Body fluid distribution

- Intracellular fluid
- Extracellular fluid
- Intravascular fluid
- Interstitial fluid
- Transcellur fluid

Blood comes into:

the right atrium from the body, moves into the right ventricle and is pushed into the pulmonary arteries in the lungs.

After picking up oxygen, the blood travels back to the heart through the pulmonary veins into the left atrium,

to the left ventricle and out to the body's tissues through the aorta.

The average circulation time in normal resting adults for the blood to travel from the arm vein, through the heart and lungs, and up to the mouth, is 13 seconds.

The normal range is 10 to 16 seconds.

net pressure that drives reabsorption —the movement of fluid from the interstitial fluid back into the capillaries —is called osmotic pressure (sometimes referred to as oncotic pressure).

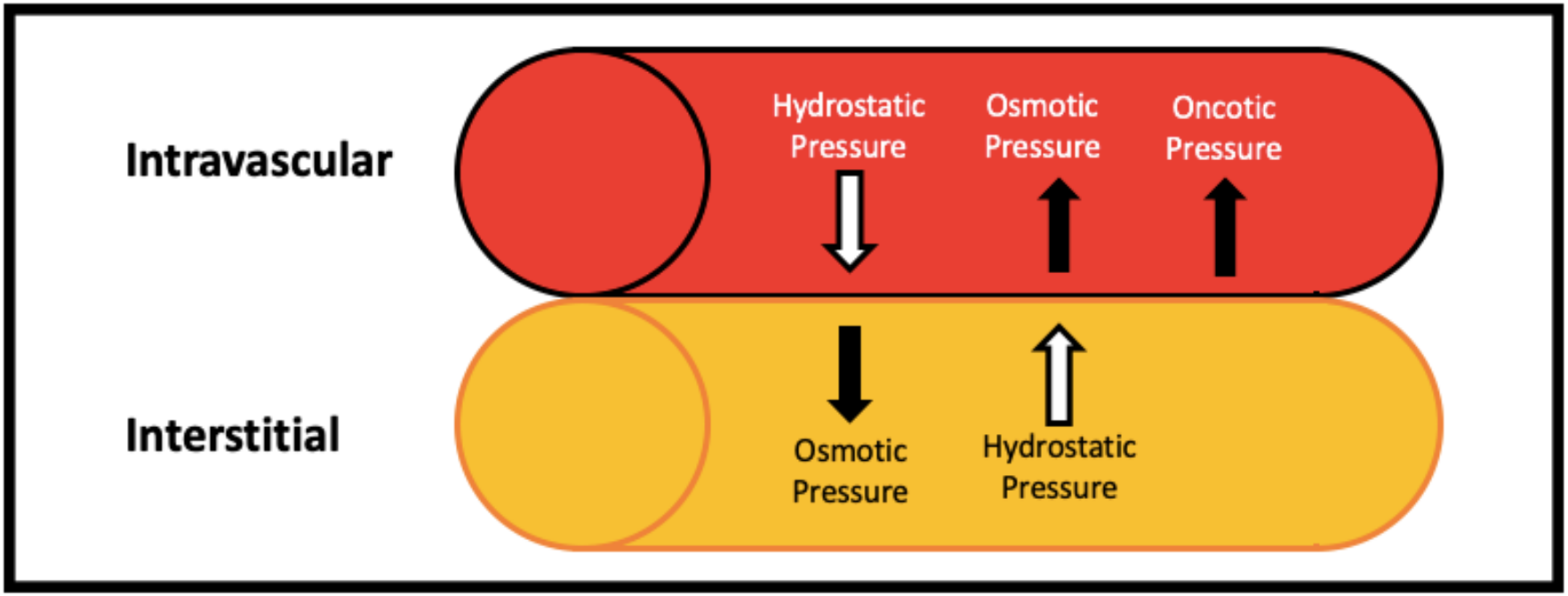
Whereas hydrostatic pressure forces fluid out of the capillary, osmotic pressure draws fluid back in.

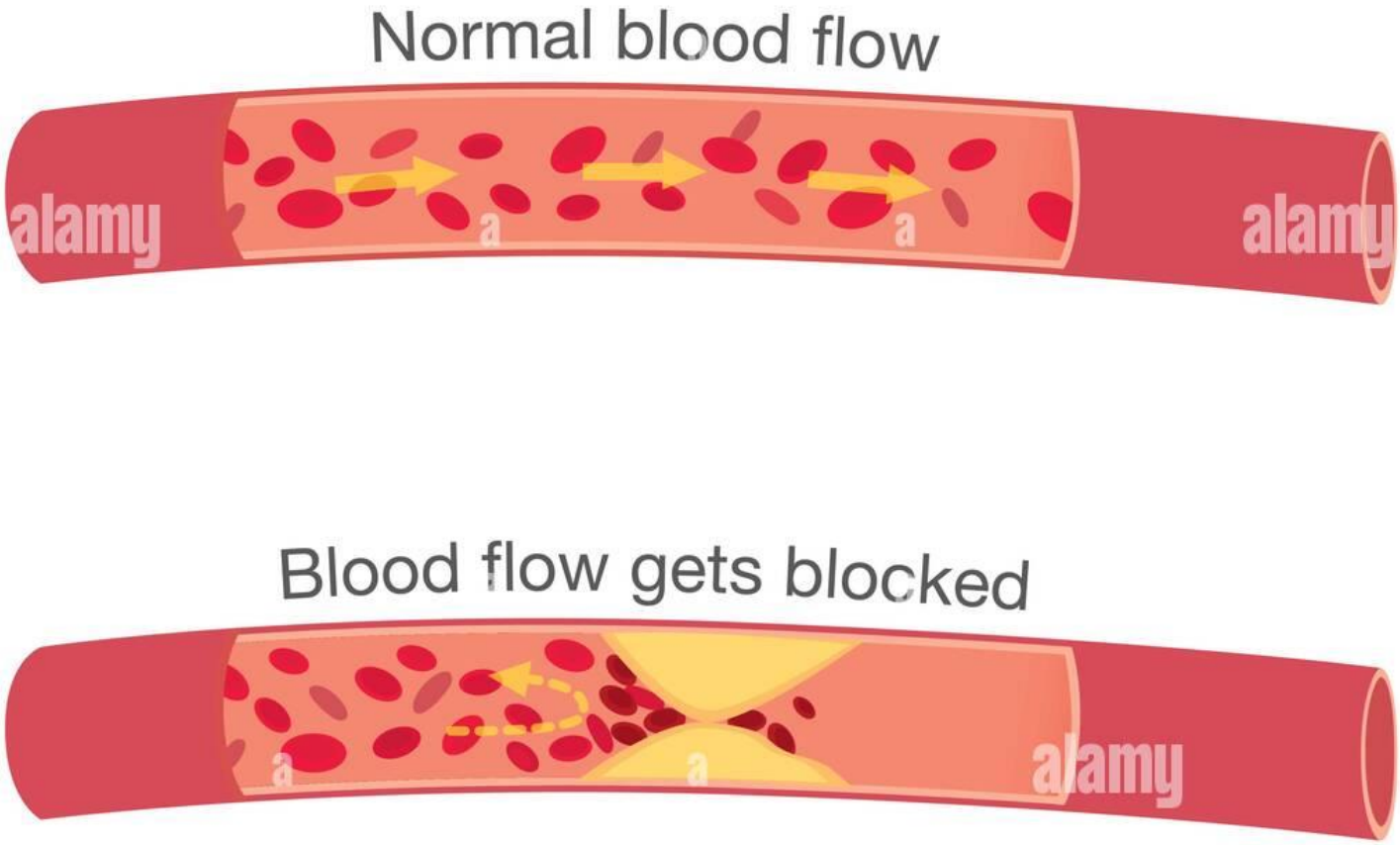
Hydrostatic pressure is the "pushing" force on water due to the presence of more fluid in one region than another.

In general, larger fluid volumes generate higher hydrostatic pressure.

Osmotic pressure is the "pulling" force on water due to the presence of solutes in solution.

