Disturbances of blood flow; water and salts balance:

Edema:

Its term refer to "pathological accumulation of excessive amount of fluid in the tissue spaces, serous cavities or pulmonary alveoli".

Normally, ***60%*** of body weight is ***water***; ***2/3*** of which is ***intracellular*** (inside the cells) and ***1/3*** is ***extra cellular*** (outside the cells).The latter is mainly ***intercellular*** (interstitial).

Intravascular fluid (blood plasma constitutes only ***5%*** of the total body water).

Nature of accumulated fluid:

General speaking, the accumulated fluids is either:

1. ***Transudate:*** This is a ***serous*** (***thin***), ***protein-poor fluid***, that is encountered for e.g. in ***heart failure*** or ***Nephrotic syndrome***.

-It has ***specific gravity <1.012*** (***protein concentration less than 2.5 g/dl***).

-It's usually related to ***increased hydrostatic pressure*** within the intravascular compartment.

2. ***Exudate:*** This differs from transudate in that it is:

- ***Protein-rich***.

- ***Encountered with inflammation***.

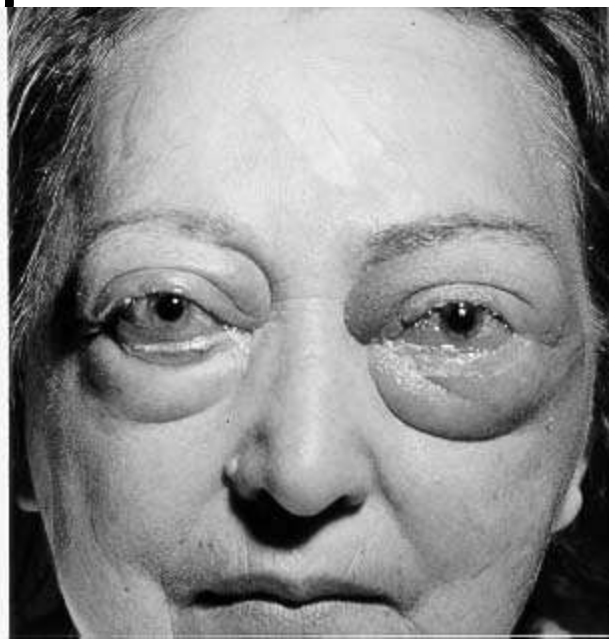
- Resulting from ***increased vascular permeability*** that leads to escape of intra-vascular proteins principally albumins.

- Having ***specific gravity >1.012*** (***protein concentration more than 2.5 g/dl***).

Types of edema:

Edema could be either:

1. ***Localized*** to one part of the body or
2. ***Generalized*** (systemic)



Anasarca: It refers to sever, generalized edema, including profound sub-cutanious tissue accumulations.

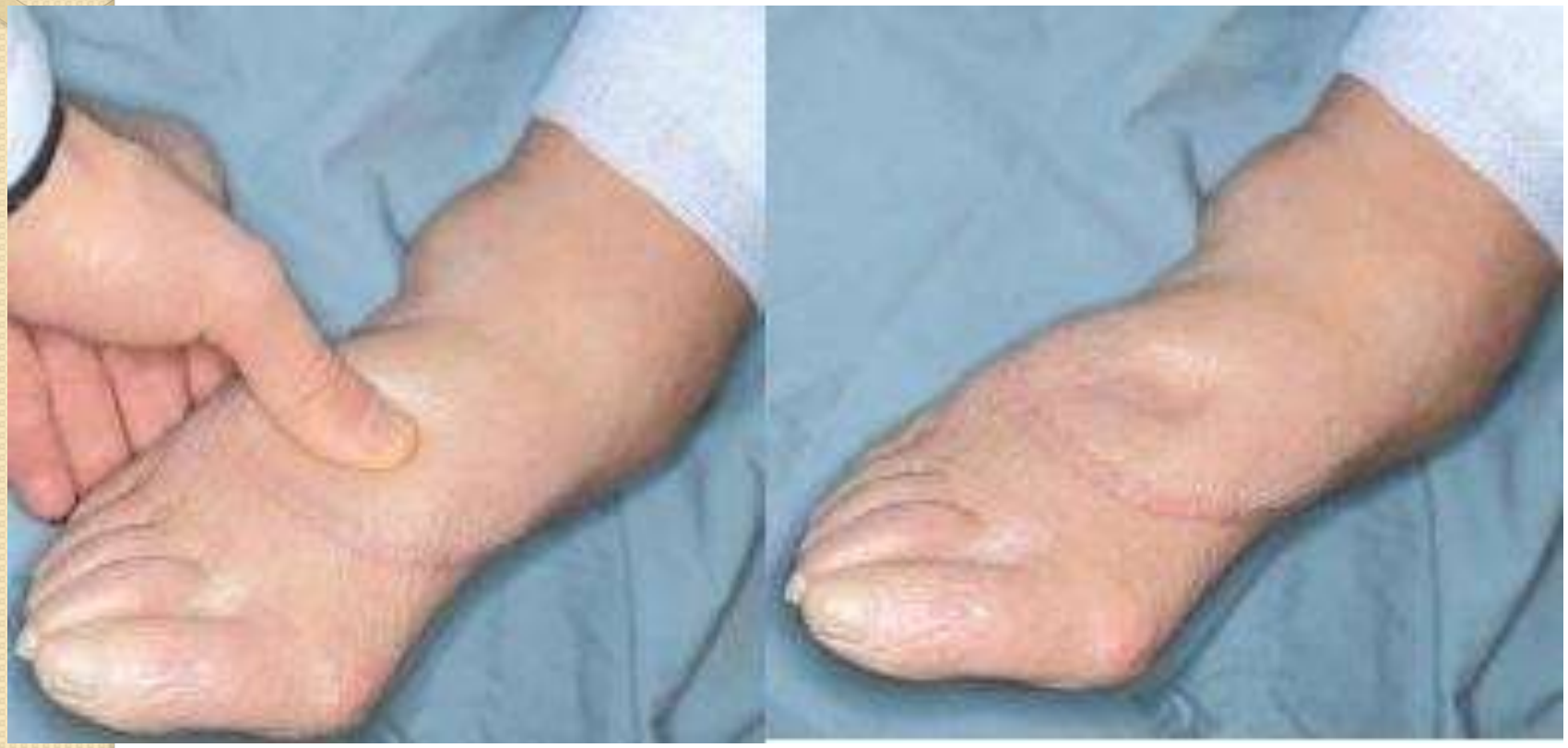
Ascities: It refers to a collection of fluid in the peritoneal cavity.

