Cell Injury, Cell Death, and Adaptation

3RD STAGE/ COLLAGE OF DENTISTRY

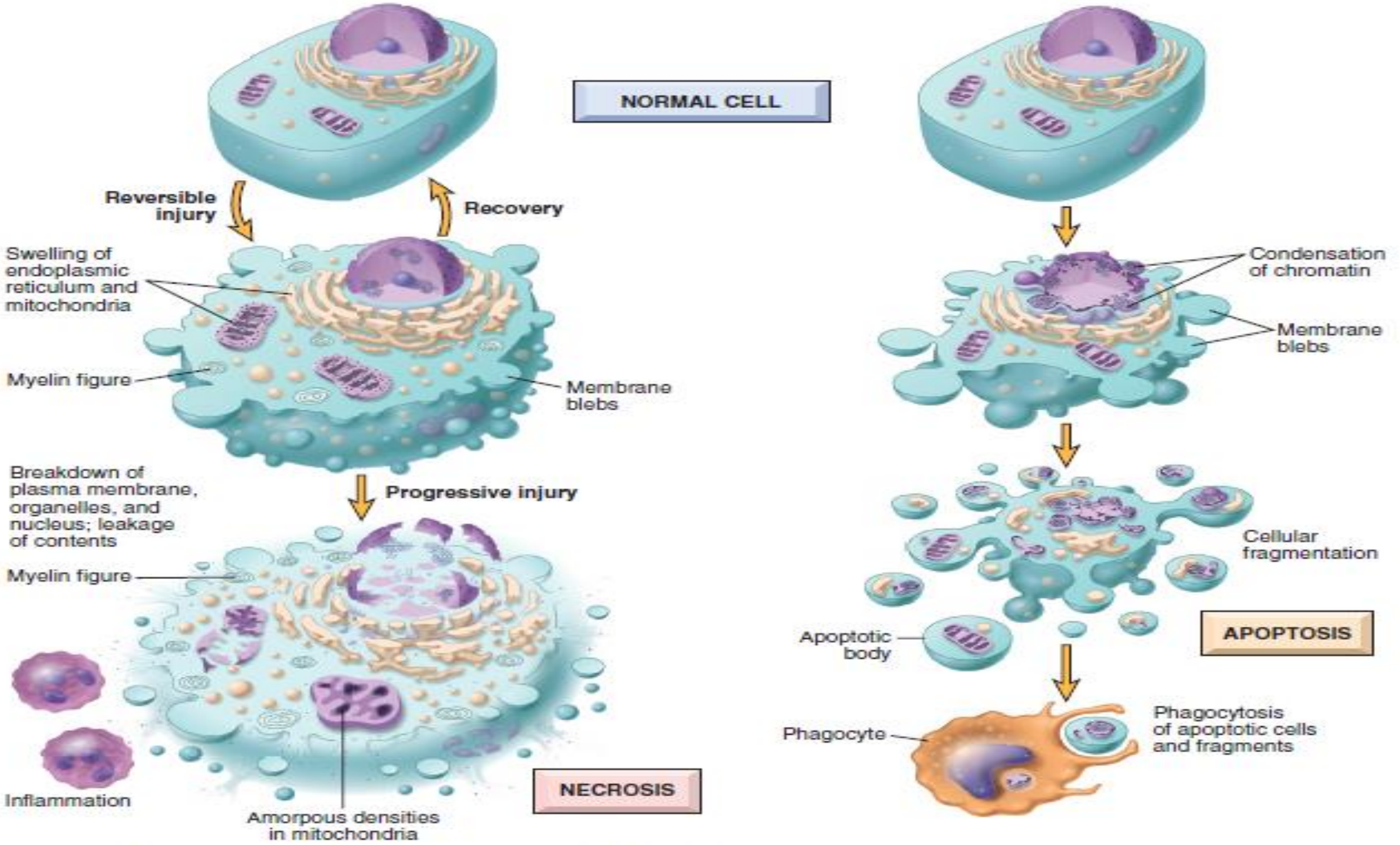