Osmotic/Oncotic vs Hydrostatic Pressures





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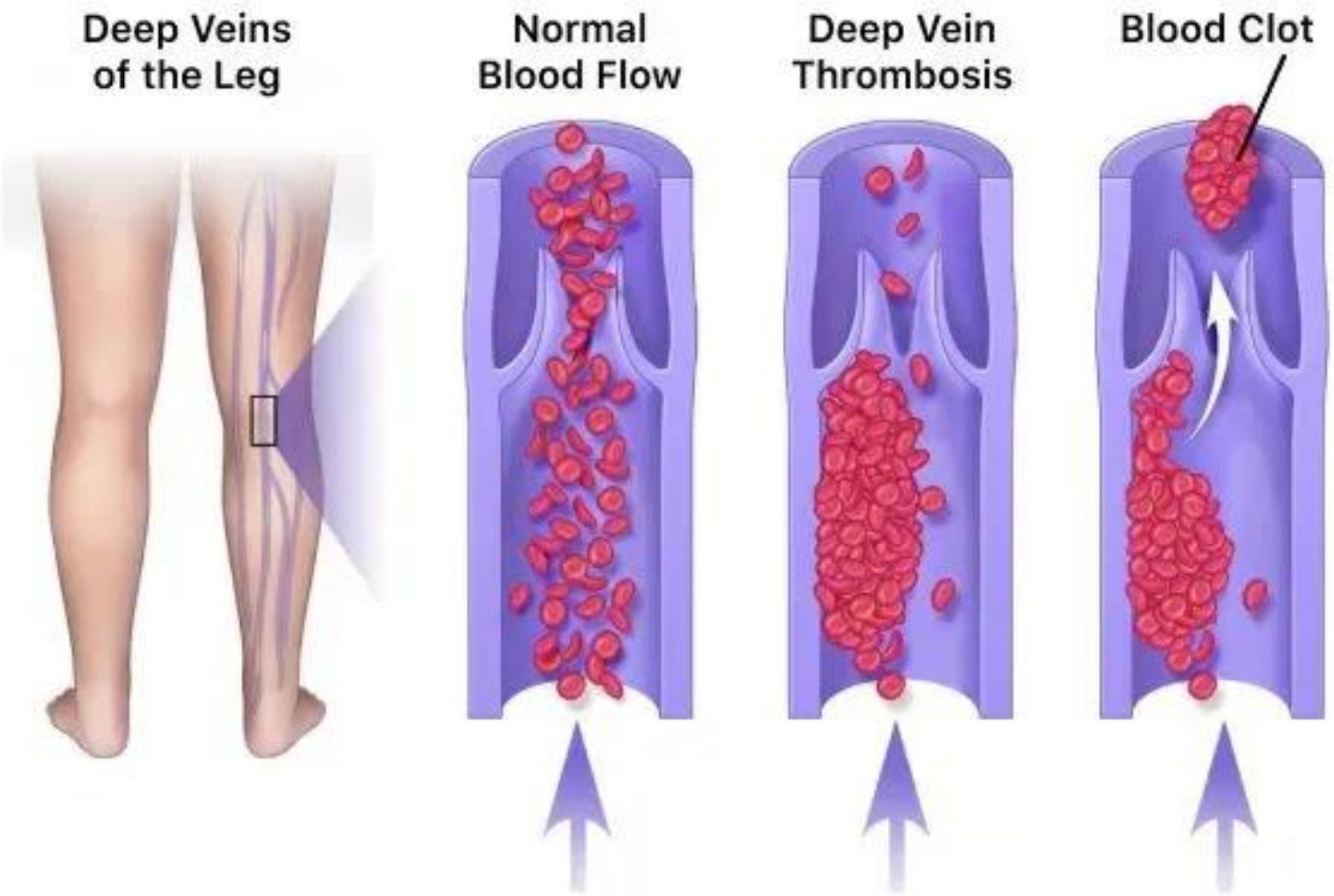
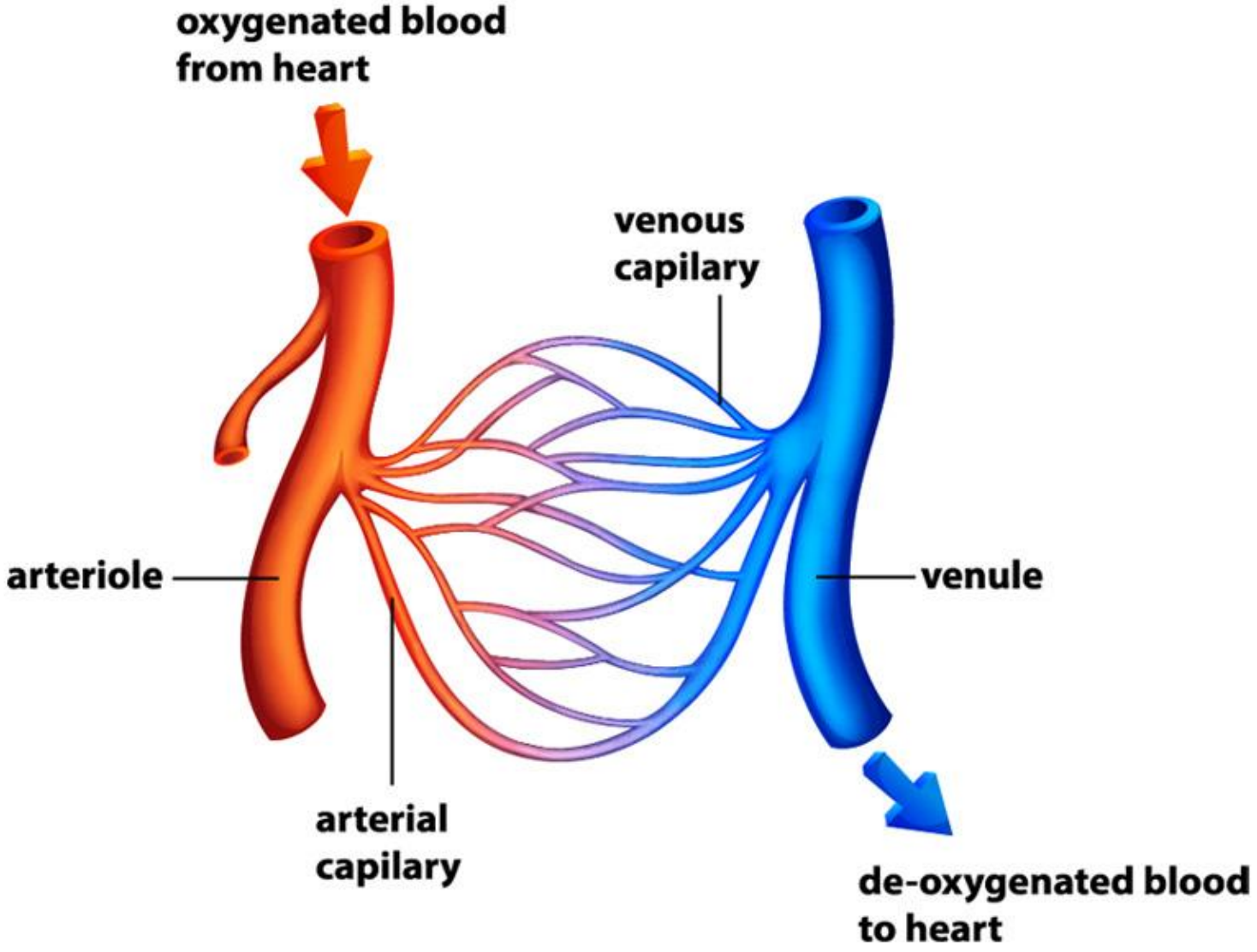
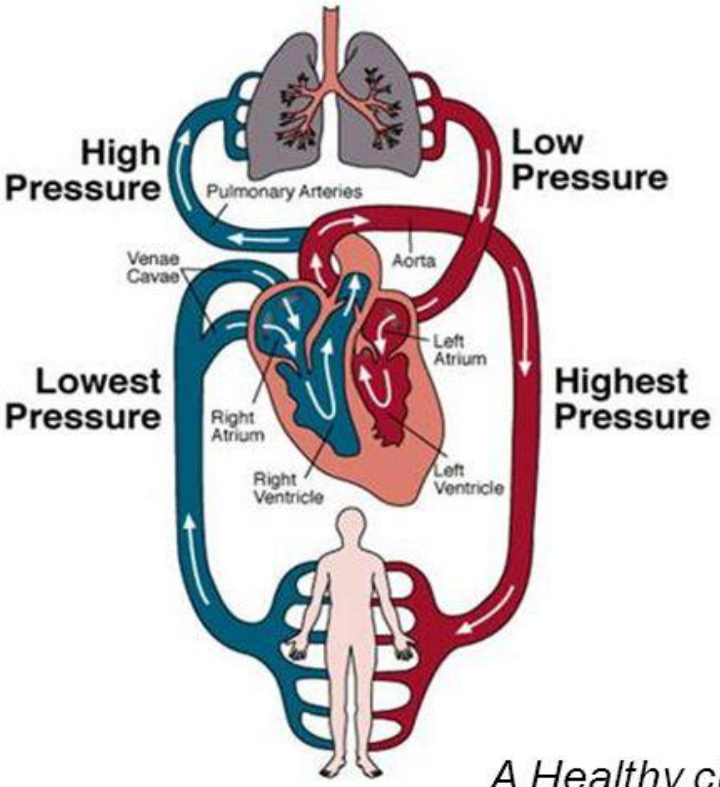
Deep Vein Thrombosis