Hydrothorax (pleural effusion): It refers to collection of the fluid within the pericardial cavity.

Hydropic changes: Cells, too, may accumulate fluid inside them and become swollen. This referred to as cellular edema.

Finger pressure over edematous sub-cutanious tissue will displace the interstitial fluid from the dermal and sub-cutanious connective tissues to leave pitted depression, often referred to clinically as "***pitting edema***".

“Pitting” Edema



Mechanisms of formation and causes:

The mean blood hydrostatic pressure at the arteriolar ends of capillaries is about 30 mmHg, while the colloidal osmotic pressure of plasma (also called oncotic pressure) is 25 mmHg, so the net difference of the two forces cause fluid to escape from within the vessels (intravascular compartment) into the tissue spaces (interstitial compartments).

In other words, fluid move from the intravascular compartments to the interstitial compartments at the arteriolar end of the microcirculation largely under the influence of the blood hydrostatic pressure.

The mean blood hydrostatic pressure at the venous ends of capillaries is lower than that of arteriolar ends (about 12 mmHg), the net differences of the two forces here works in opposite direction i.e. tissue fluid return back to the vessels.

In other words, fluid return to the intravascular compartment at the venular ends of the microcirculation mainly because of the osmotic (oncotic) pressure of the blood.

pathological accumulation of tissues fluids may results from:

1. Increased hydrostatic pressure.

2. Decrease in colloid osmotic (oncotic) pressure of the plasma.

3. Lymphatic obstruction.

4. Sodium retention.

5. Increases capillary permeability as in inflammation.

1. Increase capillary hydrostatic pressure:

Either its:

1. Generalized:

In case of right ventricular failure (or combined right and left ventricular failure), the heart fail to pump the blood that it received from the right atrium.

This will cause accumulation of the blood that is reflected back into the systemic veins as an increase in systemic venous pressure leading to generalized chronic venous congestion.

This increase in hydrostatic pressure trigger edema formation, due to involvement of the heart in this process, this type of edema is known as "***cardiac edema***".

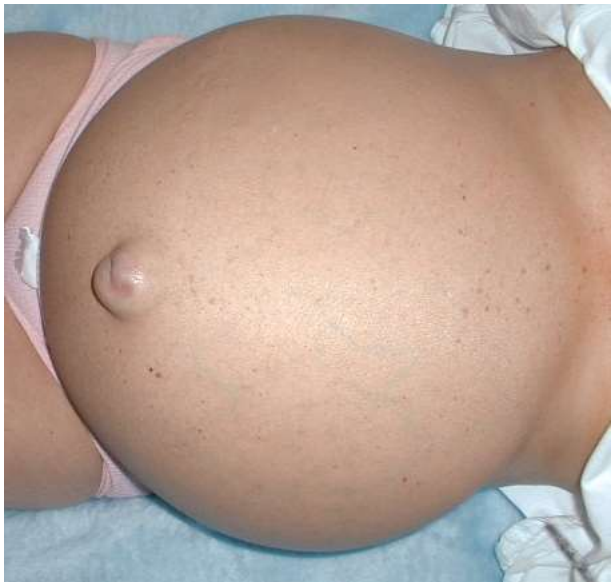
2. Localized:

In conditions of partial or complete obstruction of large venous trunk, there is a local increase in venous pressure (and venous congestion) beyond the side of obstruction.

e.g. of localized edema are:

1. ***Portal hypertension*** caused by liver cirrhosis. This produces a transudate in peritoneal cavity (ascities).
2. ***Pressure of gravid uterus*** on the iliac veins produces congestion and edema of the lower limbs.
3. ***Acute left ventricular failure*** cause acute pulmonary edema.
4. ***Thrombosis of major veins***.
5. ***Incompetence of venous valves*** secondary to varicose vein.

ASCITES



2. Decrease in colloid osmotic (oncotic) pressure of the plasma (hypo-proteinemia):

When the total plasma protein decrease below ***2.5 g*** %(normal protein content of the plasma is ***6.4-8.0 g*** %) or when the albumin fraction decrease below ***1.5g*** %(normal plasma contents is ***4.5-5.5 g*** %), the plasma osmotic (oncotic) pressure of the blood diminishes an excess of fluid passes under the force of the hydrostatic capillary pressure into the tissue spaces and serous cavities and generalized form of edema develops.

e.g. are:

1. ***Nephrotic syndrome***: result from for e.g. amyloidosis, D.M, and rapidly progressive glomerulo-nephritis.
2. ***Diffuse liver disease*** e.g. cirrhosis (decrease synthesis of plasma proteins by diseased liver).
3. ***Malnutrition*** e.g. severs protein-caloric malnutrition (Kwashiorkor).
4. ***Protein losing gastro-enteropathy***.

3. Lymphatic obstruction:

Interference with lymphatic drainage to an area of the body is followed by the retention of tissues fluid and localized edema of the affected part of the body. It is ***non-pitting edema.***

Causes:

1. Congenital absence of lymphatic vessels.
2. Tumor invasion.
3. Post-radiation.
4. Post-surgical.
5. Parasitic e.g. chronic infection with filarial worm called ***Wuchereria bancrofti*** induce lymphatic blockage , most often in the inguinal region producing epidermal thicken and ***massive edema of the external genetalia*** and ***legs***. This has been likened to that of elephants (elephantiasis).

4. Sodium and water retention:

These may be primary cause of edema, increased salt retention (which is associated with water retention) cause both increase hydrostatic pressure (due to expansion of intravascular fluid volume) and diminish vascular colloid osmotic pressure (due to dilution).

5. Increased capillary permeability:

In these instances the accumulated fluid is exudates (protein rich).

A. Localized:

In inflammatory lesion the damaged capillary endothelium (and its permeability) allows free escape of the plasma fluid and proteins into the tissue spaces where they exert a high osmotic (oncotic) pressure effect, which draws more water from the blood into the tissue spaces. The lymph flow is increased but still, the exudates accumulate and cause a localized swelling or inflammatory edema.

B. Generalized:

Increase capillary permeability is responsible for generalized edematous lesions, which accompany some allergic condition such as urticaria or angioneurotic edema (allergic edema).

