

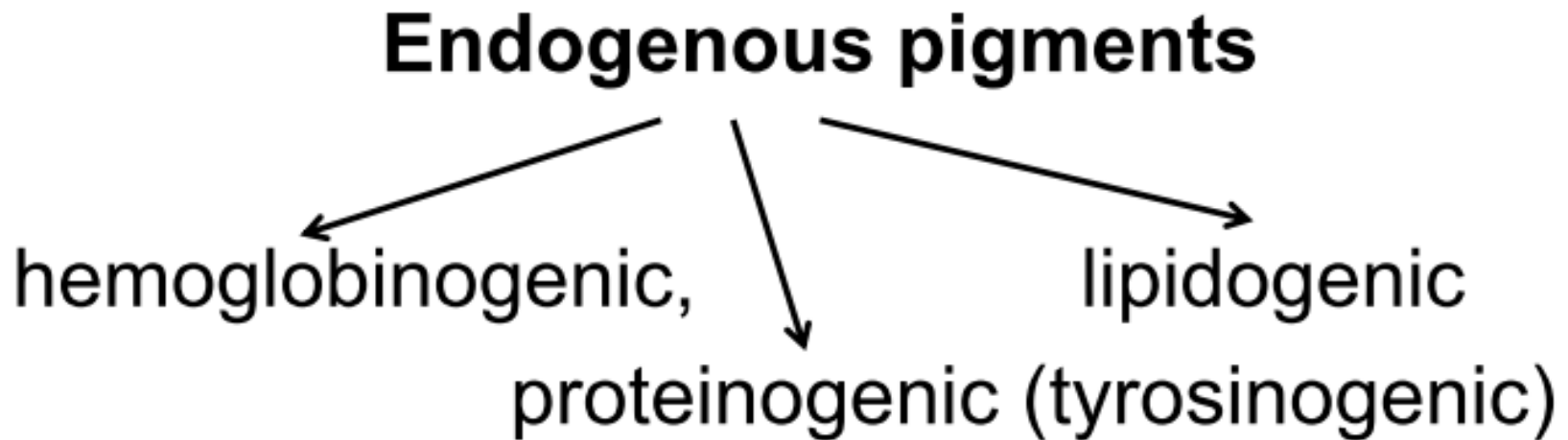
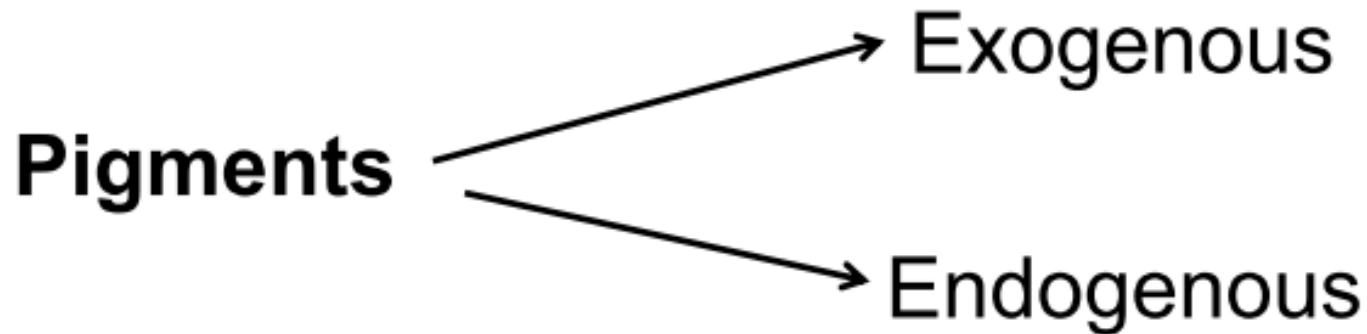
Pathological anatomy of pigment and mineral metabolism disorders (mixed dystrophies).

Mixed dystrophies

are morphological manifestations of impaired metabolism, detected both in the parenchyma and in the stroma of organs and tissues, arising from impaired metabolism of complex proteins - endogenous pigments (chromoproteins), nucleoproteins, lipoproteins and minerals.

Pigments

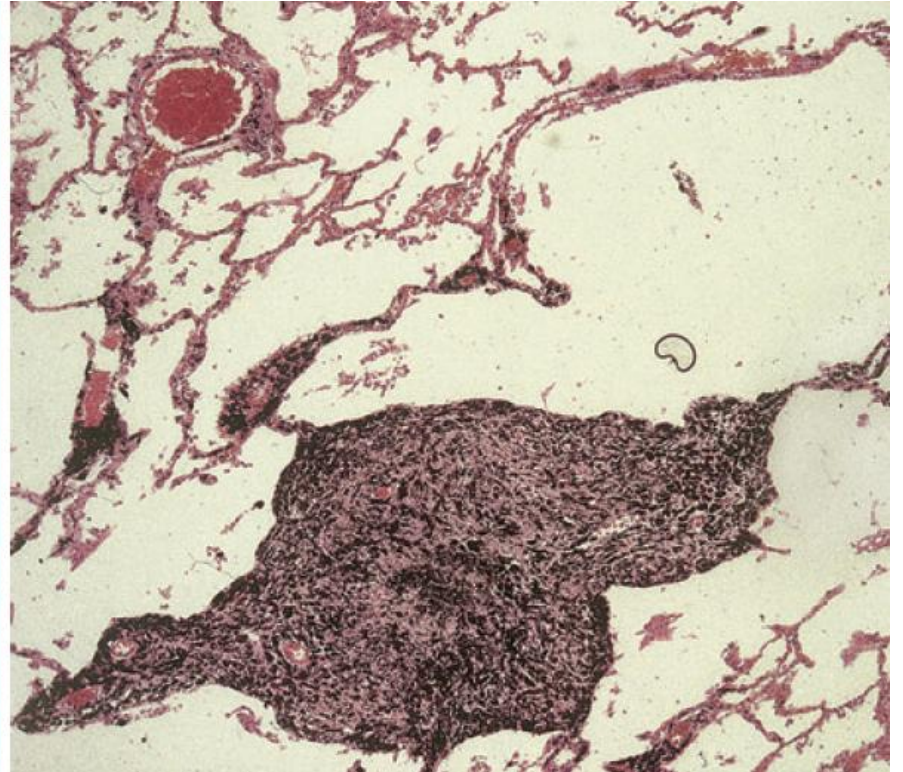
are colored substances of various chemical nature that can be found in cells in normal conditions or accumulate in pathological conditions



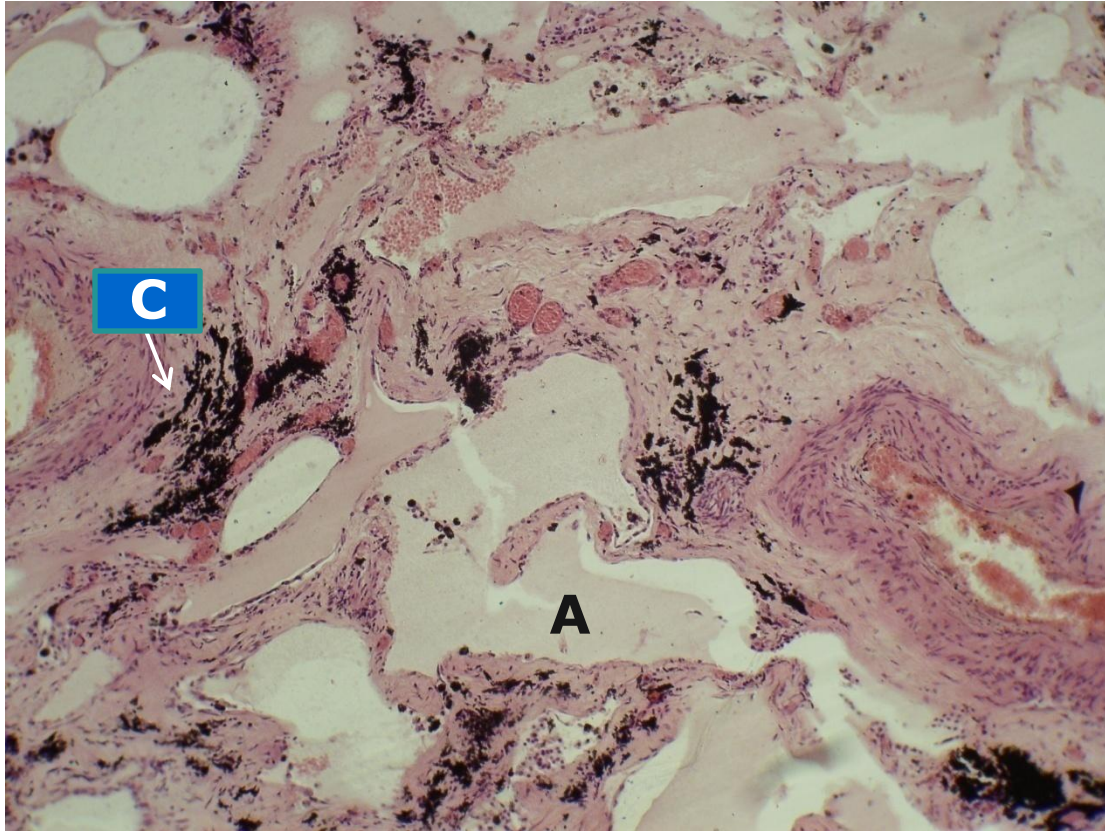
Exogenous pigments

- Carbon dust (coal dust).
Accumulations of this pigment stain the lung tissue black (anthracosis).
- Tattooing is a form of localized, exogenous pigmentation of the skin