Circulatory System Capilary Blood Flow



- HEMODYNAMIC DISORDERS



Containing

- Heart, artery, Vein
- General circulation Pulmonary circulation

Functions

- Deliver oxygen and nutrients
- Carry away metabolic wastes

A Healthy circulatory system

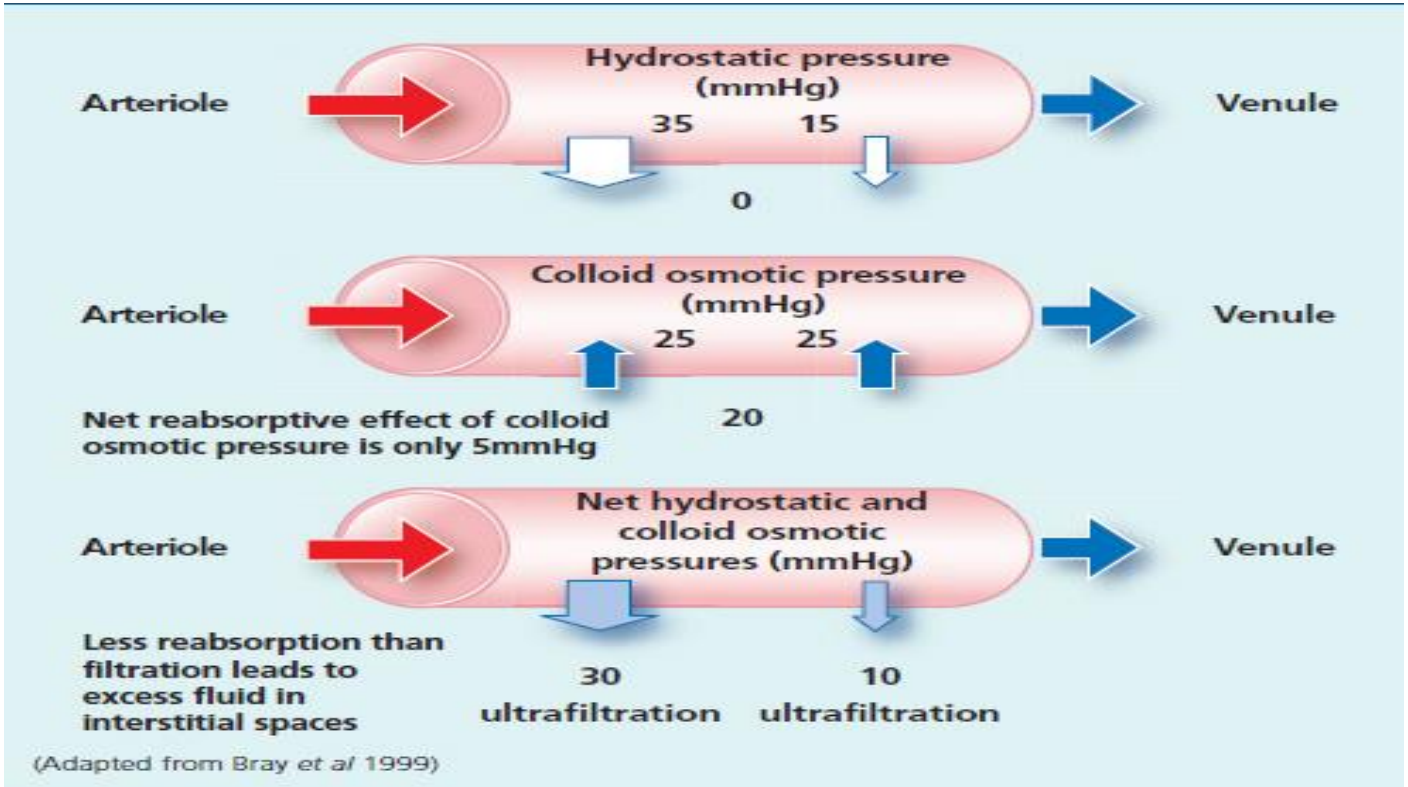
♠ *Normal blood volumn*

♠ *Homeostasis*

- Edema refers to” increased fluid in the interstitial tissue spaces.”
- Extravascular fluid can also collect in body cavities such as the pleural
- cavity (hydrotho- rax), pericardial cavity (hydropericardium), peritoneal
- cavity (hydroperitoneum, or ascites).

- **Mechanisms of edema :**

- Water extravasations (outward movement) across the vascular wall into
- the interstitial spaces. The movement of fluid between vascular and
- interstitial spaces is controlled mainly by the opposing effects of vascular
- hydrostatic pressure and plasma colloid osmotic pressure.



Types of edemas:

1- Inflammatory edema, is a protein-rich exudate with a specific gravity that is usually greater than 1.020, occurs due to increased vascular permeability.

2-Non inflammatory edema, is a protein-poor transudate that has a specific gravity less than 1.012, occurs due to other reasons other than inflammation.

Causes of non-inflammatory edema:

1- Increased Hydrostatic Pressure.

a- deep venous thrombosis in the lower extremities can cause edema restricted to the distal portion of the affected leg.

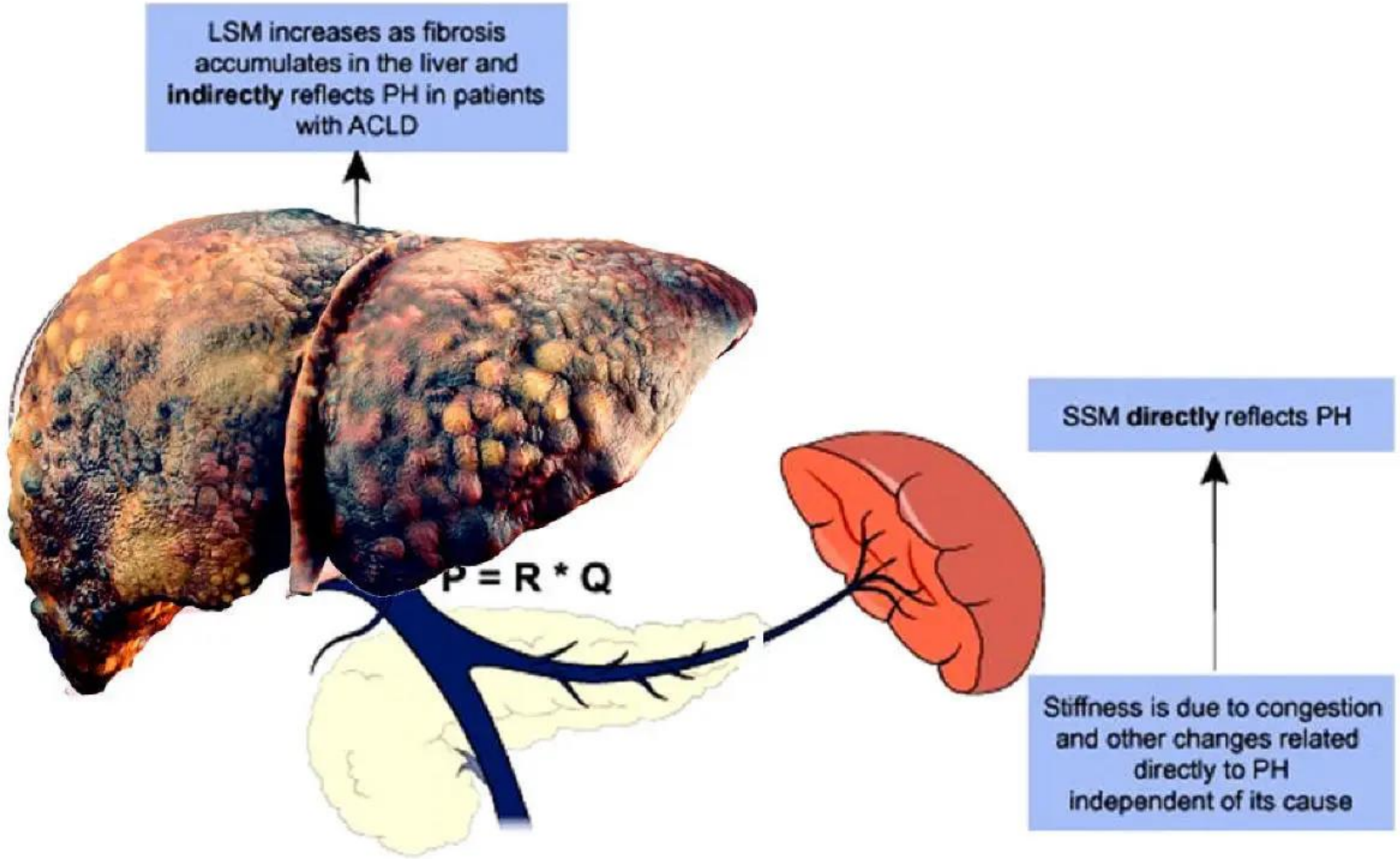
b. Portal hypertension caused by liver cirrhosis.