Clinical manifestation of edema:

- ***Sub-cutanious edema of cardiac or renal failure*** is important basically in drawing attentions and pointing to the underlying disease.
- ***Edema of the lung*** can cause very sever ***dyspnea*** and ***anoxia***. It can cause ***death*** by interfering with normal ventilation. Collection of fluids within alveoli and their septa (around capillaries) interferes with oxygen diffusion. It is also a favorable environment for ***bacterial infection***.
- ***Edema of the brain*** is a serious and can be ***rapidly fatal***. It leads to an ***increased*** in the ***intracranial pressure*** that is manifested by ***headaches***, ***vomiting*** and ***convulsion***. If sever, the brain substances may be ***herniated*** (push out) through for e.g. foramen magnum, resulting in direct ***compression of brain stem or its vascular supply***. Either of these can ***injure the vital centers within the medulla and cause death***.
- ***Edema of the larynx*** may cause ***suffocation***.

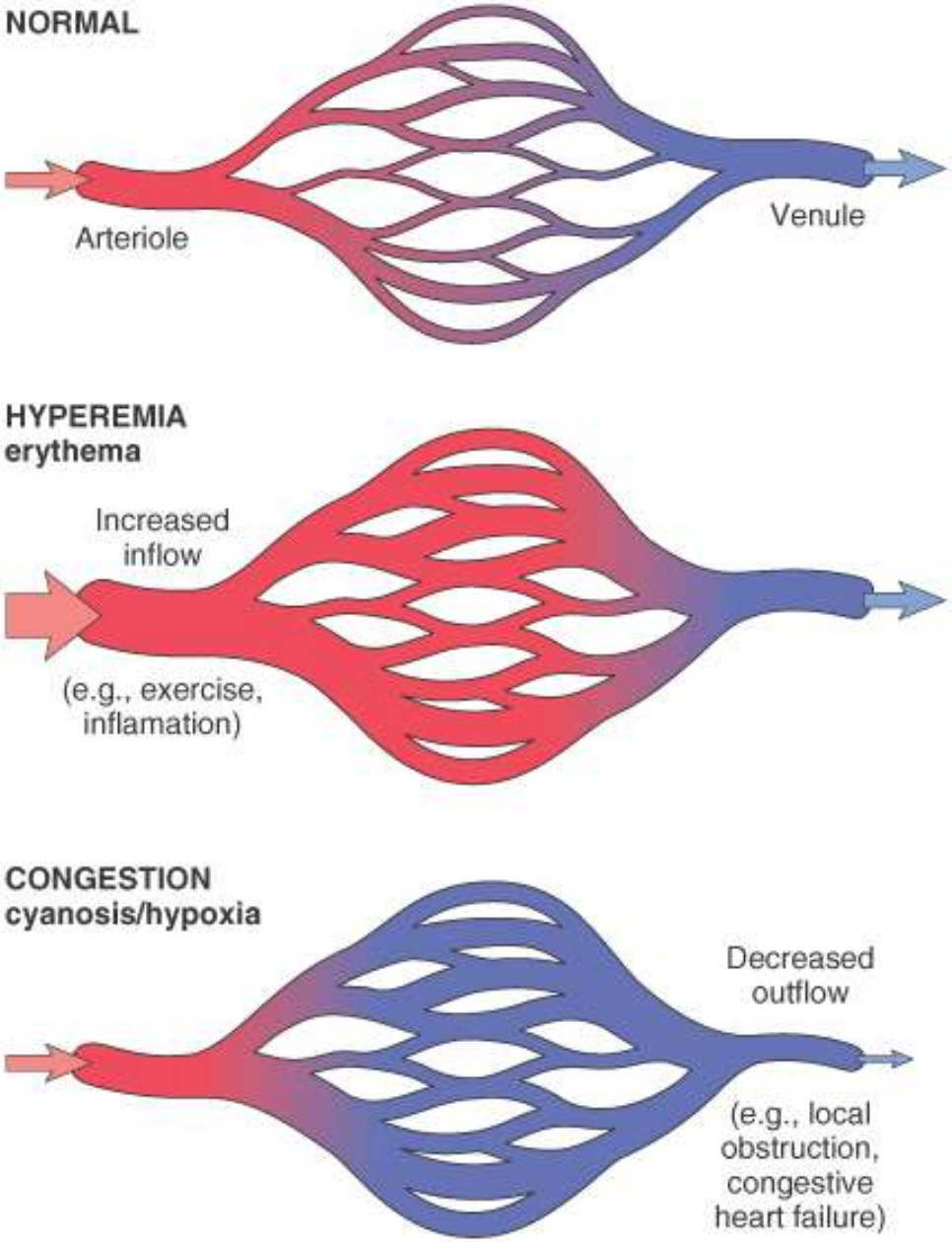
Congestion (Hyperemia):

This is an increased in the volume of the blood in an affected tissue or part of the body.

It could be either:

1. Active congestion or
2. Passive congestion.

HYPEREMIA/(CONGESTION)



1. Active congestion: Result from arterial and arteriolar dilatation that produces an increased flow of the blood into capillaries. This occurs for e.g. in exercise, febrile states and locally in inflammation.

It causes increased redness in affected part.

2. Passive (venous) congestion: This is generally the result of impaired venous drainage. It is either localized or generalized (systemic).

Venous congestion could be either:

1. Systemic venous congestion:

When the heart fails to expel the normal amount of blood (combined right and left heart failure), arteriolar tone in general is increased and this is caused by sympathetic stimulation. Additionally the ventricles are unable to expel what they receive of blood from their respective atria.

As a result damming of the blood occurs in atria and this is reflected back into systemic veins. This lead to a greater proportion of the blood to accumulate in venous compartments, which are readily distensible, this is companied by an increase in blood volume. The above two cause the veins to become engorged i.e. distended with blood.

Combined right and left sided heart failure causes systemic congestion.

2. Localized venous congestion:

- ***Pulmonary venous congestion***: This develops when there is raised pressure in the left atrium, which is transmitted into the pulmonary veins. It therefore occurs in left side heart (ventricular) failure as for e.g. due to coronary artery disease or systemic arterial hypertension.

  It also occurs in mitral valve stenosis, which restricts the flow of the blood into the left ventricles.

Localized venous congestion may also develop in any part of the body in which the venous outflows is obstructed.

Causes:

1. Venous thrombosis of major veins: Which lead to venous congestion, increased capillary pressure and edema of the part drained by the obstructed vein e.g. thrombosis of the vein of the lower limb veins femoral and popliteal that leads to congestion and swelling of the lower limb distal to the obstruction.