Antracosis of the lung



Antracosis of the lung



- A – alveoli
- C – carbon depositions

Exogenous pigments



Tattoo

Hemoglobinogenic pigments

- ***Hemoglobinogenic pigments*** are various derivatives of hemoglobin that occur during the synthesis or breakdown of red blood cells.

Normally, the following pigments are formed:

- ferritin,
- hemosiderin,
- bilirubin,
- porphyrins (precursors of heme, can be found in minimal amounts in blood and urine in normal conditions).

In conditions of pathology, the following pigments are formed:

- hematoidin,
- hematin.

Hemoglobinogenic pigments: **Ferritin**

Ferritin is an iron protein containing the protein apoferritin and a trivalent iron atom in phosphate hydroxide

Hemoglobinogenic pigments: *Ferritin*

Histochemical reactions for ferritin:

1. using cadmium sulfate according to the Klochkov method,
2. immunohistochemically using specific antibodies.
3. most often - the reaction of the formation of ***Prussian blue or the Perls reaction*** - a reaction to the detection of salts of iron (III) oxide with the help of iron-cyanide potassium and hydrochloric (hydrochloric) acid.

Hemoglobinogenic pigments: **Hemosiderin**

Hemosiderin is a ferritin polymerization product. According to its chemical structure, it is a colloidal iron hydroxide combined with mucoproteins of the cell.

Hemoglobinogenic pigments: *Hemosiderin*

- ***Hemosiderosis*** is a disease that develops with the accumulation of catabolic pigment (formed during hemolysis).
- ***Hemochromatosis*** is a disease resulting from an increased intake of iron into the body and is also accompanied by massive deposits of hemosiderin.

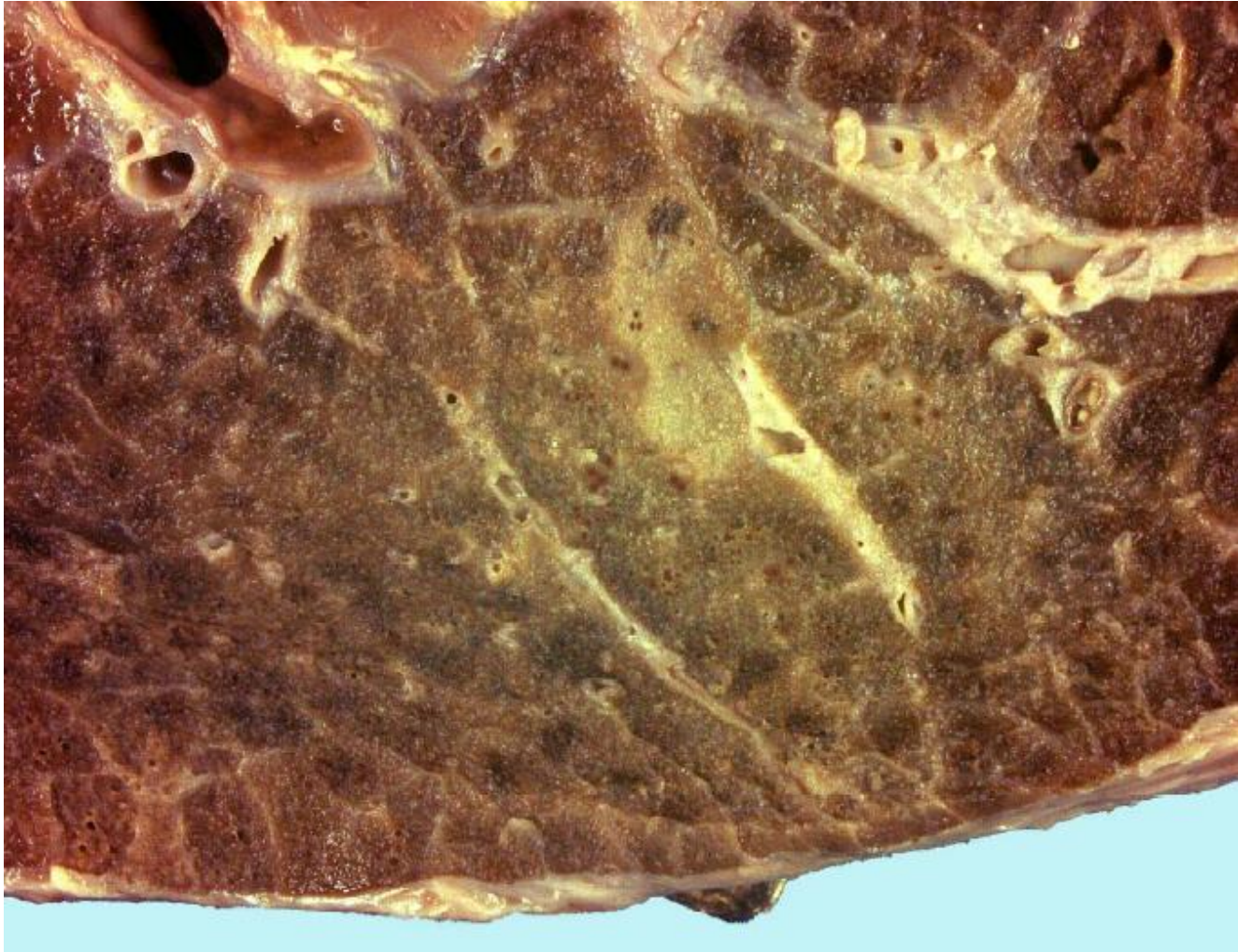
Hemosiderosis

- It occurs with increased hemolysis - the destruction of red blood cells.

Hemosiderosis:

1. Local hemosiderosis,
2. general (common) generalized hemosiderosis.

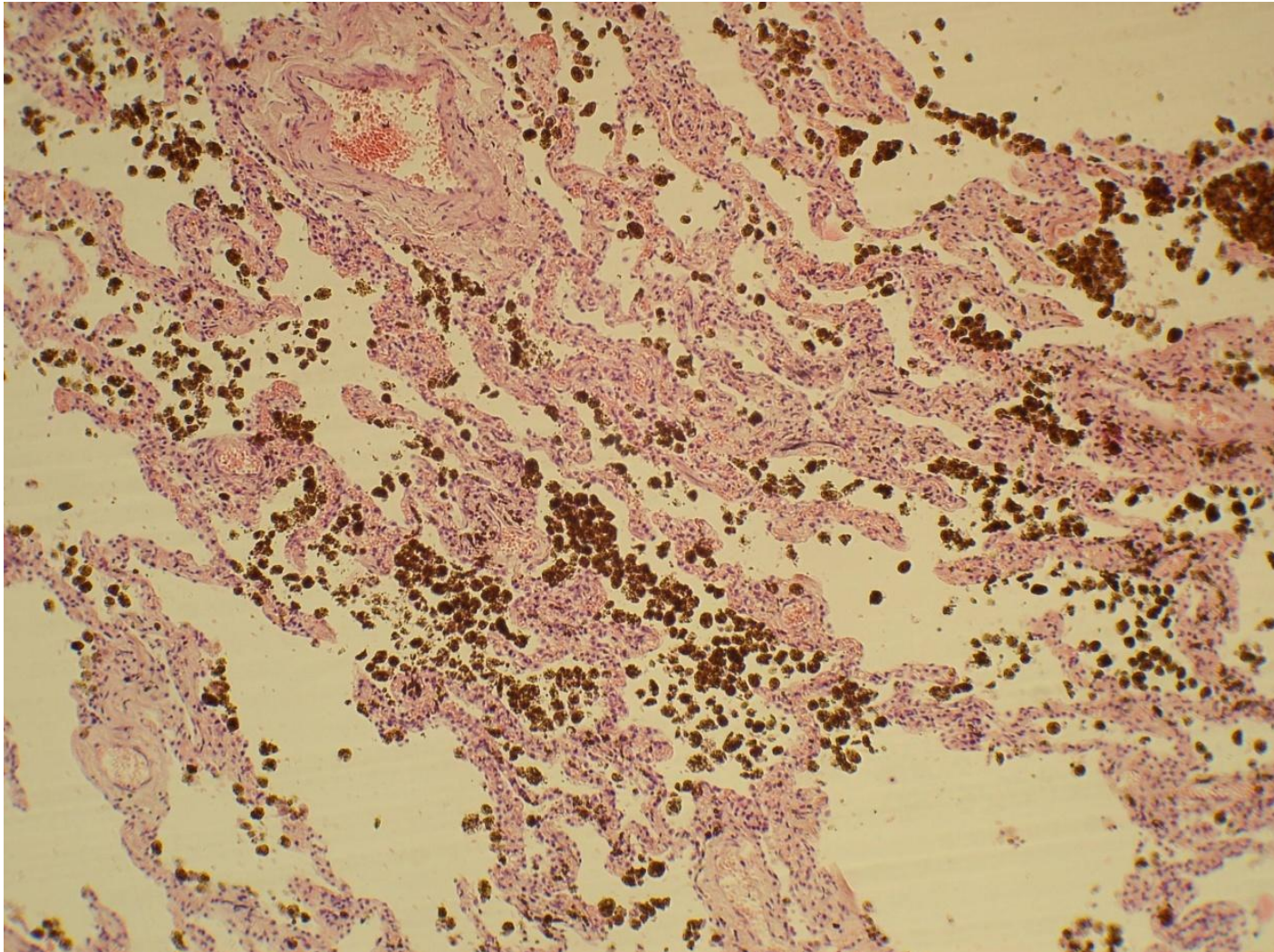
Brown induration of the lung.



Легкие увеличены в размерах, бурого цвета, плотной консистенции. Вокруг бронхов, сосудов и диффузно в ткани легкого видны прослойки белой плотной ткани (пневмосклероз).

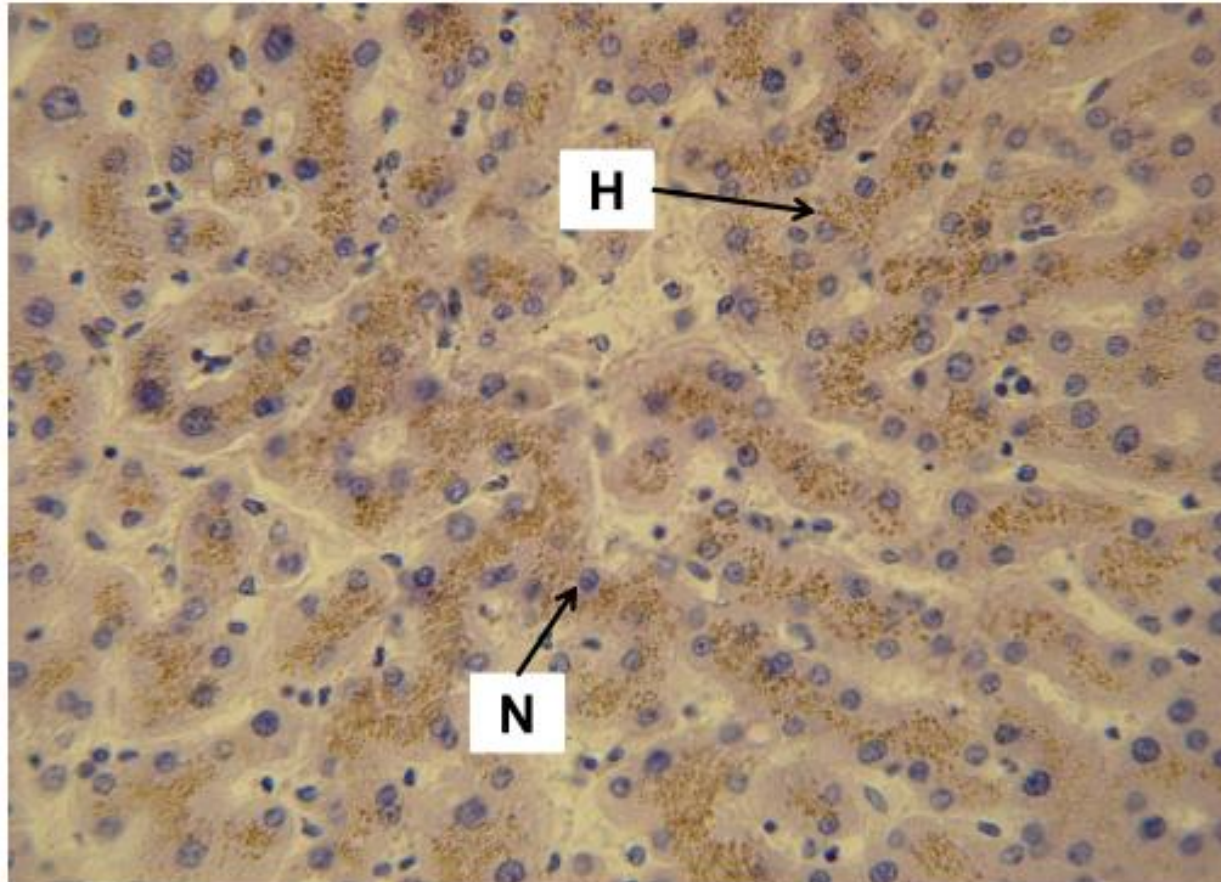
Hemosiderosis of lung.

H & E. X 100.



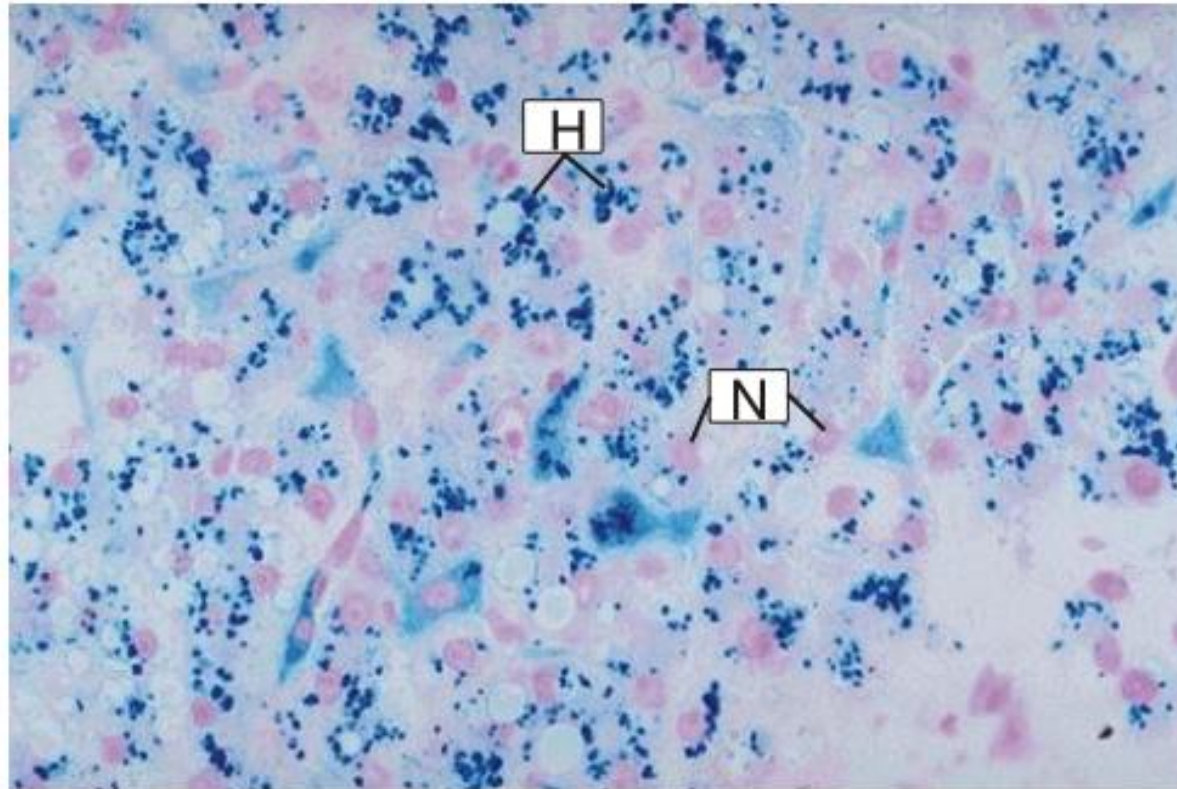
Hemosiderosis of liver.

