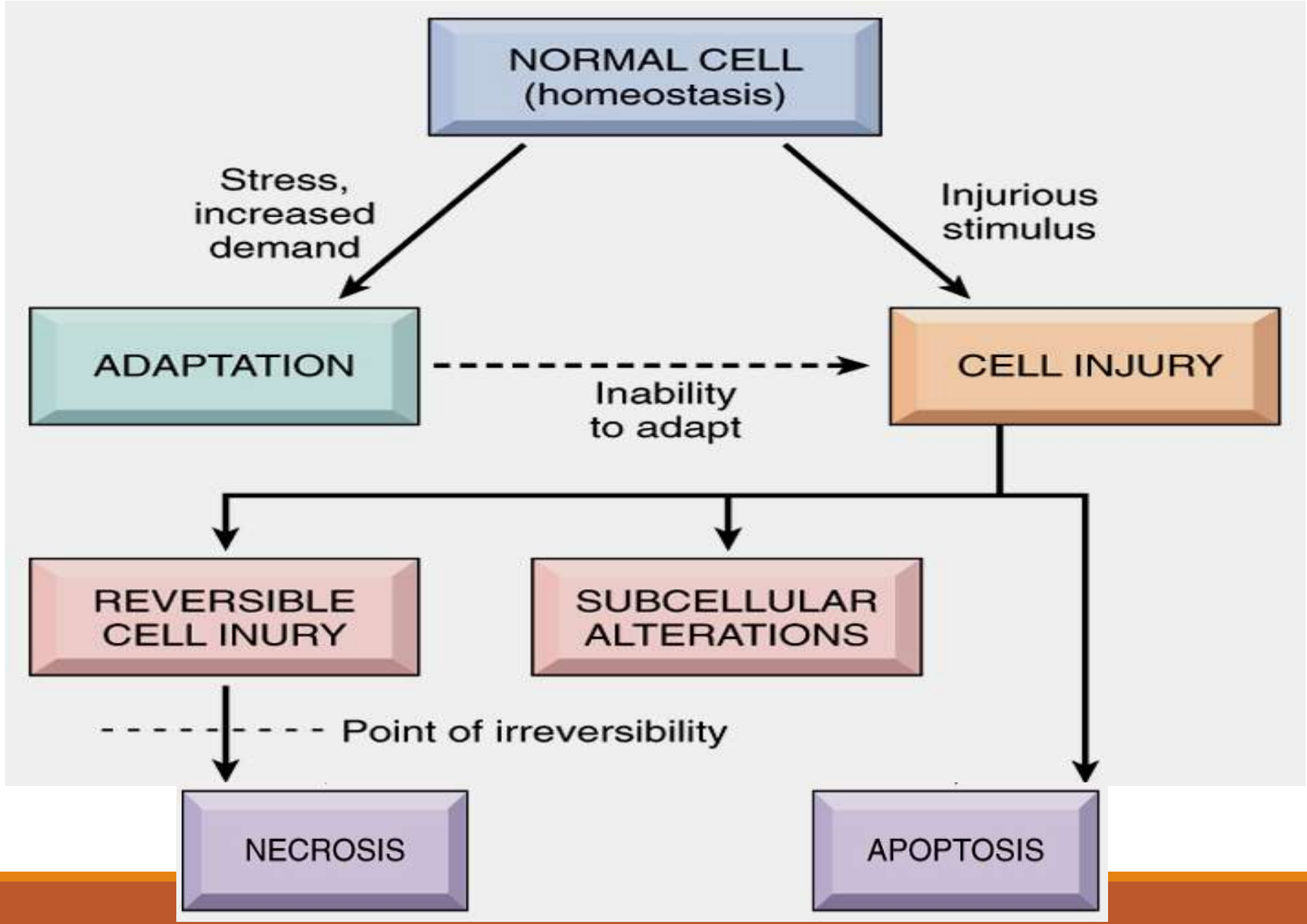
Cell Adaptation, Cell Injury and Cell Death

PRACTICAL

DR. METHAQ MUEEN

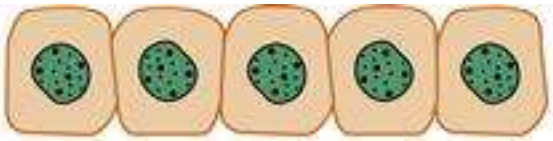
Stages in the cellular response to stress and injurious stimuli



Adaptive changes in cell growth & differentiation are include:

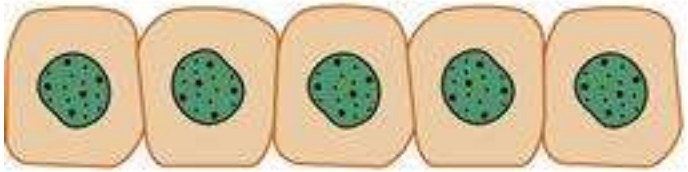
- **Atrophy** (decrease in cell size)
- **Hypertrophy** (increase in cell size).
- **Hyperplasia** (increase in cell number).
- **Metaplasia** (change in cell type).

Definition , Mechanisms , Examples

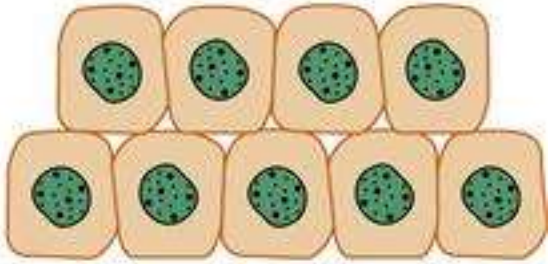


Normal

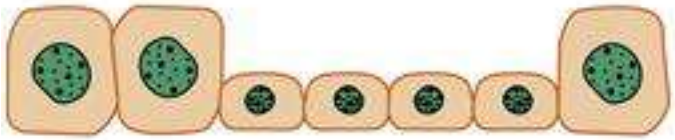
Atrophy
(decreased cell size)



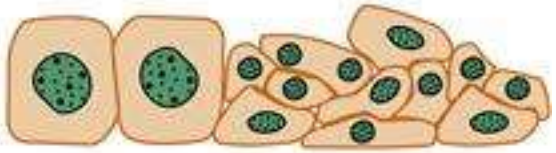
Hypertrophy
(increased cell size)



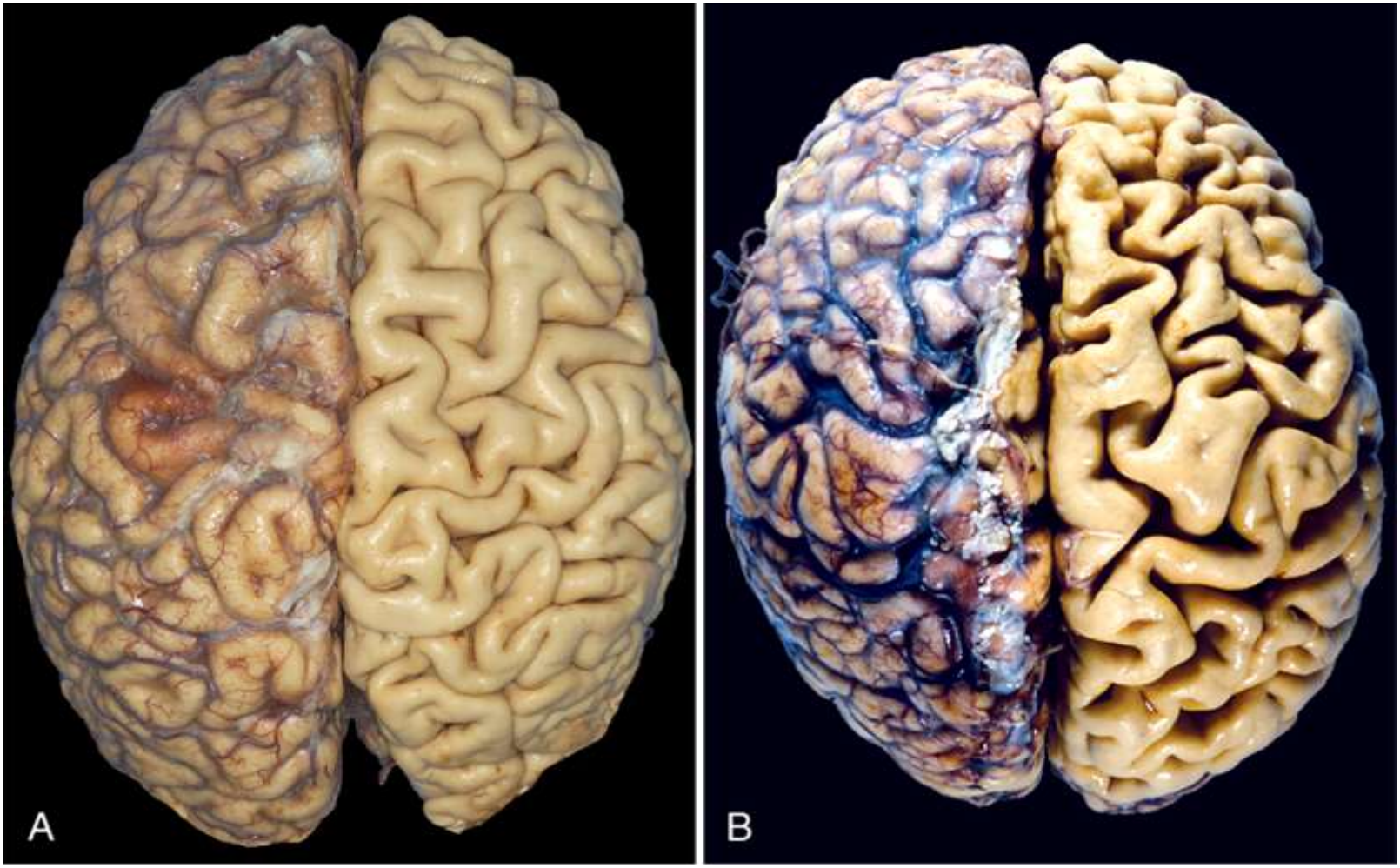
Hyperplasia
(increased cell number)



Metaplasia
(conversion of one cell
type to another)

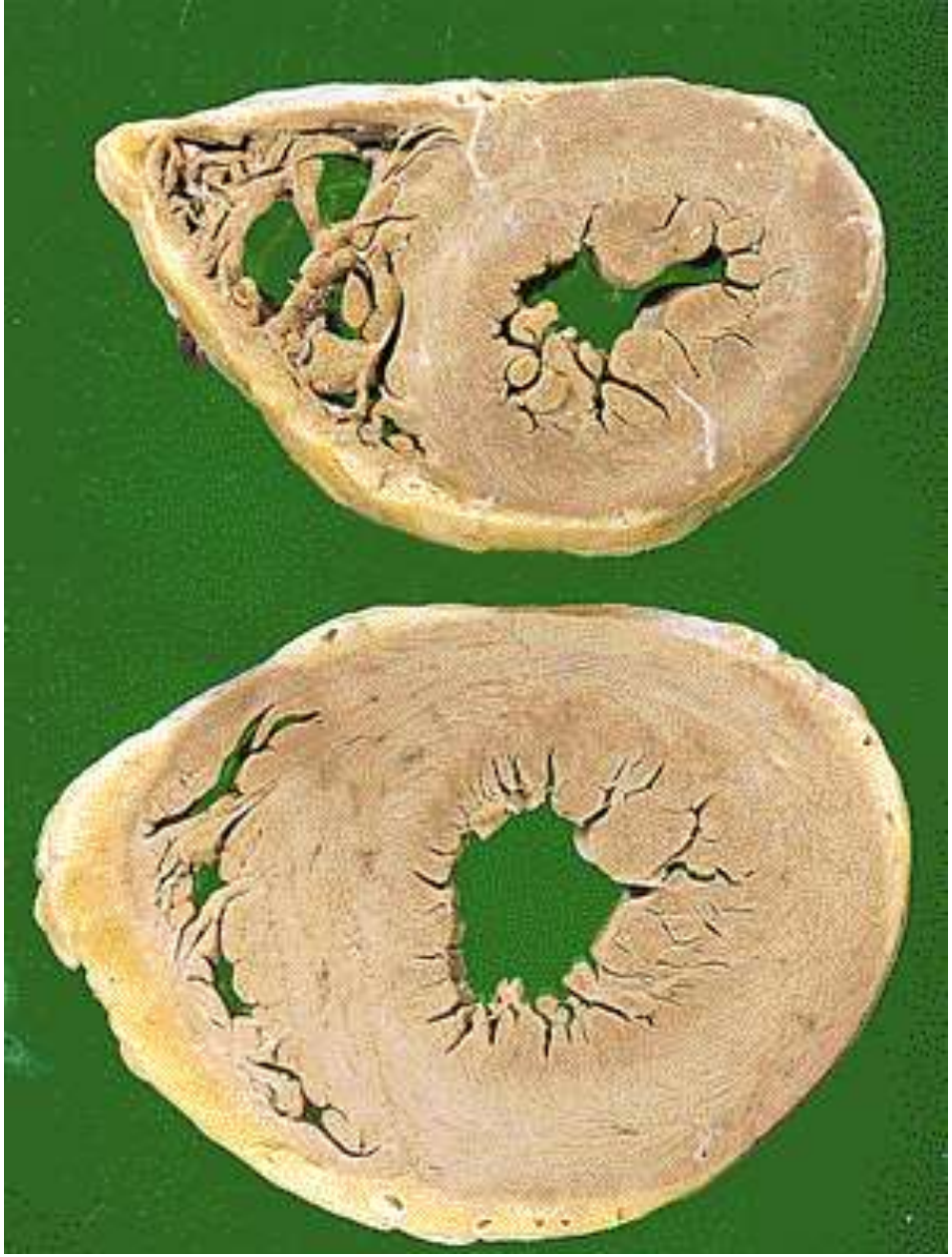


Dysplasia
(disorderly growth)



Brain atrophy

A, Normal brain of a young adult. B, Atrophy of the brain in an 82-year-old male with atherosclerotic disease. Atrophy of the brain is due to **aging** and **reduced blood supply.** Note that loss of brain substance narrows the gyri and widens the sulci. The meninges have been stripped from the right half of each specimen to reveal the surface of the brain.



Comparison between normal heart (above) & hypertrophied heart (below)

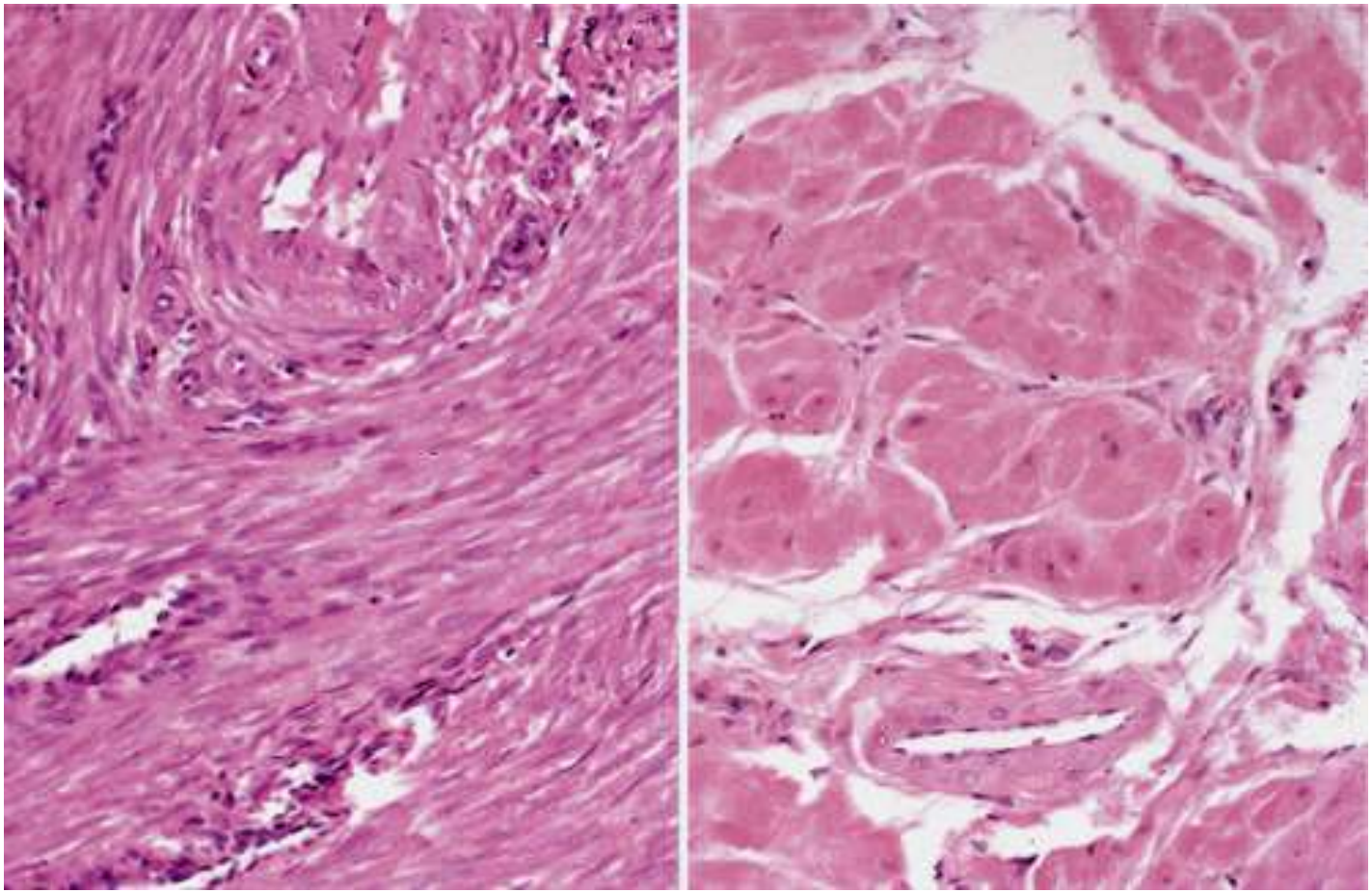
Lt. ventricular hypertrophy

This is cardiac hypertrophy. The number of myocardial fibers never increases, but their size can increase in response to an **increased workload**, leading to the marked thickening of the left ventricle in this patient with **hypertension**. Note: normal Lt. ventricular wall thickness is 1.2 cm. to 1.5 cm

Left: is a normal uterus showing the normal mass of smooth muscle in its wall.

Right: is a uterus from a **pregnant women**, in which the striking **increase in mass of smooth muscle** is evident. At cellular level this is due to **both hyperplasia and hypertrophy of uterine smooth muscle**.

Uterine hypertrophy and hyperplasia in pregnancy



Normal Vs hypertrophied uterine smooth muscle cells

Lt. small spindle-shaped uterine smooth muscle cells from a normal uterus. Compare this with (Rt) large, plump hypertrophied smooth muscle cells from a gravid uterus (same magnification).