2. Cirrhosis of the liver: This leads to sever obliteration and distortion of the intra-hepatic portion of the portal circulation

Chronic venous congestion develops in portal system of veins produce the following effects:

A. ***Congestive splenomegaly***.

B. ***Ascities*** due to transudate collects in peritoneal sac.

C. ***Esophageal varices*** due to dilatation of the collateral veins between the portal and systemic circulation.

3. Mechanical compression of the veins as for e.g. by a tumor, strangulated hernia,

Organs morphological changes in chronic venous congestion:

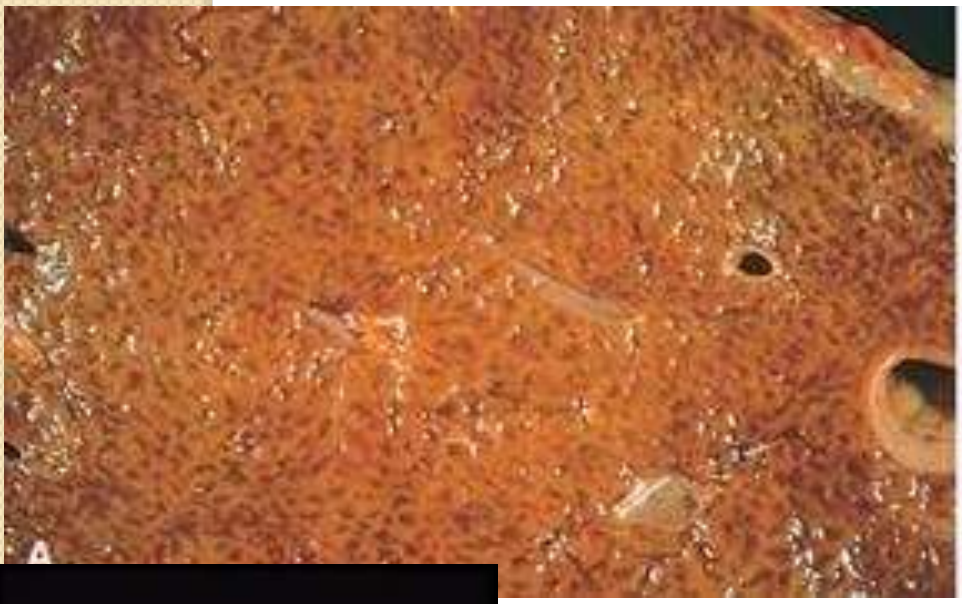
Liver:

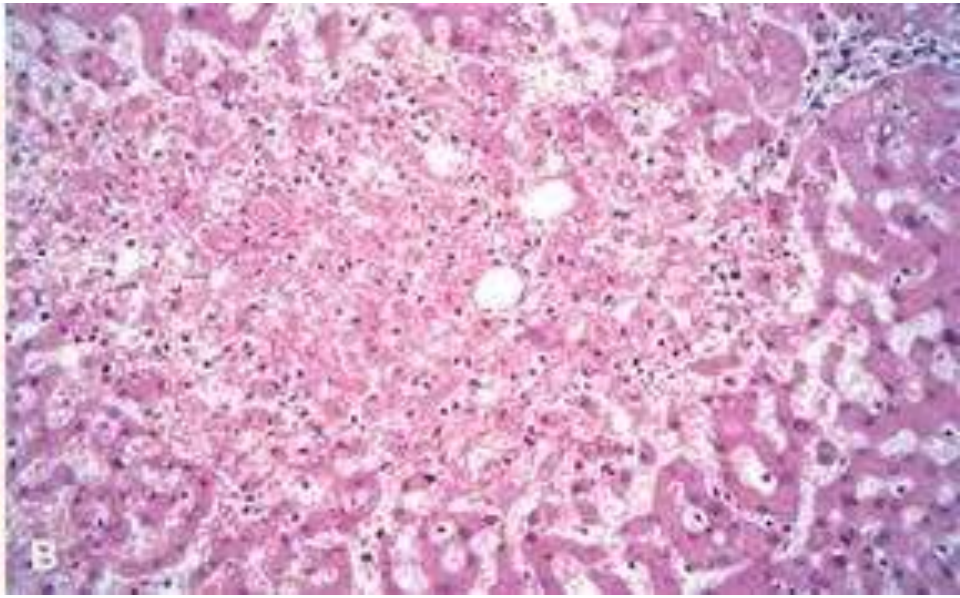
The main changes are noted around the ***central veins*** of the hepatic lobules (***centri-lobular region***).

Macroscopical changes (i.e. gross appearance):