c. Pressure of gravid uterus on the iliac veins produces congestion and edema of the lower limbs.

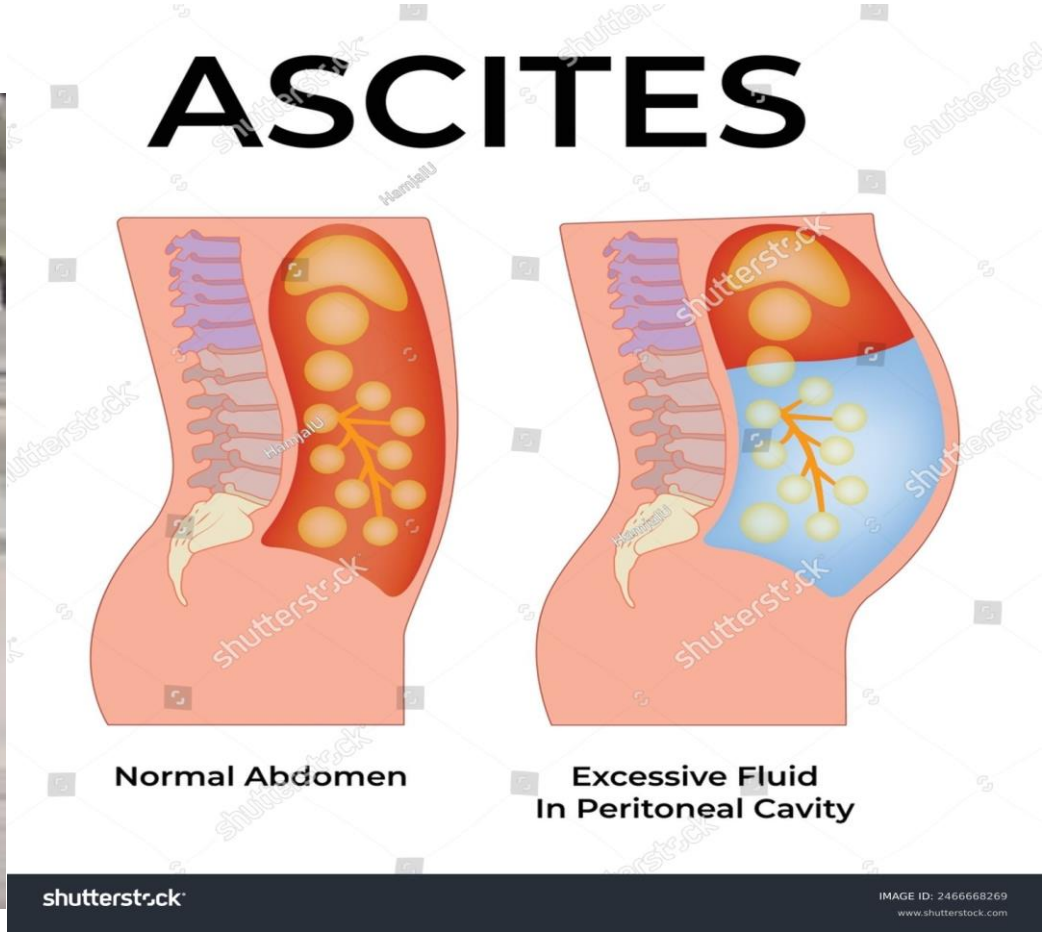
d- Acute left ventricular failure causes acute pulmonary edema

Generalized increases in venous pressure, with resultant systemic edema, occur most commonly in congestive heart failure in which reduced cardiac output results in reduced renal perfusion, inducing sodium and water retention by the kidneys and eventually, edema.