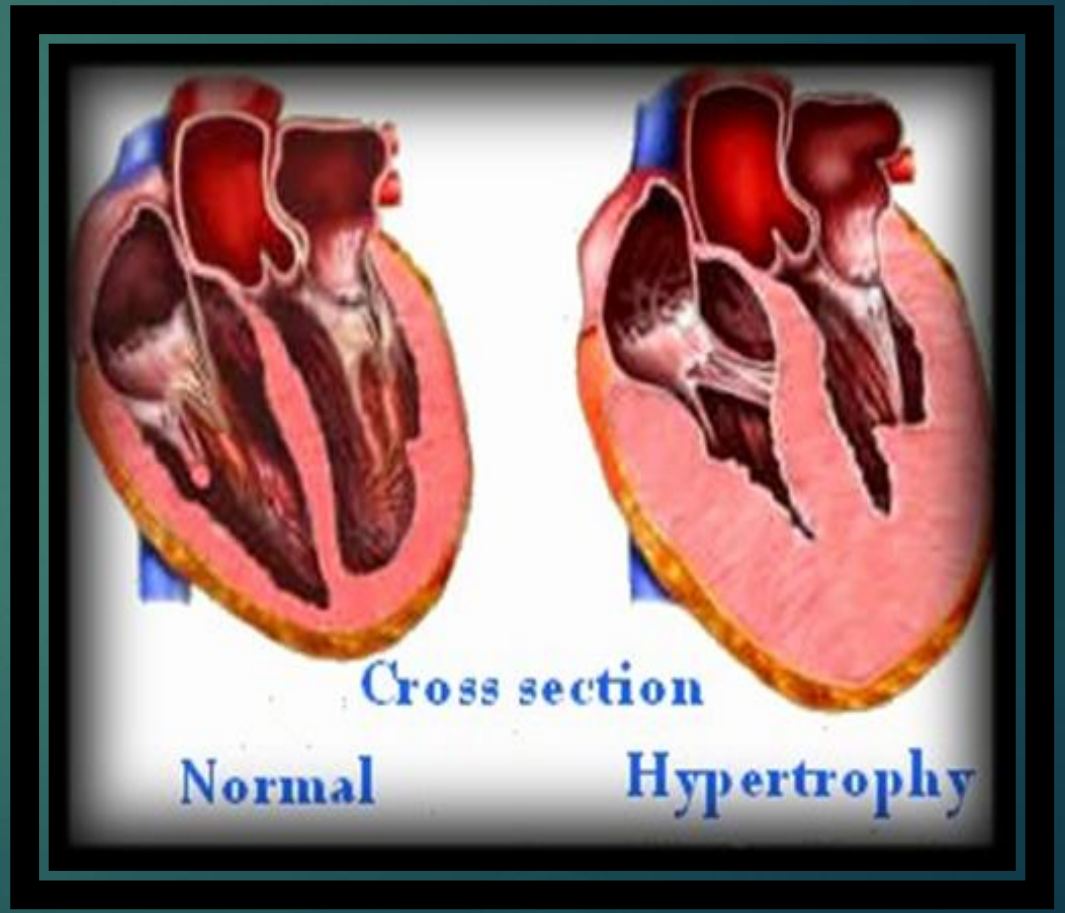
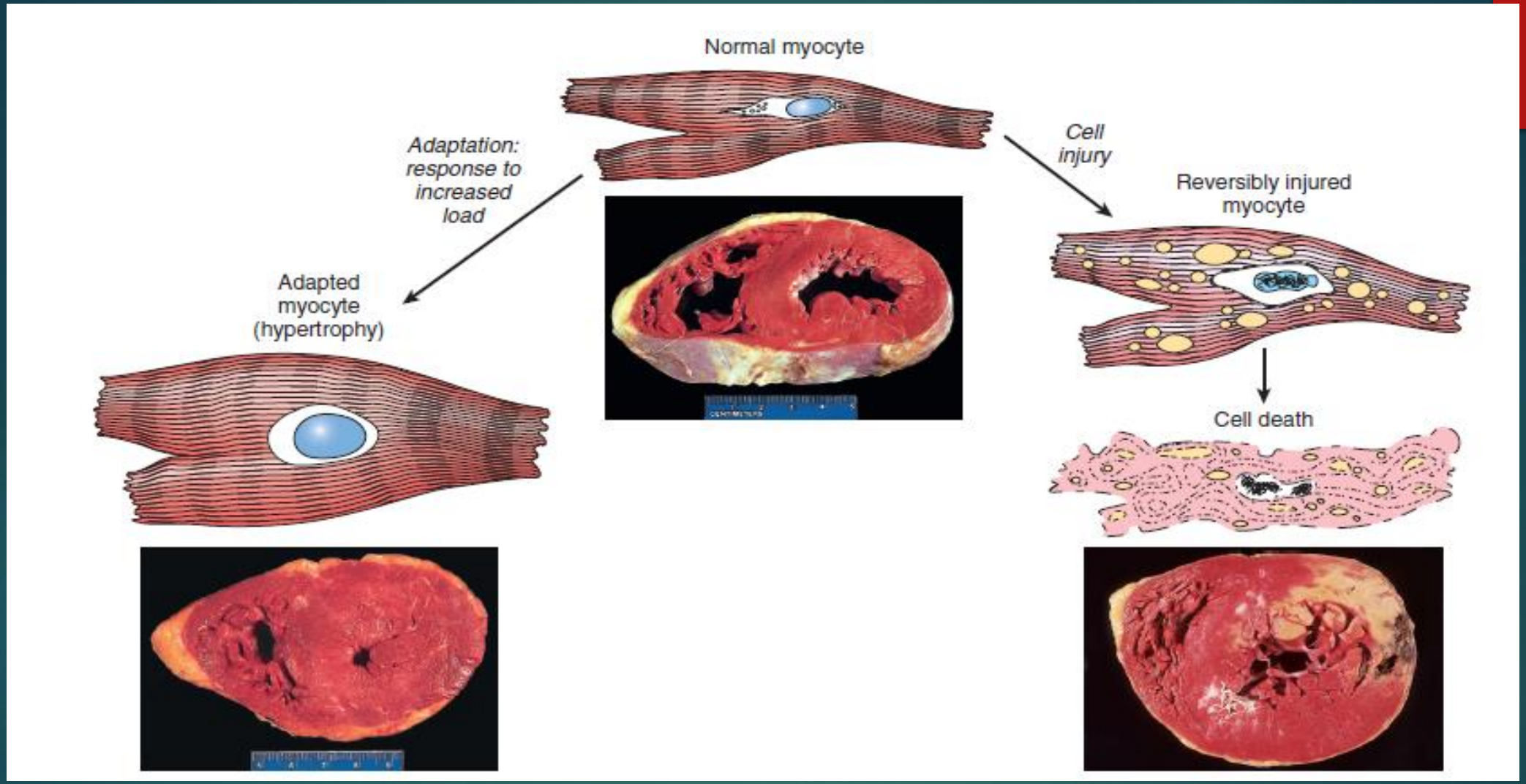


Figure 2.4 Schematic illustration of the morphologic changes in cell injury culminating in necrosis or apoptosis.