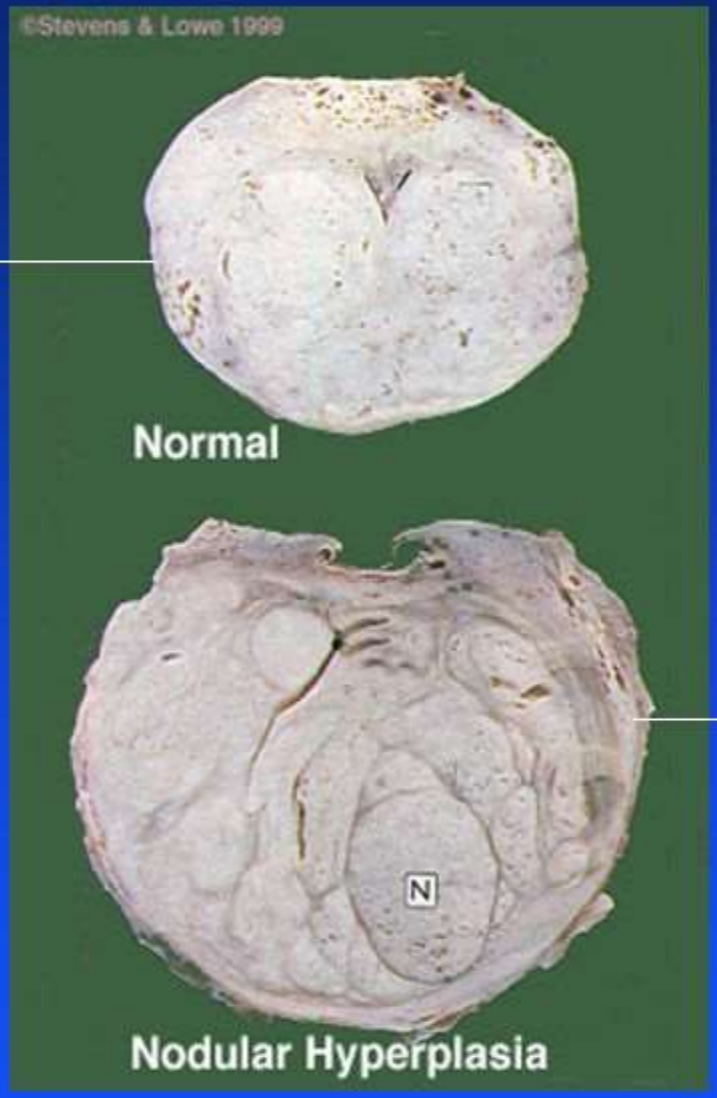
Endometrial hyperplasia

The prominent folds of **endometrium** in this uterus (opened to reveal the endometrial cavity) are an example of **hyperplasia**. The hyperplasia involves both endometrial glands and stroma.

Cellular adaptations in disease

Nodular hyperplasia of prostate

From a young man showing uniform texture of gland

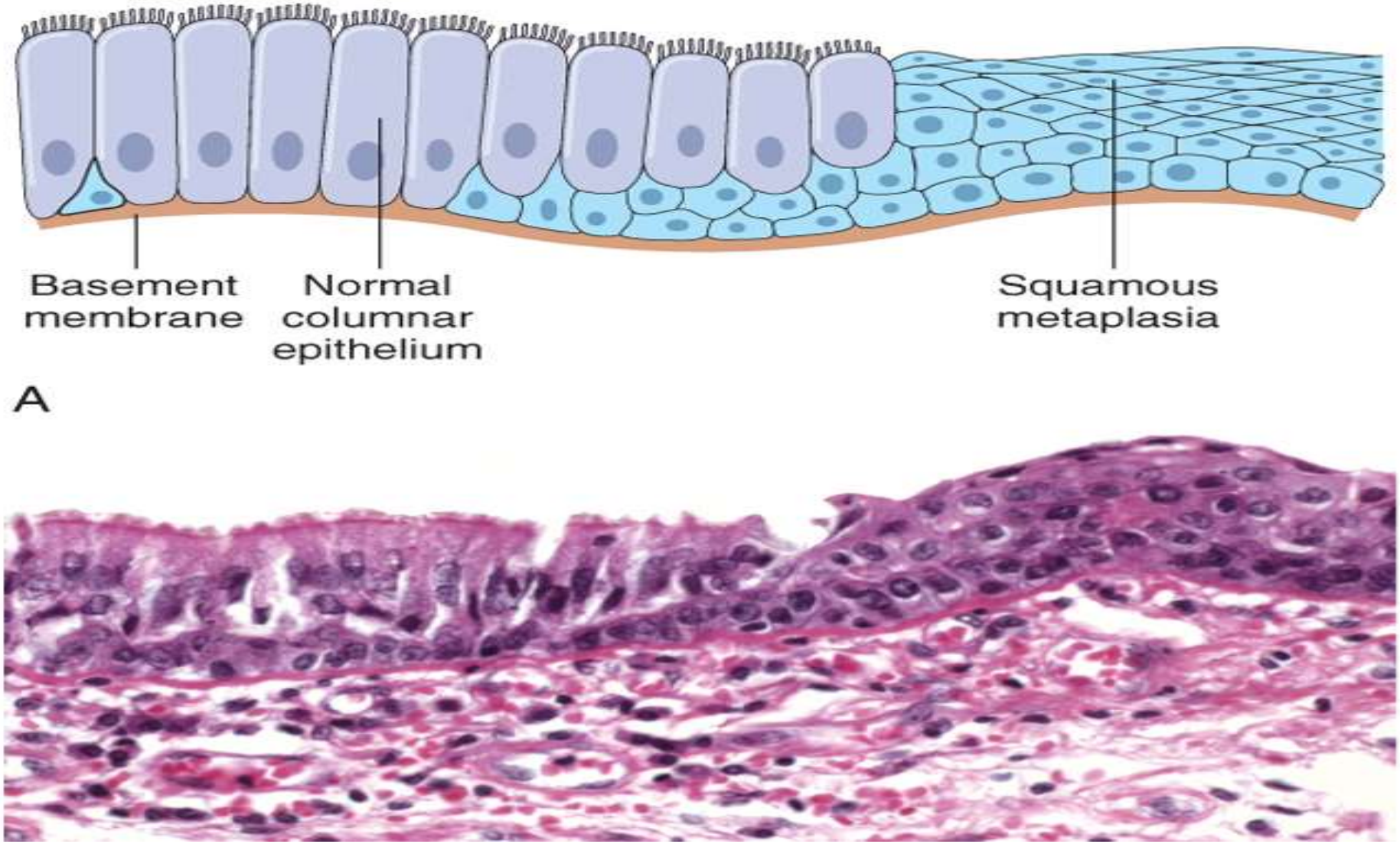


From an elderly man showing irregular hyperplastic nodules. This would cause obstruction

Verruca vulgaris(Wart)

Multiple papules with rough surfaces at infection sites

HPV cause squamous epithelium hyperplasia



Epithelial Metaplasia

Metaplasia of normal columnar (left) to squamous epithelium (right) in a bronchus, shown (above) schematically and (down) histologically.

Columnar (intestinal) metaplasia esophagus (Barrett esophagus)

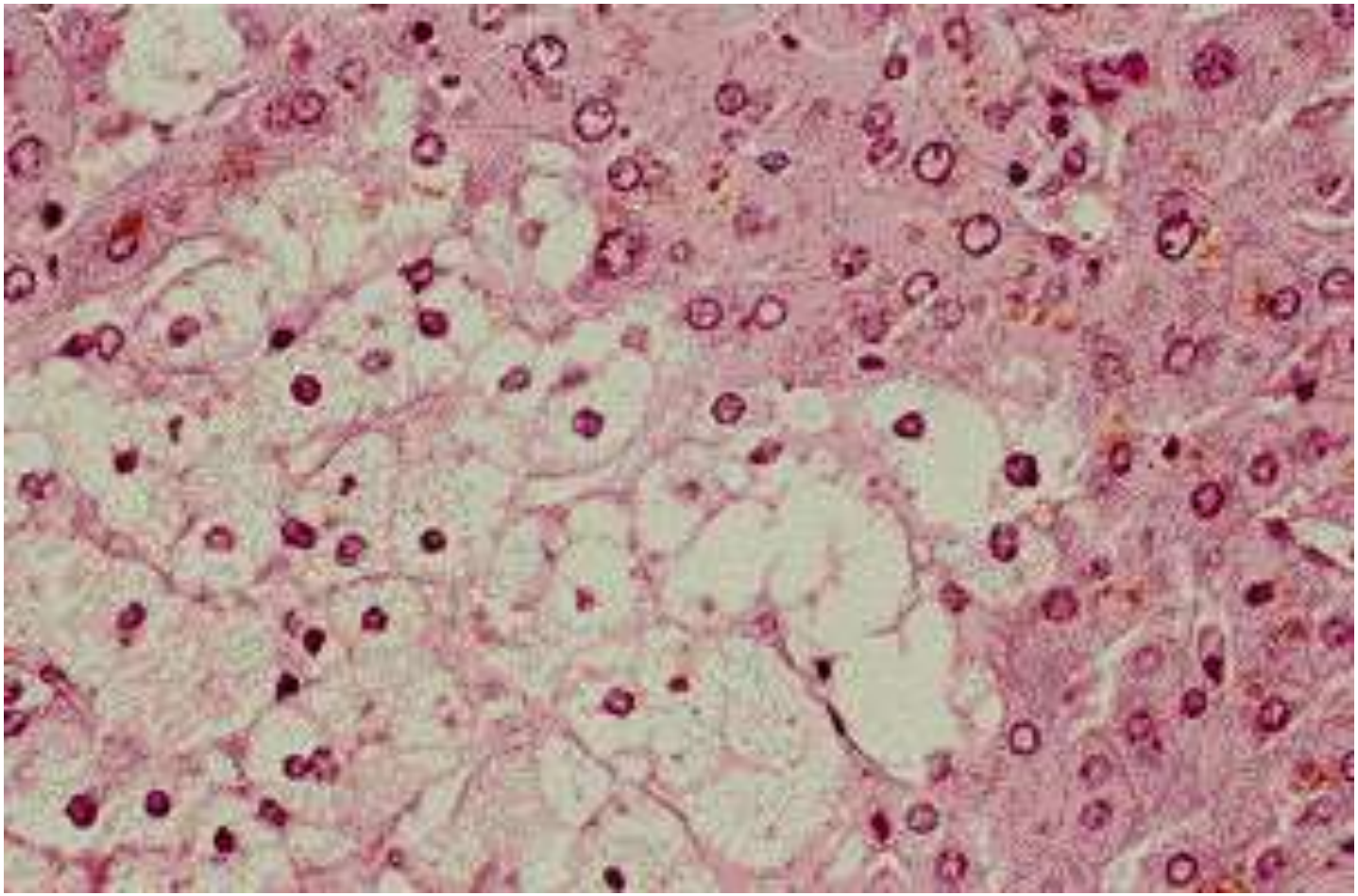
Metaplastic transformation (arrow) of the normal oesophageal stratified squamous epithelium (Lt) to mature columnar epithelium (Barrett esophagus)

Cell injury is either

Reversible Cell injury the cells return back to their stable baseline state after removal the cause of cell injury. This is called **Degeneration**

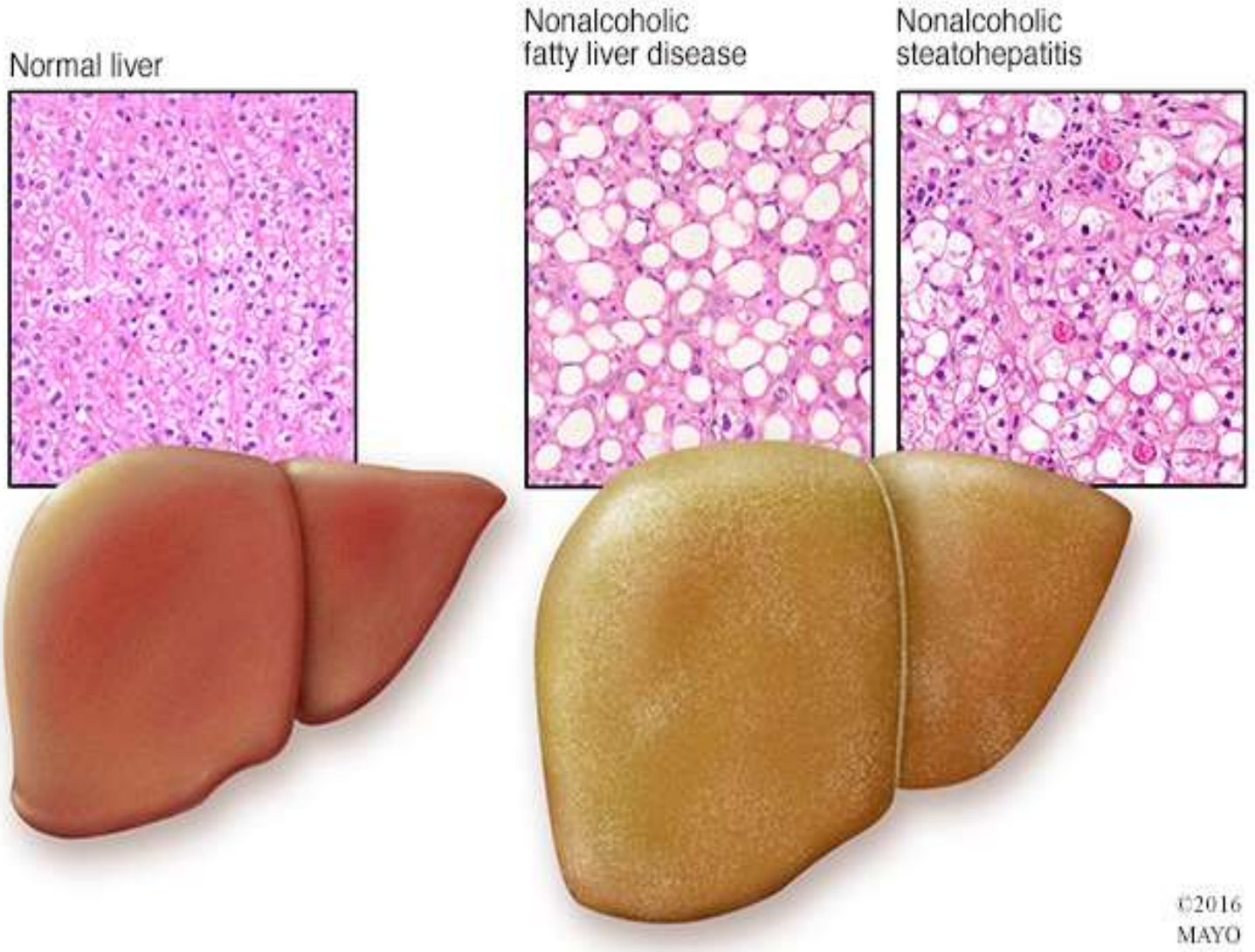
Irreversible Cell injury cells cant return to their baseline state after removal the cause of cell injury. This is called **Cell death**

MORPHOLOGY OF REVERSIBLE CELL INJURY



Cellular swelling (hydropic change)

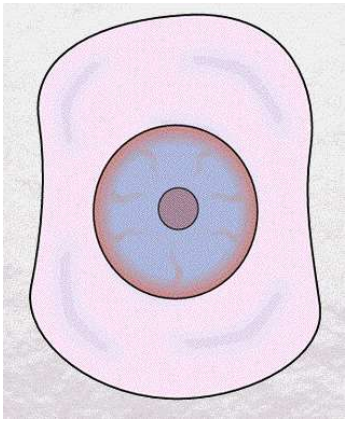
The affected hepatocytes are distended by accumulated water that imparts cytoplasmic pallor.