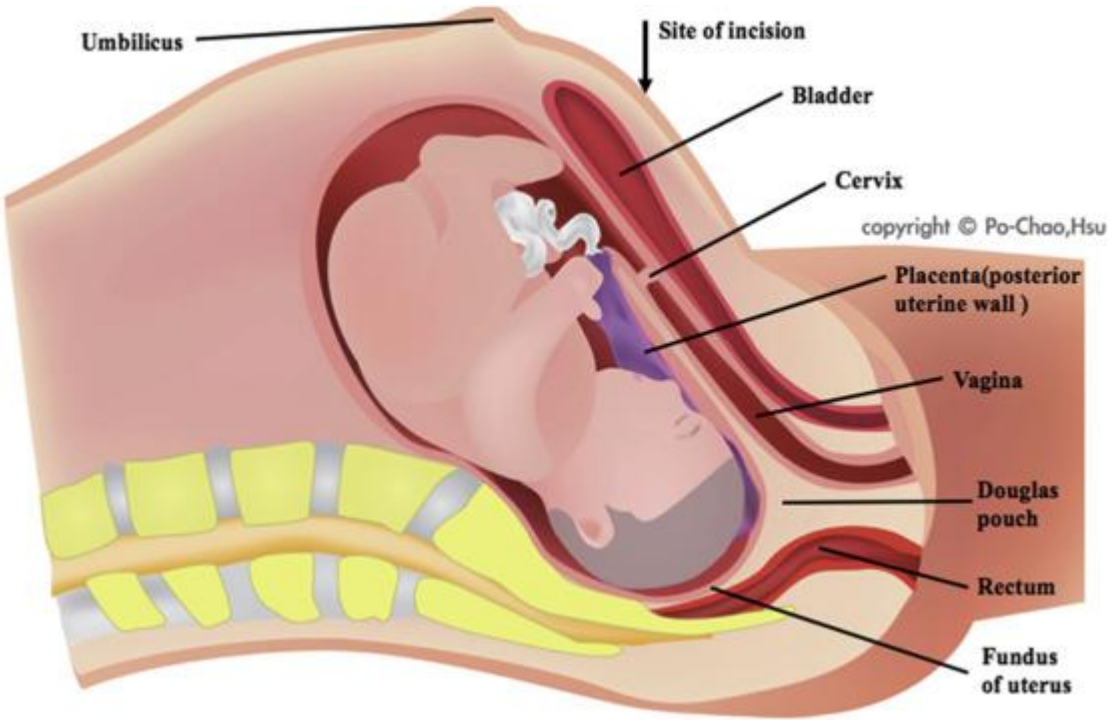
Portal hypertension



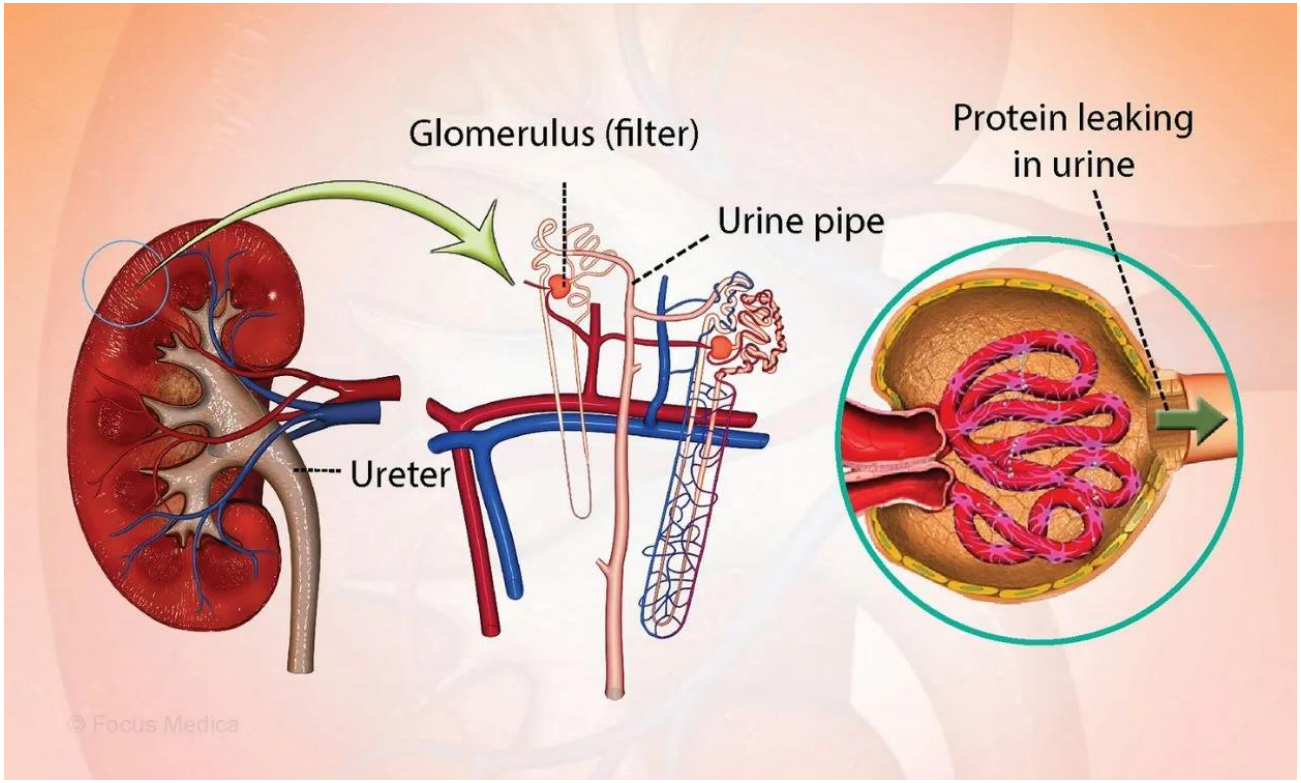
Ascites is a condition that occurs when fluid collects in spaces in your belly (abdomen). If severe, it may be painful. The problem may keep you from moving around comfortably. Ascites can set the stage for an infection in your abdomen. Fluid may also move into your chest and surround your lungs.



Pressure of gravid uterus on the iliac veins produces congestion and edema of the lower limbs.



Nephrotic syndrome is a collection of symptoms due to kidney damage. This includes protein in the urine, low blood albumin levels, high blood lipids, and significant swelling. Other symptoms may include weight gain, feeling tired, and foamy urine.



2-Reduced Plasma Osmotic Pressure:

Albumin is the serum protein synthesized by the liver, most responsible for maintaining intravascular colloid osmotic pressure; reduced osmotic pressure occurs when:-
Albumin is lost from the circulation.

2- Albumin synthesis is reduced which occurs in diffuse liver diseases (e.g., liver cirrhosis)

3- protein malnutrition in each case, reduced plasma osmotic pressure leads to a net movement of fluid into the interstitial tissues resulting in edema.

3-Lymphatic Obstruction:

Obstruction of lymphatic drainage and consequent lymphedema is usually localized; it can result from inflammatory or neoplastic lesions.

-**Sodium and Water Retention:**

Increased salt and water causes both increased hydrostatic pressure (due to expansion of the intravascular volume) and reduced vascular osmotic pressure. Salt retention can occur in poststreptococcal glomerulonephritis and acute renal failure.

Morphology of edema:

Subcutaneous edema: This can be diffuse or more prominent in regions with high hydrostatic pressures.

Finger pressure over significantly edematous subcutaneous tissue displaces the interstitial fluid and leaves a finger-shaped depression, so called pitting edema

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

Pulmonary edema: This is a common clinical problem that is encountered with left ventricular failure

Brain Edema: This may be localized to sites of focal injury (e.g., infarct, abscesses or neoplasms) or may be generalized, as in encephalitis, hypertensive crises, or obstruction to the brain's venous outflow.

Trauma may result in local or generalized edema, depending on the nature and extent of the injury

Clinical significance of edema:

1- Minimal effects.

2- Subcutaneous tissue edema in cardiac or renal failure is important primarily because it indicates underlying disease.

3- In the lungs, edema fluid will fill alveoli and can result in lifethreatening breathing difficulties.

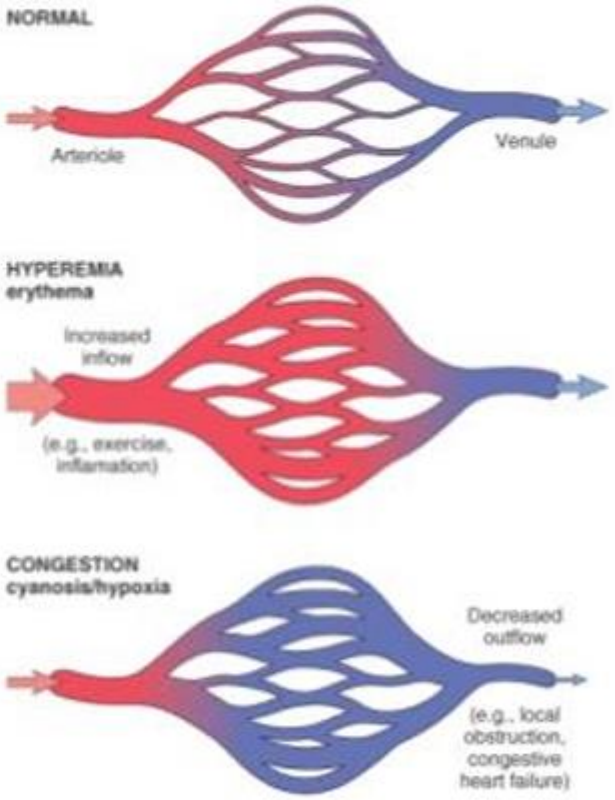
Hyperemia and Congestion:

Both indicate a local increased volume of blood in a particular tissue.

The affected tissue is redder than normal because of engorgement with oxygenated blood.

Hyperemia

- A local increased volume of blood in a particular tissue
  - Dilatation of small vessels
- Two types
  - Arterial (active) hyperemia-hyperemia
    - from augmented blood flow due to arteriolar dilation
  - Venous hyperemia-congestion, cyanosis
    - a *passive process* resulting from impaired venous return out of a tissue
    - closely related to the development of edema
      - so that congestion and edema commonly occur together



Congestion is a passive process resulting from impaired venous return out of a tissue.
It may occur systemically, as in cardiac failure, or it may be local, resulting from an isolated venous obstruction.
The tissue has a blue-red color (cyanosis), especially as worsening congestion leads to accumulation of deoxygenated hemoglobin in the affected tissues.

Congestion of capillary beds is closely related to the development of edema, so that congestion and edema commonly occur together.
Chronic passive congestion: It is long-standing congestion, in which the stasis of poorly oxygenated blood causes chronic hypoxia (decrease oxygen supply), result in degeneration or death of cells and subsequent tissue fibrosis.