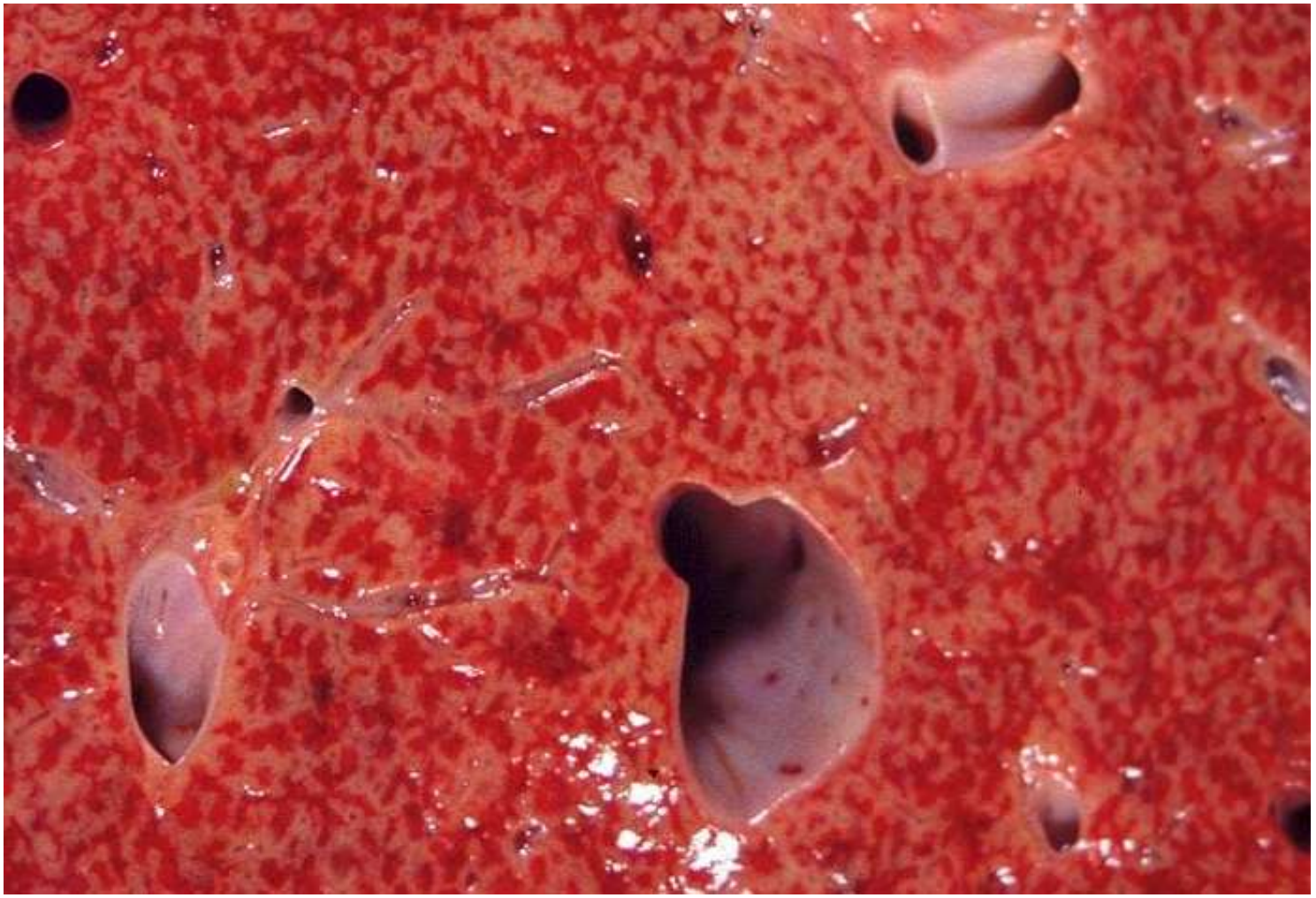
The liver ***enlarge*** and its ***firm*** in consistency. Its cut surface show a ***mottled appearance*** of ***dark areas*** (where centri-lobular zone are congested with blood), contrasting with ***pale peripheral*** (peri-portal) areas, this appearance is similar to that of cut surface of a nutmeg, hence the term "***nutmeg liver***".

CHRONIC PASSIVE HYPEREMIA/CONGESTION, LIVER





Acute Passive Congestion, Liver



Microscopical changes:

The ***central vein*** and the ***central ends of sinusoids*** appear ***distended*** and ***packed with red cells.***

The ***hepatic cells in the center of the lobules*** undergo ***degeneration*** and sometime ***necrosis*** as

a result of the anoxia and the pressure effects of congested (dilated)sinusoids.

The ***hepatic cells at the periphery of the lobules*** are either ***normal*** or ***show little form of injury*** such as fatty changes. Therefore, each lobule presents a ***dark brown center*** (congested) and ***light yellow periphery*** (fatty degeneration).

Spleen:

Grossly:

The organ ***enlarges***, ***firm*** in consistency with ***tense*** and ***thick capsules***.

Microscopically:

- The ***venous sinuses*** are ***distended*** with blood cells and ***contain*** large number of ***macrophages loaded with hemosiderin***.
- The ***lymphoid follicles*** are ***atrophied***.
- The ***fibrous trabeculae*** are ***increased in***

Kidney:

Grossly: The organ is:

- Slightly ***enlarged***.
- ***Firm*** in consistency.
- ***Dark red*** in color.
- The ***cut surface*** presents ***dark red dots*** (congested glomeruli) and ***dark red streaks*** (congested veins).

Microscopically:

The ***glomerular capillaries*** are ***distended***

Lungs:

Grossly: The lungs are ***heavy***, ***dark red*** color and ***firm*** in consistency.

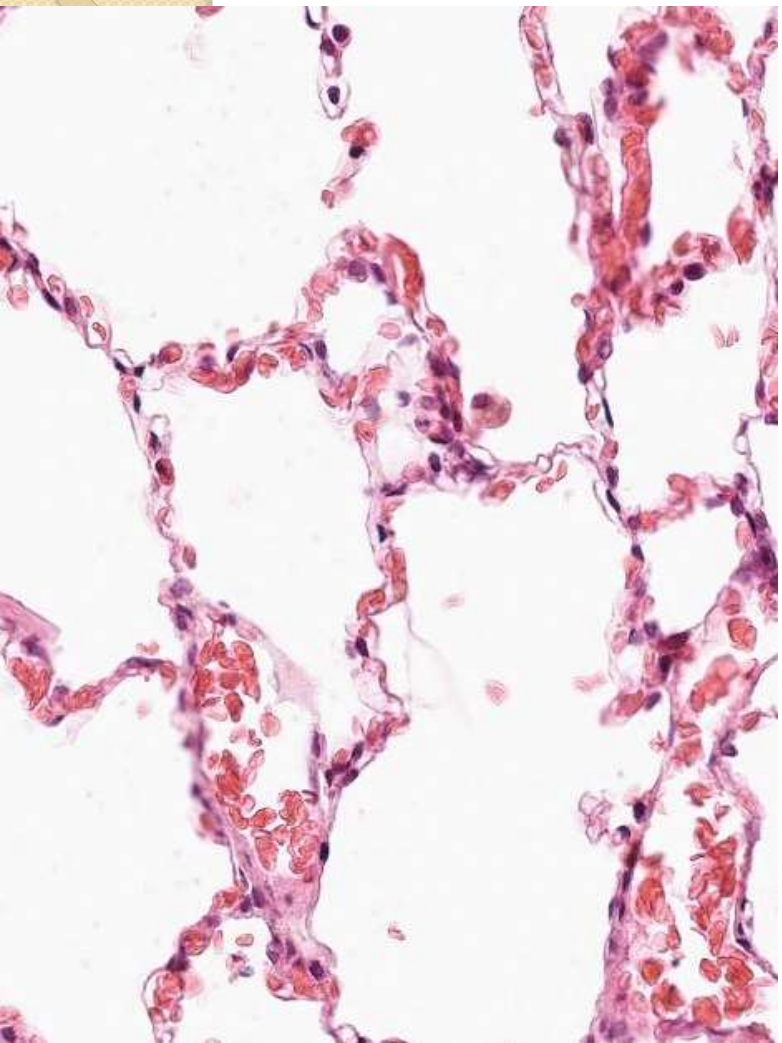
Microscopically:

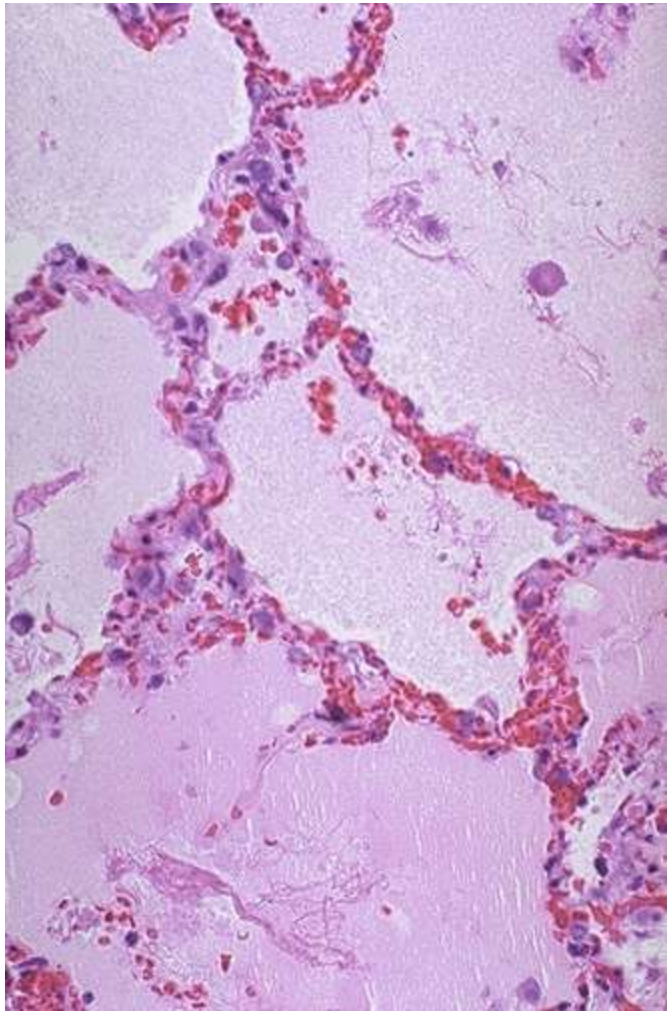
- The ***alveolar capillaries*** and ***venules*** are ***dilated***, and ***packed with red cells***.
- Some of ***alveolar capillaries rupture*** leading to ***intra-alveolar hemorrhage***.
- ***Macrophages*** move into ***alveolar space*** to ***engulf*** the ***red cells*** and ***hemosiderin granules***. These macrophages are called ***"heart failure cells"*** because of the association of their presence and heart failure.

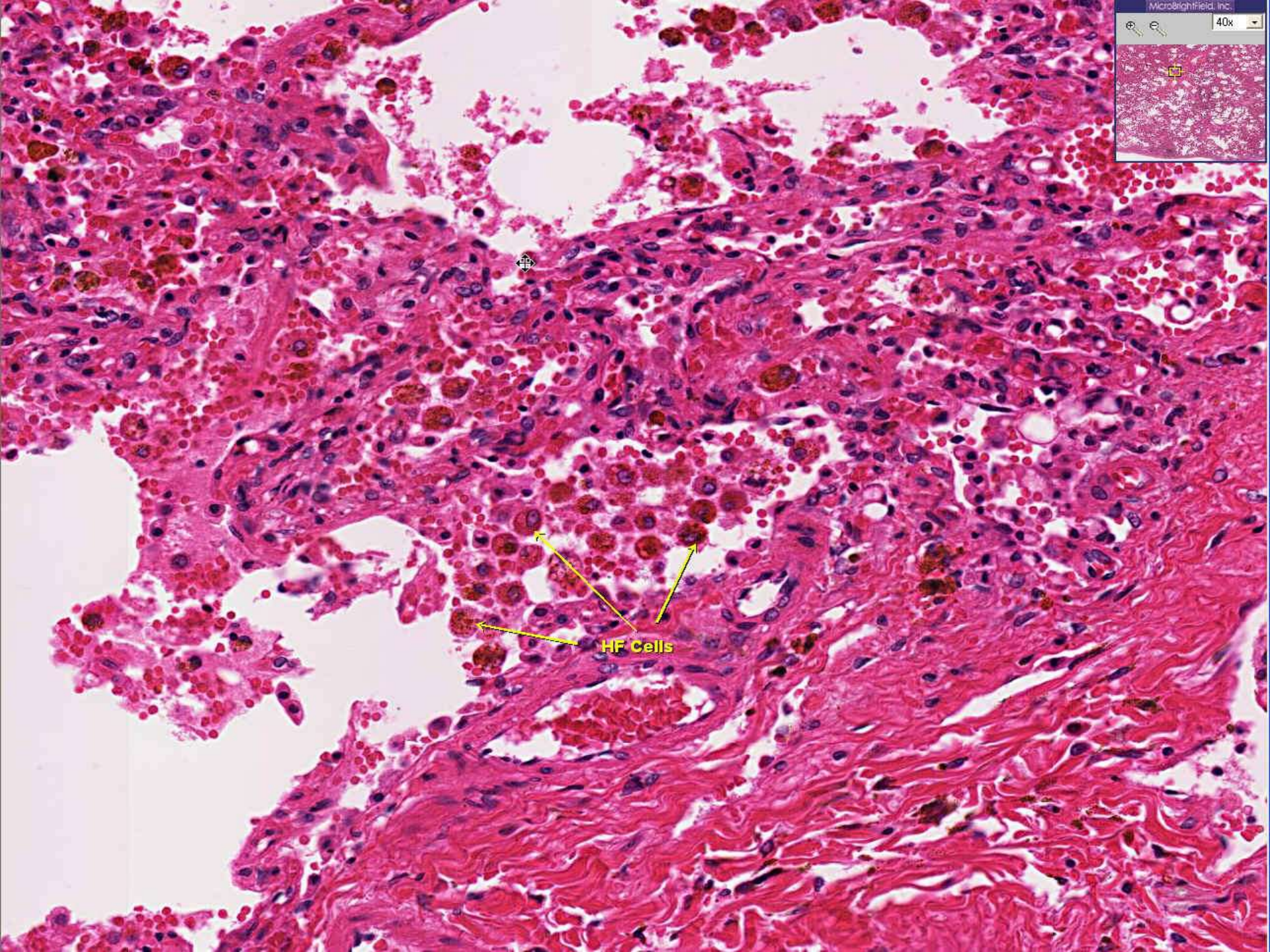
Some of the heart failure cells move back to the interstitial tissues where a portion of the pigment hemosiderin gets deposited.