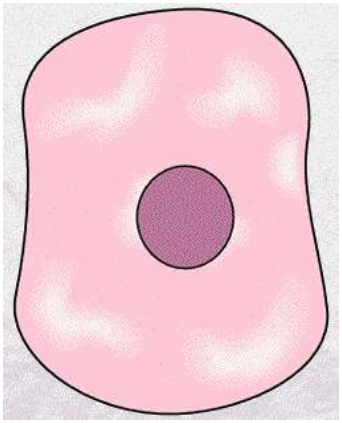
Necrosis

Cell necrosis: Nuclear changes

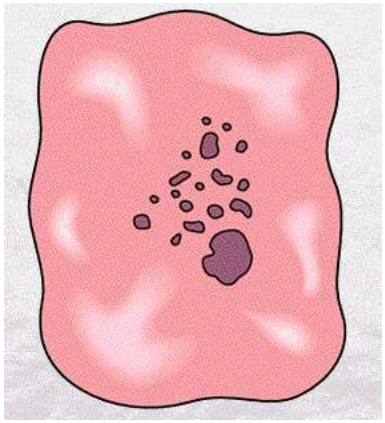
normal



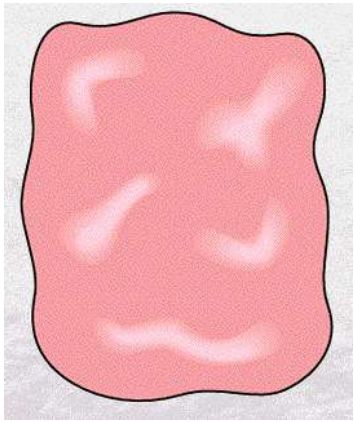
pyknosis



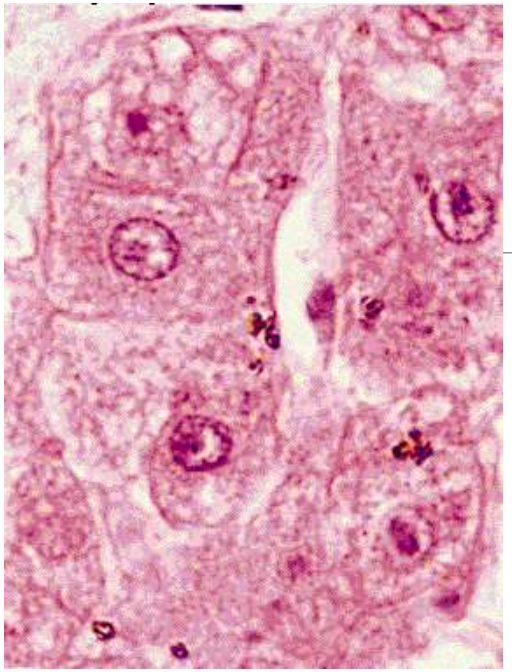
karyorrhexis



karyolysis

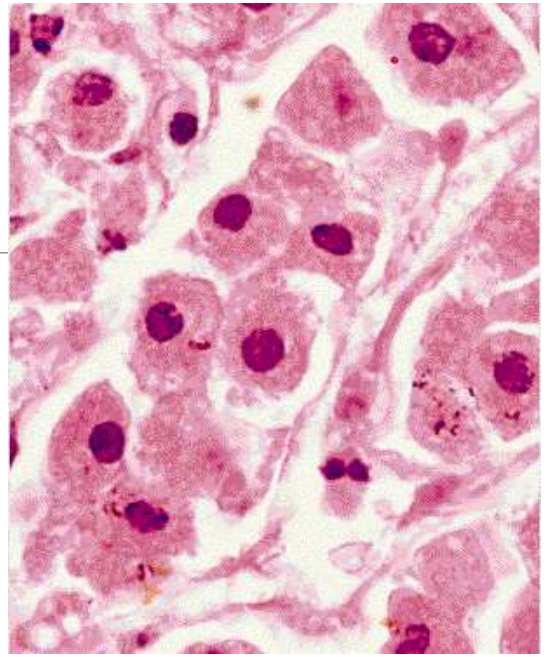


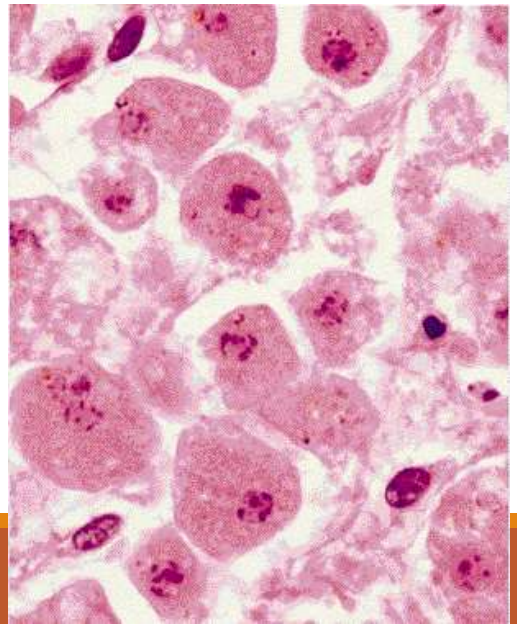
Liver cell necrosis: Nuclear changes



normal

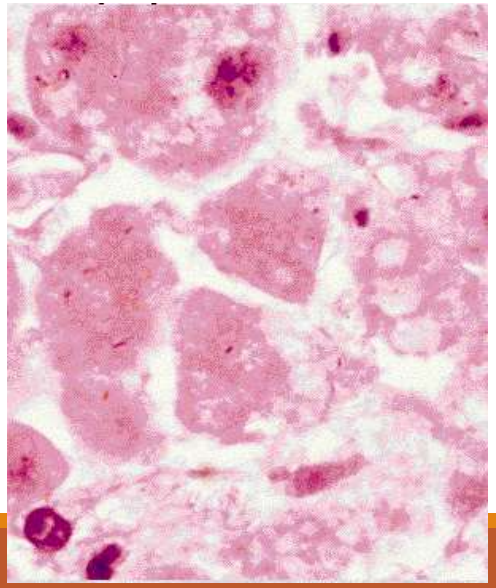
pyknosis

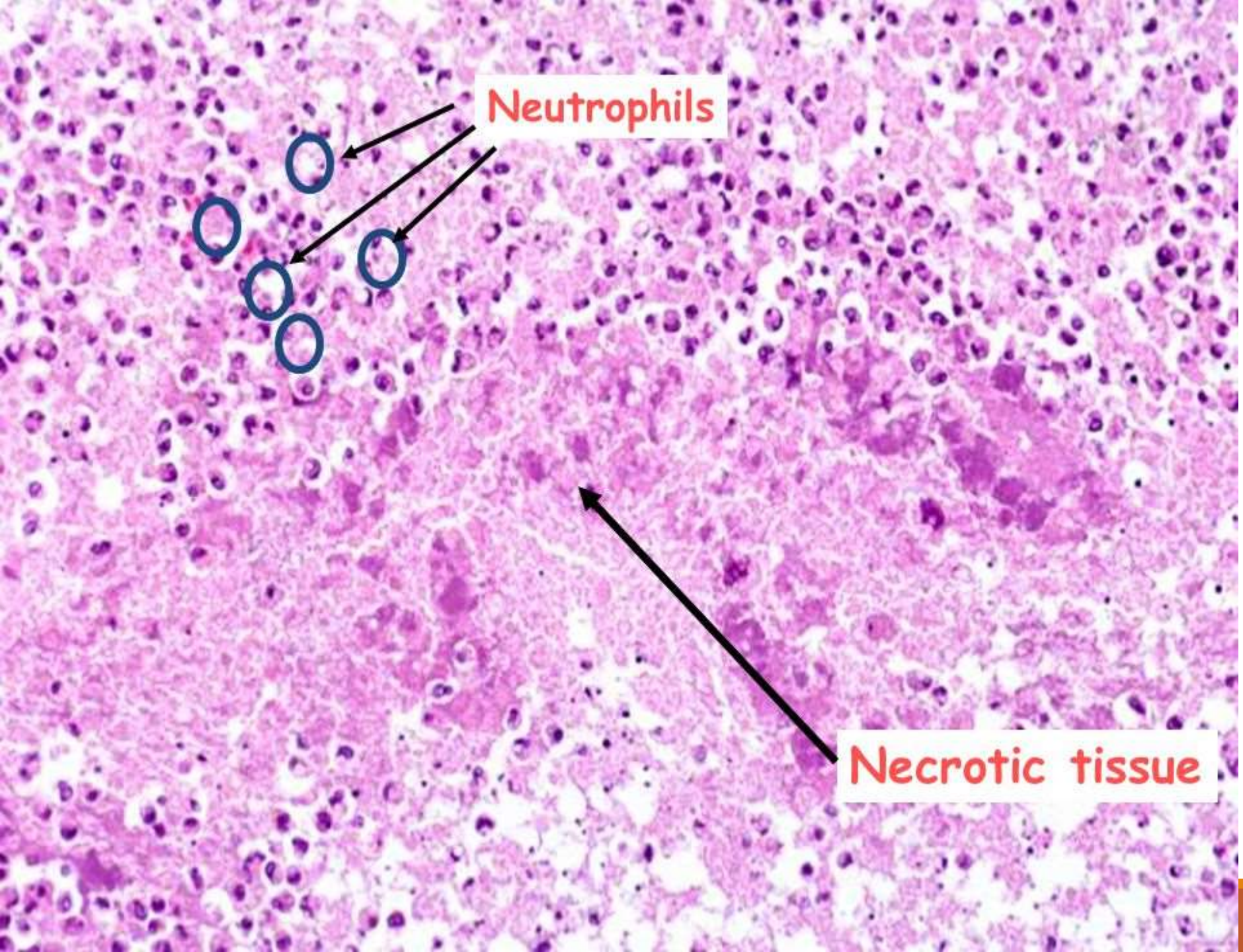




karyorrhexis

karyolysis




Neutrophils
Necrotic tissue

Types of Necrosis:

1- Coagulative Necrosis

2-Liquifactive Necrosis:

3- Caseous Necrosis

4- Gangrenous Necrosis:

1.Dry gangrene

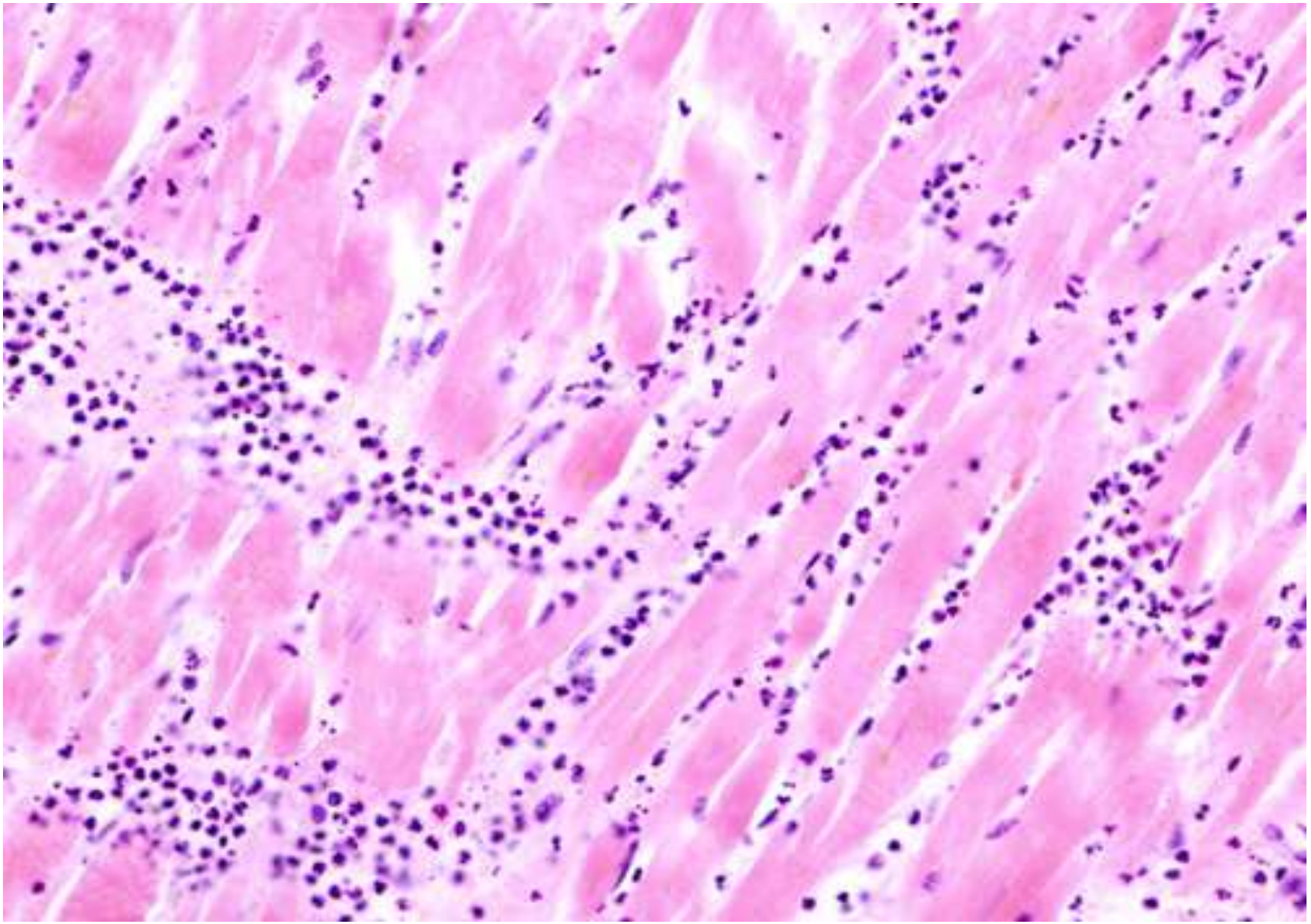
2. Wet gangrene

3. Gas gangrene

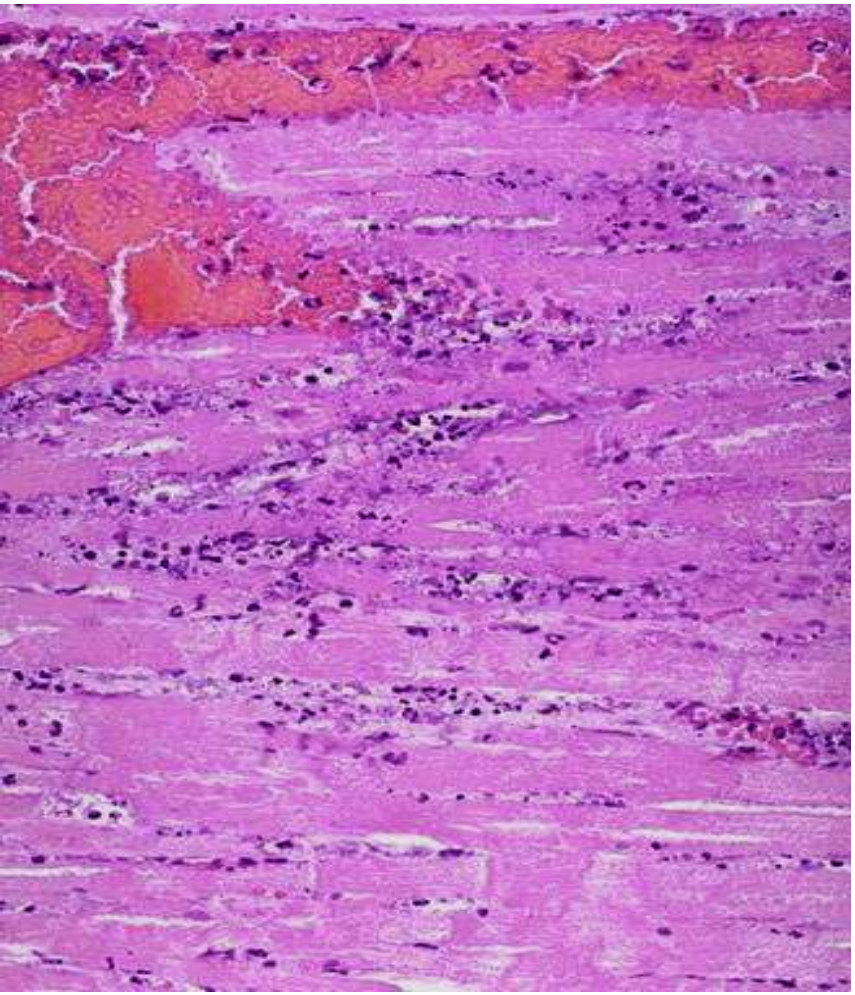
5- Fat Necrosis

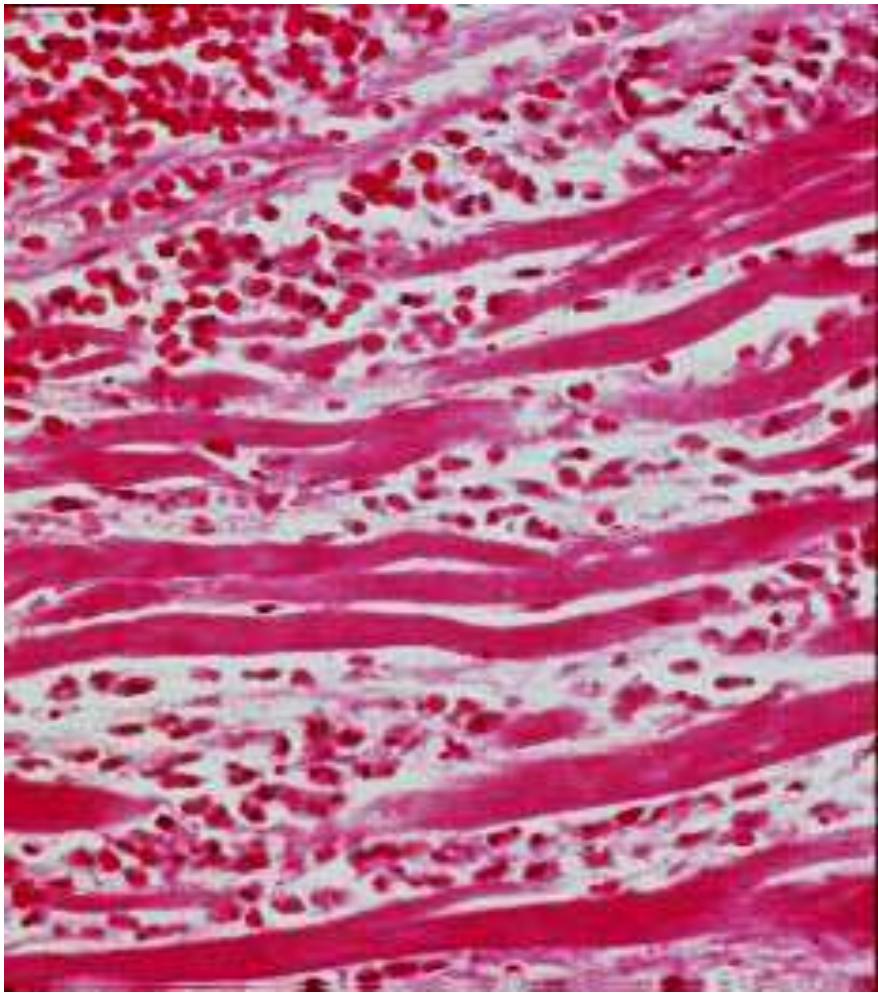
1- TRAUMATIC Fat Necrosis.

2. ENZYMATIC Fat Necrosis.



Myocardil infarction coagulative necrosis





Coagulative necrosis myocardium

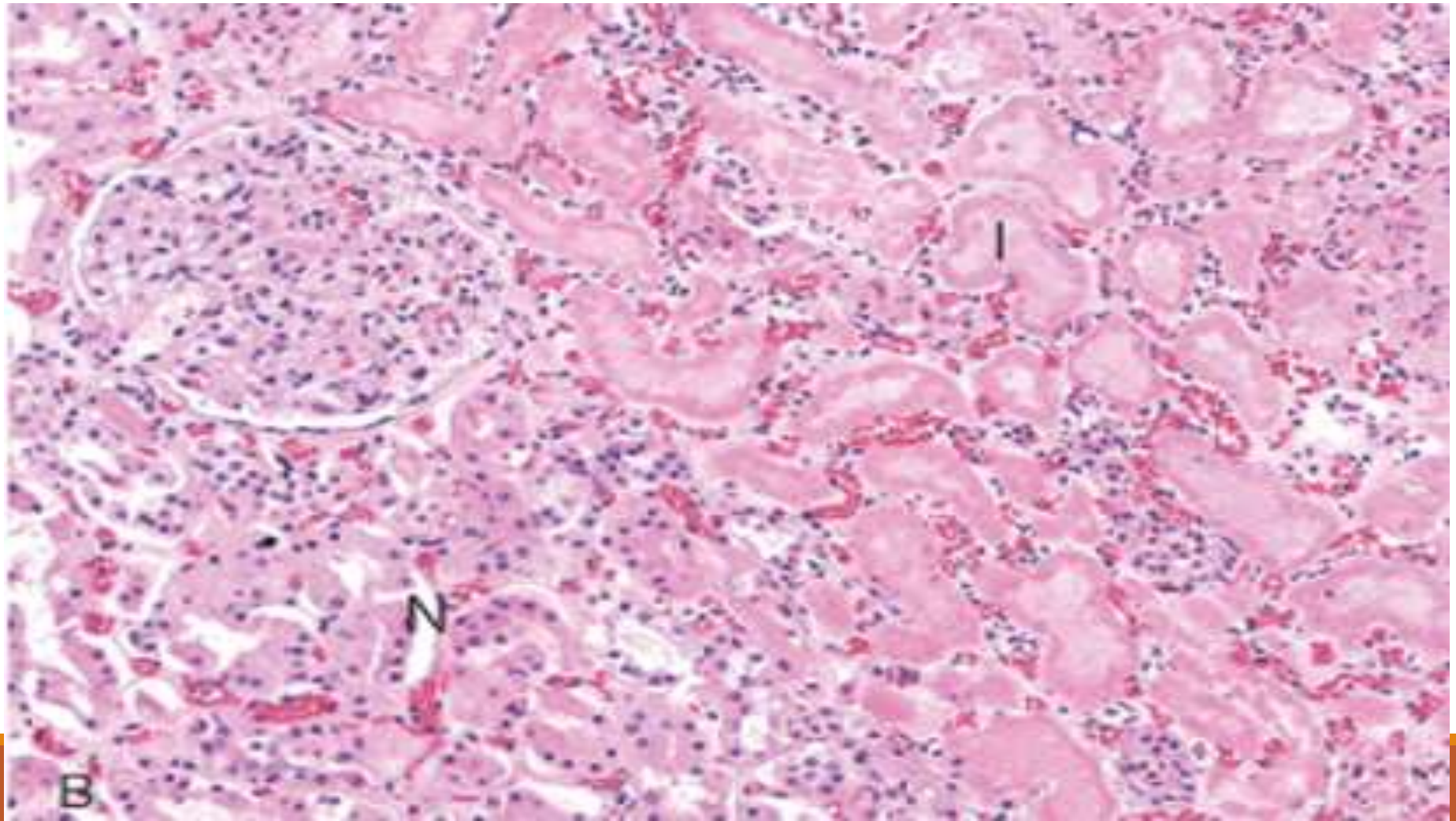
The necrotic myocytes are intensely eosinophilic with loss of both cross striations & nuclei. The outlines of individual fibres are still maintained. There are inflammatory cells infiltration & RBCs in-between the necrotic fibers.