Hypertrophy: Physiologic hypertrophy ..... Pathologic hypertrophy





CELL ADAPTATION

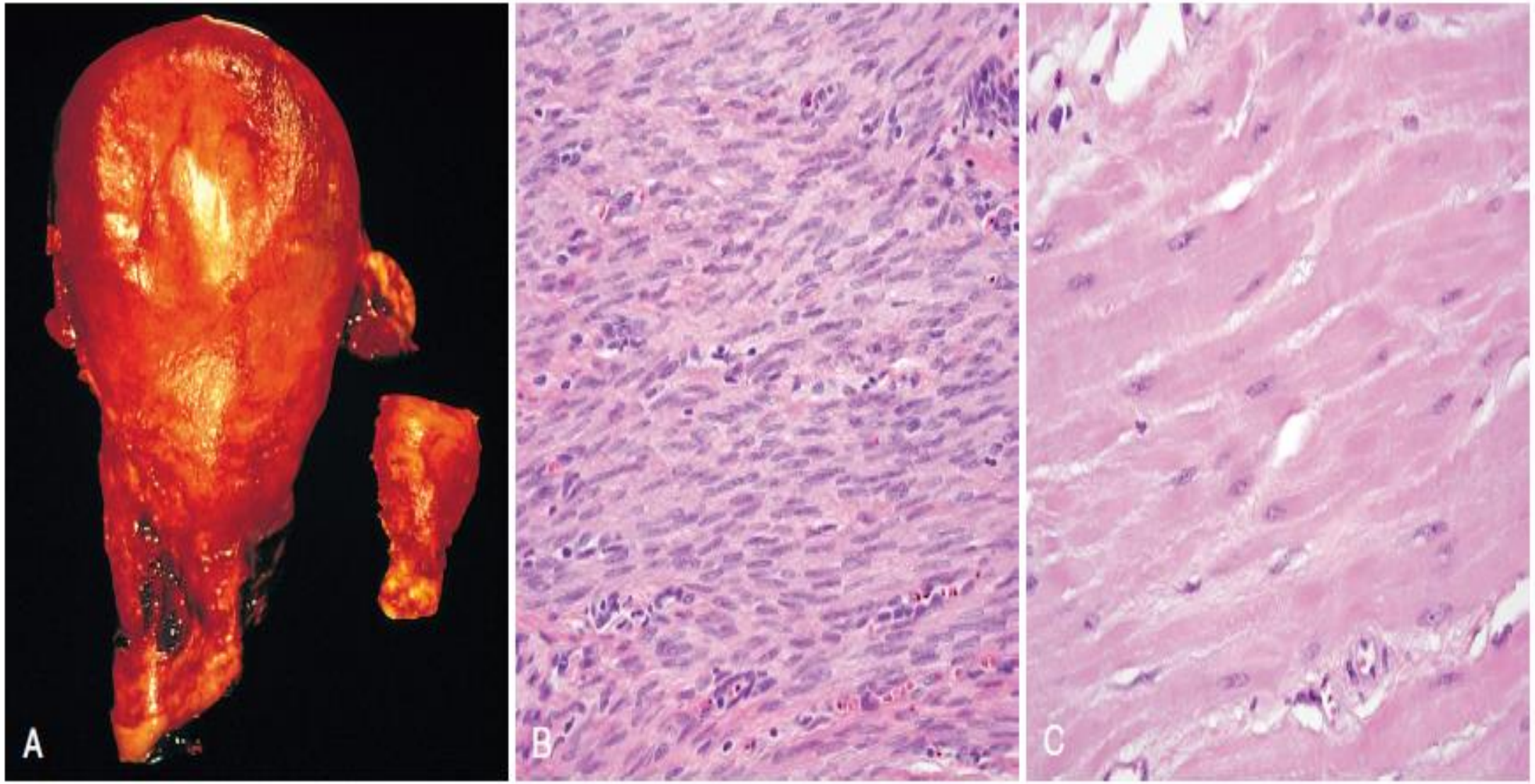
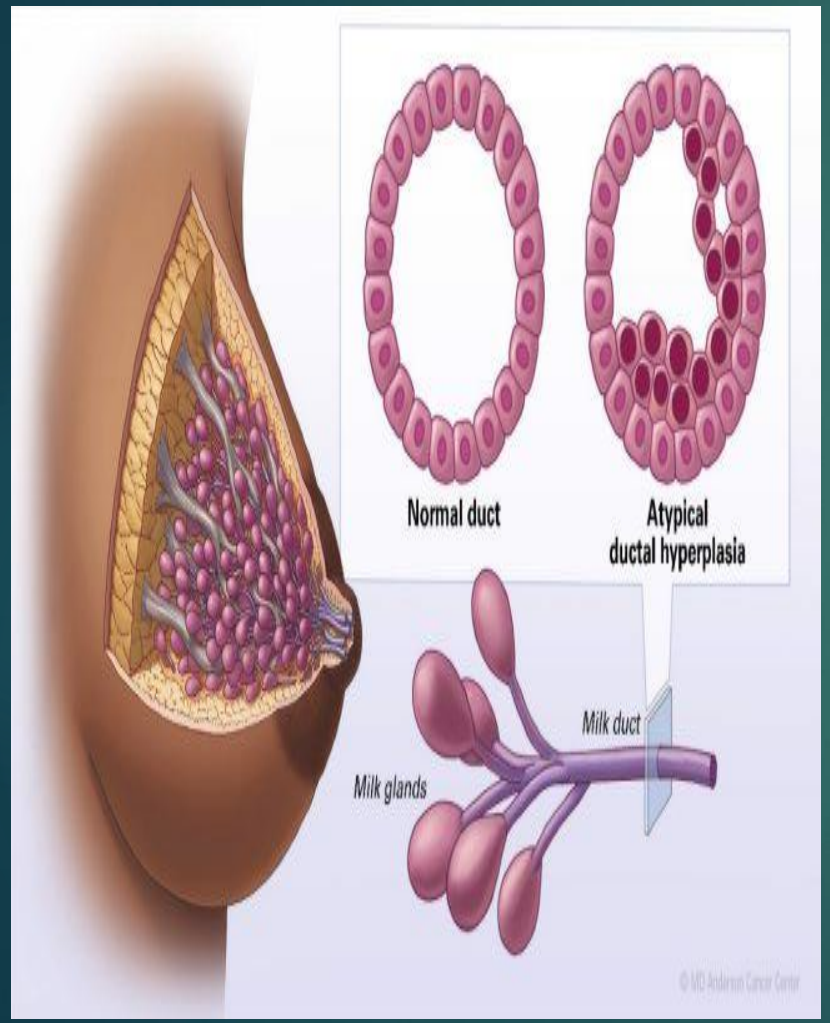
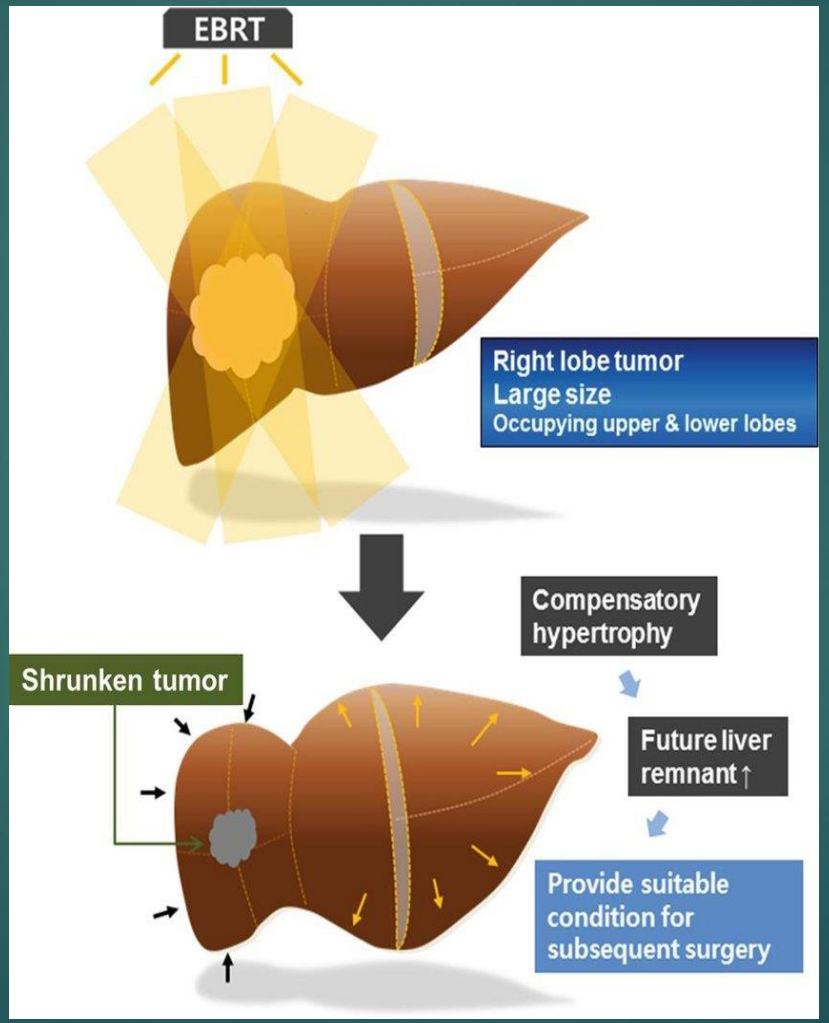