H & E. X 400.



- H – hemosiderin
- N – nucleus of hepatocyte

**Hemosiderosis of liver.
Prussian blue. X 520.**



H – hemosiderin
N – nucleus of hepatocyte

Porphyria



a rare hereditary disease in which the blood pigment hemoglobin is abnormally metabolized.

Porphyrins are excreted in the urine, which becomes dark; other symptoms include mental disturbances and extreme sensitivity of the skin to light.



Bilirubin

- Bilirubin is the main bile pigment, the end product of hemolysis.
- With an excessive accumulation of bilirubin in the blood (more than 2-2.5 mg%), jaundice develops in the tissues (icteric coloration of the skin, sclera, mucous membranes, etc. appears).

Jaundice

Hemolytic (suprahepatic) jaundice

- It arises in connection with the enhancement of the process of bilirubin formation.
- The indirect (unconjugated) fraction of bilirubin increases.

Parenchymal (hepatic) jaundice

- Development is associated with impaired consumption (capture) of bilirubin by hepatocytes.
- the indirect (unconjugated) fraction of bilirubin increases.

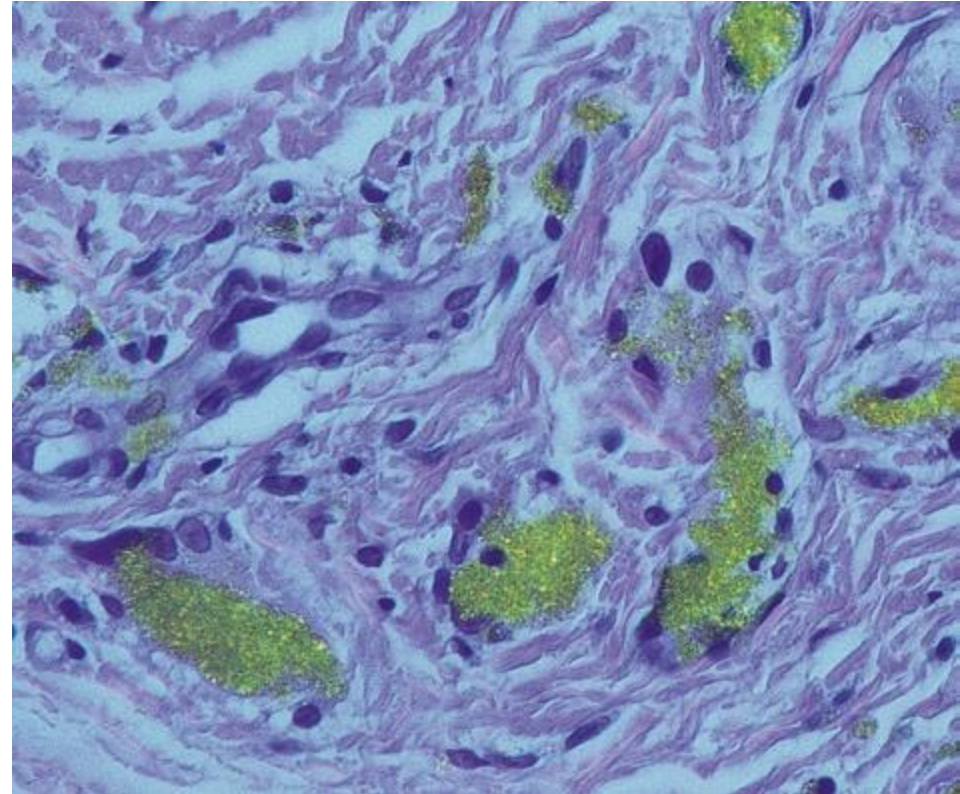
Mechanical (subhepatic) jaundice

- It occurs when there is a violation of the outflow of bile through the extrahepatic bile ducts (obstructive jaundice).