- The ***hemosiderin deposition*** with ***its fibrogenic effect*** is reflected by gross picture is known as ***"brown induration's***".

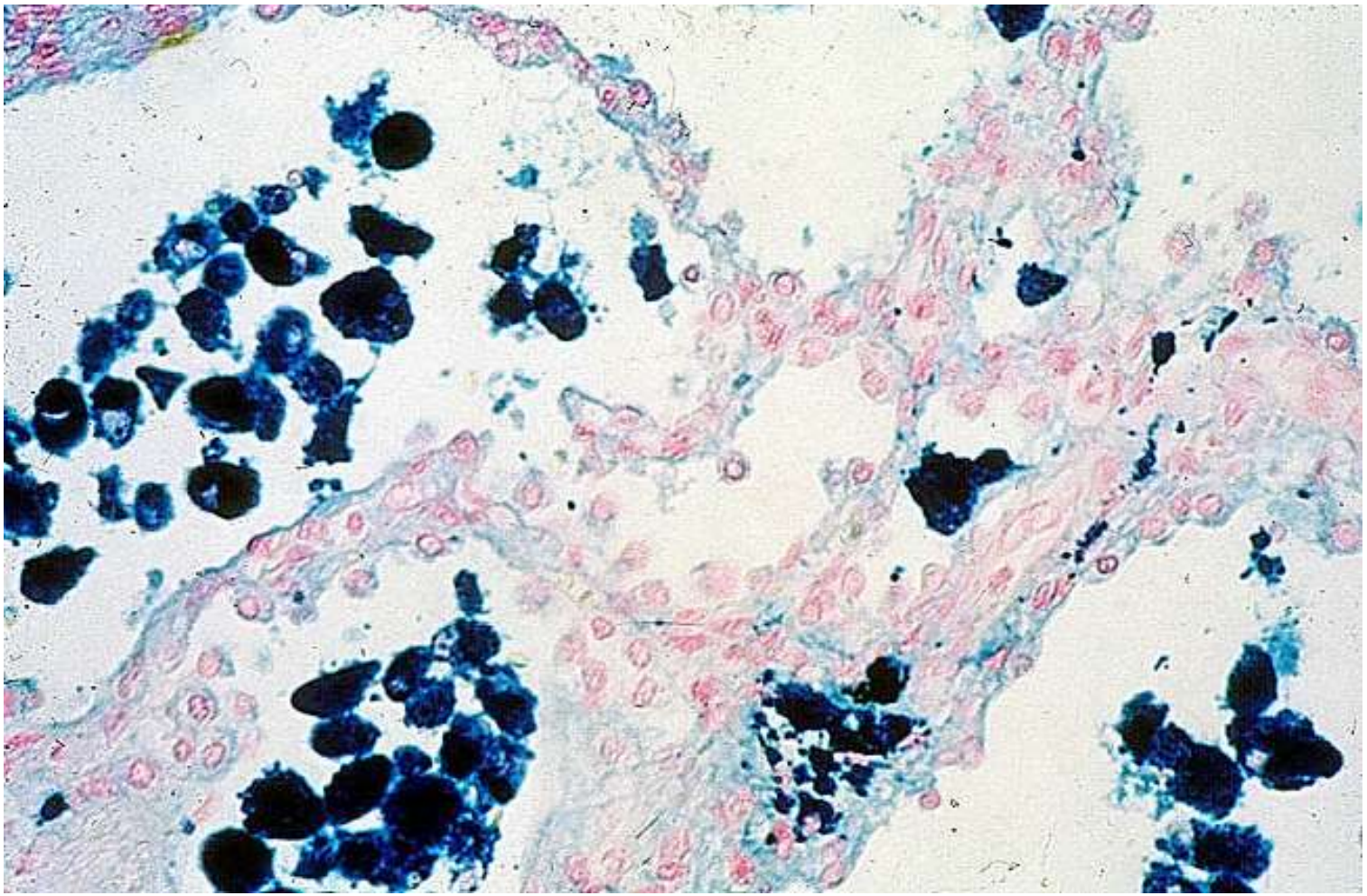
ACUTE PASSIVE HYPEREMIA/CONGESTION, LUNG






MicroBrightField, Inc.
40x
HF Cells

CHRONIC PASSIVE HYPEREMIA/CONGESTION, LUNG



Hemorrhage:

This term signifies extravasations of the blood due to vessels rupture. It may be manifested in a variety of ways depending on the ***size***, ***extend*** and ***location*** of bleeding.

- Hemorrhage may be ***external*** or ***internal***.

- ***Hematoma***: Refers to accumulation of blood within a tissue.
- ***Petechiae***: Are small (1-2 mm in diameter) hemorrhagic spots of the skin, mucus membrane or serous surface. It is typically associated with:

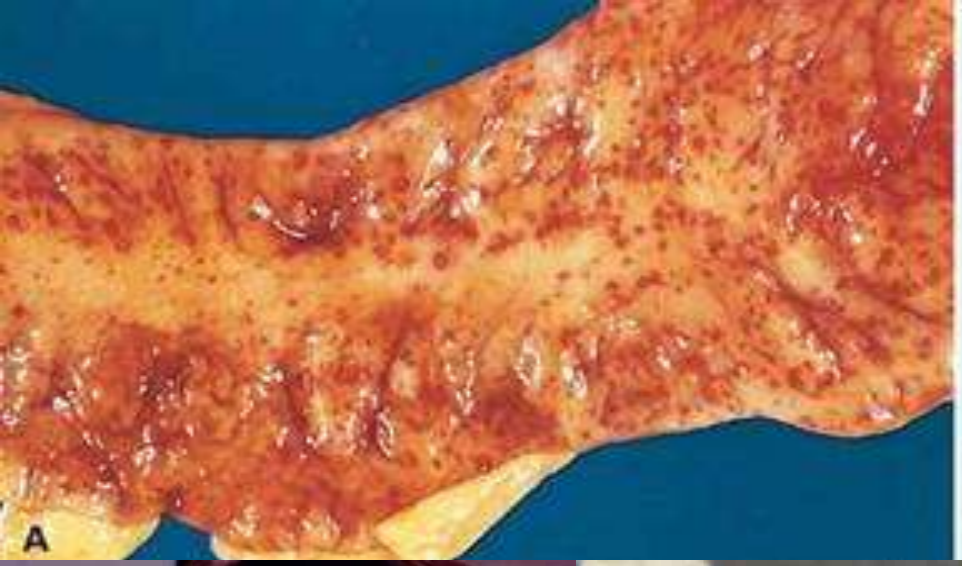
1. Locally increase intravascular pressure.
2. Thrombocytopenia.
3. Defective platelets functions e.g. in uremia.
4. Clotting factors deficiency.