Kidney: there is a wedge-shaped firm pale area of coagulative necrosis (infarction) in the renal cortex of the kidney.

Diagnosis : Coagulative necrosis of kidney

Microscopically, the renal cortex has undergone anoxic injury so that the cells appear pale and ghost-like renal parenchyma at the far right
the architecture is preserved but loss of cellular detailes.

Diagnosis : coagulative necrosis of renal tissue



Lung abscess

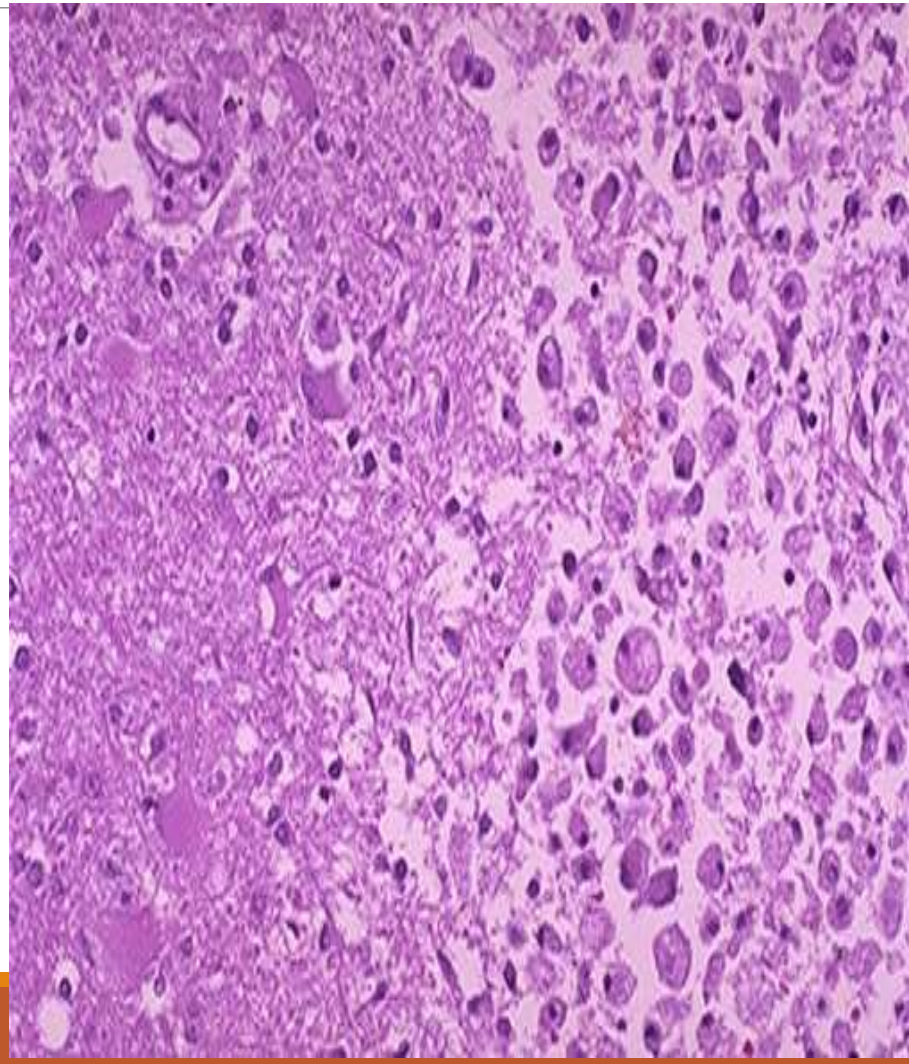
This is an example of liquefactive necrosis. There is confluent bronchopneumonia (scattered pale areas) complicated by abscess formation, which is seen here as a cystic cavity (arrow). The contained pus poured off during the sectioning of the lung tissue.

Gross Slide on the left

affected area is wedge-shaped, pale, soft & cystic. this infarct in the brain is organizing and being resolved, the liquefactive necrosis leads to resolution with cystic spaces

Mic. slide on the right: loss of both architecture and cellular detailes

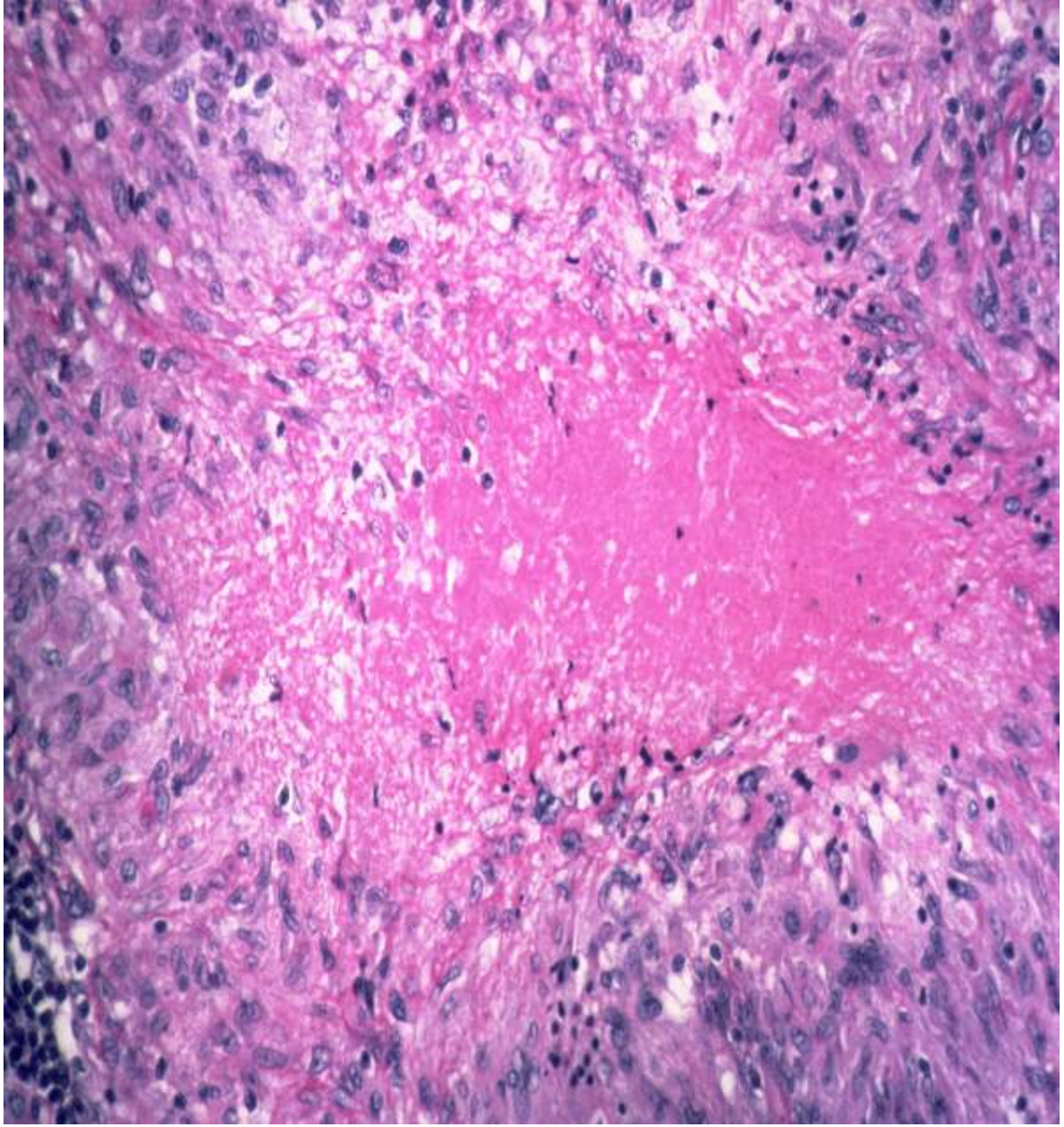
liquefactive necrosis of the brain demonstrates many macrophages & edema at the right which are cleaning up the necrotic cellular debris.



Caseous necrosis

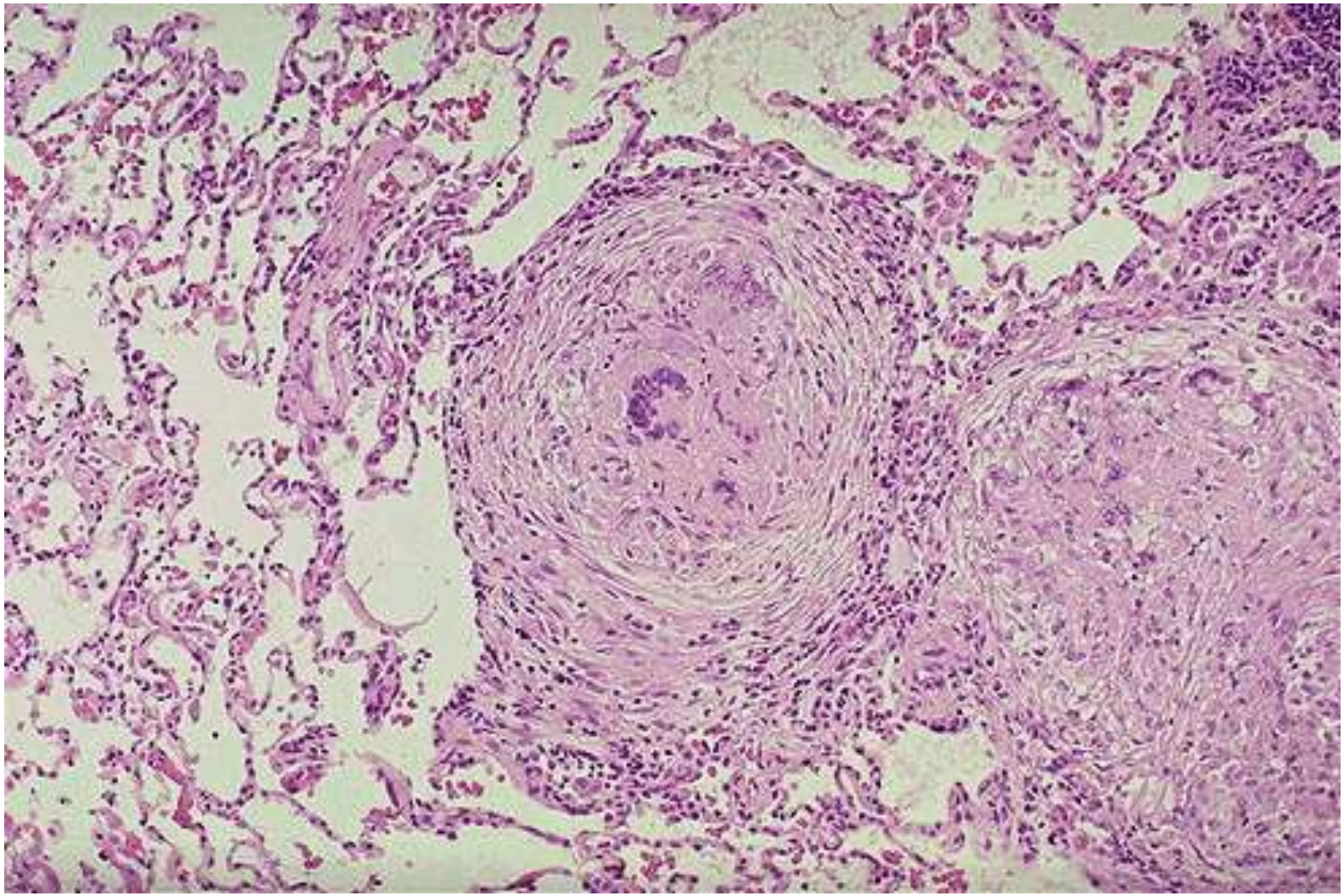
A tuberculous lung with a large area of caseous necrosis containing yellow-white and cheesy debris.

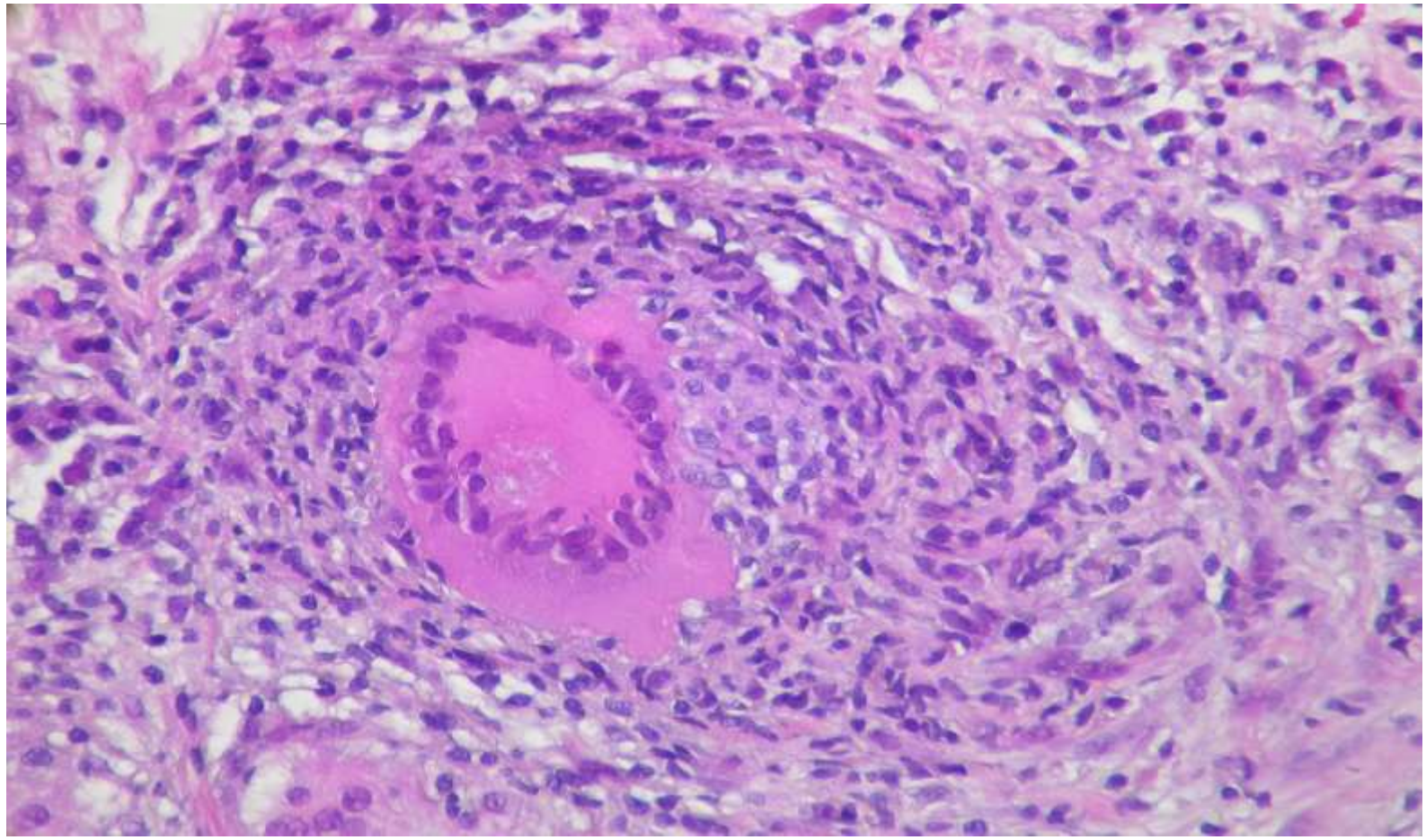
Microscopically, caseous necrosis is characterized by amorphous (acellular), eosinophilic granular pink areas of necrosis, surrounded by a granulomatous inflammatory process



Caseous necrosis

TB granulomas lung





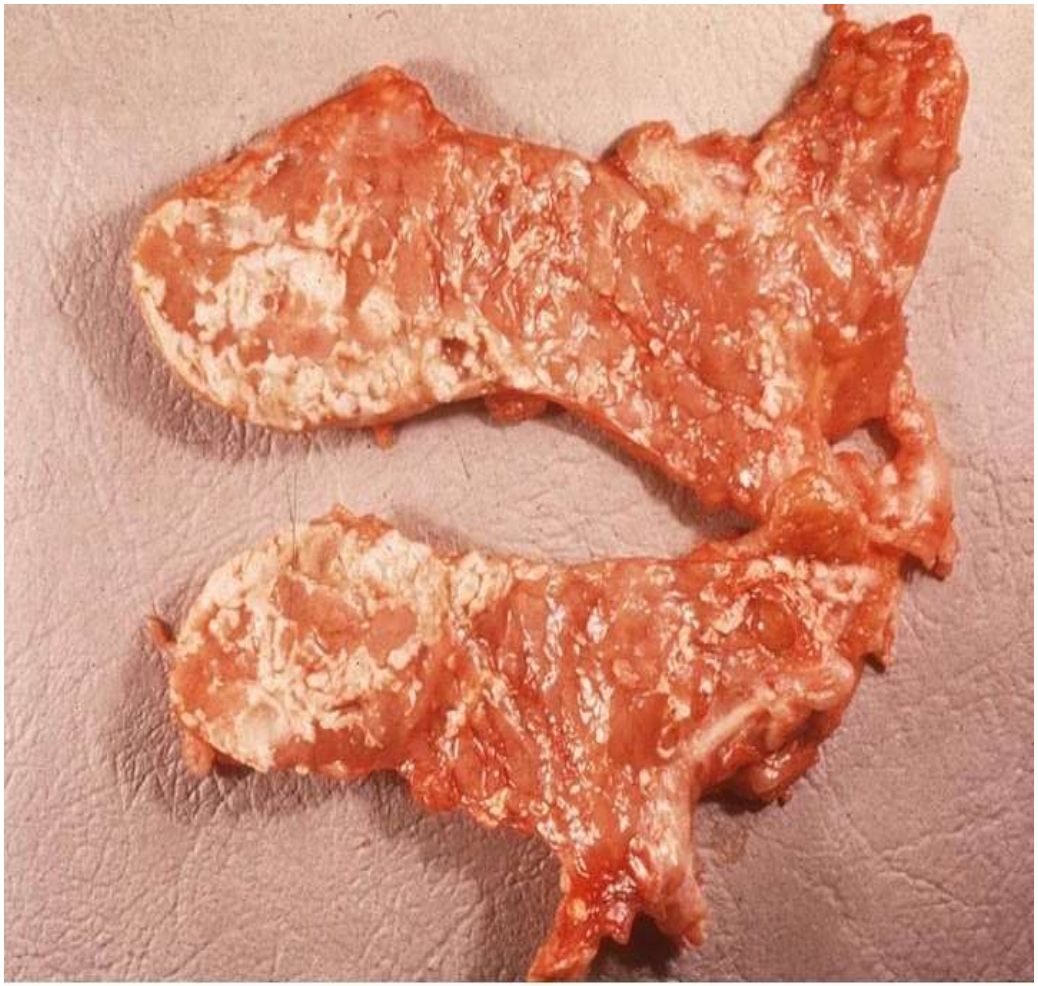
Granuloma and giant cell

Ganagrene of lower limb

Dry gangrene

Wet gangrene

Fat necrosis of acute pancreatitis



http://picasaweb.google.com/lh/photo/2bVfmGoECVga4crlneb67w

Injury to the pancreatic acini leads to release of powerful enzymes which damage fat through lipases; these liberate fatty acids which complex with calcium leading to the production of soaps, and these appear grossly as the soft, chalky white areas seen here on the cut surfaces.

