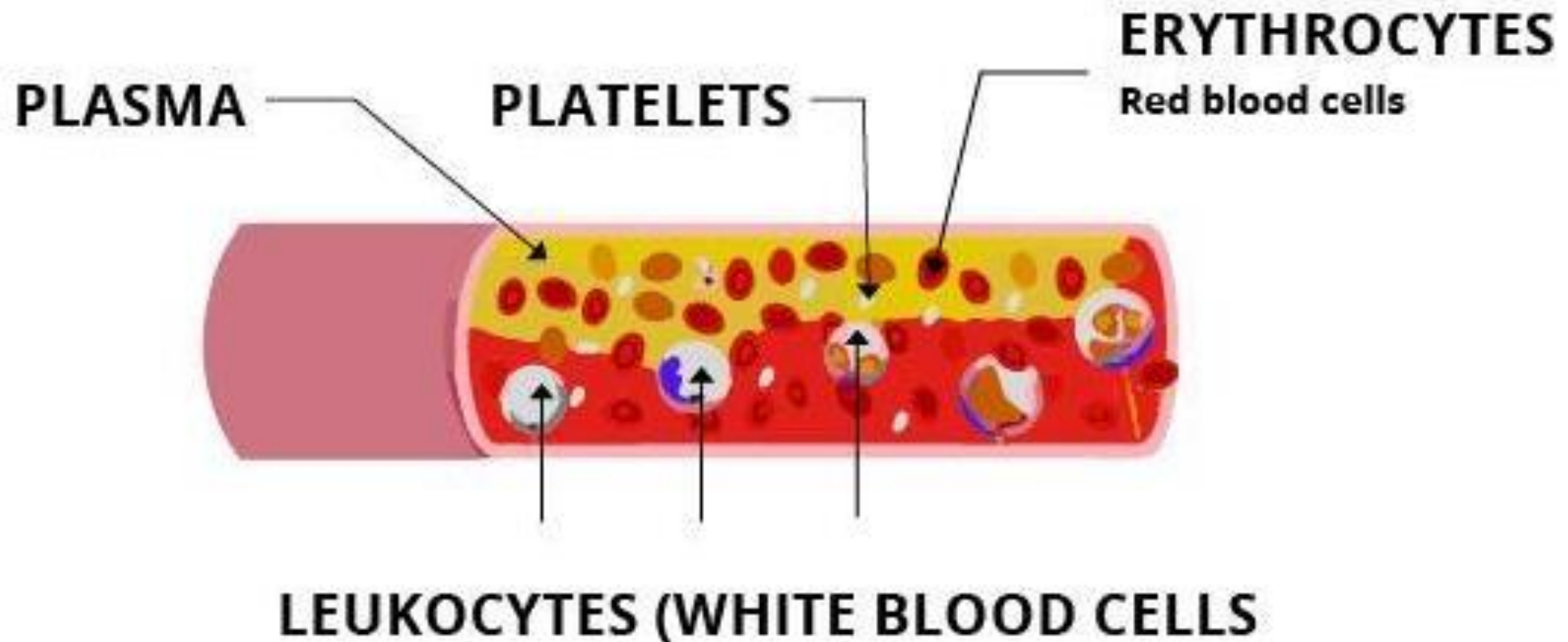
1. **Blood plasma** is a yellowish liquid component of blood that contains salts, water, nutrients, enzymes, and essential proteins.
2. **Red blood cells** consist of Hemoglobin, a protein.
3. **WBC, Platelets & clotting pathway.**
  - **So any disturbances in these processes lead to pathological conditions: e.g**
    1. Defect in Fluid and electrolyte balance → EDEMA.
    2. Damage to blood vessels or defective clot formation → HEMORRHAGE
    3. **Disturbance in clotting pathway leads to either:**
      - A. Hemorrhage.
      - B. Thromboembolism





# COMPOSITION OF BLOOD

FORMED ELEMENTS SUSPENDED IN PLASMA



# VA Introduction - From me



- Trauma can damage blood vessels, affecting their structural integrity.
- **Hemostasis** the process where blood clots form to stop excessive bleeding after vessel damage.
- If hemostasis is inadequate, it can cause hemorrhages, which may reduce blood flow to tissues, leading to **hypotension, shock, or even death**.
- Thrombosis (inappropriate clotting) or embolism (clots traveling to other areas) can block blood vessels.
- **Blocked blood vessels** can lead to **ischemic cell death or infarction**.
- Thromboembolism is responsible for three major causes of illness and death in developed countries: *heart attacks (myocardial infarction), pulmonary embolism (PE), and strokes (cerebrovascular accidents)*.

# ❖ Clinically!



## 1. Fluid and electrolytes disturbance:

- ✓ Increased volume → HYPEREMIA AND CONGESTION
- ✓ Abnormal distribution → EDEMA
- ✓ Decreased volume →
  - A. INFARCTION - Localized.
  - B. Shock – Generalized hypoperfusion.



## 2. Inadequate hemostasis :

- ✓ HEMORRHAGE
- ✓ THROMBOSIS and EMBOLISM

## 3. Disturbance in RBC:

- ✓ Extravasation from vessels → HEMORRHAGE.

# VA Hyperemia & Congestion!



- Hyperemia and congestion both refer to an increase in blood volume within a tissue, but have different underlying mechanisms!





# Hyperemia!



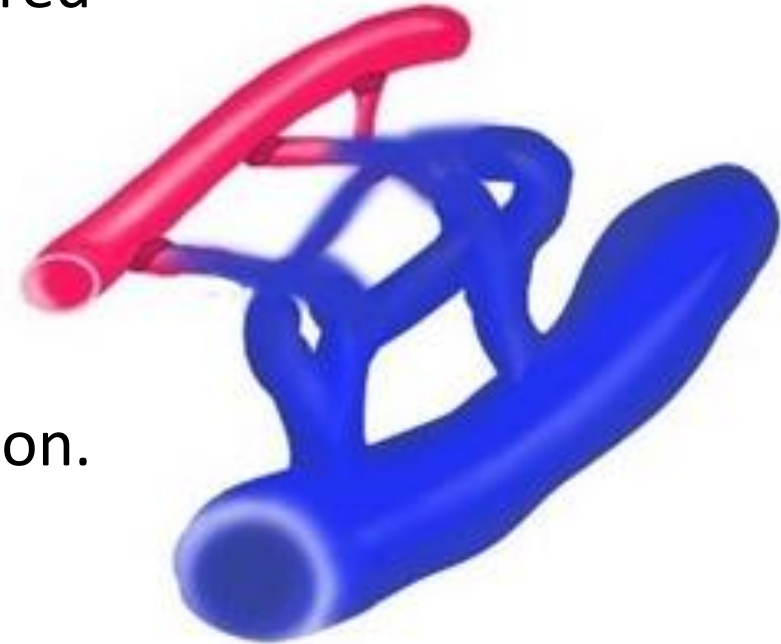
- **Hyperemia** is an **a**ctive process resulting from **a**rteriolar dilation and increased blood inflow, as occurs at sites of inflammation or in exercising skeletal muscle.



# VA Congestion!



- **cOngestion** is a **passive process** resulting from impaired **O**utflow of venous blood from a tissue.
- **It can occur:**
  1. Systemically, as in cardiac failure.
  2. Locally as a consequence of an isolated venous obstruction.
- In long-standing chronic congestion → inadequate tissue perfusion and persistent hypoxia may lead to → parenchymal cell death and secondary tissue fibrosis, and the elevated intravascular pressures may cause → edema or sometimes rupture capillaries → producing focal hemorrhages.





# ❖ Clinically!



- **Hyperemic tissues** are redder than normal because of engorgement with **oxygenated blood**.
- **Congested tissues** have an abnormal **blue-red color (cyanosis)** that stems from the accumulation of **deoxygenated hemoglobin** in the affected area.



# ❖ Hyperemia & Congestion - Clinically



- Cut surfaces of **hyperemic** or **congested** tissues feel wet and typically ooze blood.