MICROSCOPY

CHRONIC VENOUS CONGESTION - LIVER

CENTRAL Vein (dilated and congested)

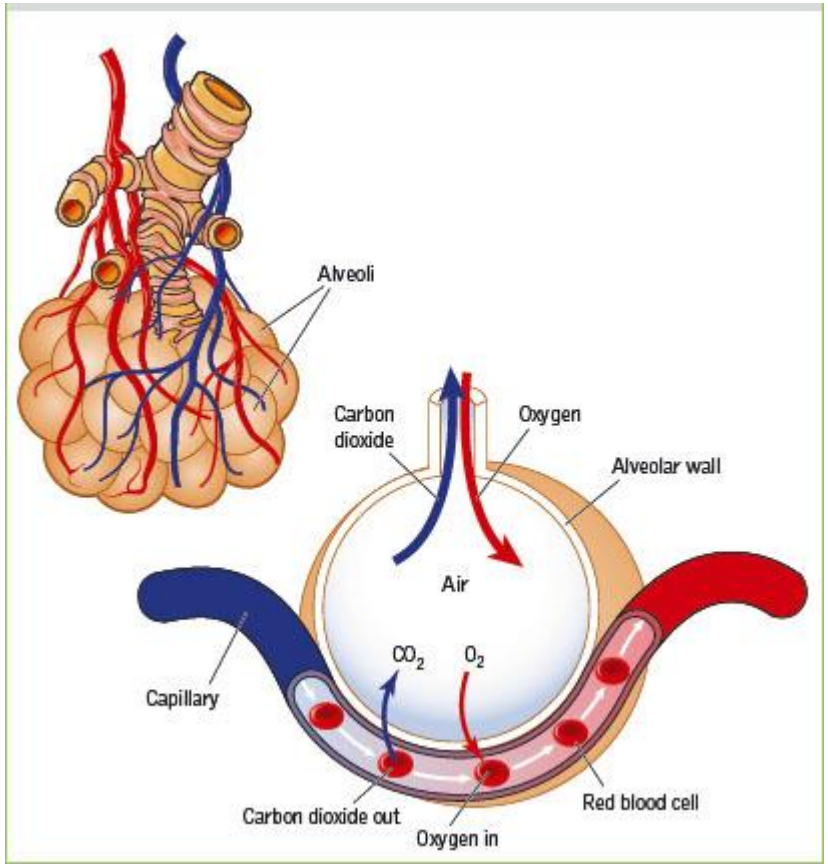
Central hemorrhagic necrosis

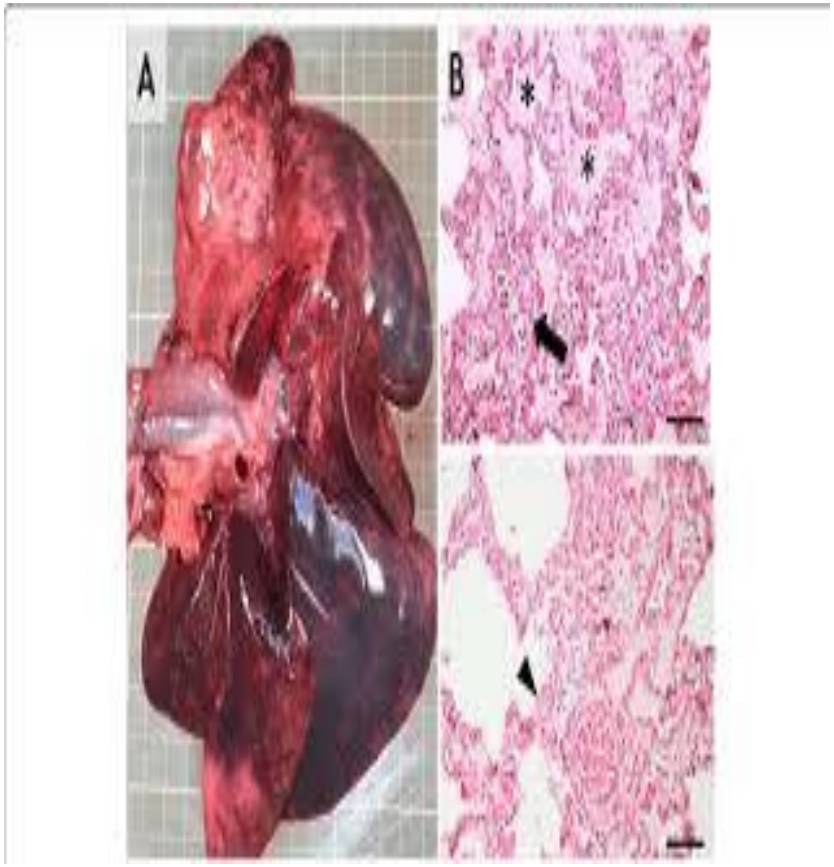
Fatty Change

Portal triad

@VijayPatho

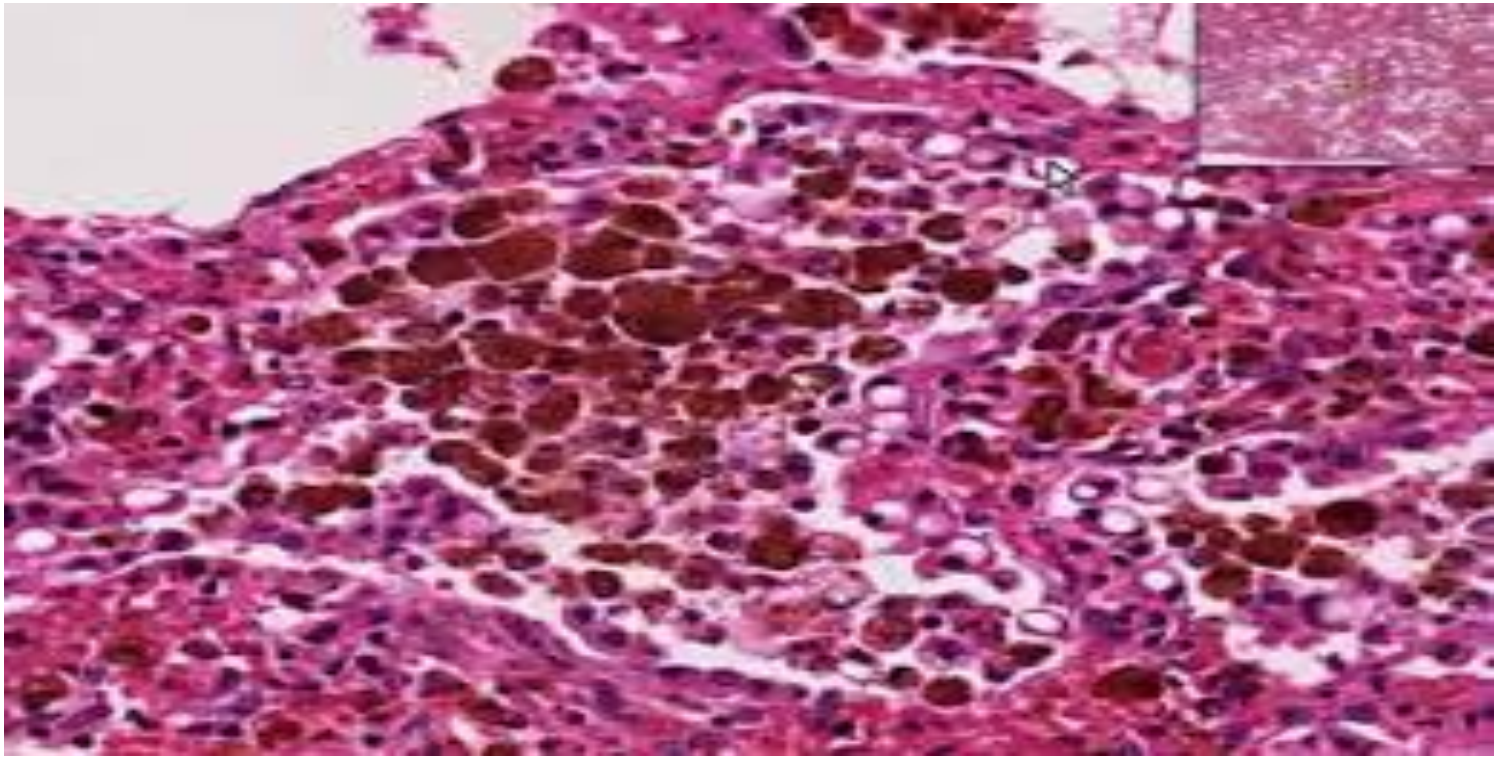
Acute pulmonary congestion is characterized by alveolar capillaries engorged with blood; alveolar septal edema and/or focal minute intraalveolar hemorrhage.