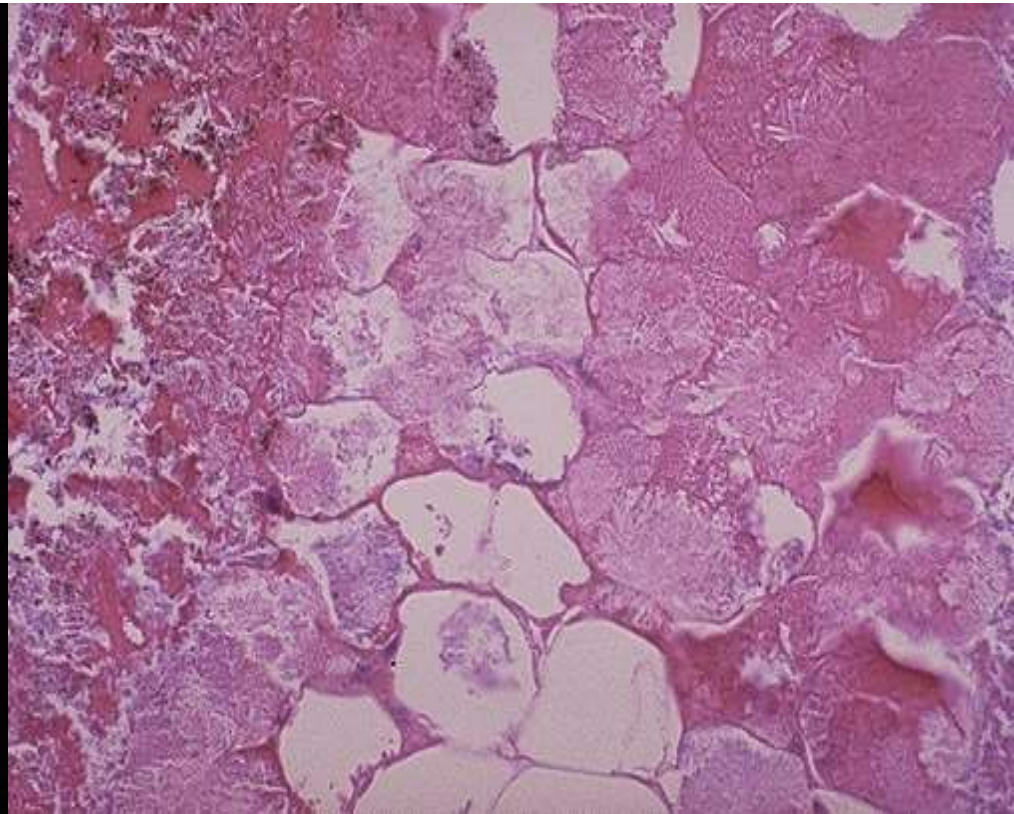
Slide on left:

gross: soft, chalky white areas with foci of hemorrhage seen on the cut surfaces of inflamed pancreas

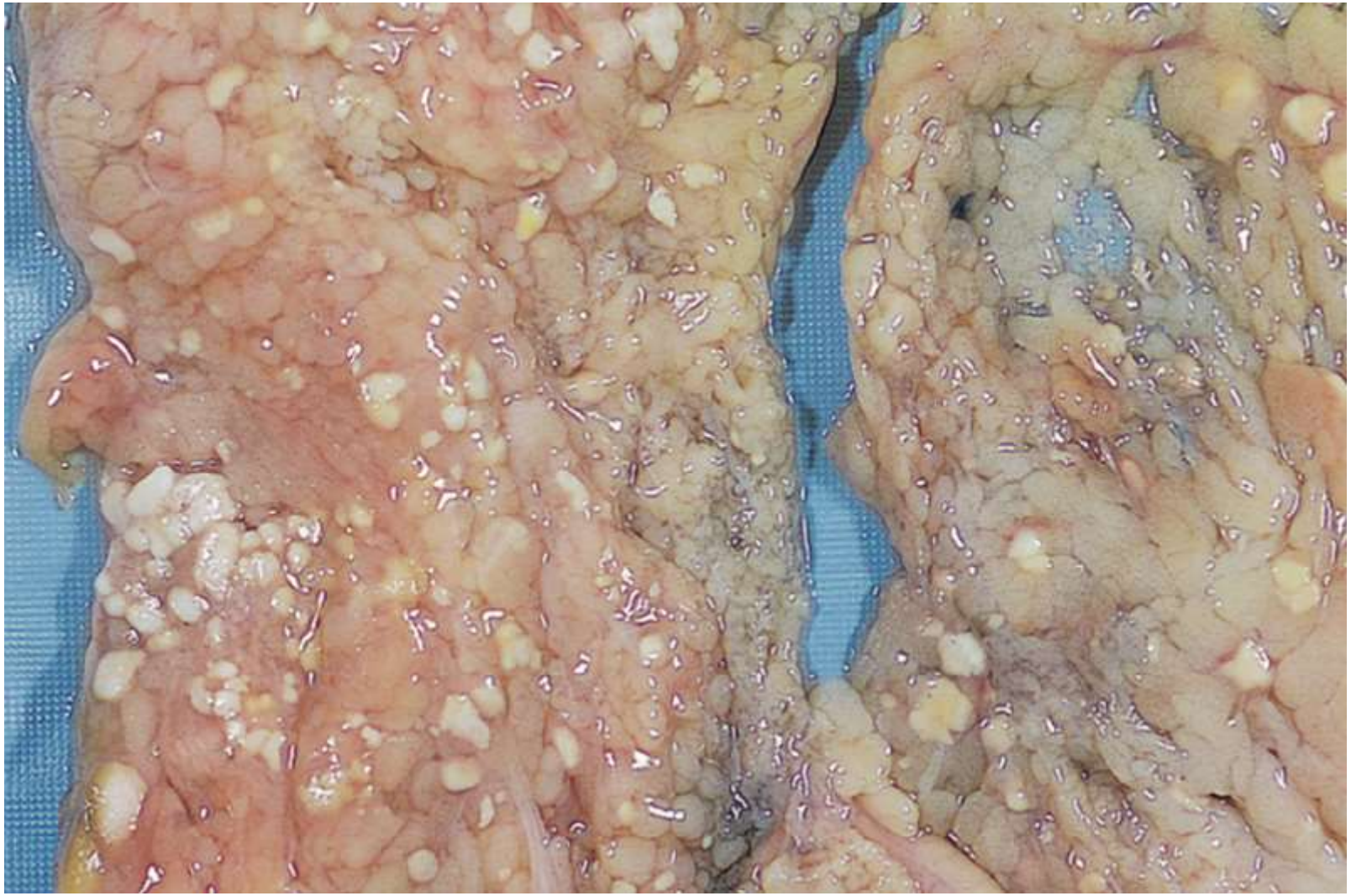
Diagnosis : acute pancreatitis with fat necrosis & calcification

---

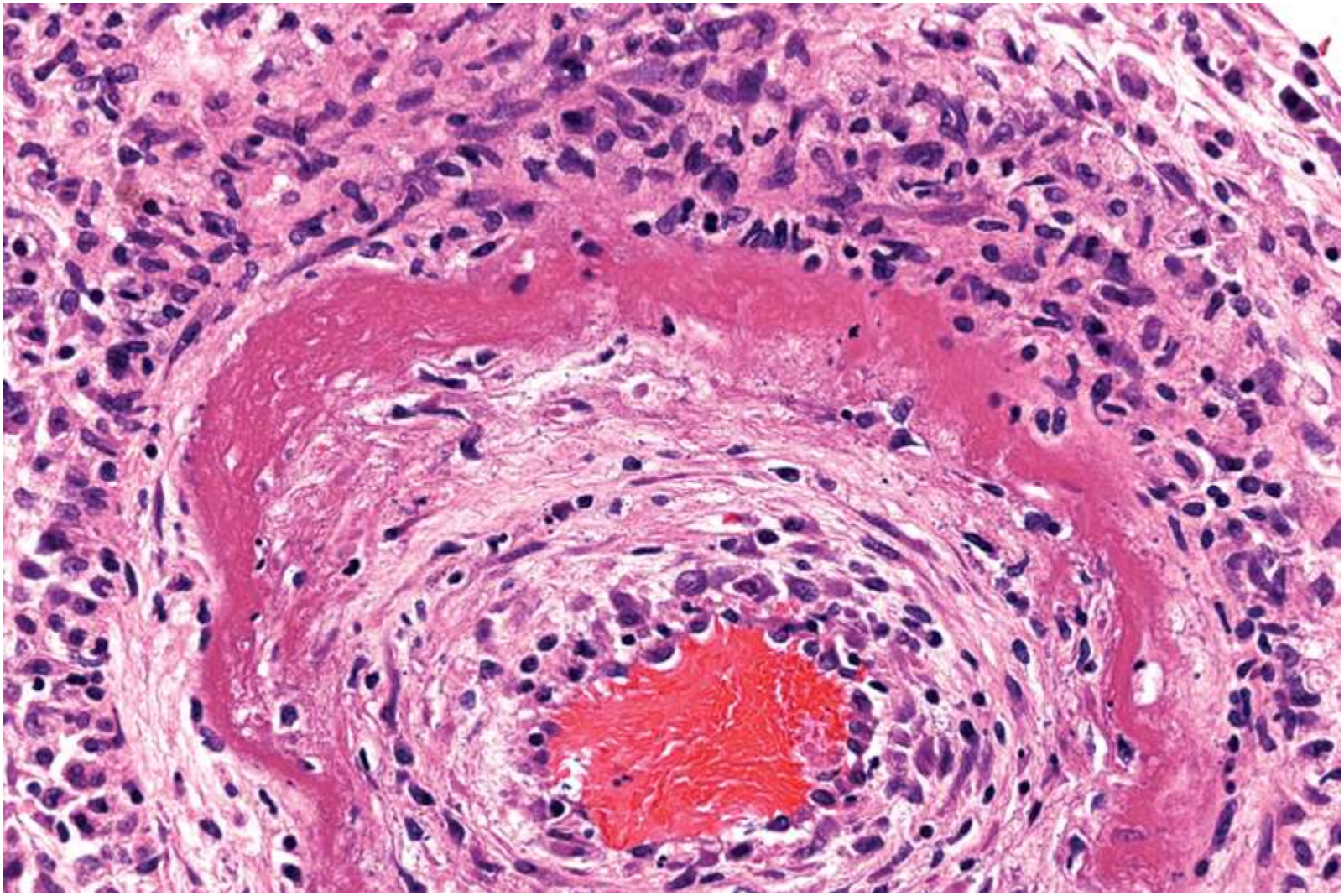
slide on the right: Microscopically, fat necrosis is seen here. Though the cellular outlines vaguely remain, the fat cells have lost their peripheral nuclei and their cytoplasm has become a pink amorphous mass of necrotic material.



Fat necrosis in acute pancreatitis.



The areas of white chalky deposits represent foci of fat necrosis with calcium soap formation (saponification) at sites of lipid breakdown in the mesentery.



Fibrinoid necrosis of an artery in polyarteritis nodosa.

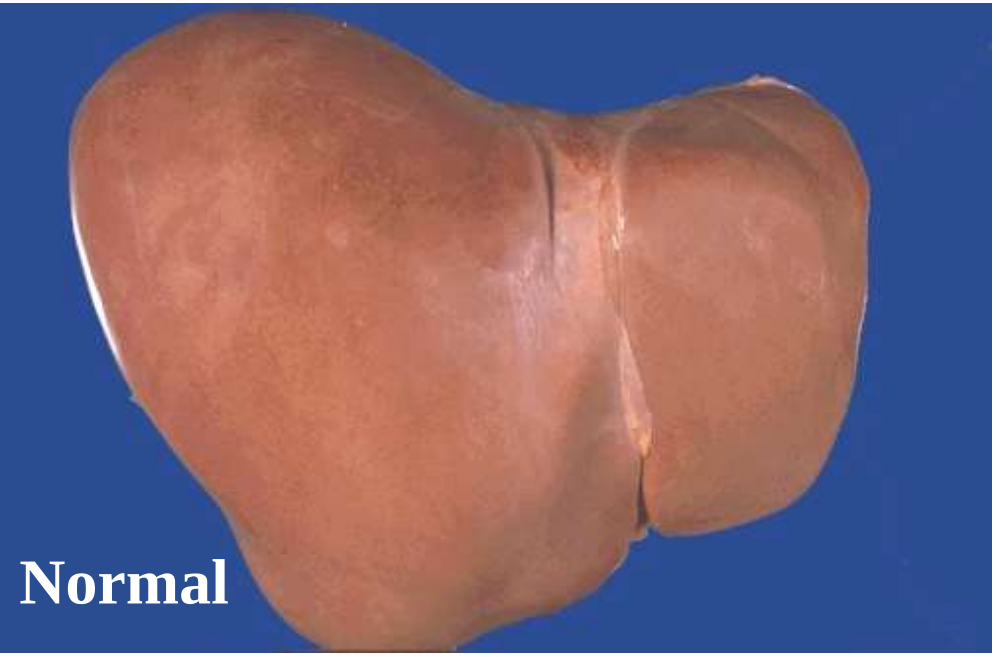
The wall of the artery shows a circumferential bright pink area of necrosis with protein deposition and inflammation (dark nuclei of neutrophils).

The cytoplasm is intensely esoniphilic (pinkish) and the nucleus condensed (pyknotic)