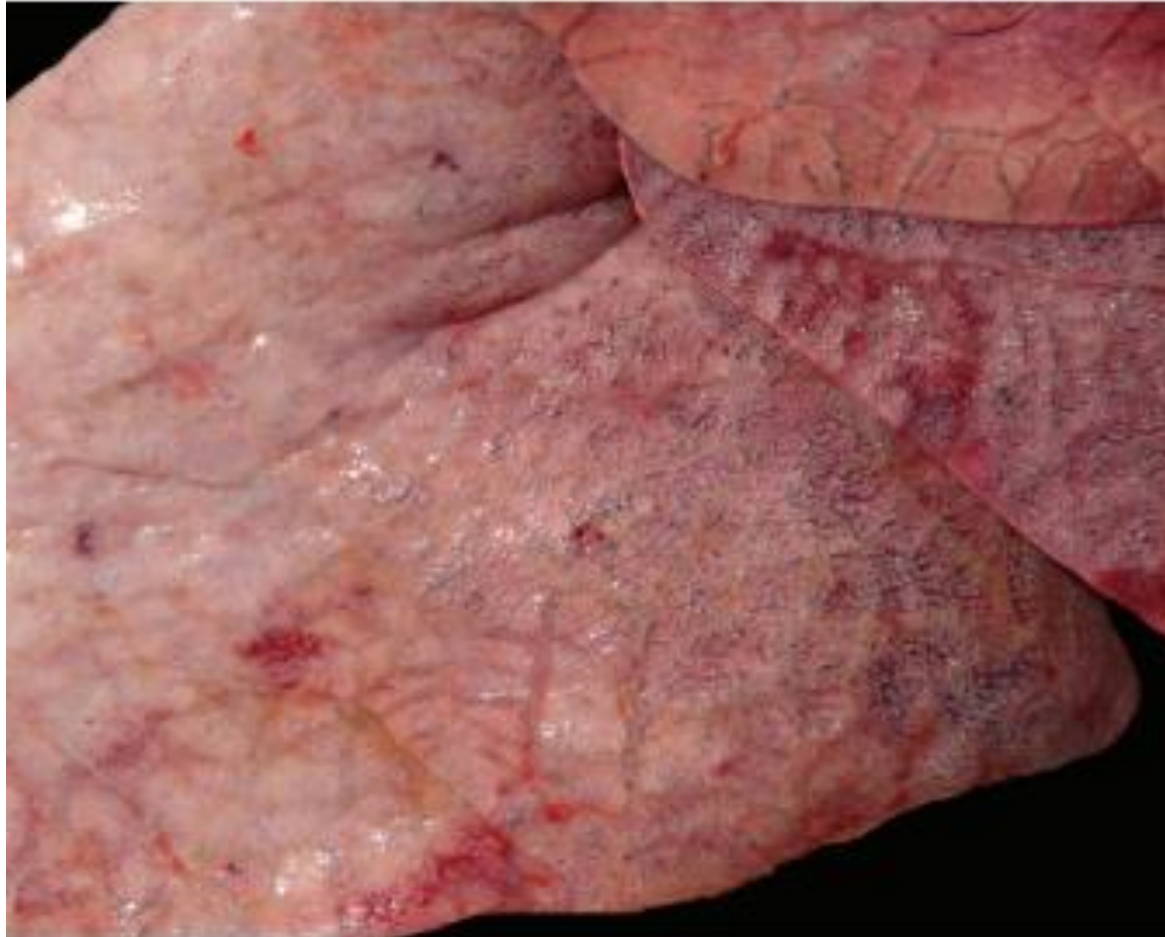


Fig.1. Bovine lung. Diffusely armed, crepitant, edematous and emphysematous bovine lung with abundance of air blebs on the pleural surface.

# ❖ Lung congestion - Morphology!



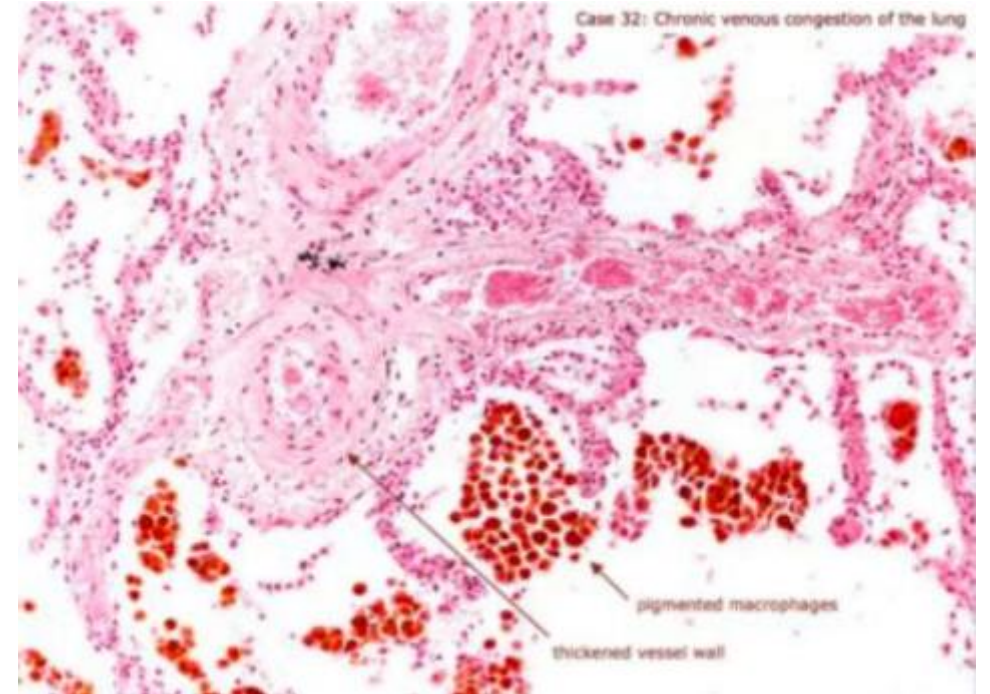
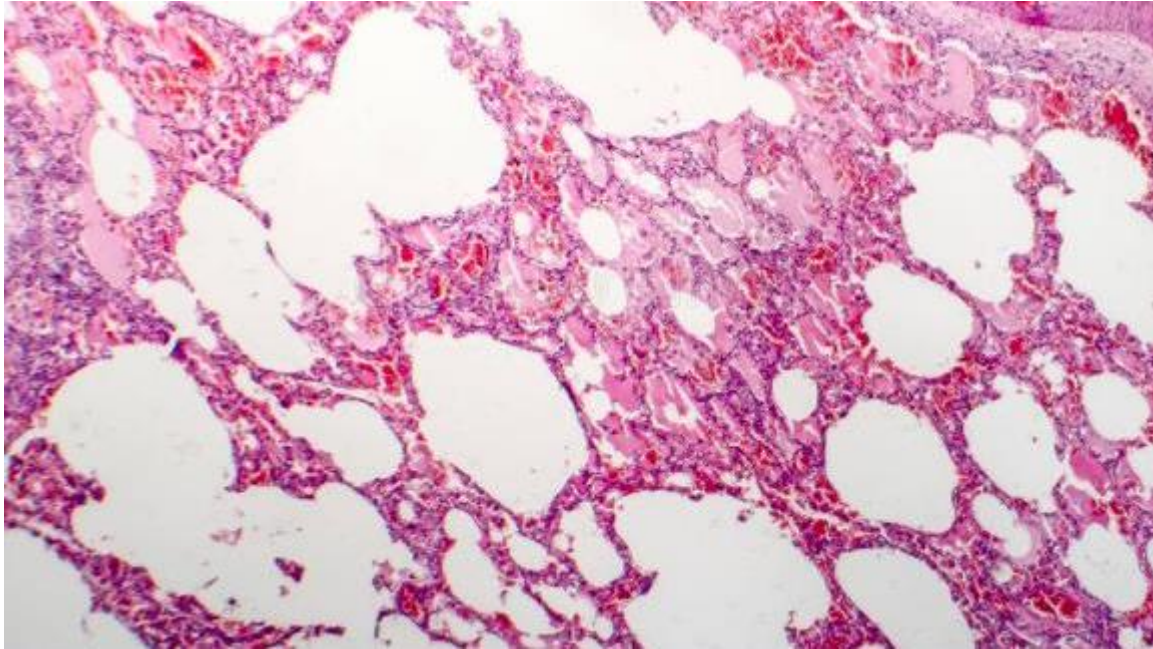
- **Microscopic examination:**

- I. **Acute pulmonary congestion:** is marked by blood-engorged alveolar capillaries and variable degrees of alveolar septal edema and intra-alveolar hemorrhage.

- II. **chronic pulmonary congestion:** the septa become thickened and fibrotic, and the alveolar spaces contain numerous macrophages laden with hemosiderin (**“heart failure cells”**) derived from phagocytosed red cells.