- **Skin jaundice**



- **Bilirubin in the breakdown of a hematoma (HE) x 250**



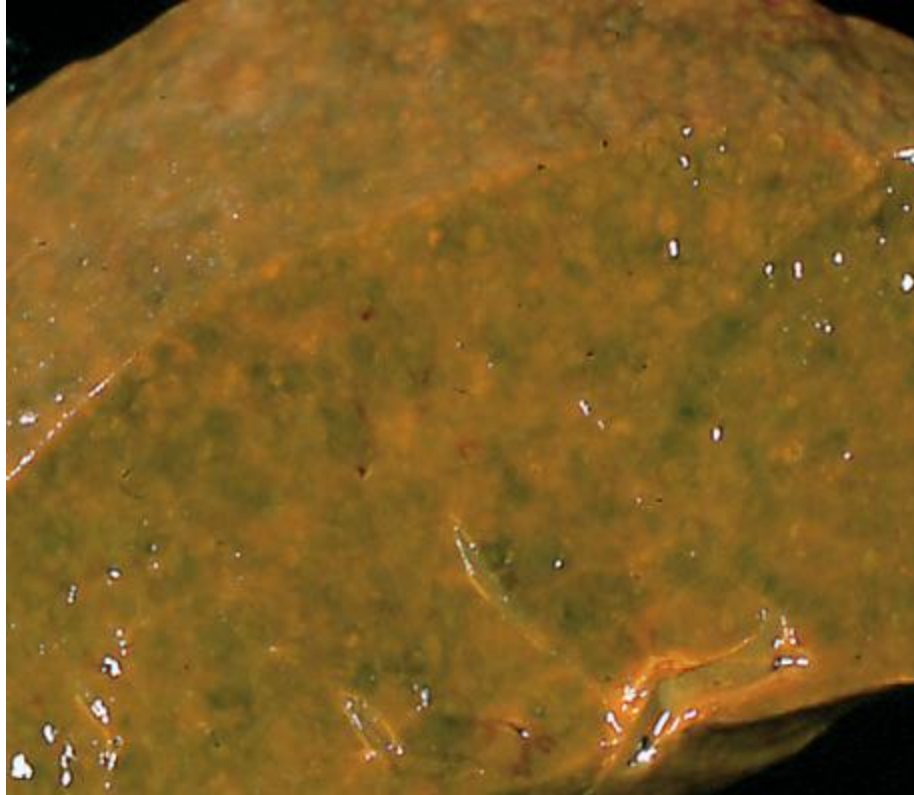
- **Normal liver**



- **Liver in jaundice**



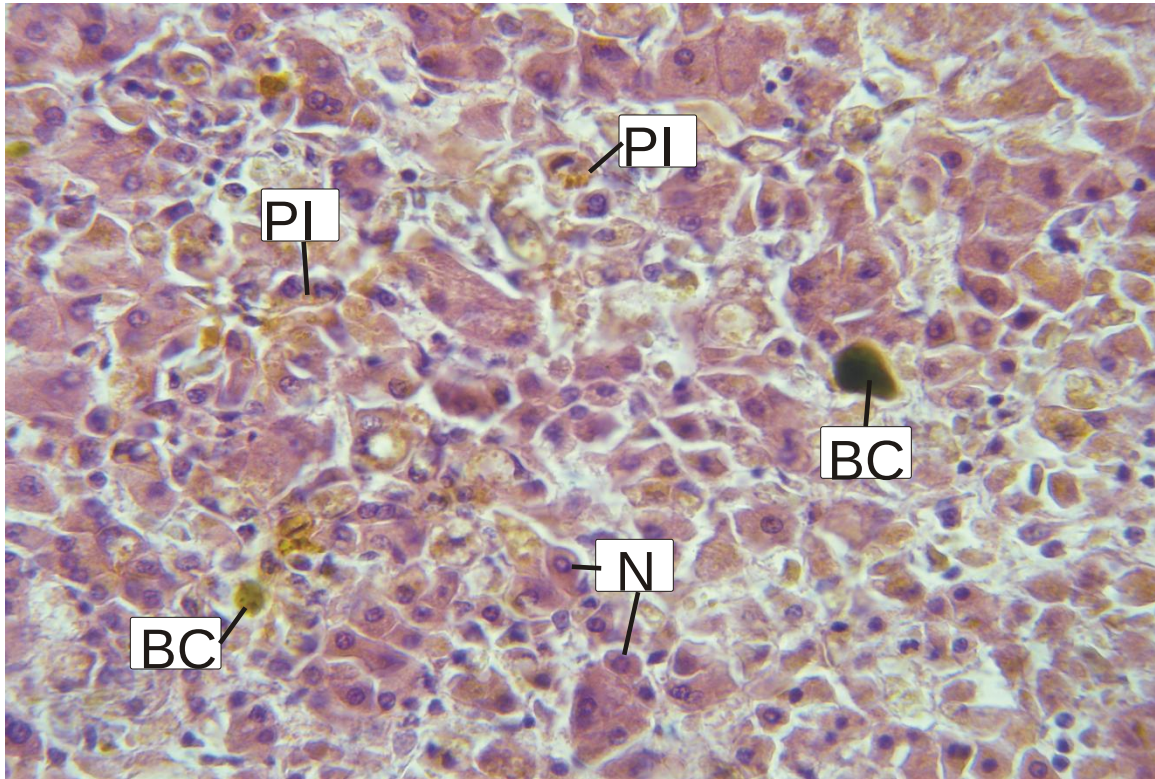
- **Liver in cholestasis**



- **Cholestatic liver cirrhosis**



Deposition of bilirubin in the liver. H&E. X 400.



PI - pigment inclusions
BC - distended bile
capillaries
N - nuclei of hepatocytes

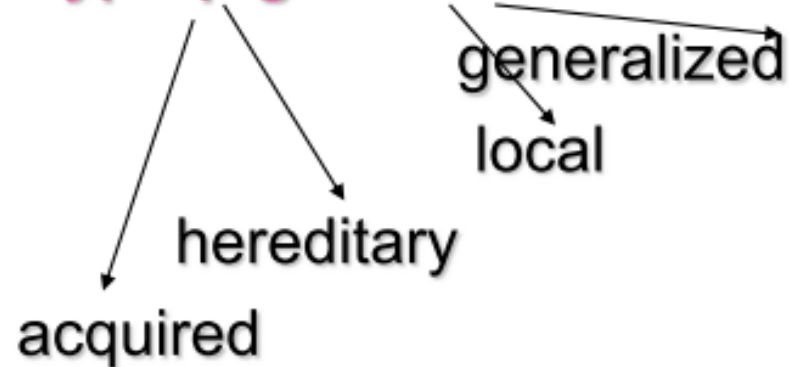
Common to both obstructive and hepatocellular cholestasis is the accumulation of bile pigment within the hepatic parenchyma. Elongated green-brown plugs of bile are visible in dilated canaliculi, most prominent toward the centers of lobules; this may become panlobular in the most severe cases.

Proteinogenic (tyrosinogenic) pigments

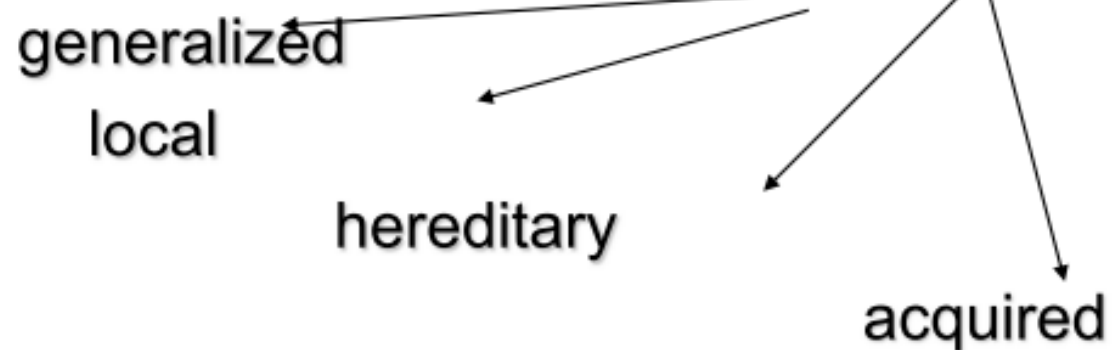
- **Melanin** is a brownish-black pigment synthesized in specialized structures - melanosomes in cells called melanocytes, from tyrosine under the action of the enzyme tyrosinase.

Disorders of melanin metabolism

Hyperpigmentation



Hypopigmentation

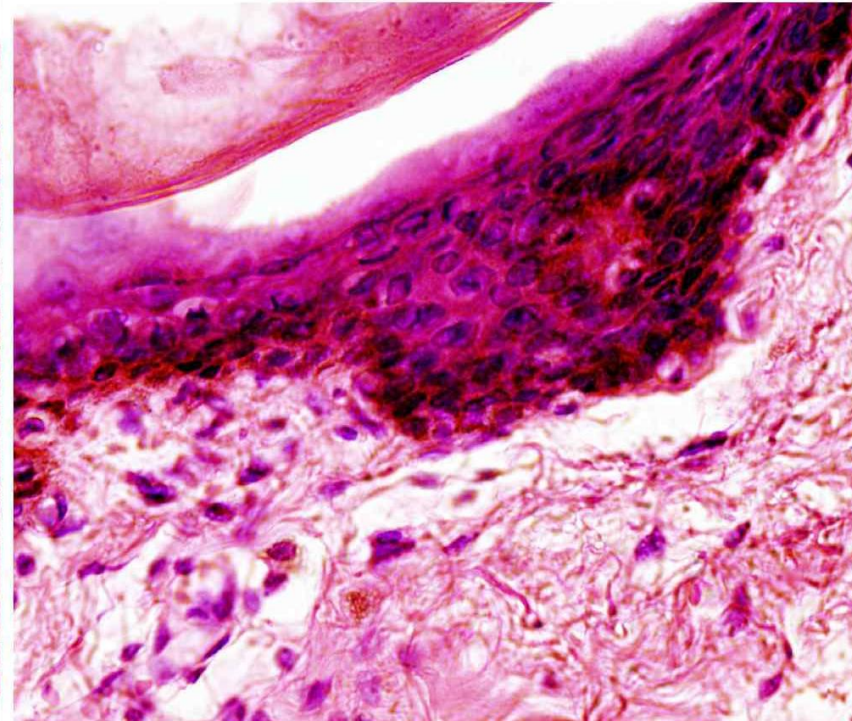
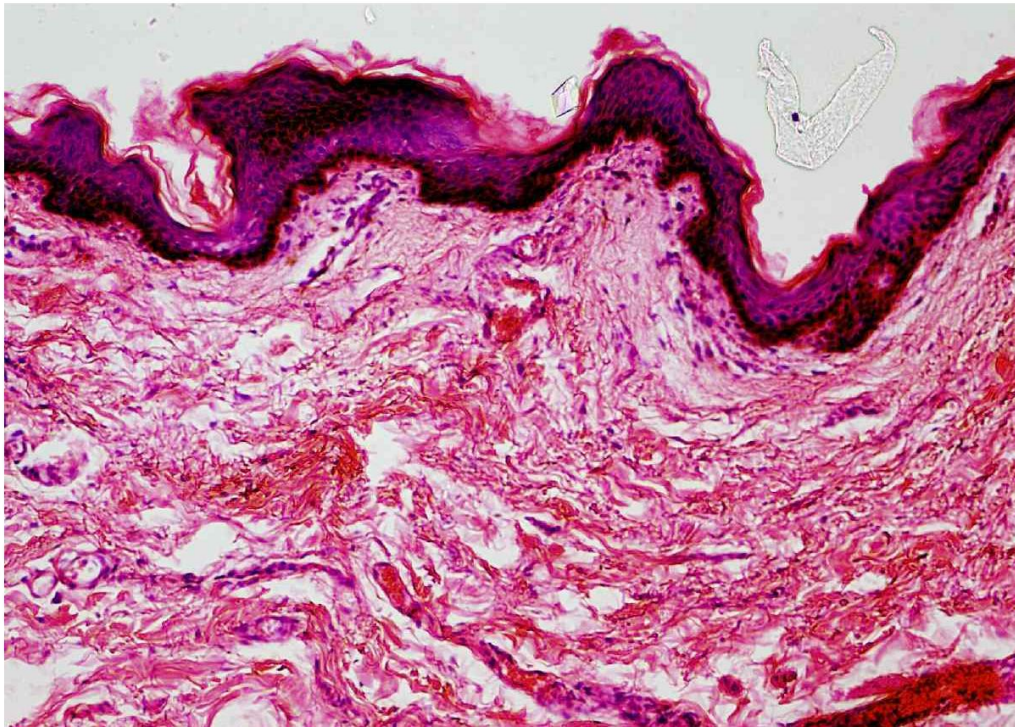


Skin in Addison's disease.