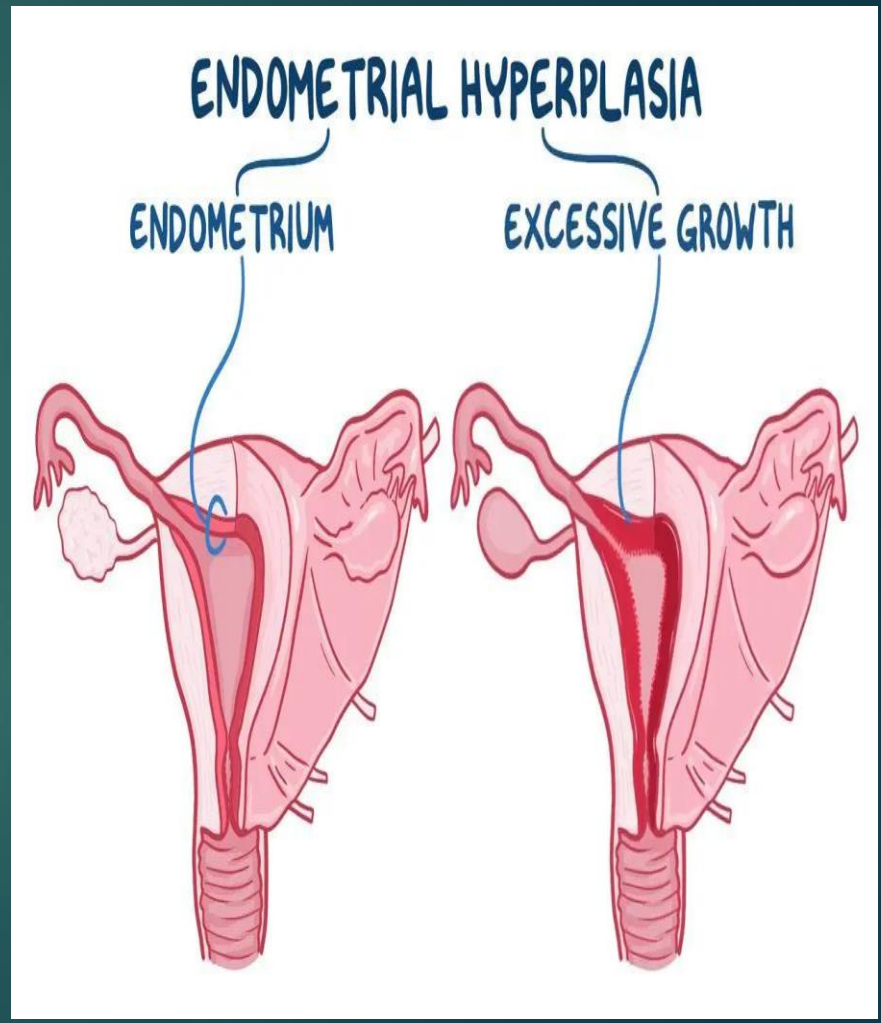
Figure 2.25 Physiologic hypertrophy of the uterus during pregnancy. (A) Gross appearance of a normal uterus *(right)* and a gravid uterus (removed for postpartum bleeding) *(left)*. (B) Small spindle-shaped uterine smooth muscle cells from a normal uterus, compared with (C) large plump cells from the gravid uterus, at the same magnification.