# VA Lung congestion - Morphology!

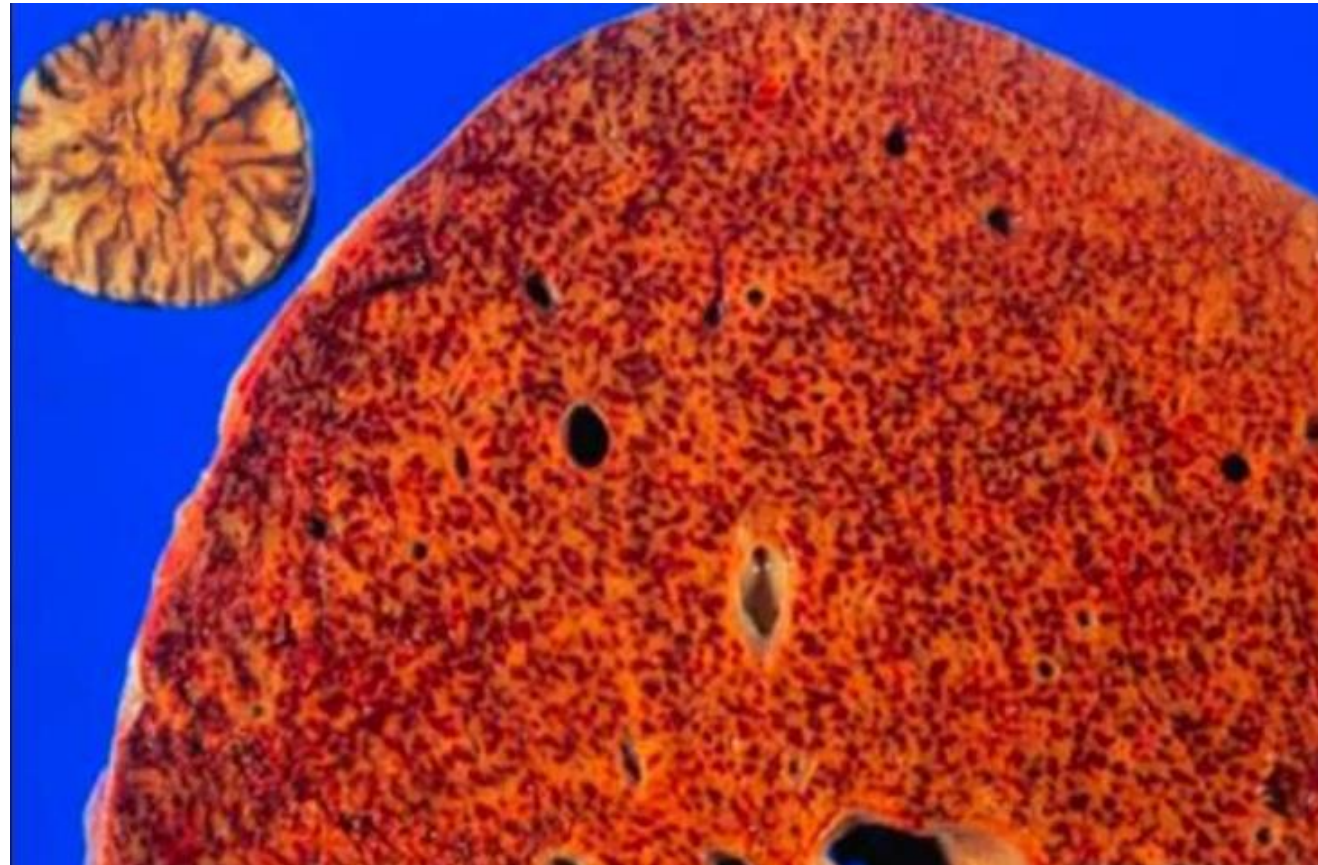


# VA Hepatic congestion - Morphology!



- **Gross examination:**

- Central areas are red and slightly depressed compared with the surrounding tan viable parenchyma, creating “nutmeg liver”





# VA Hepatic congestion - Morphology!

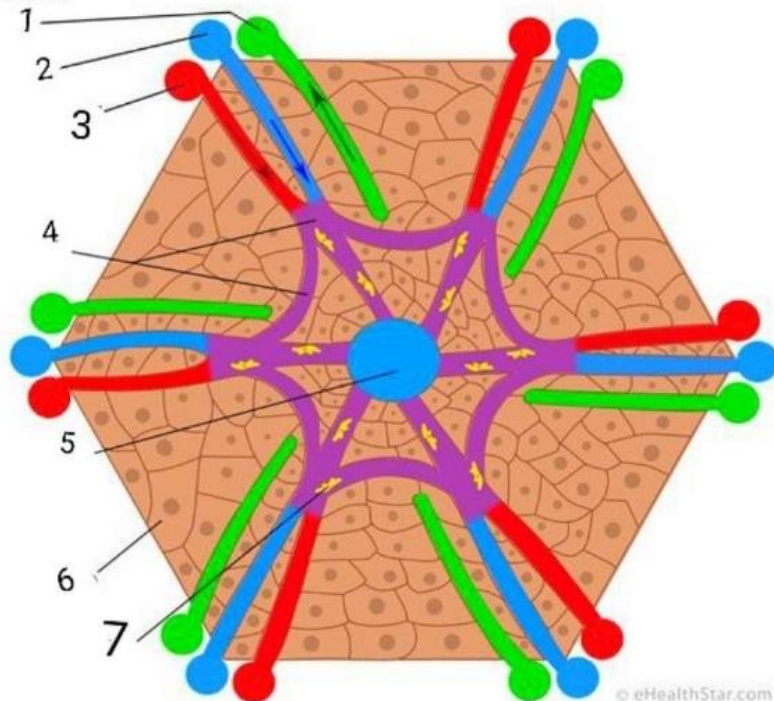


- **Microscopic examination:**

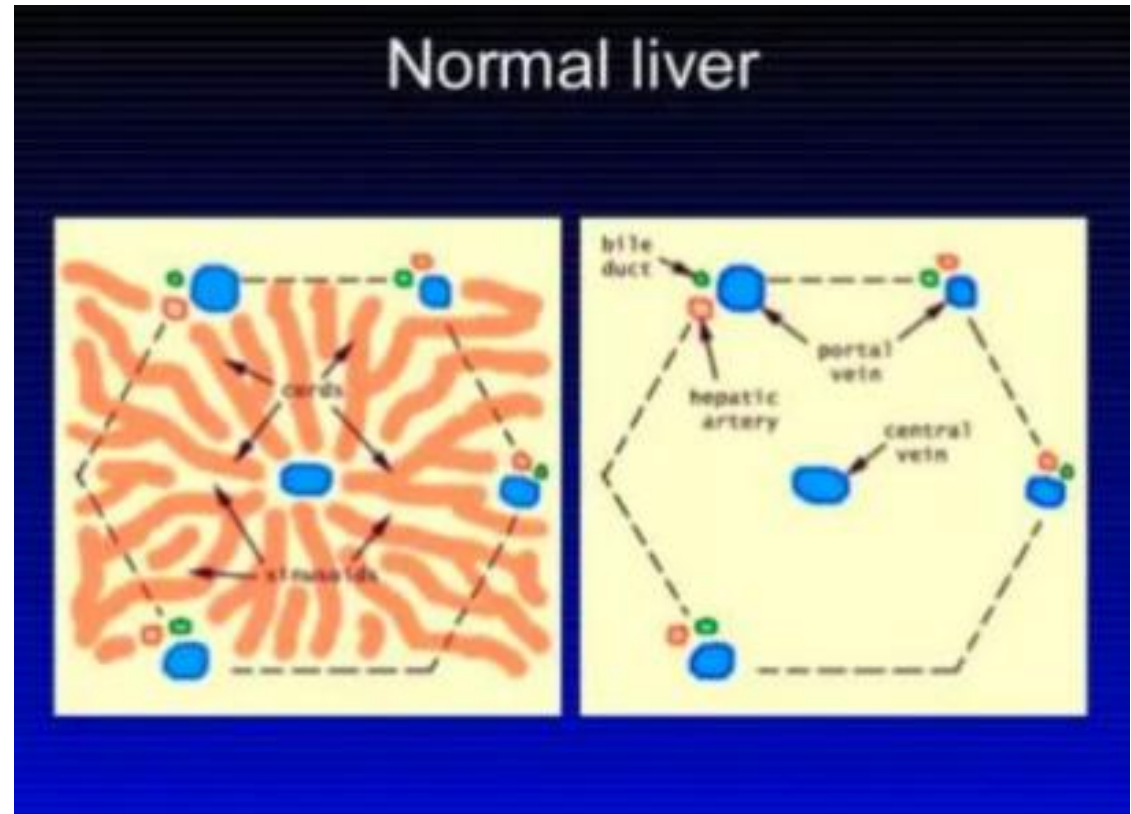
- Centrally located hepatocytes are prone to necrosis more than the periportal hepatocytes which is better oxygenated because of their proximity to hepatic arteriole

## Hepatic Lobule

Portal triad:

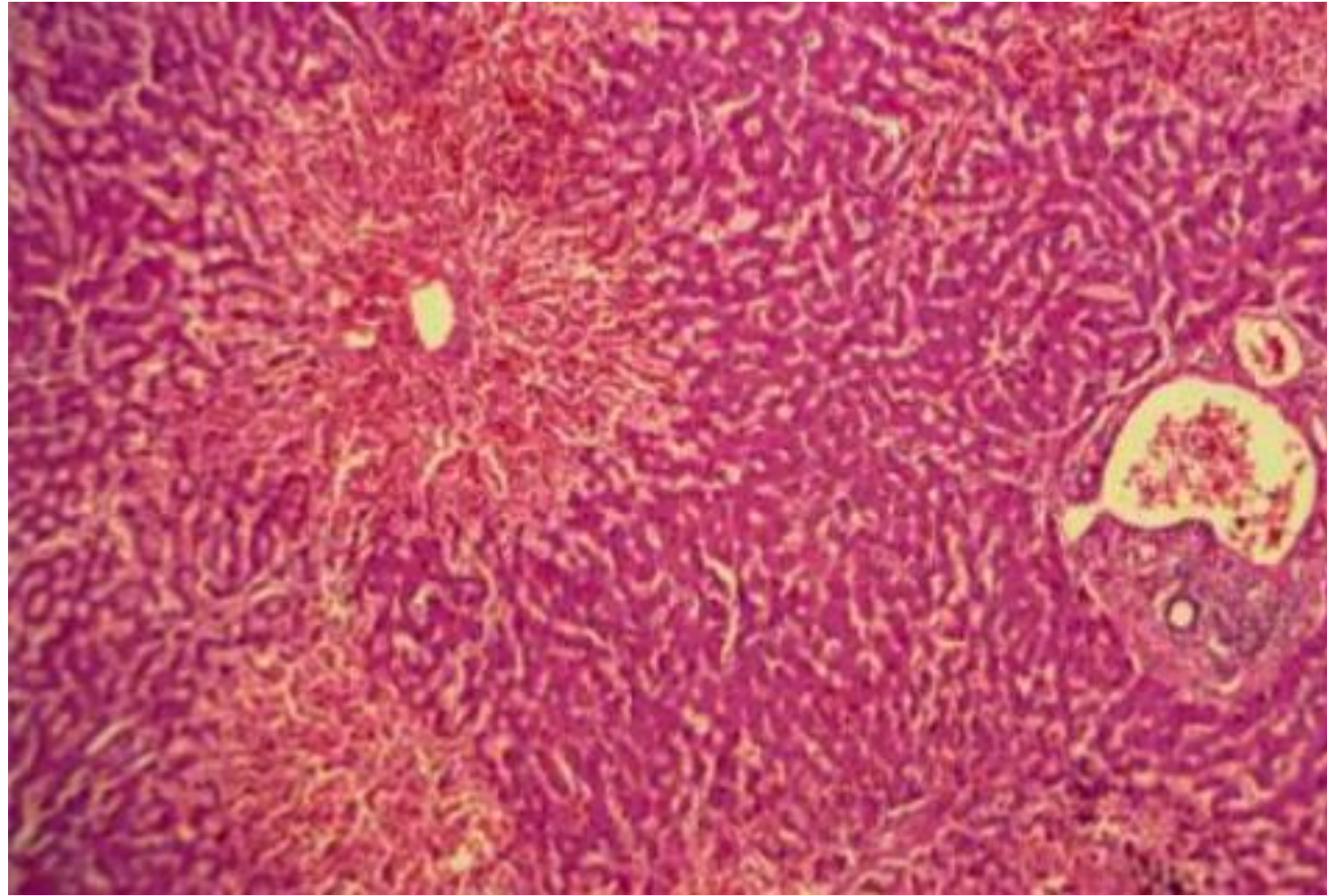


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# VA Hepatic congestion - Morphology!