Pigmentation of the oral mucosa and hypermelanosis.

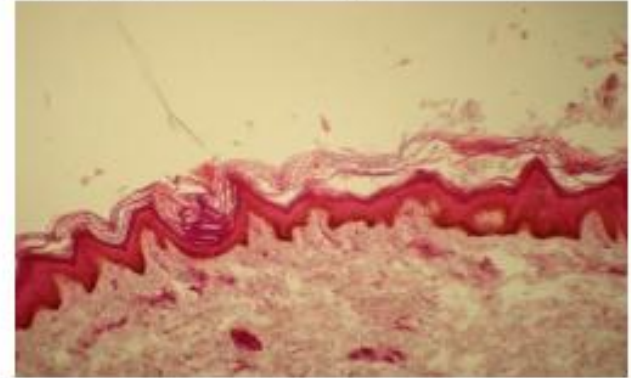
Micropreparation. Skin in Addison's disease.



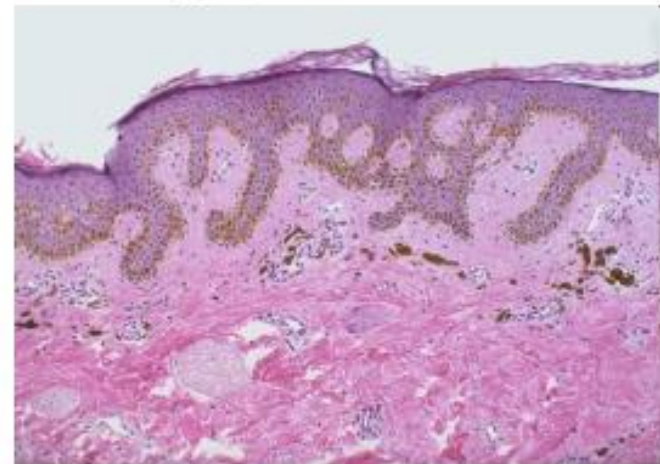
Local hyperpigmentation



- Freckles;
- Melanosis of skin;



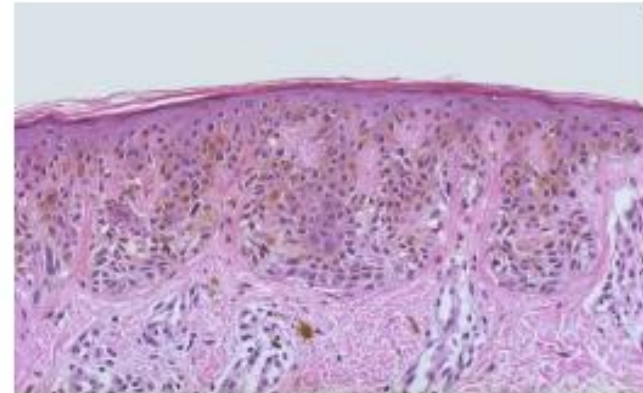
- Lentigo;



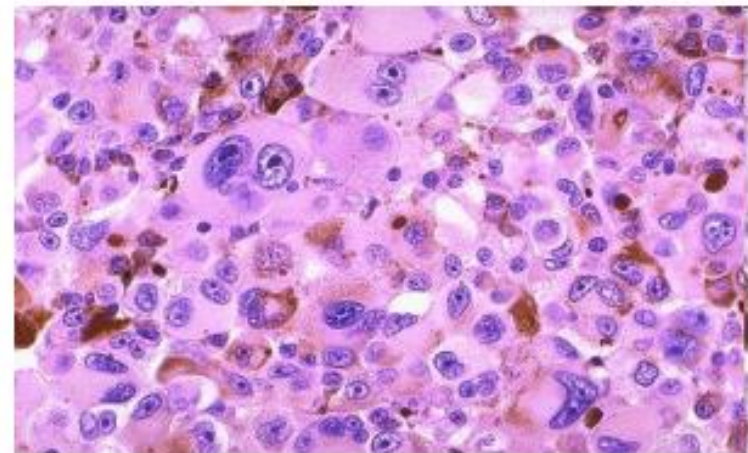
Local hyperpigmentation



- Pigmental nevus,



- Melanoma.



Hypopigmentation

- Albinism;



- Vitiligo (acquired leukoderma)



Lipidogenic pigments

- Lipidogenic pigments (lipid pigments) are pigments formed during the metabolism of fats

Lipidogenic pigments

- lipofuscin,
- vitamin E deficiency pigment,
- ceroid
- lipochromes

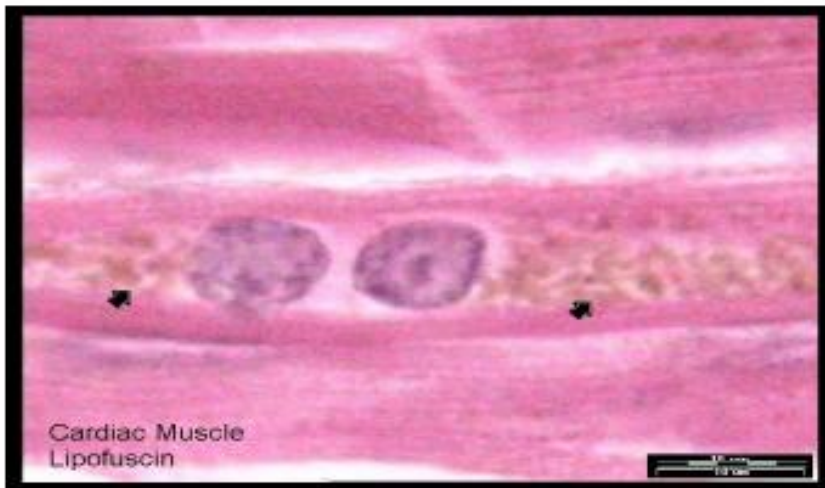
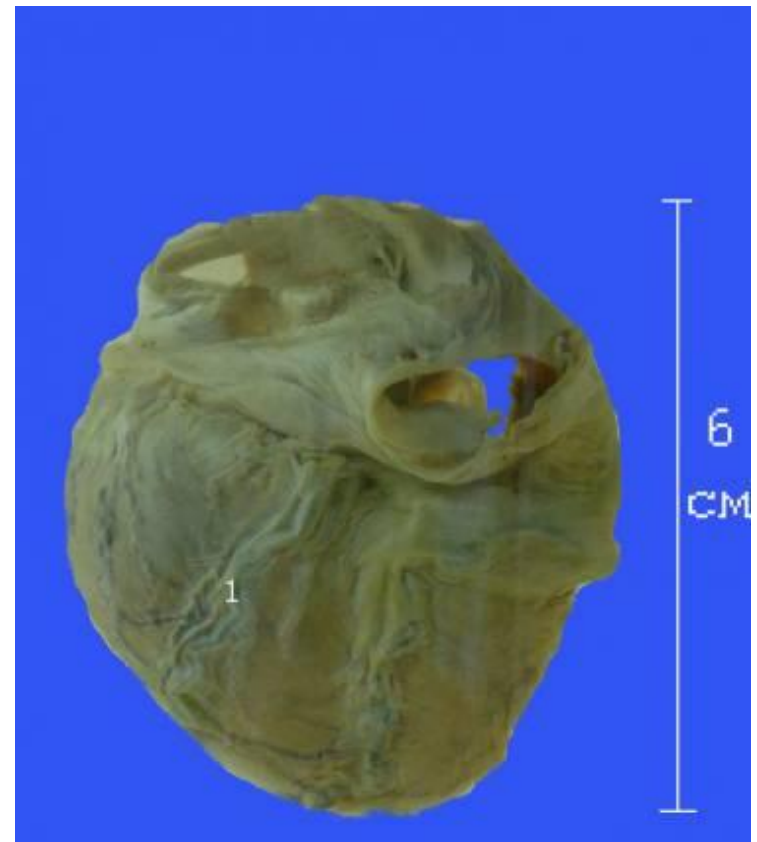
Lipofuscin

- An insoluble pigment, also known as aging, wear pigment.
- Forms golden brown granules in the cell.
- Consists of polymers of lipids and phospholipids associated with protein.
- The accumulation of lipofuscin in cells is lipofuscinosis.
- Lipofuscin is most commonly accumulated:in myocardial cells,liver hepatocytes,skeletal muscles with aging or exhaustion, which is accompanied by the development of ***brown organ atrophy***.