Apoptosis of epidermal keratinocyte

Intracellular Accumulations

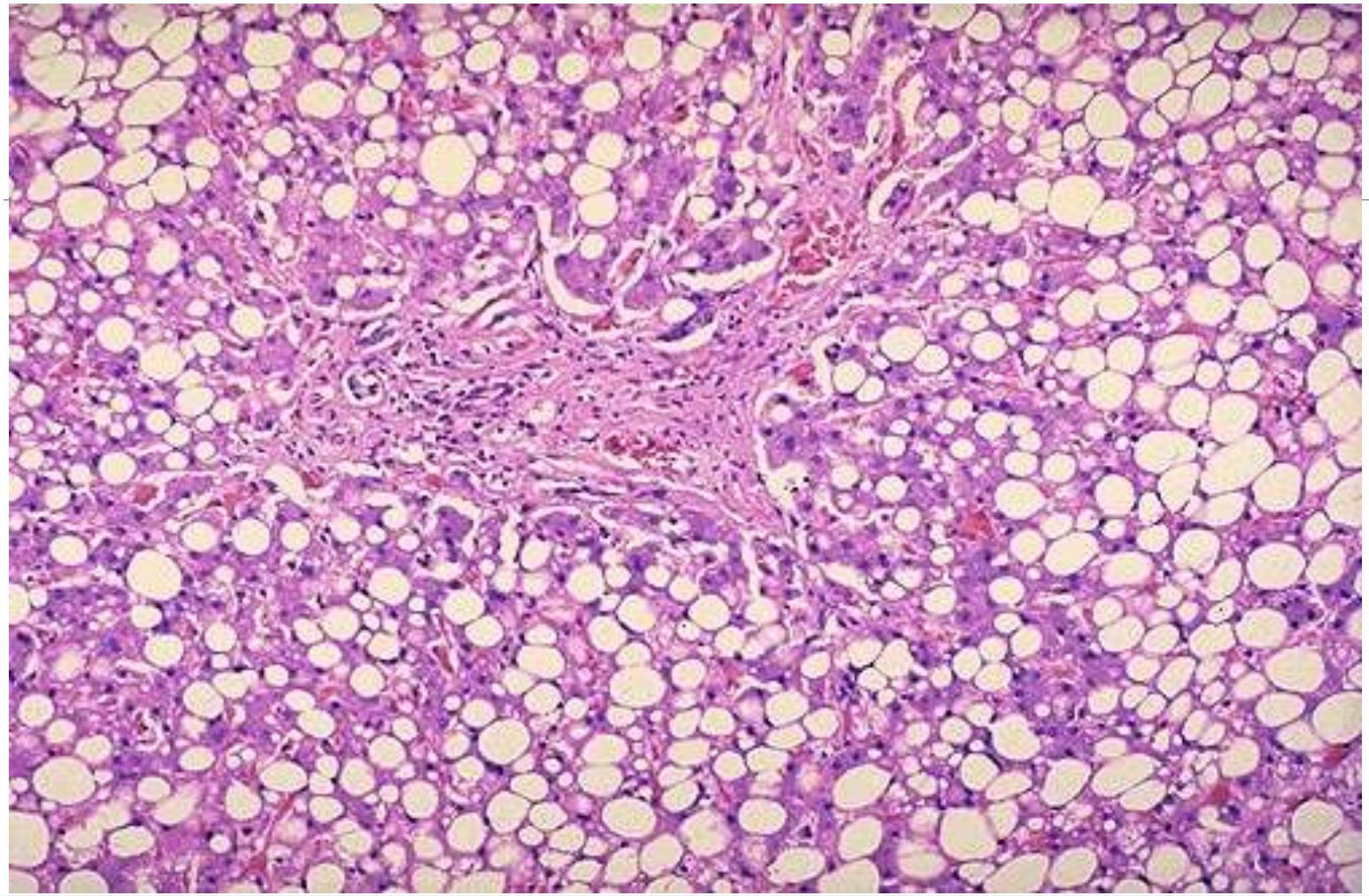
Fatty change liver



Severe fatty change liver

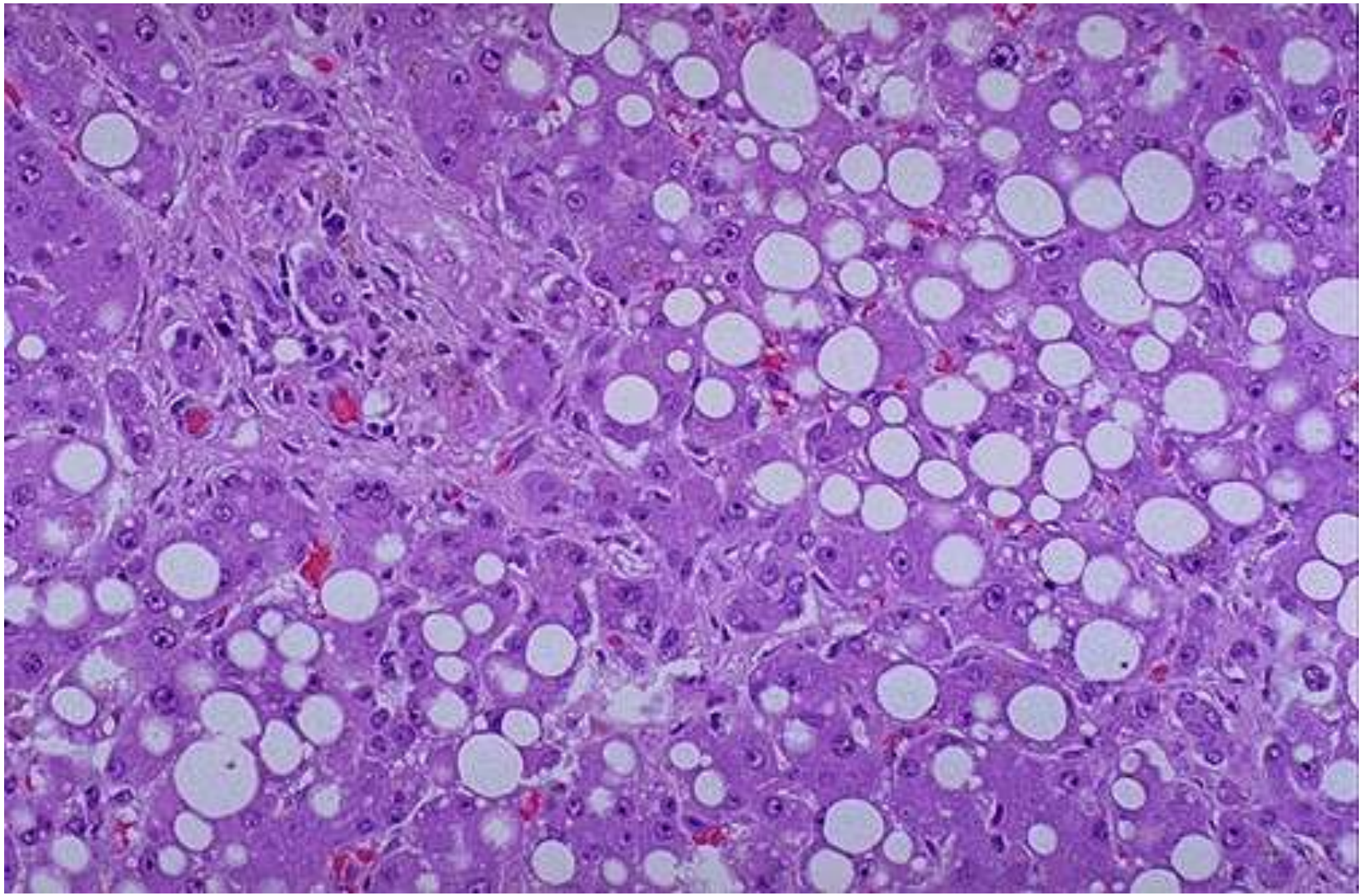
In the liver mild fatty change shows no gross changes, but with progressive accumulation, the organ enlarges and become increasingly yellow, soft and greasy to touch.

Fatty change liver



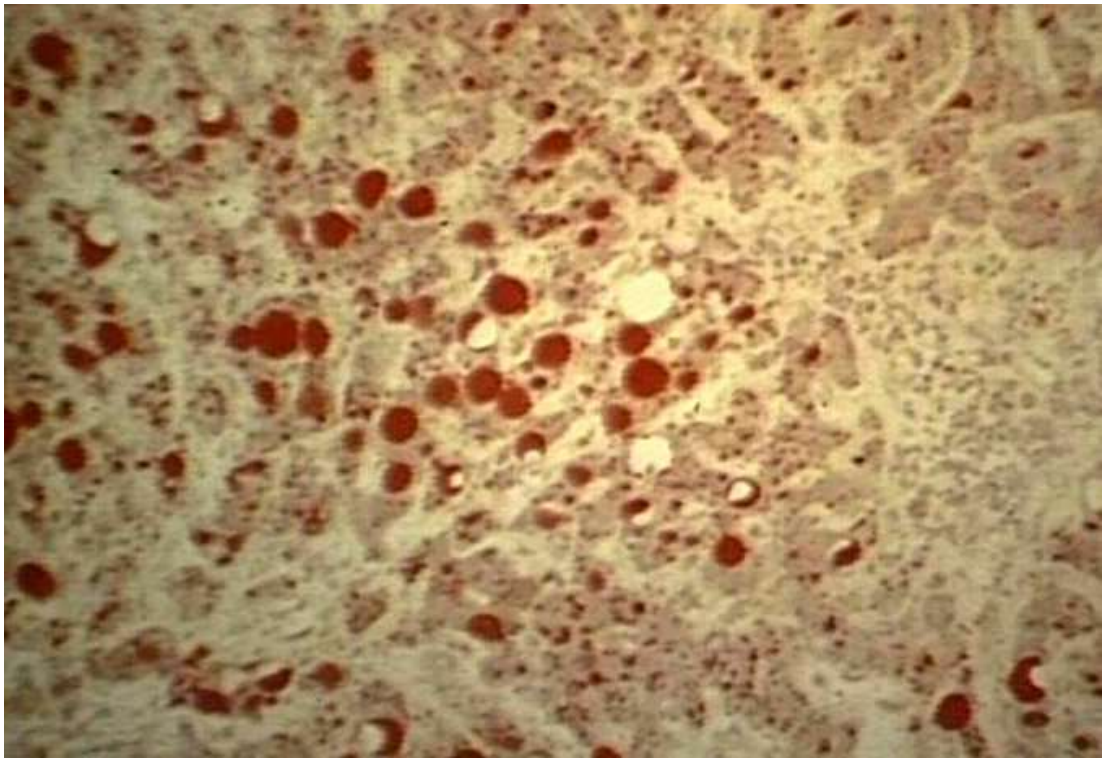
In the early stages: small fat vacuoles around the nucleus but with progression these coalesce into a large clear space that displaces the nucleus to the periphery (macrovesicular steatosis).

Fatty change liver

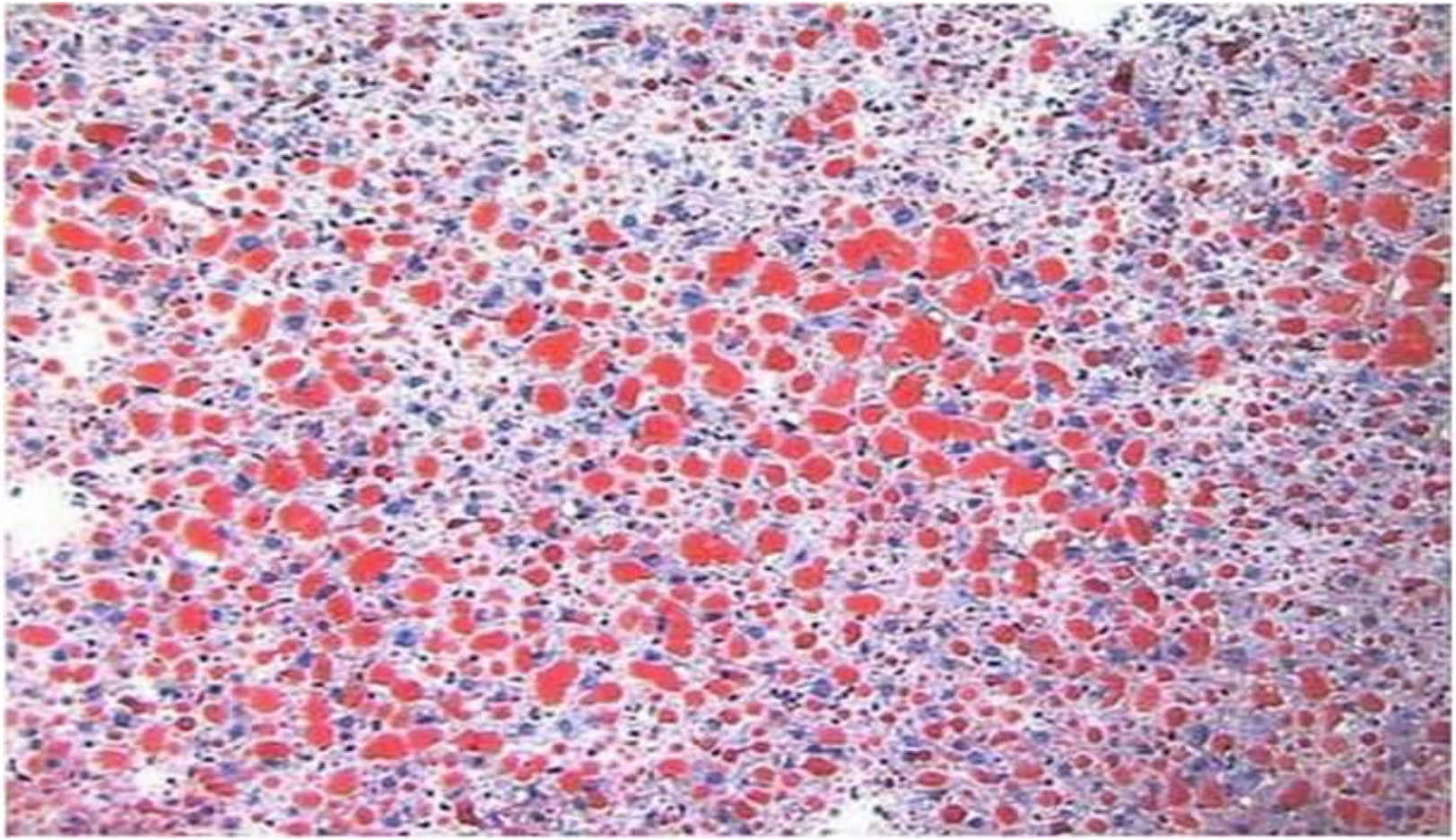


Macrovesicular steatosis a higher power of previous figure.