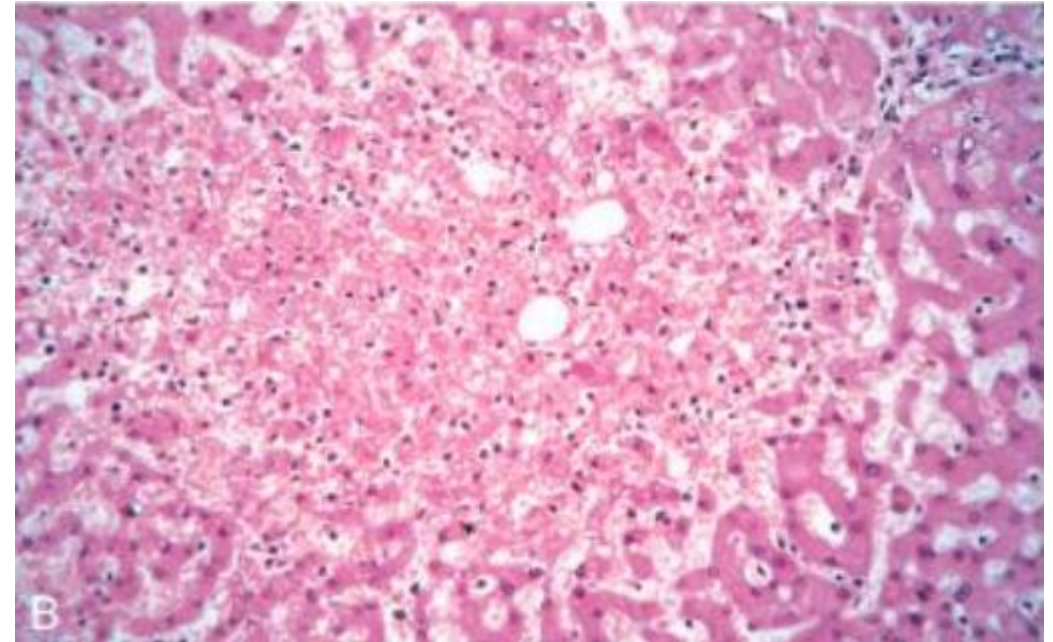


# VA Hepatic congestion - Morphology!



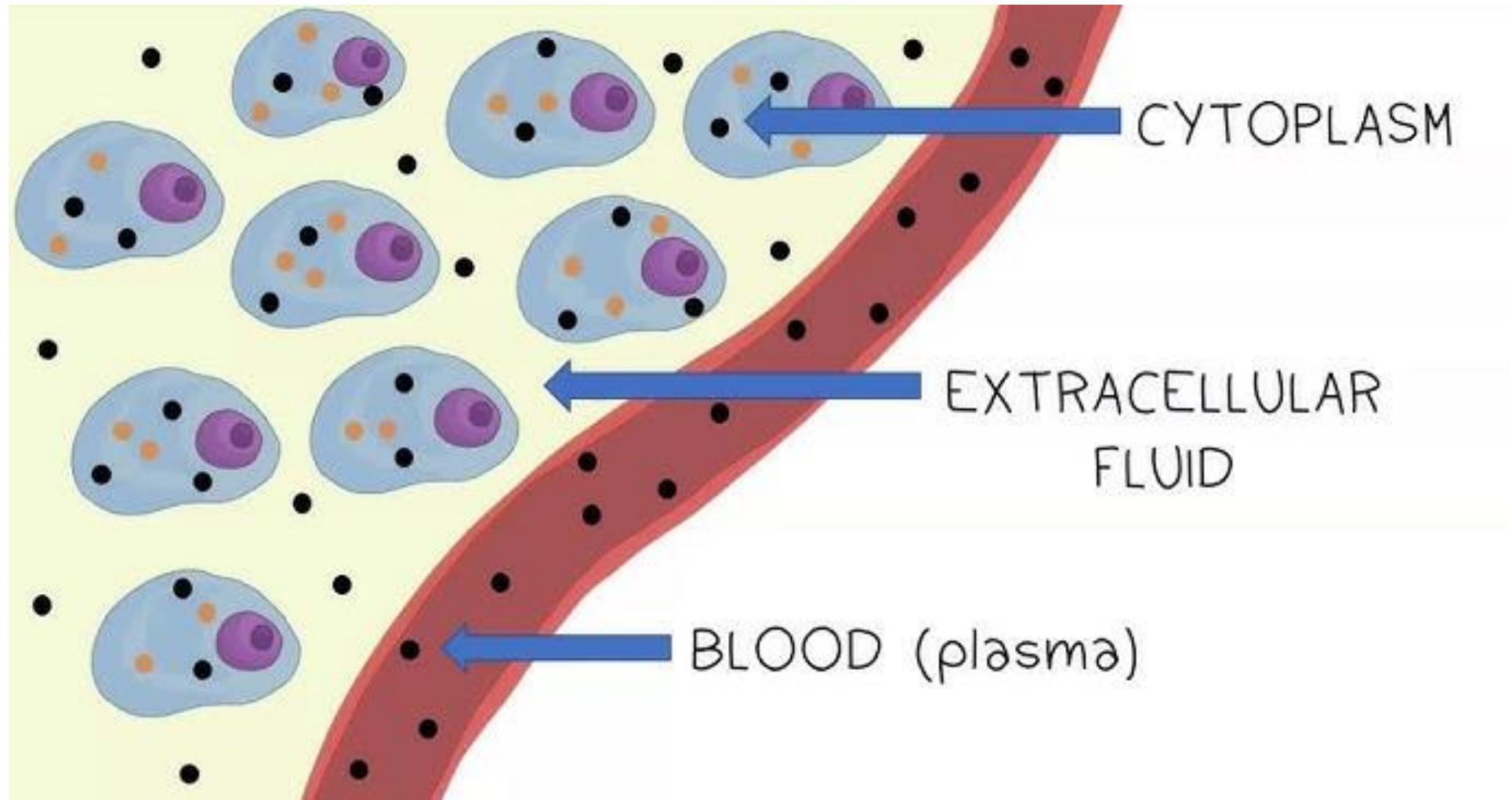
- **Microscopic examination:**

1. Centrilobular hepatocyte necrosis.
2. Hemorrhage.
3. Hemosiderin-laden macrophages



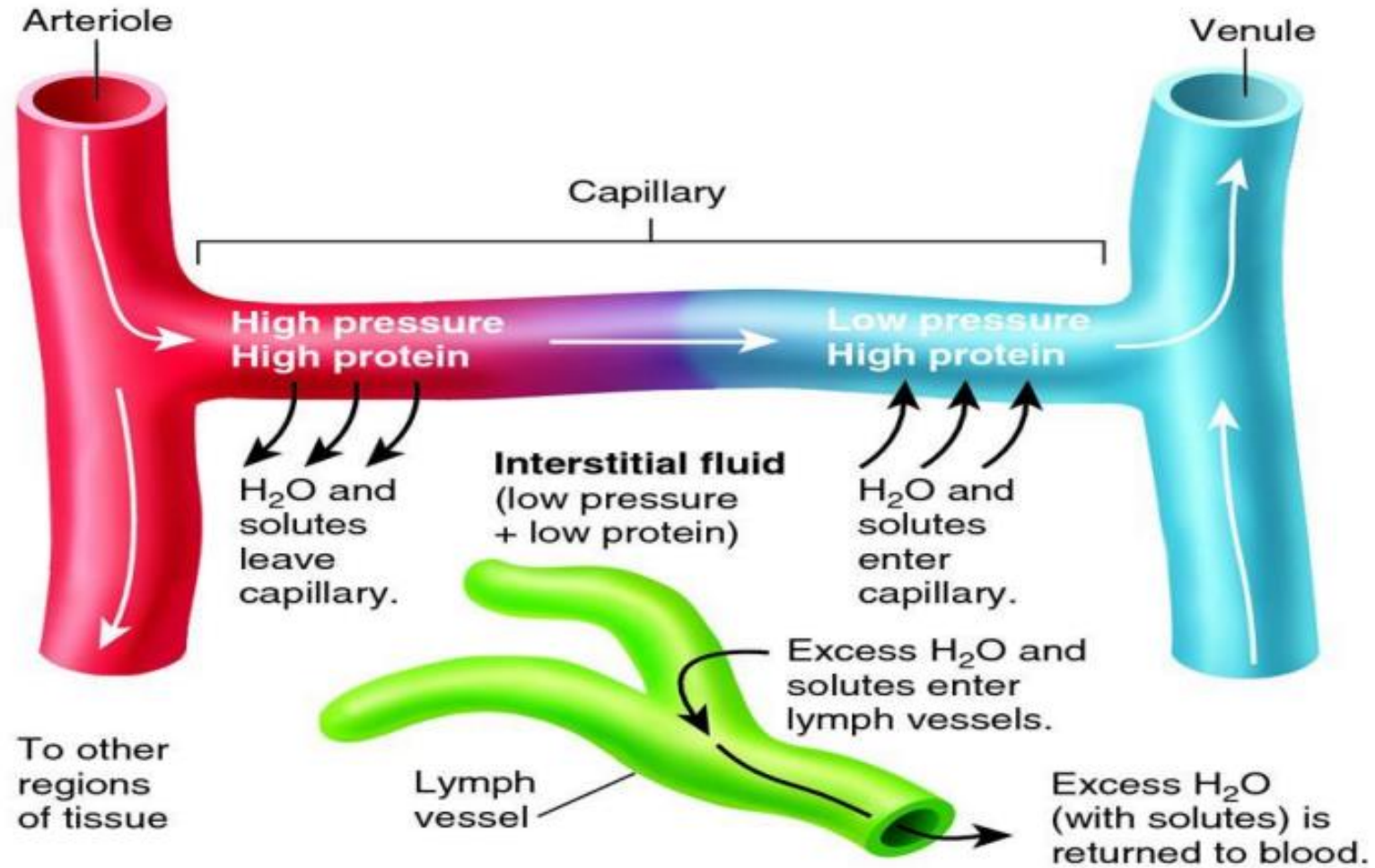
- Microscopic preparation shows centrilobular hepatic necrosis with hemorrhage and scattered inflammatory cells.

# Edema!





# Edema!



# Edema!



- Is an accumulation of interstitial fluid within tissues and subcutaneously.
- Extravascular fluid can also collect in body cavities and such accumulations are often referred to collectively as **effusions.**
- **Examples include:**
  1. Effusions in the pleural cavity (hydrothorax).
  2. The pericardial cavity (hydropericardium).
  3. The peritoneal cavity (hydroperitoneum, or ascites).
- **Anasarca** is **severe, generalized edema** marked by profound swelling of subcutaneous tissues and accumulation of fluid in body cavities.
- Anasarca is a medical condition that leads to general swelling of the whole body



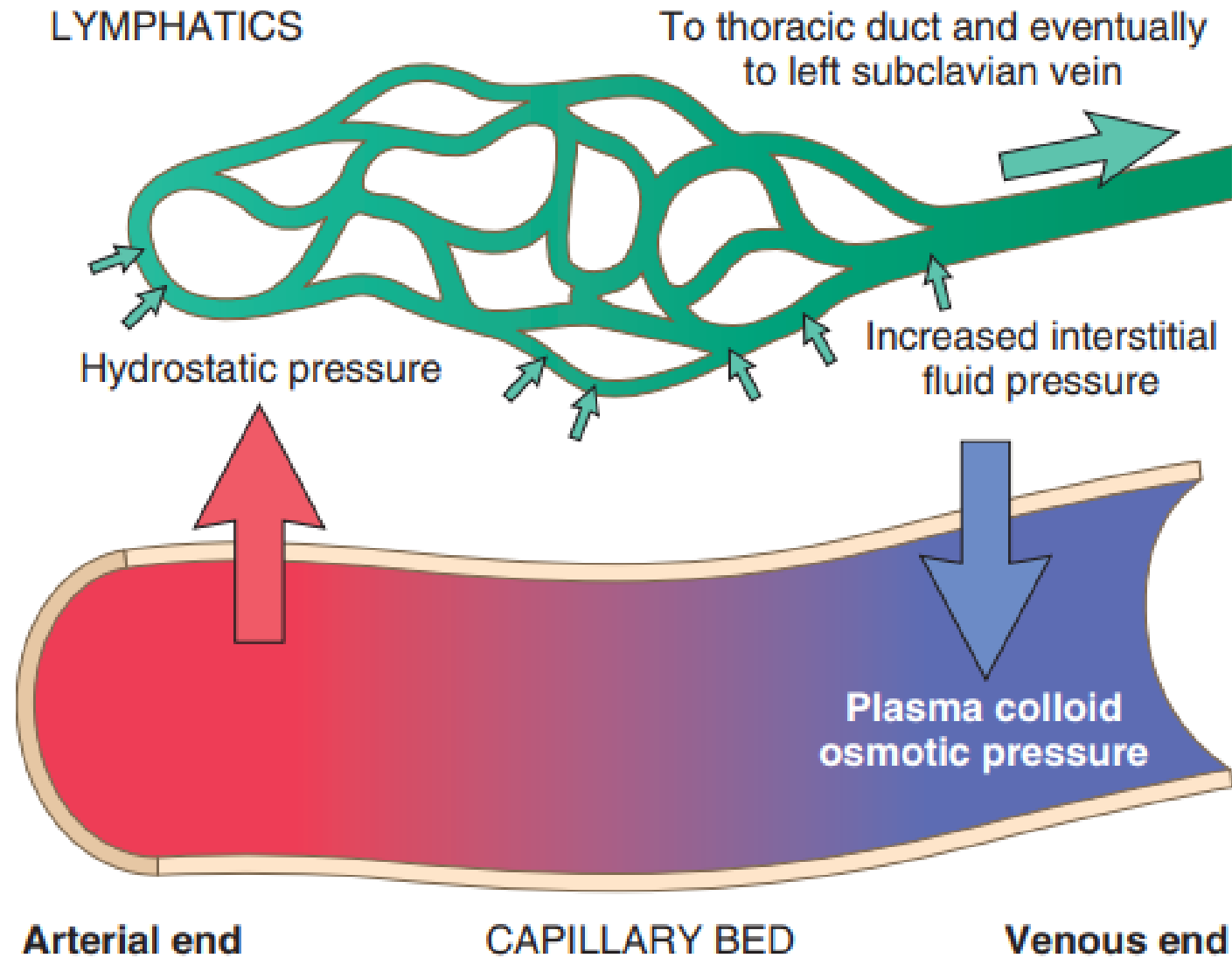
# VA Edema - Mechanism!