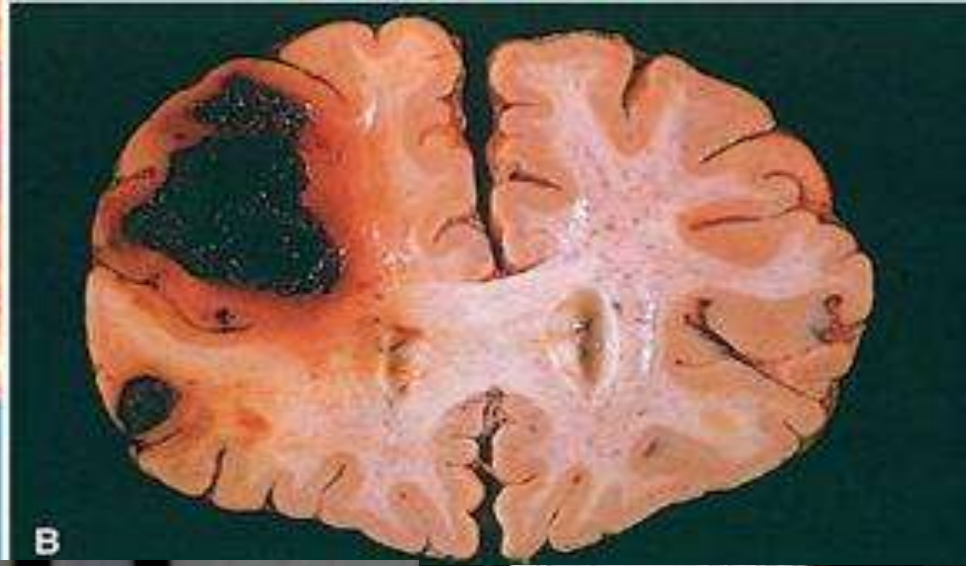
Purpura: These are slightly larger than Petechiae (≥ 3 mm in diameter). They may associated with some condition that cause petechiae but may also occur due to ***trauma***, ***inflammation of the vessels*** and ***increased vascular weakness***(fragility)as in amyloidosis.

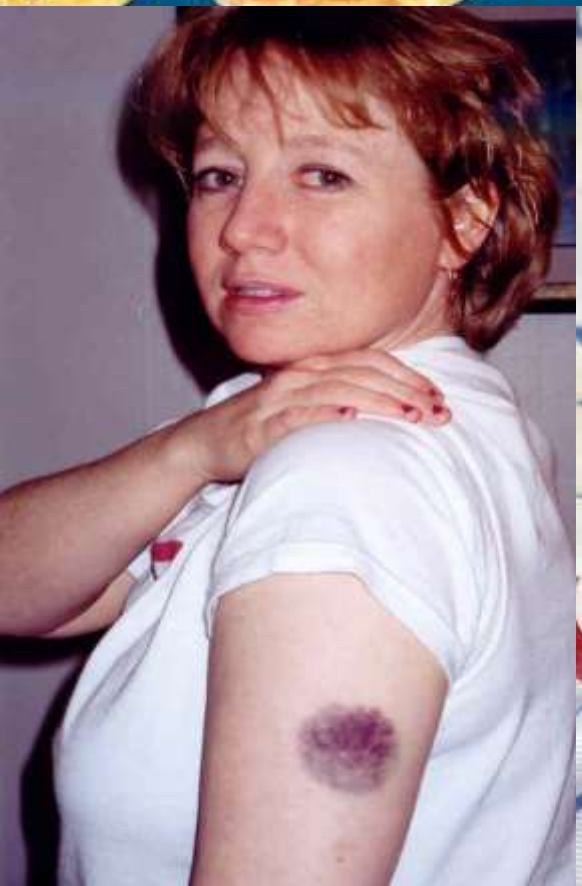
- ***Ecchymosis*** (bruises): are larger (>1-2 cm) subcutaneous hematoma are characteristically caused by trauma.

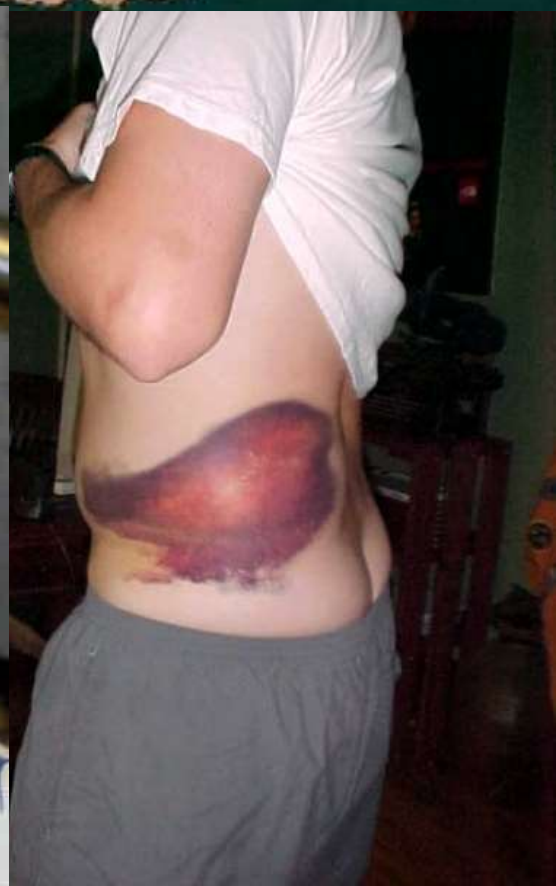
The condition is intensified (i.e. even with trivial trauma) in the presence of any of the above mentioned conditions associated with petechiae or ecchymosis.

The sequential color changes in this ecchymosis i.e. from ***red-blue*** to ***blue-green*** and then to ***yellow-brown*** are due to conversion of ***hemoglobin*** to ***bilirubin*** and eventually to ***hemosiderin***.


A


B





Hemothorax: Refers to large accumulation of blood in pleural cavity.

- ***Hemopericardium***: Refers to large accumulations of blood in pericardial cavity.

- ***Hemarthrosis***: Refers to large accumulations of blood in joint space.

- ***Hemoperitonium***: Refers to large accumulations of blood in peritoneal cavity.