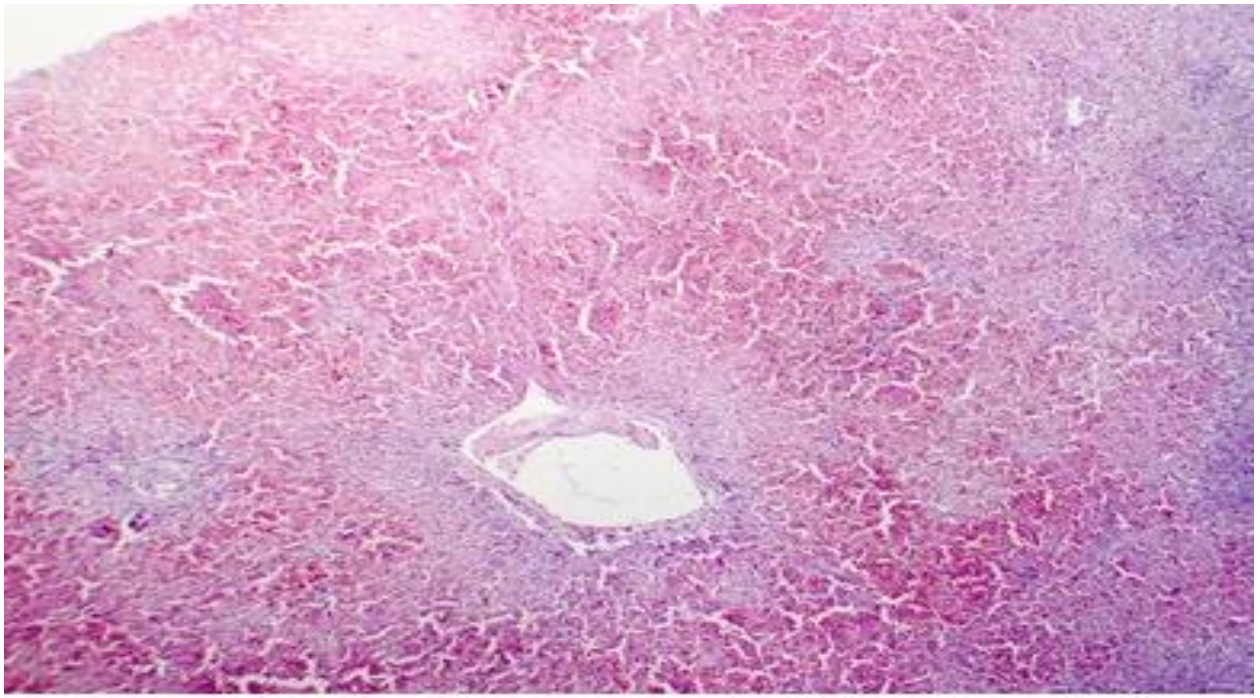


In chronic pulmonary congestion the septa become thickened and fibrotic, and the alveolar spaces may contain numerous hemosiderin laden macrophages which are called "heart failure cells".

Heart failure cells are siderophages generated in the alveoli of the lungs of people with left heart failure or chronic pulmonary edema, when the high pulmonary blood pressure causes red blood cells to pass through the vascular wall.



In acute hepatic congestion the central vein and sinusoids are distended with blood, and there may even be central hepatocyte degeneration; the periportal hepatocytes, better oxygenated because of their proximity to hepatic arterioles, undergo less severe hypoxia and may develop only fatty change.



In chronic hepatic congestion, the central regions of the hepatic lobules are grossly red-brown and slightly depressed (because of a loss of cells) and are accentuated against the surrounding zones of uncongested tan, sometimes fatty liver, which is called "nutmeg liver". Microscopically, there is centrilobular necrosis of hepatocytes.

Hyperemia is active process resulting from increased blood flow due to arteriolardilation (e.g., at sites of inflammation or in skeletal muscle during exercise).

The affected tissue is redder than normal because of engorgement with oxygenated blood.

Congestion is a passive process resulting from impaired venous return out of a tissue. It may occur systemically, as in cardiac failure, or it may be local, resulting from an isolated venous obstruction.

A hematoma is usually caused by a broken blood vessel that was damaged by surgery or an injury.

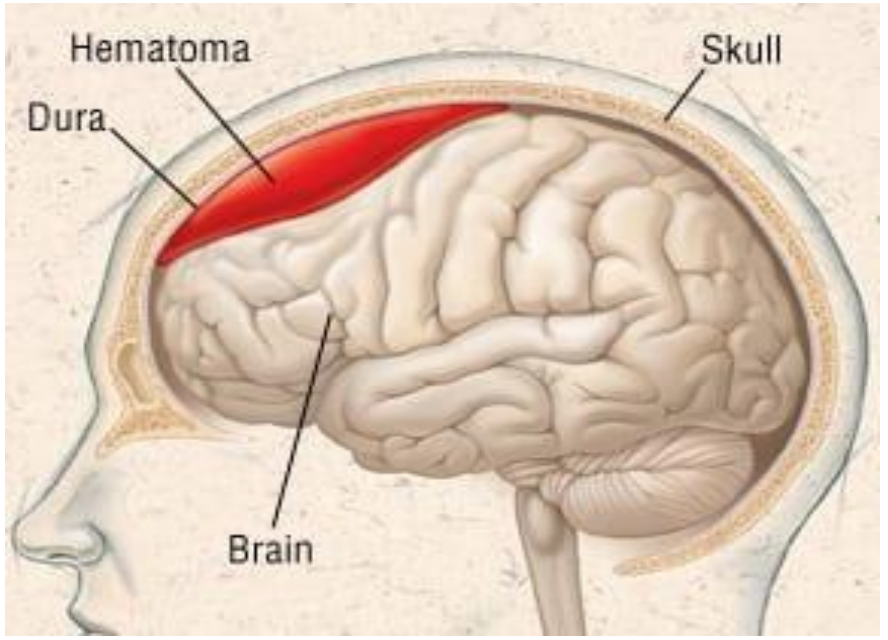
Petechiae:**1-2mm**are tiny spots of bleeding under the skin or in the mucous membranes (mouth or eyelids).

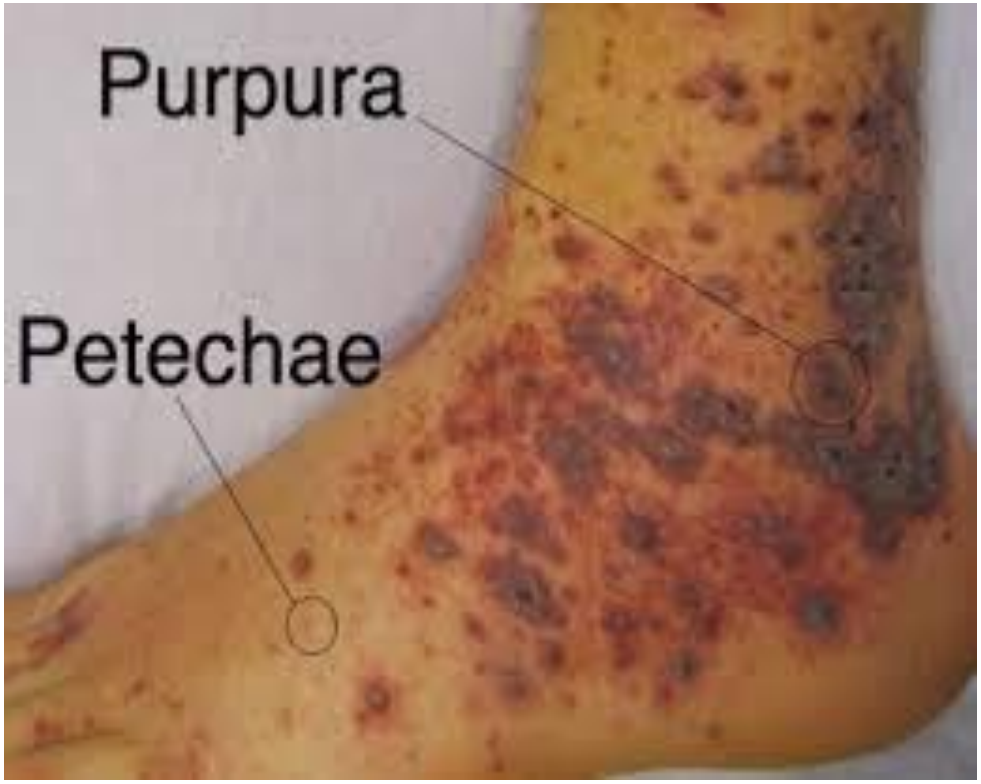
Purpura: 2-3mmis purple spots or patches on your skin or in your mucus membranes (such as your mouth and throat). The spots appear differently depending on your skin tone.