- Capillary hydrostatic and osmotic forces are normally balanced so there is little net movement of fluid into the interstitium.
- However, increased hydrostatic pressure or diminished plasma osmotic pressure leads to extravascular fluid accumulation (edema).
- Tissue lymphatics drain much of the excess fluid back to the circulation by way of the thoracic duct; however, if the capacity for lymphatic drainage is exceeded, tissue edema results.



# Edema!



# Edema!



## Increased Hydrostatic Pressure

### *Impaired Venous Return*

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

### *Arteriolar Dilation*

- Heat
- Neurohumoral dysregulation

## Reduced Plasma Osmotic Pressure (Hypoproteinemia)

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

## Lymphatic Obstruction

- Inflammatory
- Neoplastic
- Postsurgical
- Postirradiation

## Sodium Retention

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

## Inflammation

- Acute inflammation
- Chronic inflammation
- Angiogenesis

# Edema - Mechanism!



## 1. Increased Hydrostatic Pressure:

- Increases in hydrostatic pressure are mainly caused by disorders that impair venous return, either:

A. Localized: e.g deep venous thrombosis.

B. Generalized increases in venous pressure: e.g **congestive heart failure.**

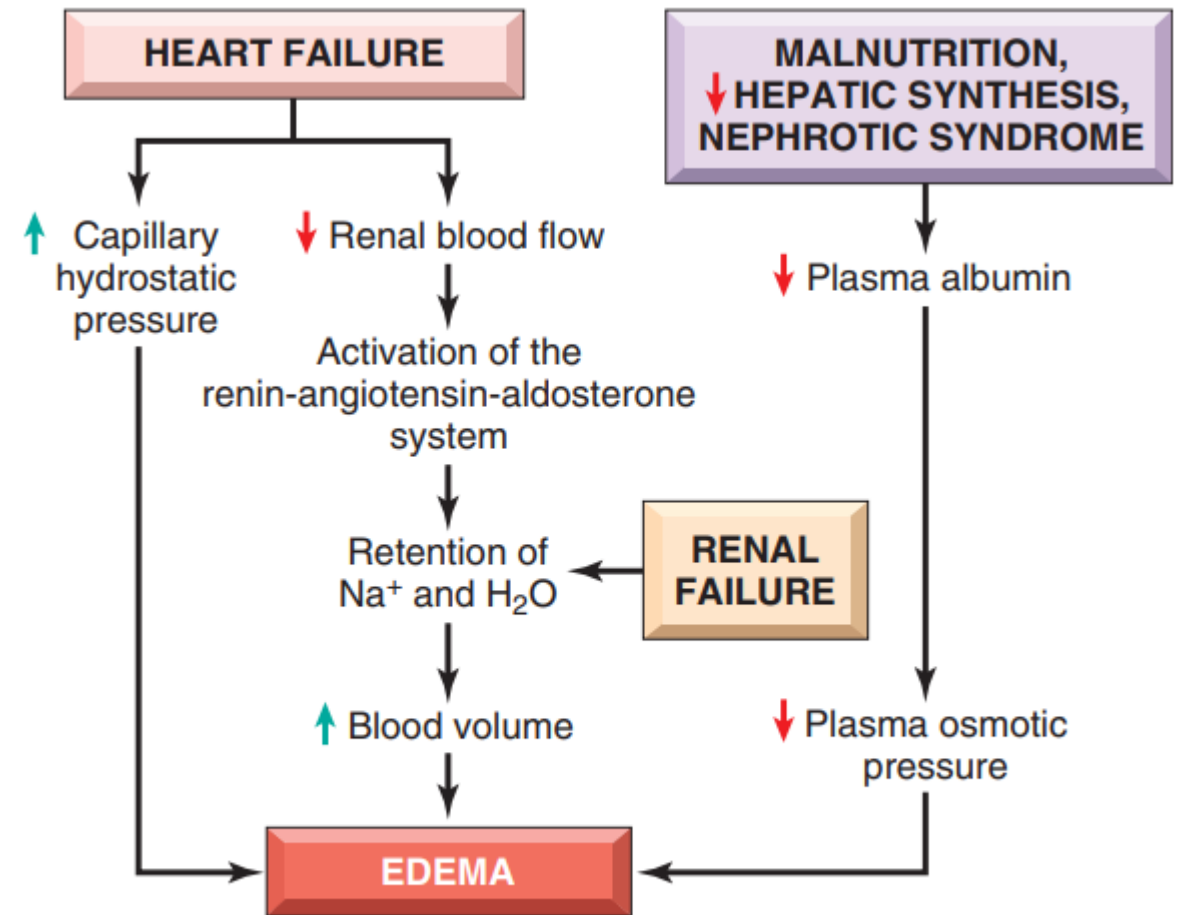


Fig. 4.3 Pathways leading to systemic edema resulting from heart failure, renal failure, or reduced plasma osmotic pressure.

# Edema - Mechanism!



## 2. Reduced Plasma Osmotic Pressure

- Reduction of plasma albumin concentrations leads to decreased colloid osmotic pressure of the blood and loss of fluid from the circulation.
- Albumin accounts for almost half of the total plasma protein.
- **Common causes of reduced plasma osmotic pressure:**
  - A. **Lost from the circulation:** e.g. Nephrotic syndrome
  - B. **Synthesis of inadequate amounts:** e.g. severe liver disease (e.g., cirrhosis) and protein malnutrition.

# Edema - Mechanism!



## 3. Lymphatic Obstruction

- Edema may result from lymphatic obstruction that compromises resorption of fluid from interstitial space.
- Results from a localized obstruction caused by an **inflammatory** or **neoplastic condition**

A. Infiltration and obstruction of superficial lymphatics by **breast cancer** may cause edema of the overlying skin; the characteristic **finely pitted appearance of the skin of the affected breast** is called **peau d'orange** (orange peel).



# Edema - Mechanism!



## 3. Lymphatic Obstruction

- The parasitic infection **filariasis** can cause massive edema of the **lower extremity and external genitalia (so called "elephantiasis")**





# Edema - Mechanism!



## 4. Sodium and Water Retention

- **Excessive retention of salt** lead to edema by increasing hydrostatic pressure (because of expansion of the intravascular volume) and reducing plasma osmotic pressure.
- Excessive salt and water retention are seen in a wide variety of diseases that compromise renal function, including poststreptococcal glomerulonephritis and acute renal failure.

# Edema - Morphology!



- ✓ Edema is easily recognized on gross inspection!
- ✓ Microscopic examination shows clearing and separation of the extracellular matrix (ECM) elements.
- ✓ Although any tissue can be involved, edema most commonly is encountered in **subcutaneous tissues**, lungs, and brain.