Lipofuscinosis



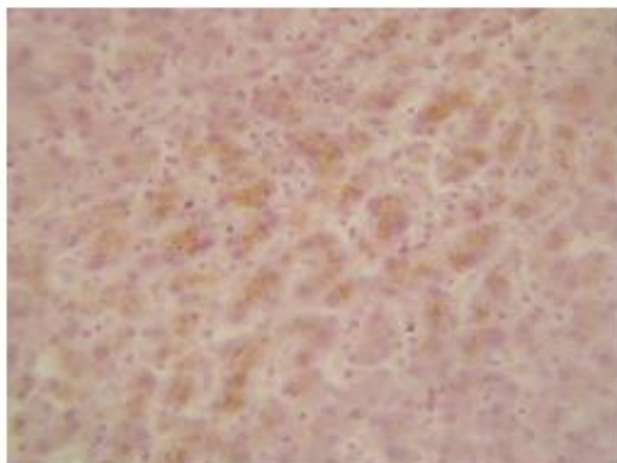
- **Brown atrophy of myocardium.**



Lipofuscinosis



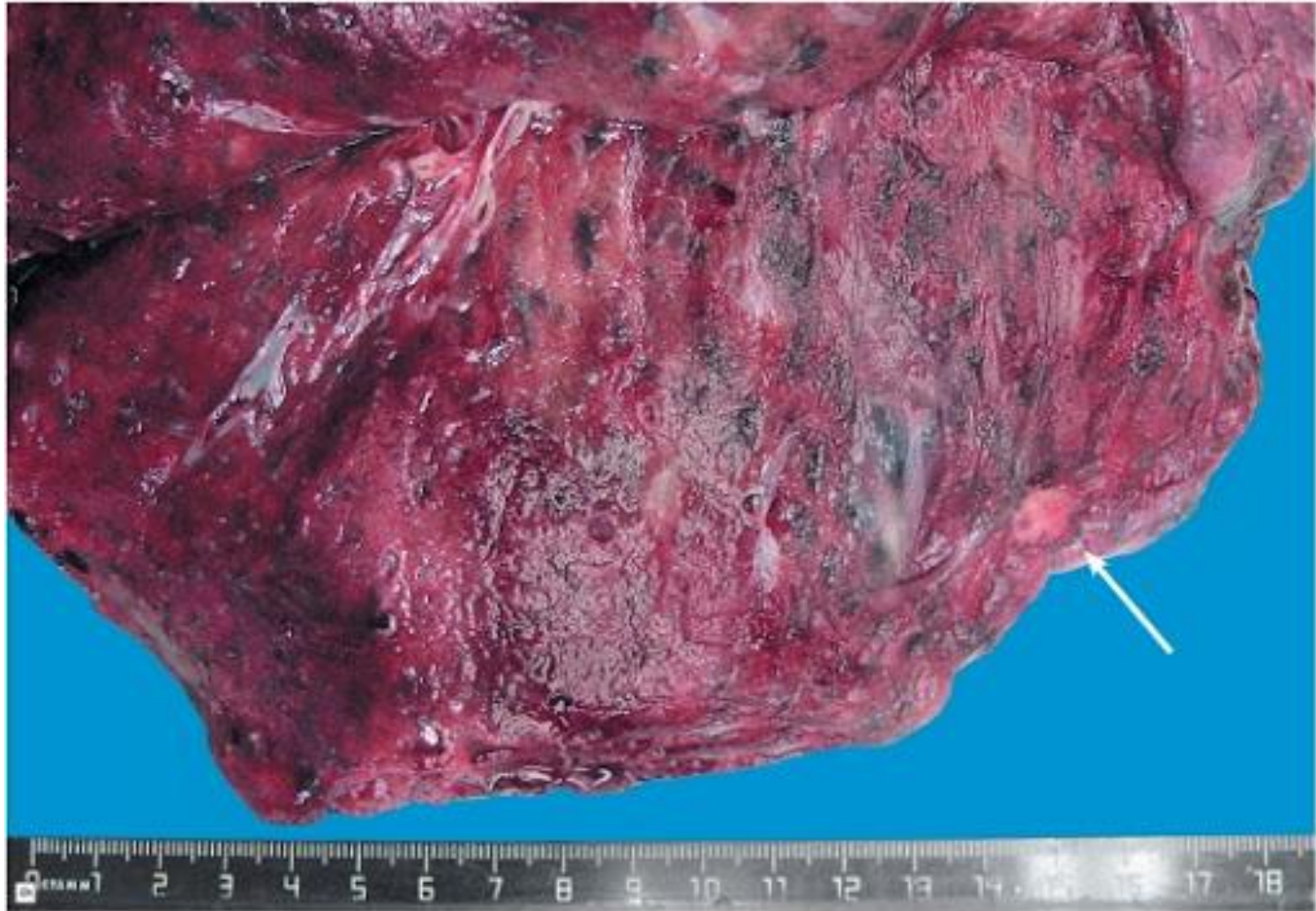
- Lipofuscinosis of liver



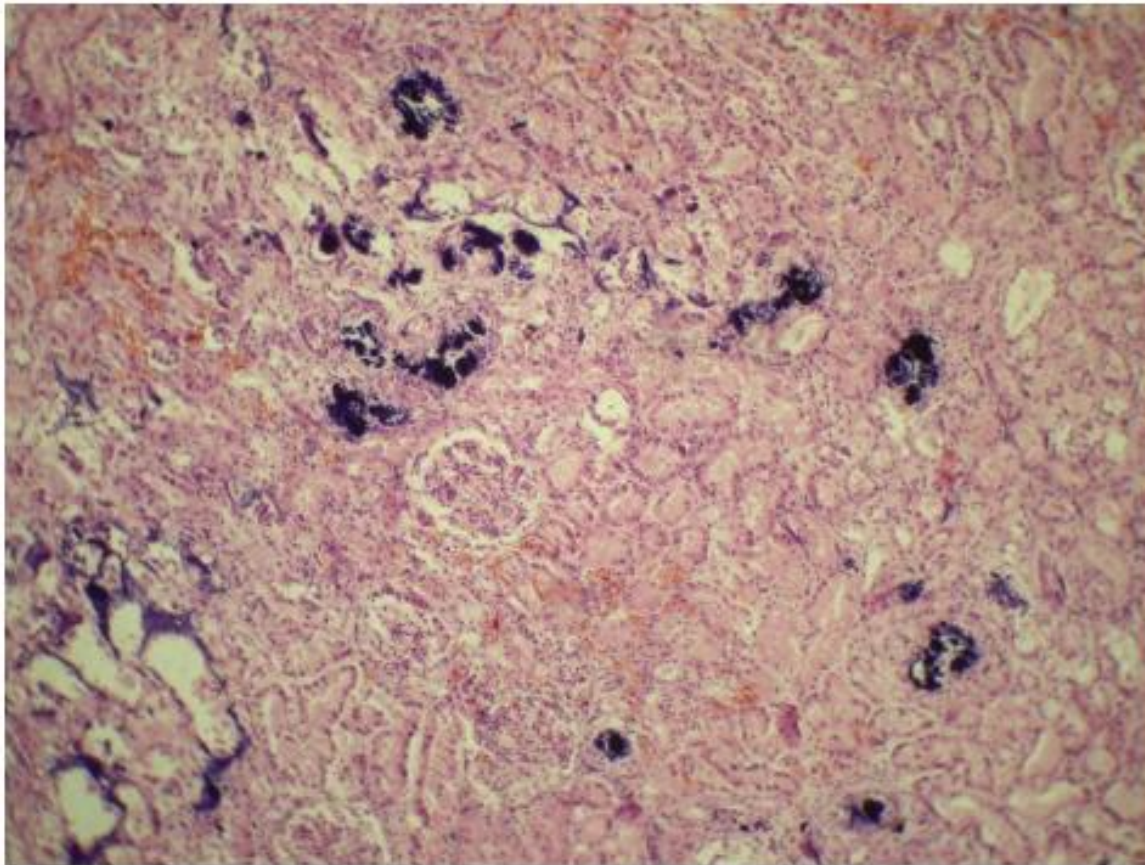
Pathologic Calcification

- the abnormal tissue deposition of calcium salts, together with smaller amounts of iron, magnesium, and other mineral salts.
- There are two forms of pathologic calcification:
 1. *dystrophic calcification*, when the deposition occurs locally in dying tissues ; it occurs despite normal serum levels of calcium and in the absence of derangements in calcium metabolism.
 2. *metastatic calcification*, almost always results from hypercalcemia secondary to some disturbance in calcium metabolism.