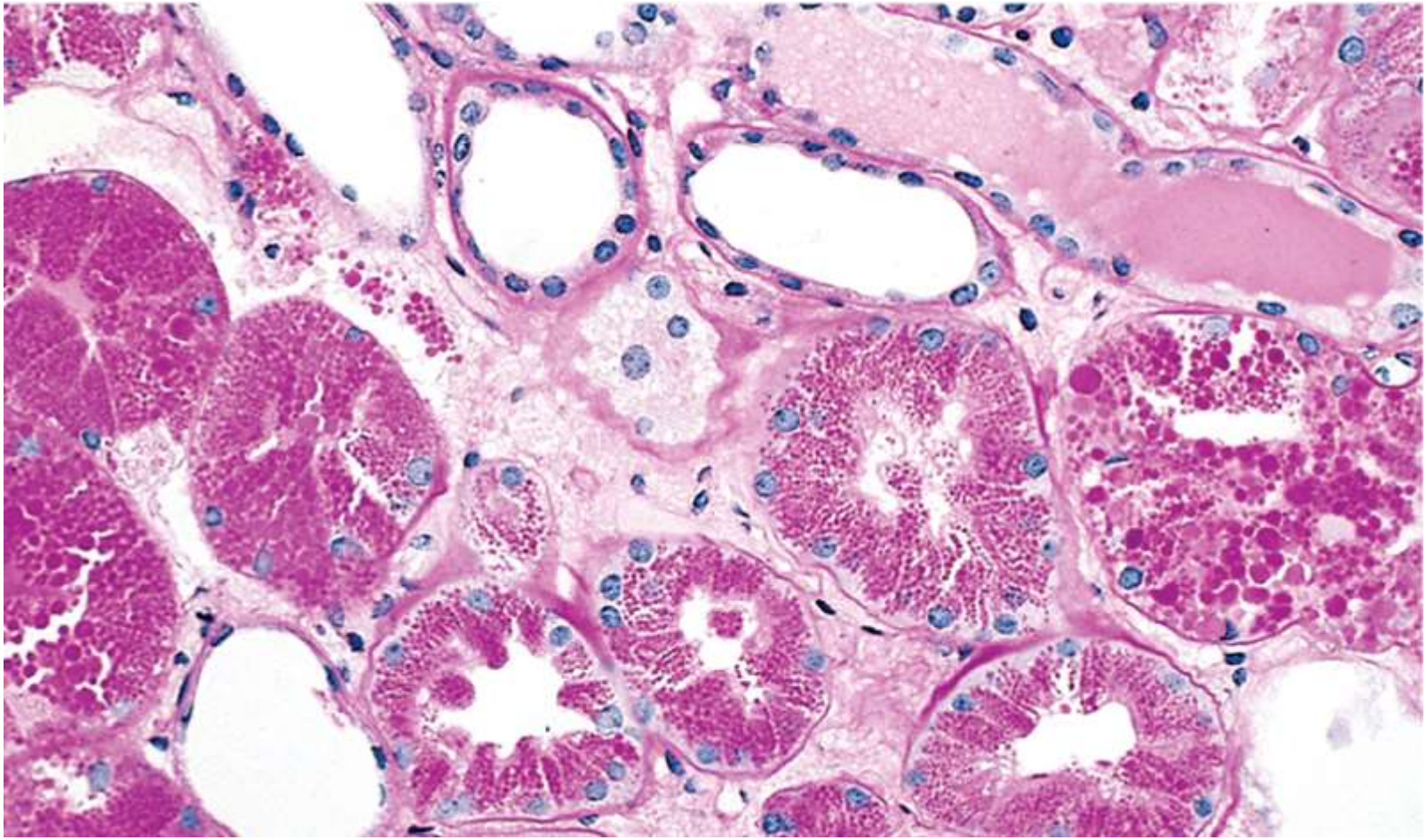
1. Sudan black



2. oil red O

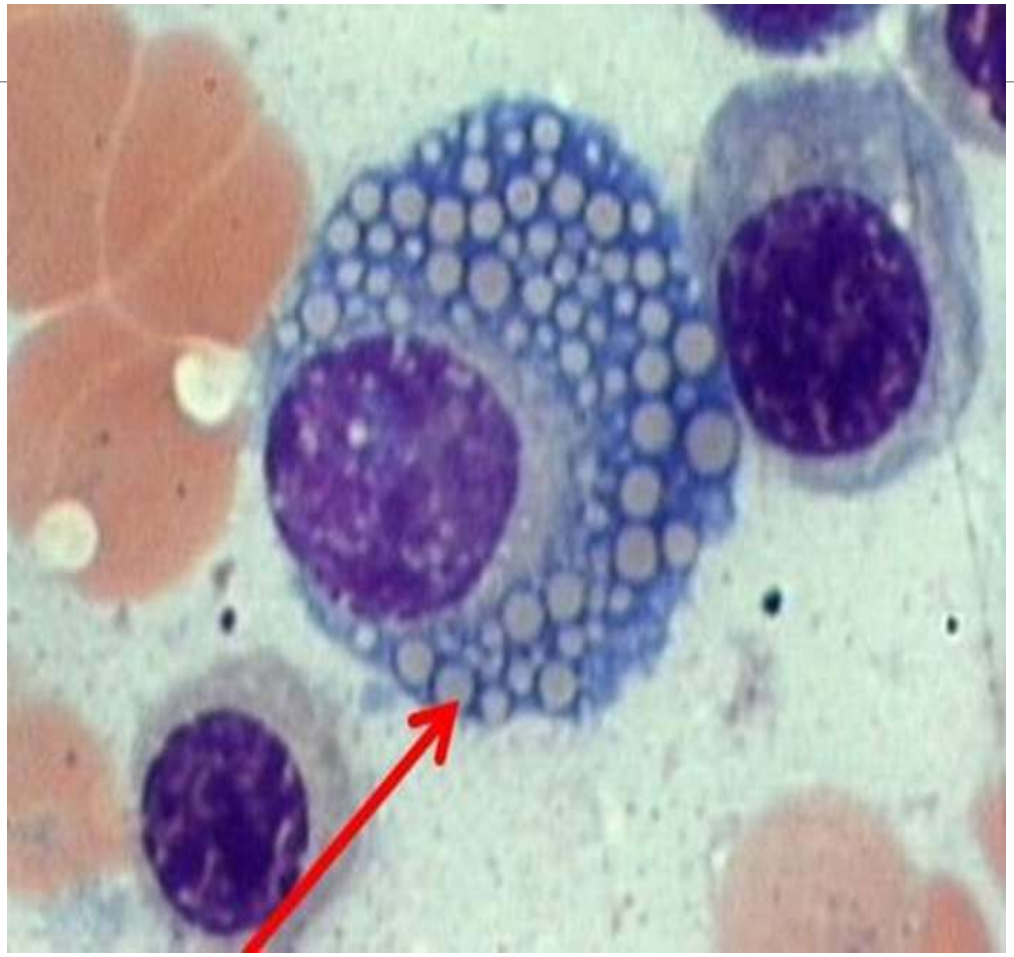


Protein reabsorption droplets in the renal tubular epithelium



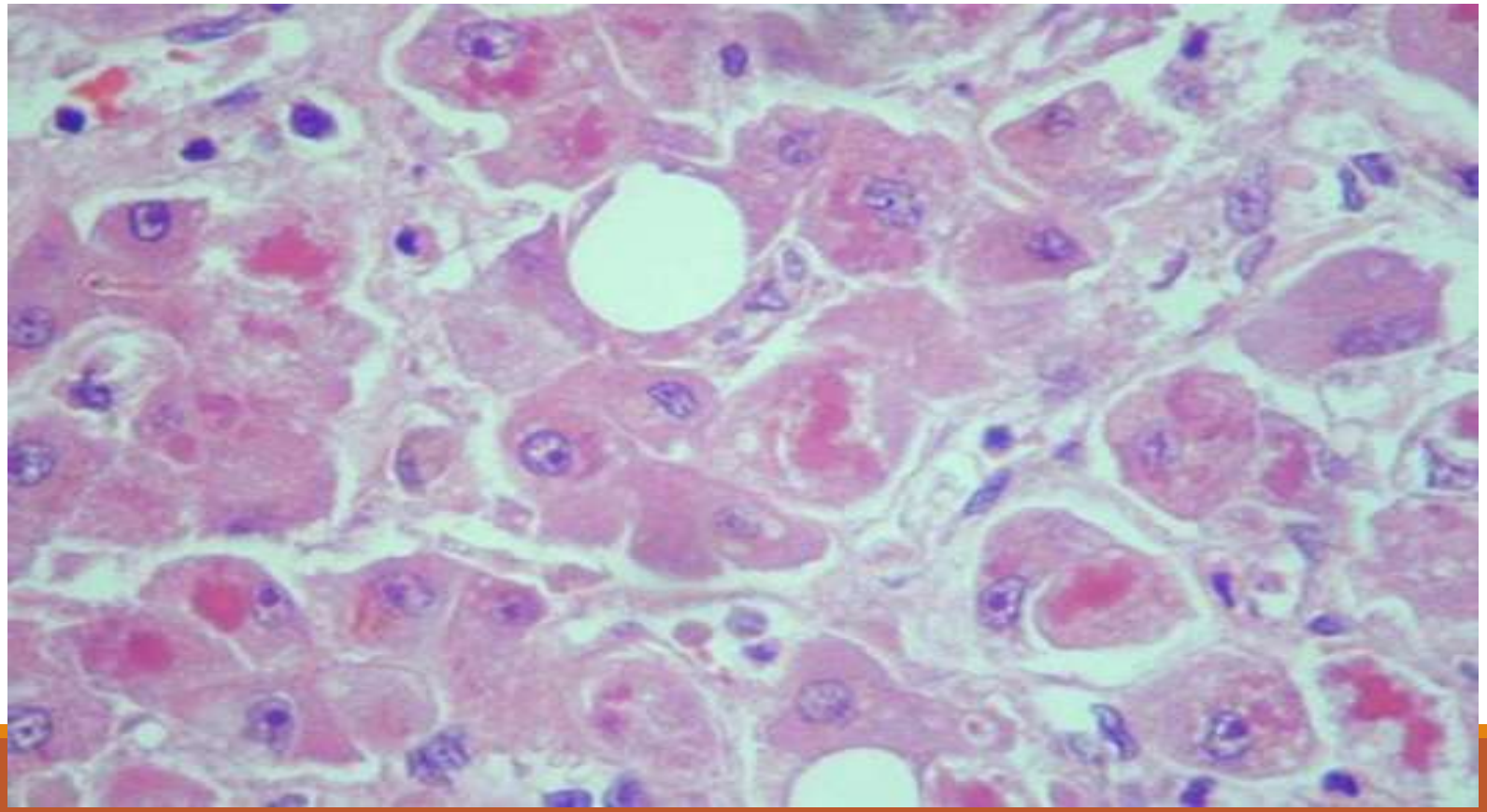
In nephrotic syndrome, there is a abnormally large reabsorption of the protein. Pinocytic vesicles containing this protein fuse with lysosomes, resulting in the histologic appearance of pink, hyaline cytoplasmic droplets

Plasma cells: Russel bodies

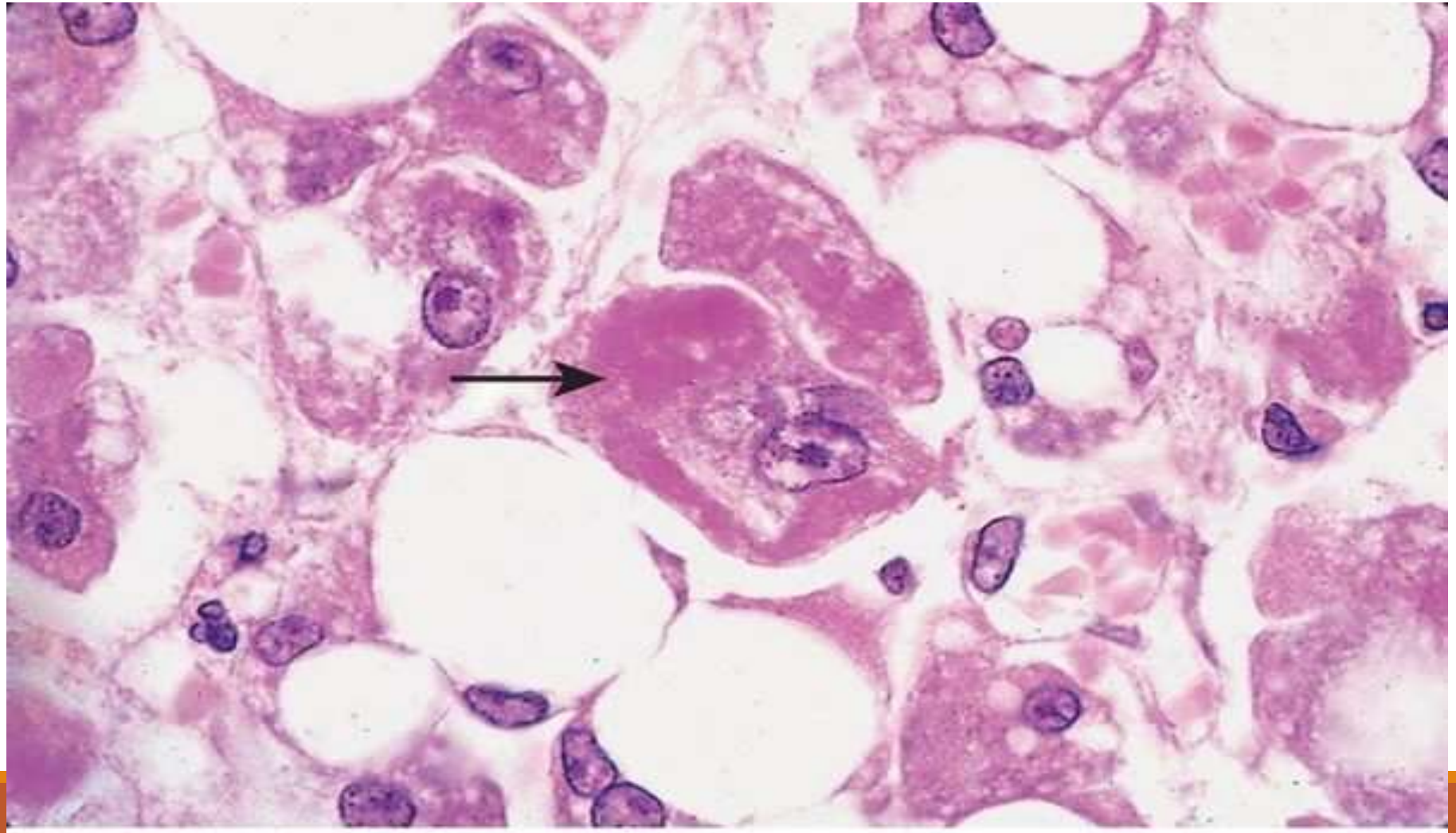


(MALLORY Hyaline body)

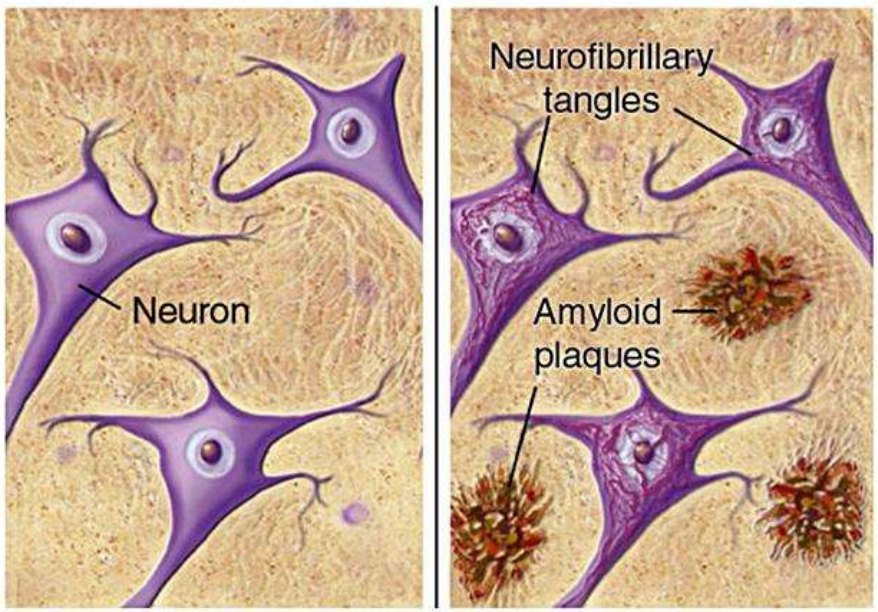
Eosinophilic globules seen in liver cells, consists predominantly of keratin intermediate filaments accumulated in **alcoholic liver disease**



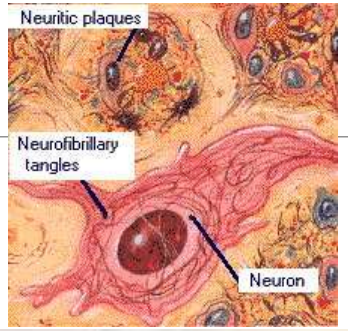
At high magnification can be seen globular red hyaline material within hepatocytes.

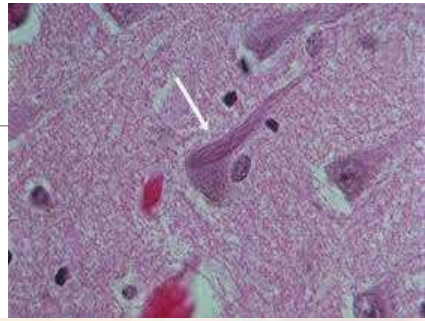


Normal vs. Alzheimer's Diseased Brain



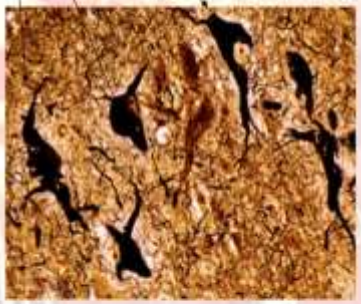
BrightFocus® Foundation
Cure in Mind. Cure in Sight.



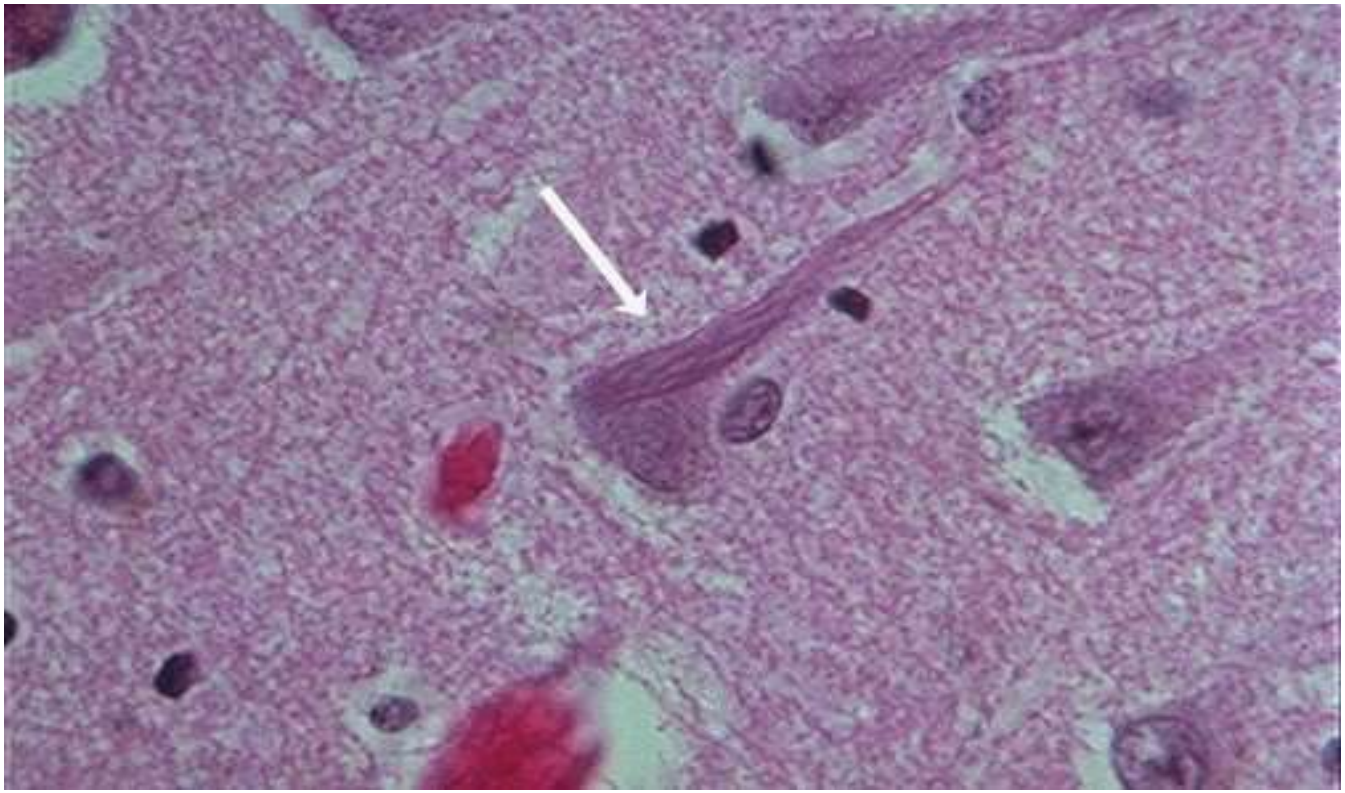


Neurofibrillary Tangles

- Tangles develop inside nerve cells
- Abnormal collections of twisted protein fibers
- Protein threads are composed of the hyperphosphorylated *tau* protein



Neurofibrillary Tangles- Alzheimer disease



Pigments:

They are colored substances, either Exogenous (coming from outside) or Endogenous pigments (synthesized within the body itself).

Exogenous Pigments.

ANTHRACOSIS (Carbon Accumulation) :

Tattooing:

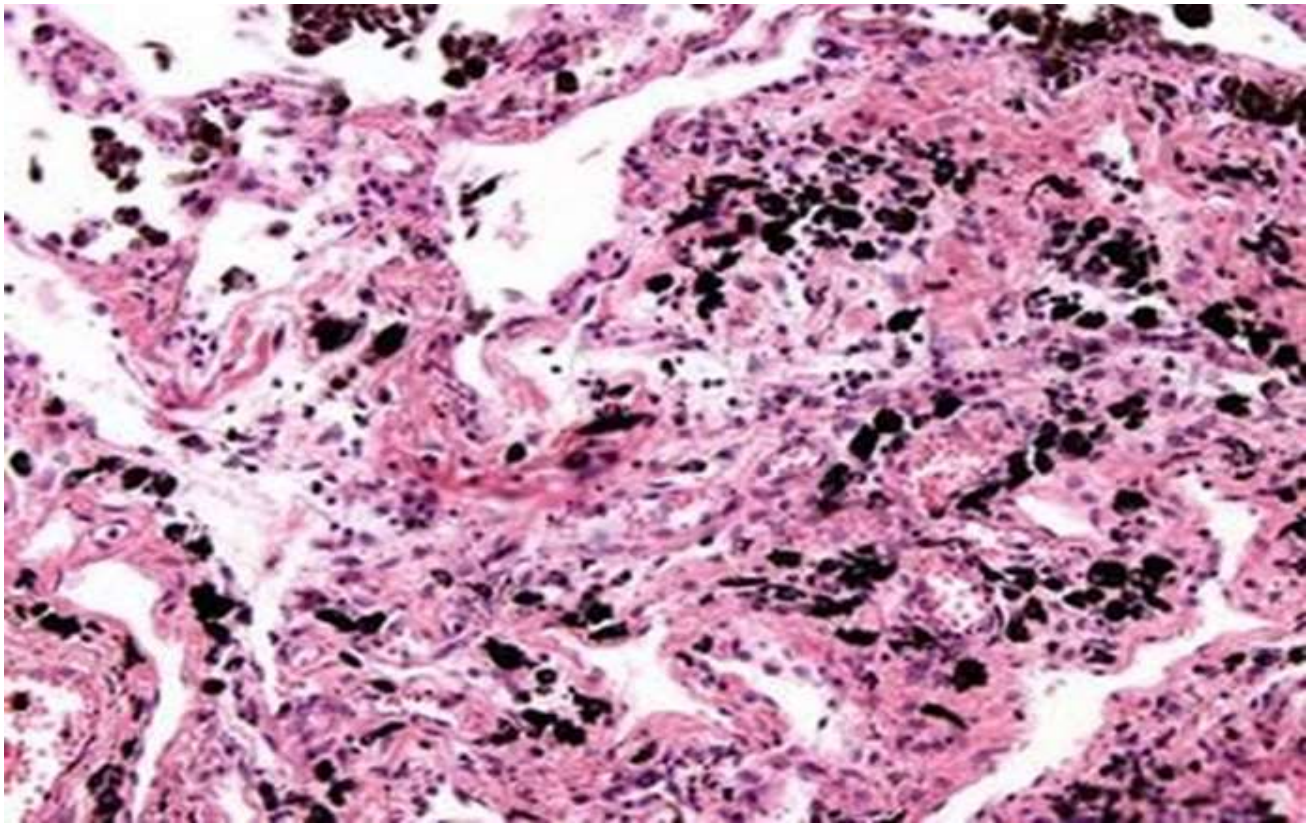
Endogenous Pigments.