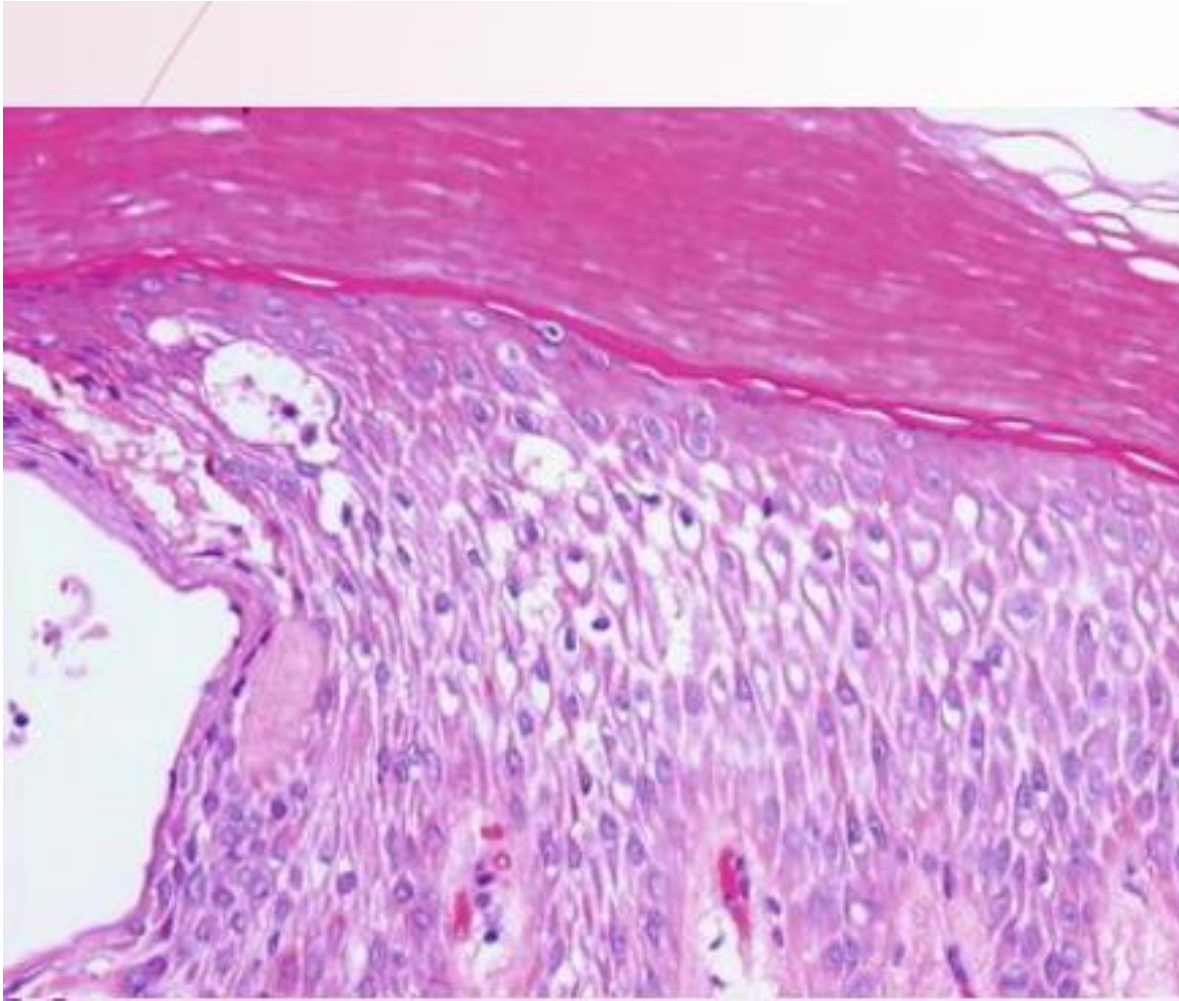




# Subcutaneous edema:

- ✓ Can be diffuse but usually accumulates preferentially in the legs with standing and the sacrum with recumbency, a relationship termed **dependent edema**.
- ✓ Finger pressure over edematous subcutaneous tissue displaces the interstitial fluid, leaving a finger-shaped depression; this appearance is called pitting edema.
- ✓ Under microscope: skin shows clearing and separation of the extracellular matrix

# Subcutaneous edema:



# Edema!



- Edema resulting from renal dysfunction or nephrotic syndrome often manifests first in loose connective tissues (e.g., the eyelids, causing periorbital edema).





# Edema-Clinical Features!



- **Subcutaneous edema:**

- ✓ Is important to recognize primarily because it signals potential underlying cardiac or renal disease.
- ✓ When significant, it also can impair wound healing and the clearance of infections.

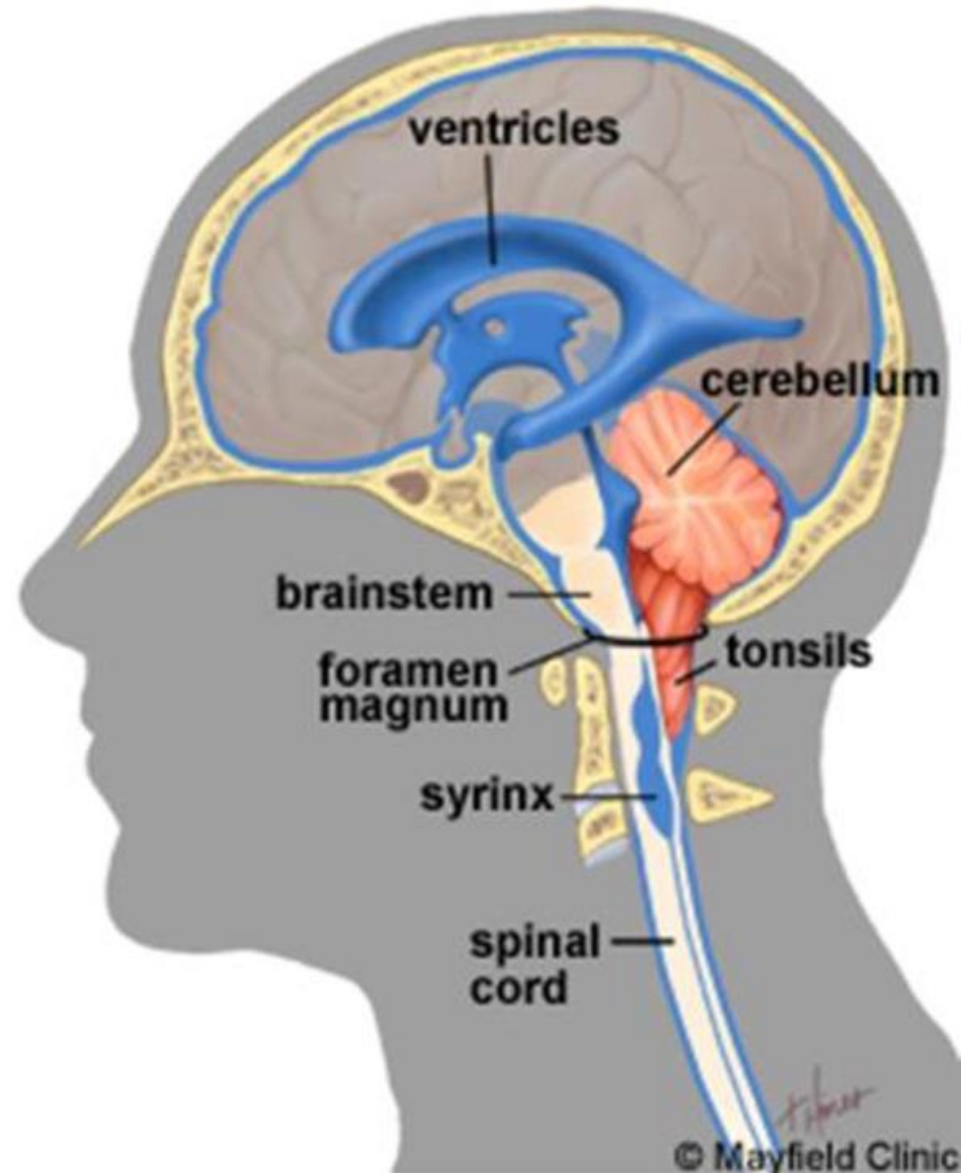
- **Pulmonary edema:**

- ✓ It can cause death by interfering with normal ventilatory function; besides impeding oxygen diffusion, alveolar edema fluid also creates a favorable environment for infections.

- **Brain edema:**

- ✓ Is life threatening; if the swelling is severe, the brain can herniate (extrude) through the foramen magnum pressure, the brain stem vascular supply can be compressed, leading to death due to injury to the medullary centers controlling respiration and other vital functions.

# Edema-Clinical Features!



# ❖ Hemorrhage!

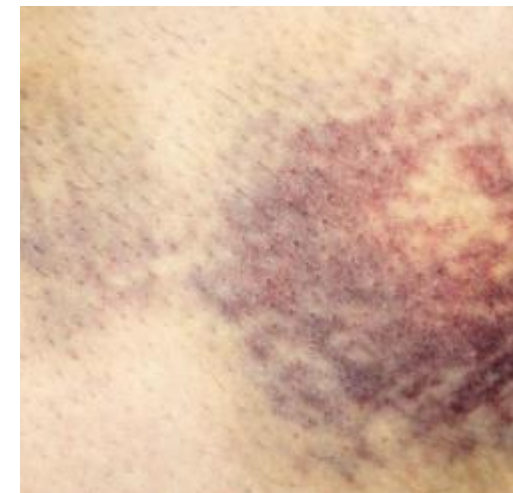


- Extravasation of blood from vessels, is most often the result of damage to blood vessels or defective clot formation.
- Trauma, atherosclerosis, or inflammatory or neoplastic erosion of a vessel wall also may lead to hemorrhage.
- **Hemorrhagic diatheses:** The risk of hemorrhage (often after a seemingly insignificant injury) is increased in a wide variety of clinical disorders collectively called hemorrhagic diatheses.