Petrification in the lung



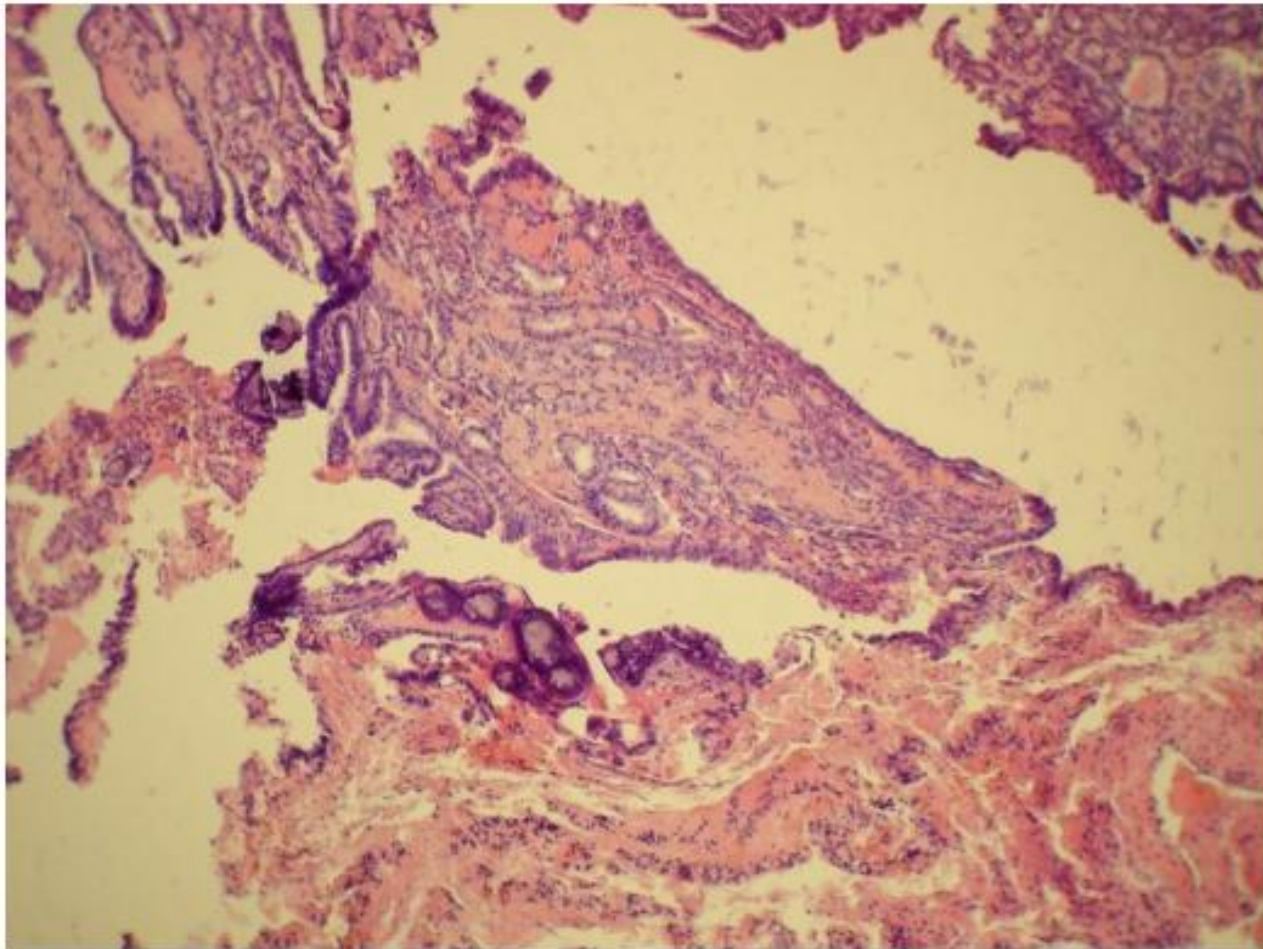
**Depositions of calcium salts in the kidney.
H&E. X 100.**



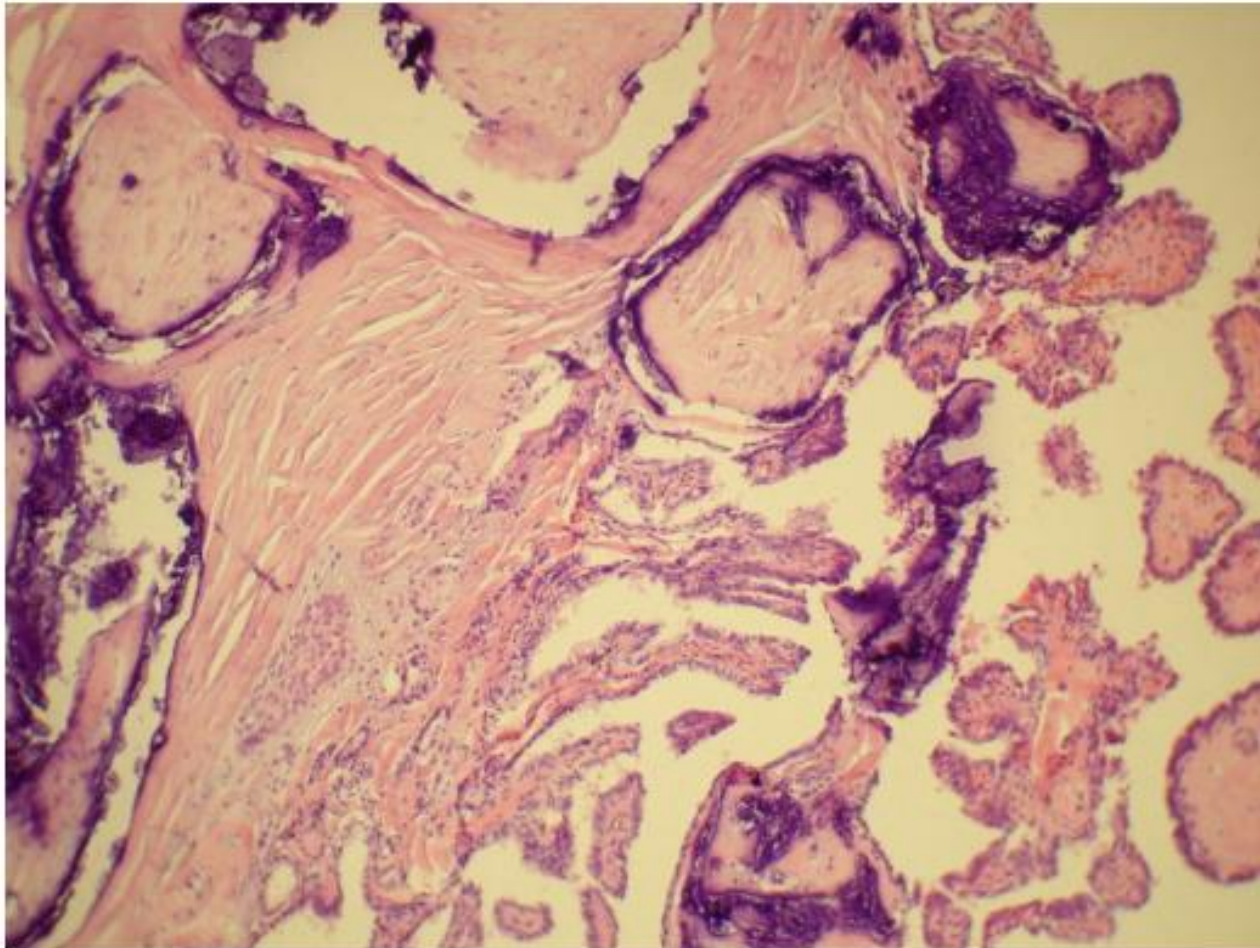
- Metastatic calcification
- Dystrophic calcification

Metastatic calcification appears to begin also in mitochondria except in kidney tubules, where it develops in the basement membranes, probably in relation to extracellular vesicles budding from the epithelial cells.

**Depositions of calcium salts in the thyroid gland.
Papillary adenocarcinoma. H&E. X 100.**



**Depositions of calcium salts in the thyroid gland.
Papillary adenocarcinoma. H&E. X 100.**



Myocardial calcinosis

(HE) x 50