Ecchymosis" 1-2cmis the medical term for bruises. These form when blood pools under your skin.

Hematomas may occur in any blood vessel, including veins, arteries, and capillaries. The location of the hematoma may change its nature.

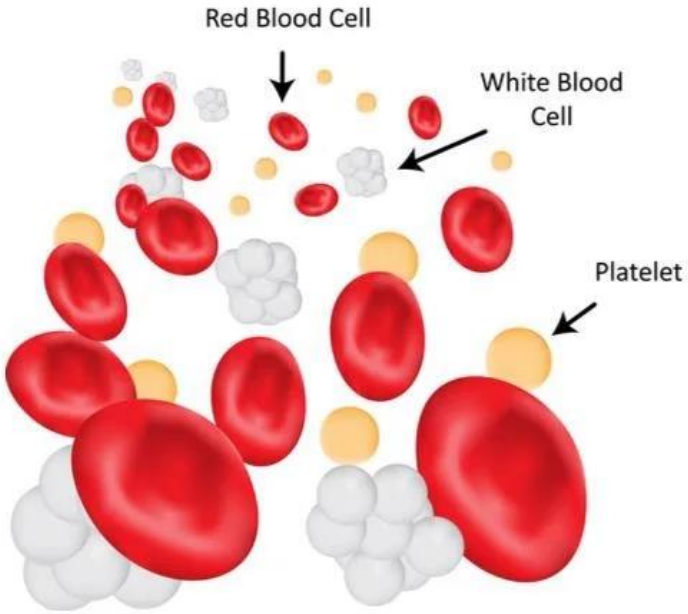
A hematoma is similar to a hemorrhage, but a hemorrhage refers to ongoing bleeding while the blood in a hematoma has typically already clotted.


Hematoma
Skull
Dura
Brain

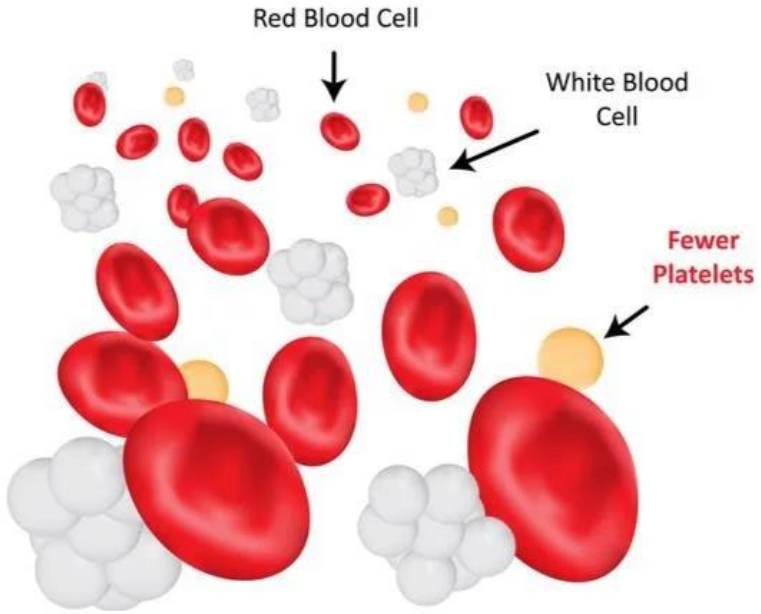

Purpura
Petechae

Thrombocytopenia

Normal Blood

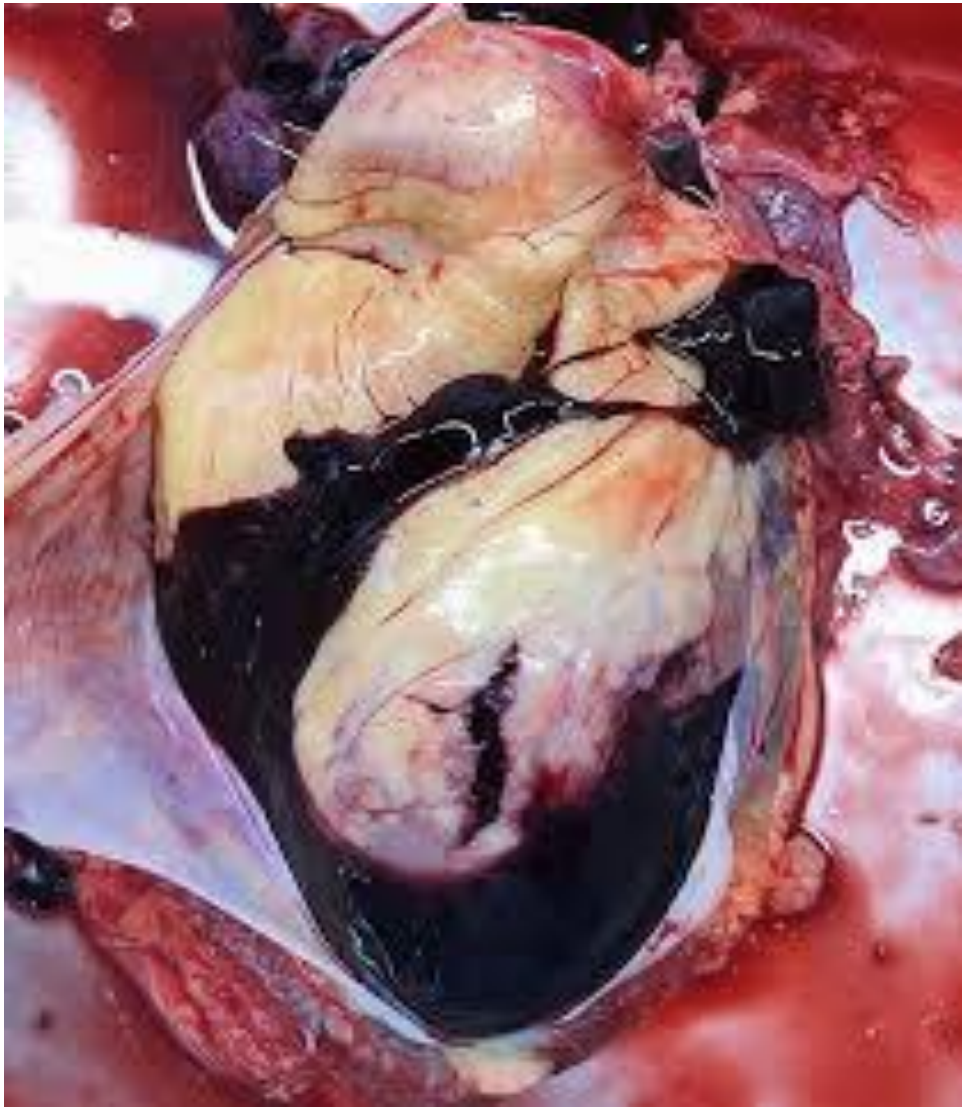


Platelet Deficiency




ADAM


A
B
C



The clinical significance of hemorrhage:

1- Rapid removal of as much as 20% of the blood volume or slow losses of larger amounts may have little effects in healthy adults.

2- Greater losses, however, can cause hemorrhagic shock.

3- The site of hemorrhage is also important; bleeding that would be harmless in the subcutaneous tissues may cause death if located in the brain.

4- Chronic or recurrent external blood loss (e.g., a peptic ulcer or menstrual bleeding) causes a net loss of iron, resulting in an iron deficiency anemia