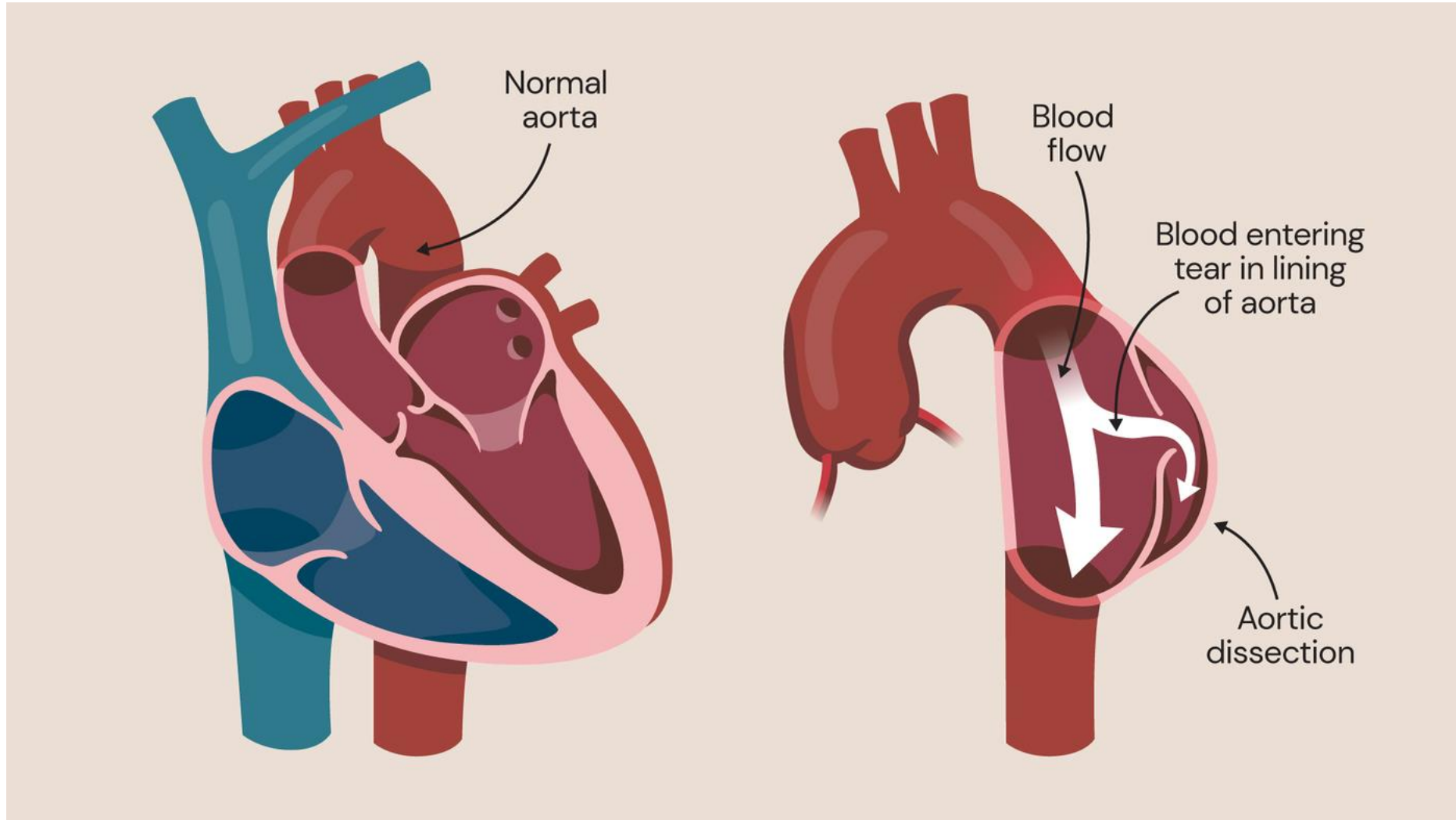
# ❖ Hemorrhage!



- Hemorrhage may be manifested by different appearances and clinical consequences:
- Hemorrhage may be **external** or accumulate within a tissue as a **hematoma**.
- May range in significance from trivial (e.g., a bruise) to fatal (e.g., a massive retroperitoneal hematoma resulting from rupture of a dissecting aortic aneurysm.)
- **Extensive hemorrhages** can occasionally result in **jaundice** from the massive breakdown of red cells and hemoglobin.



# VA Hemorrhage!



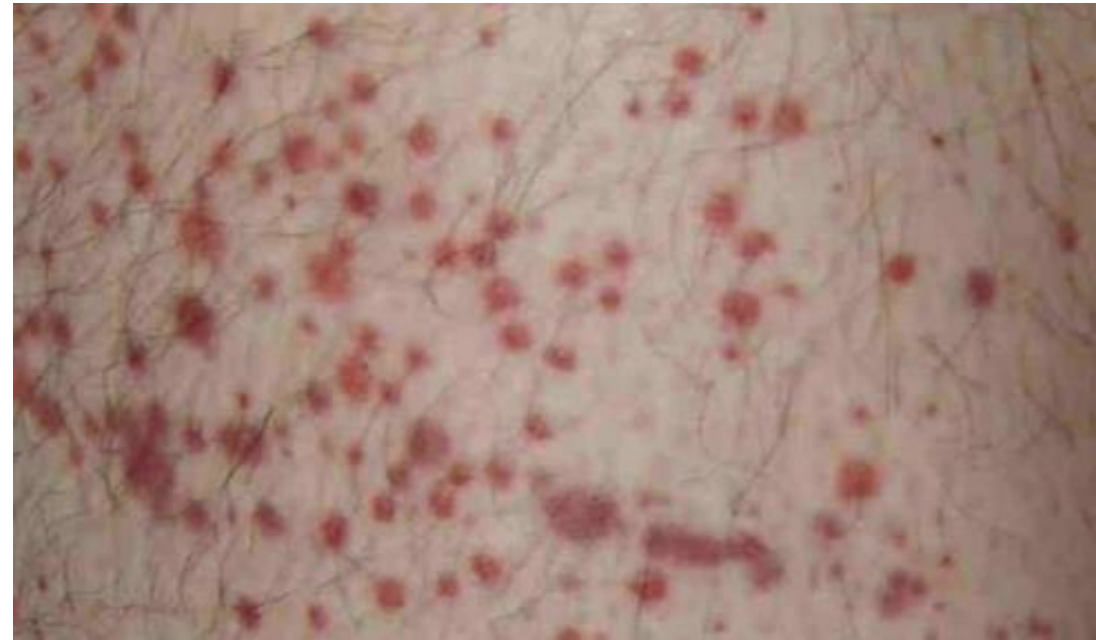


# Subcutaneous bleeding manifests as



## 1. Petechiae:

- Are minute (1 to 2 mm in diameter) hemorrhages into **skin, mucous membranes, or serosal surfaces.**
- Causes:
  1. Low platelet counts (thrombocytopenia).
  2. Defective platelet function.
  3. Loss of vascular wall support, as in vitamin C deficiency.



# Subcutaneous bleeding manifests as



## 1. Purpura:

- Are slightly larger (3 to 5 mm) hemorrhages.
- Purpura can result from the same disorders that cause petechiae, as well as:
  1. Trauma.
  2. Vascular inflammation (vasculitis).
  3. Increased vascular fragility



# Subcutaneous bleeding manifests as



## 3. Ecchymoses:

- Are larger (1 to 2 cm) subcutaneous hematomas (also called bruises).
- Extravasated red cells are phagocytosed and degraded by macrophages; the characteristic color changes of a bruise result from the enzymatic conversion of **hemoglobin (red-blue color)** to **bilirubin (blue-green color)** and **eventually hemosiderin (golden-brown)**



# ❖ Hemorrhage



- The clinical significance of any particular hemorrhage depends on:
  - ✓ The volume of blood that is lost.
  - ✓ The rate of bleeding.



«Wherever the art of medicine is loved,  
there is also a love of humanity.»

- Hippocrates-