Lipofuscin:

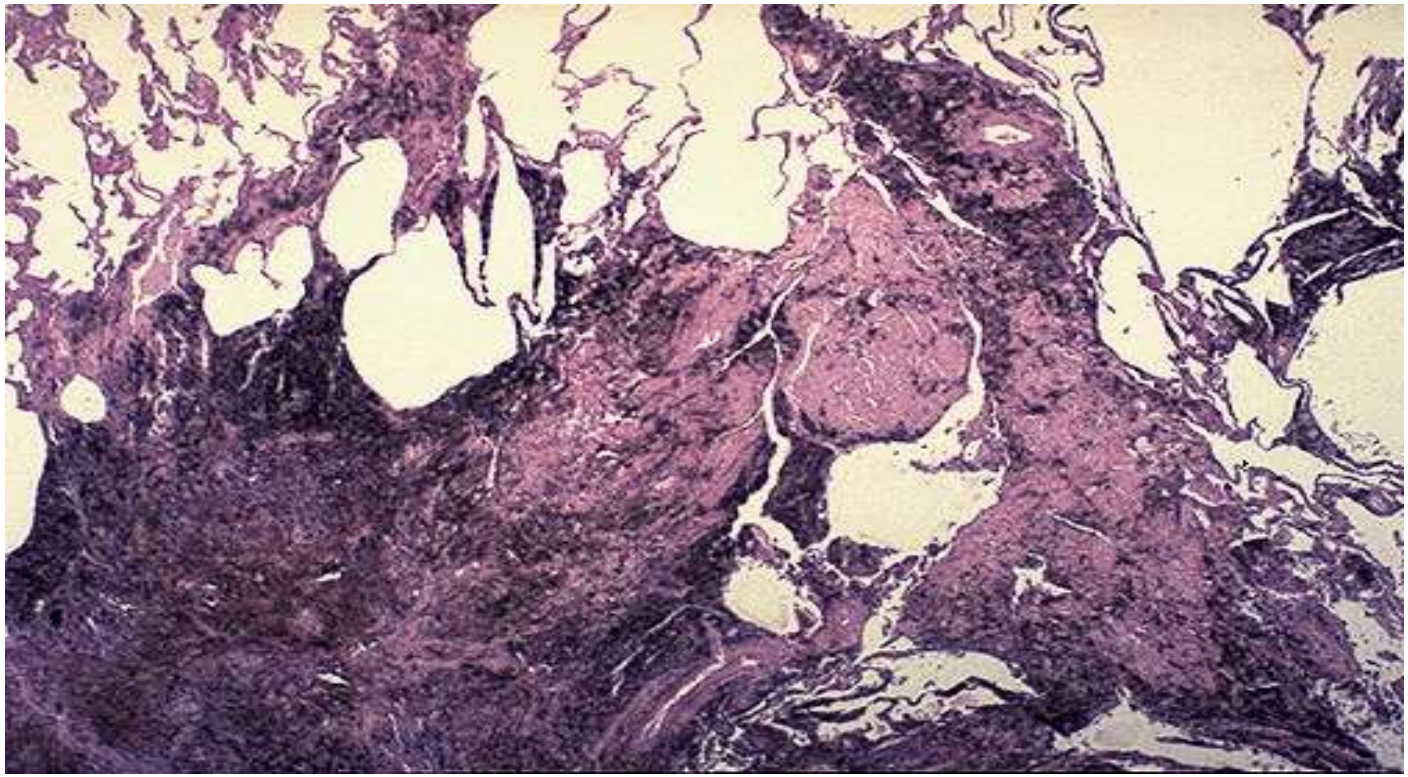
Melanin

hemosidren

Coal workers pneumoconiosis

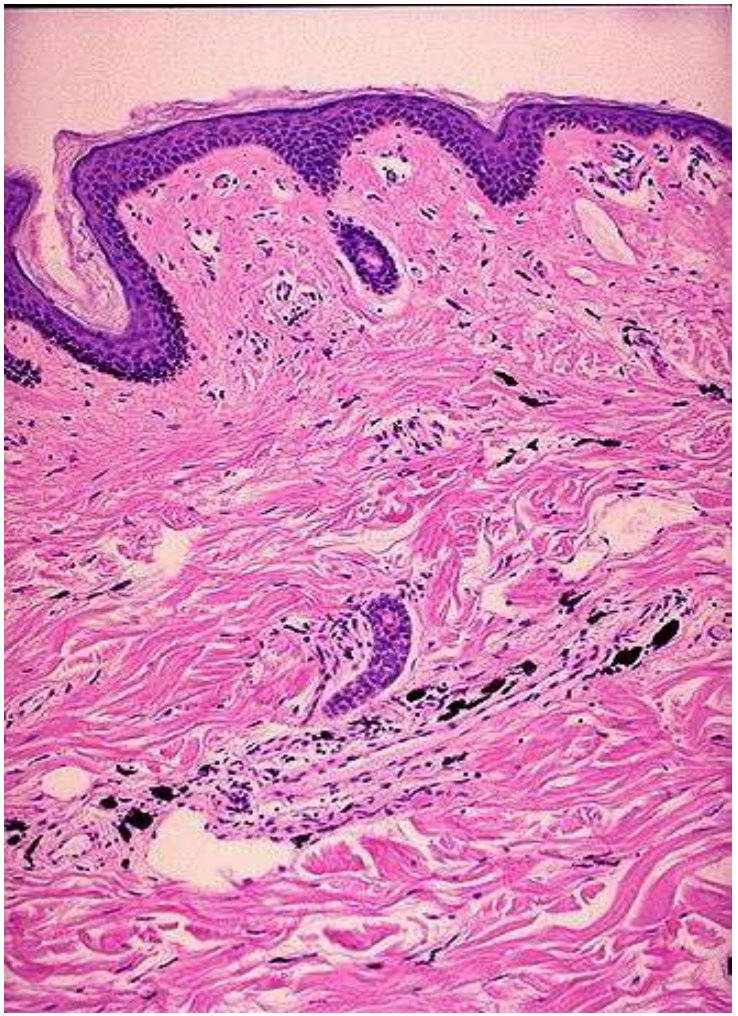


Lung: coal worker’s pneumoconiosis



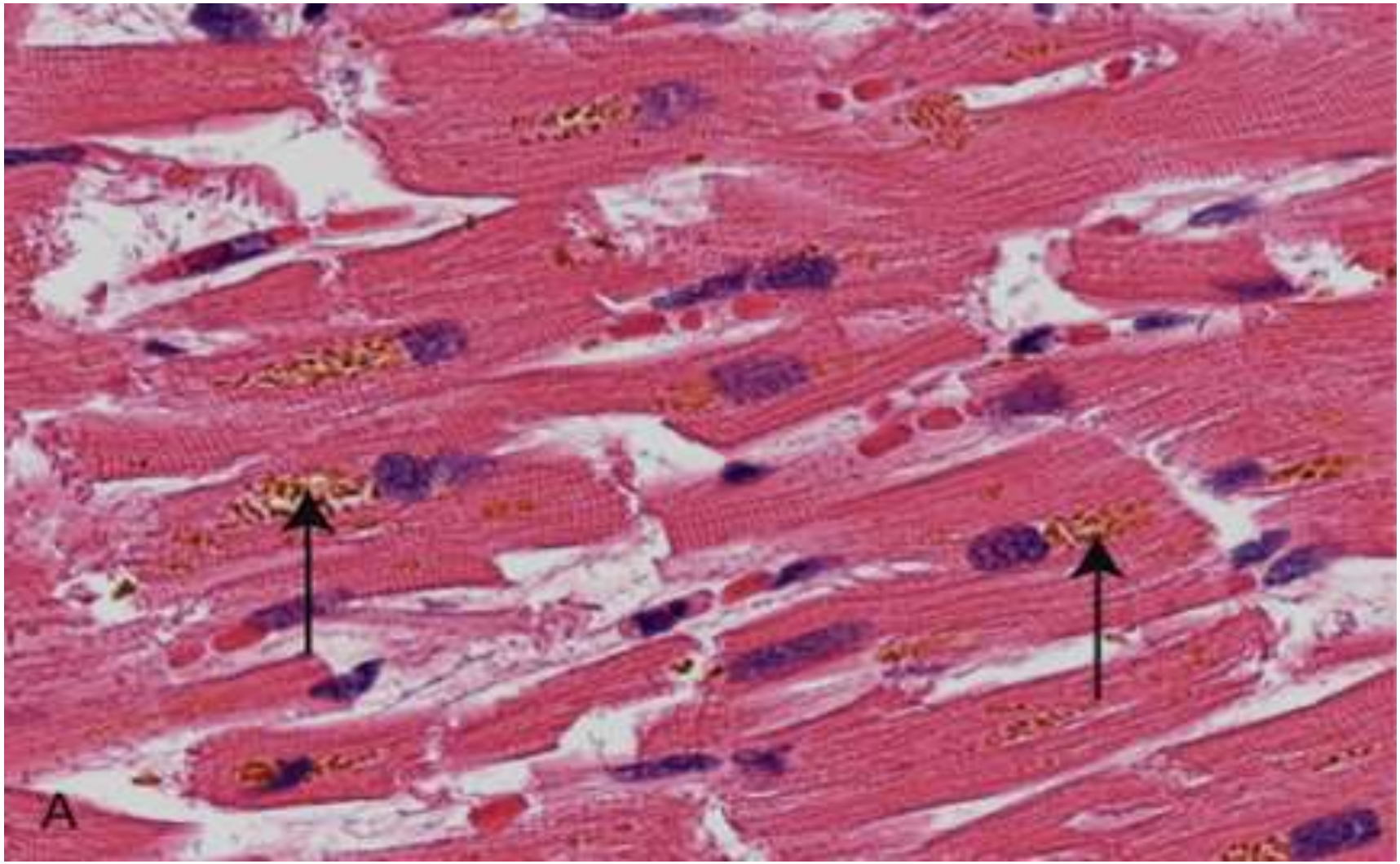
Anthracotic pigment ordinarily is not fibrogenic, but in massive amounts (as in "black lung disease" in coal miners) a fibrogenic response can be elicited to produce excessive collagenous fibrosis impregnated with the black pigment.

Skin tattoo

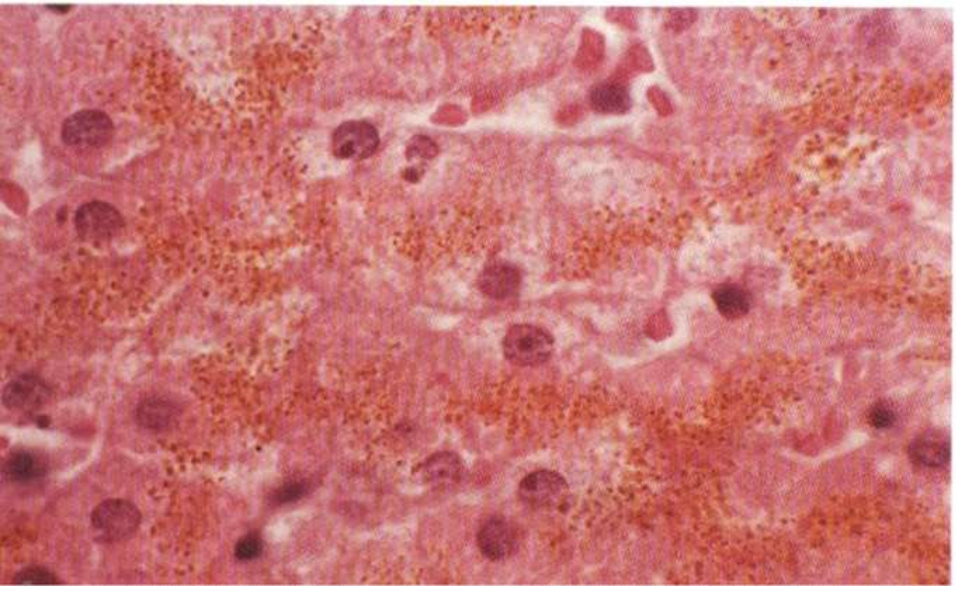


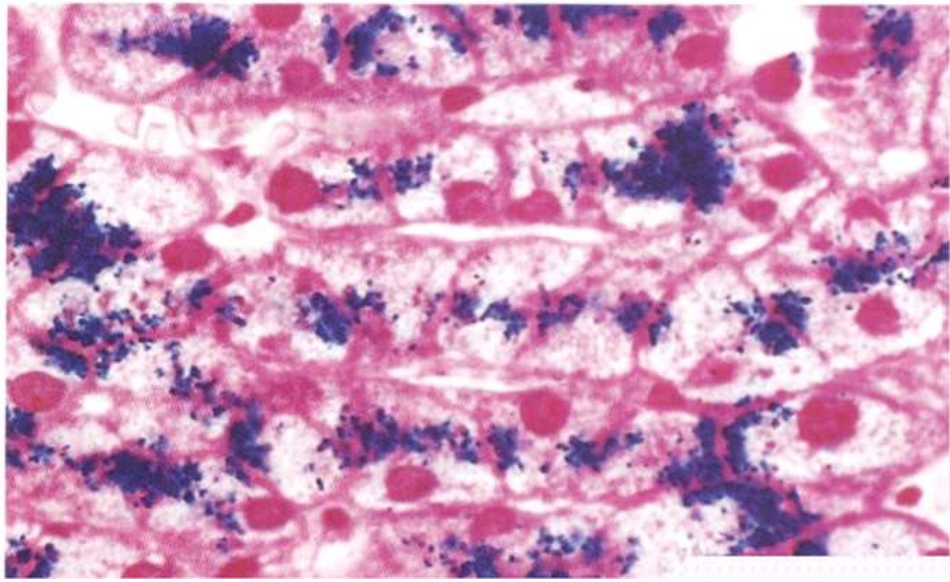
Lt. Here is a tattoo. The pigment in tattoos is transferred to the dermis with a needle. Rt. This is the microscopic appearance of tattoo pigment (black) in the dermis. Note that this pigment lies within the dermis macrophages.

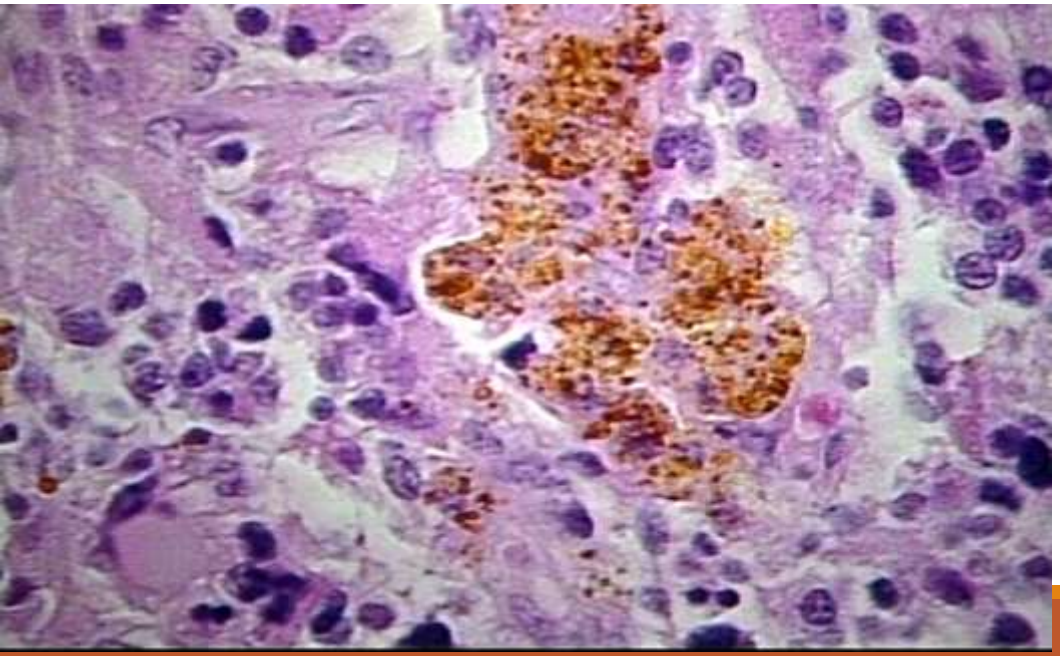
Lipofuscin granules in a cardiac myocytes



Hemosiderin granules liver cells

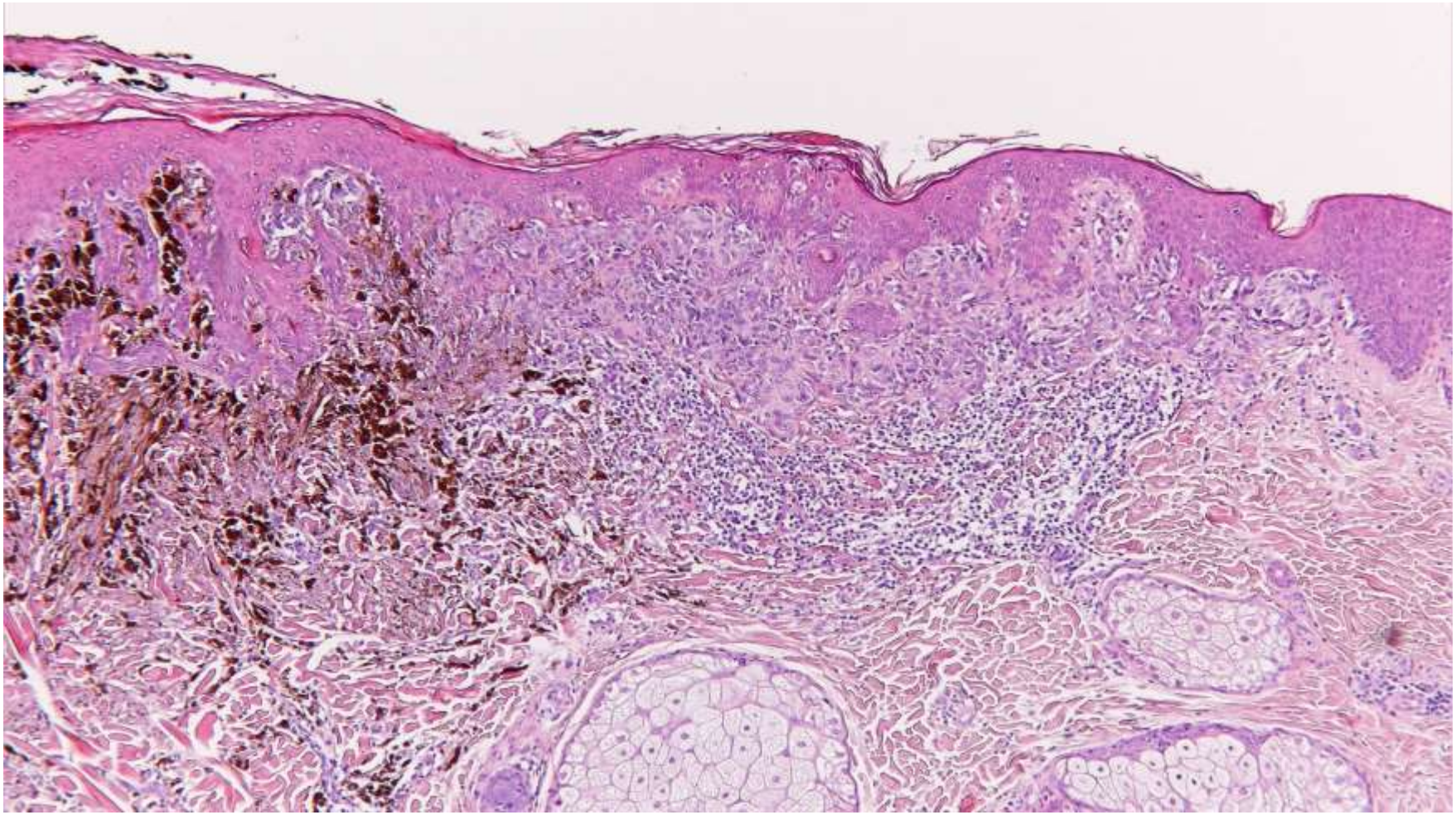






Prussian blue stain

melanin



THANK YOU