Hyperplasia: Hormonal hyperplasia ....Compensatory hyperplasia:

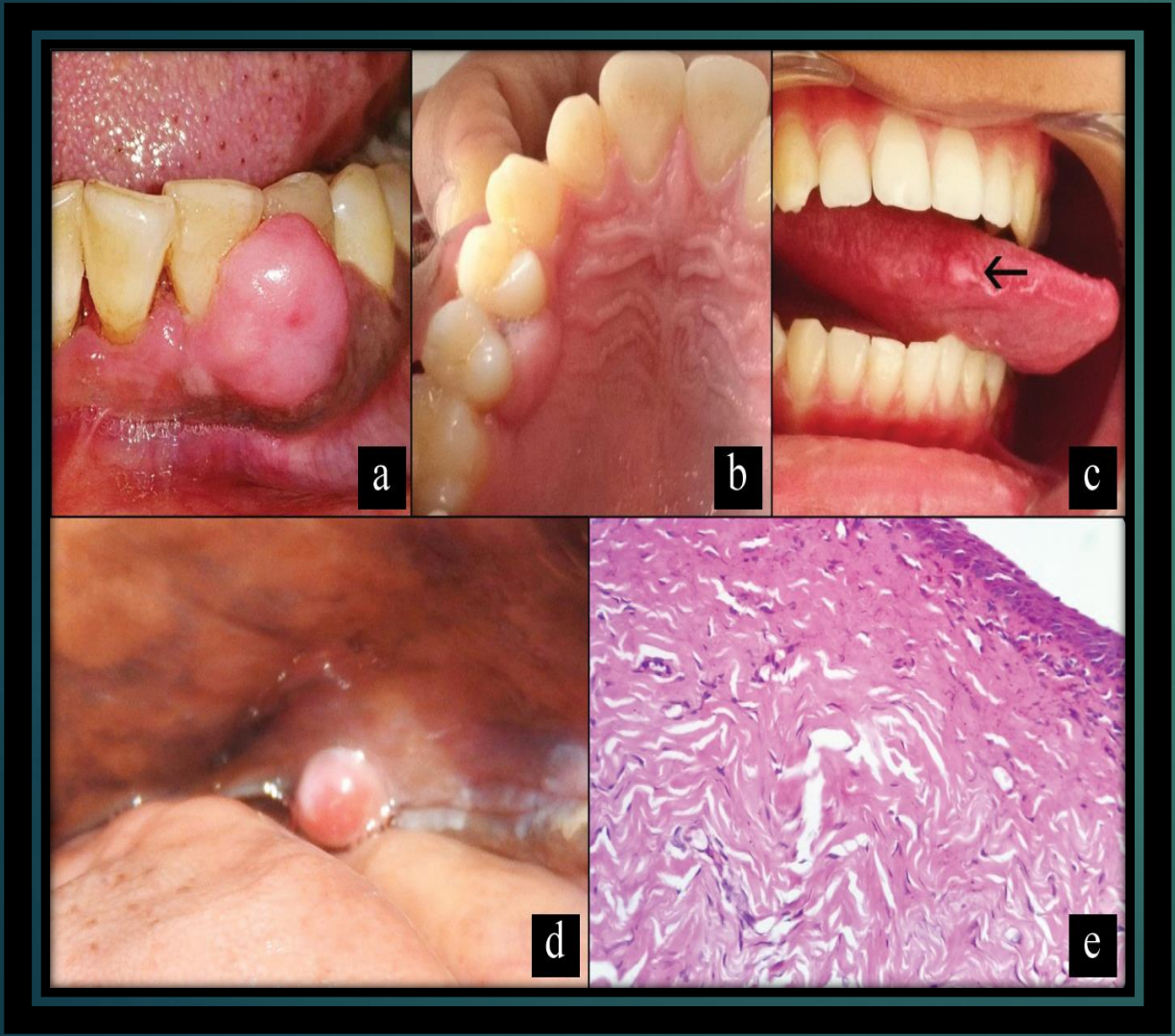
Pathologic hyperplasia ... Endometrial hyperplasia

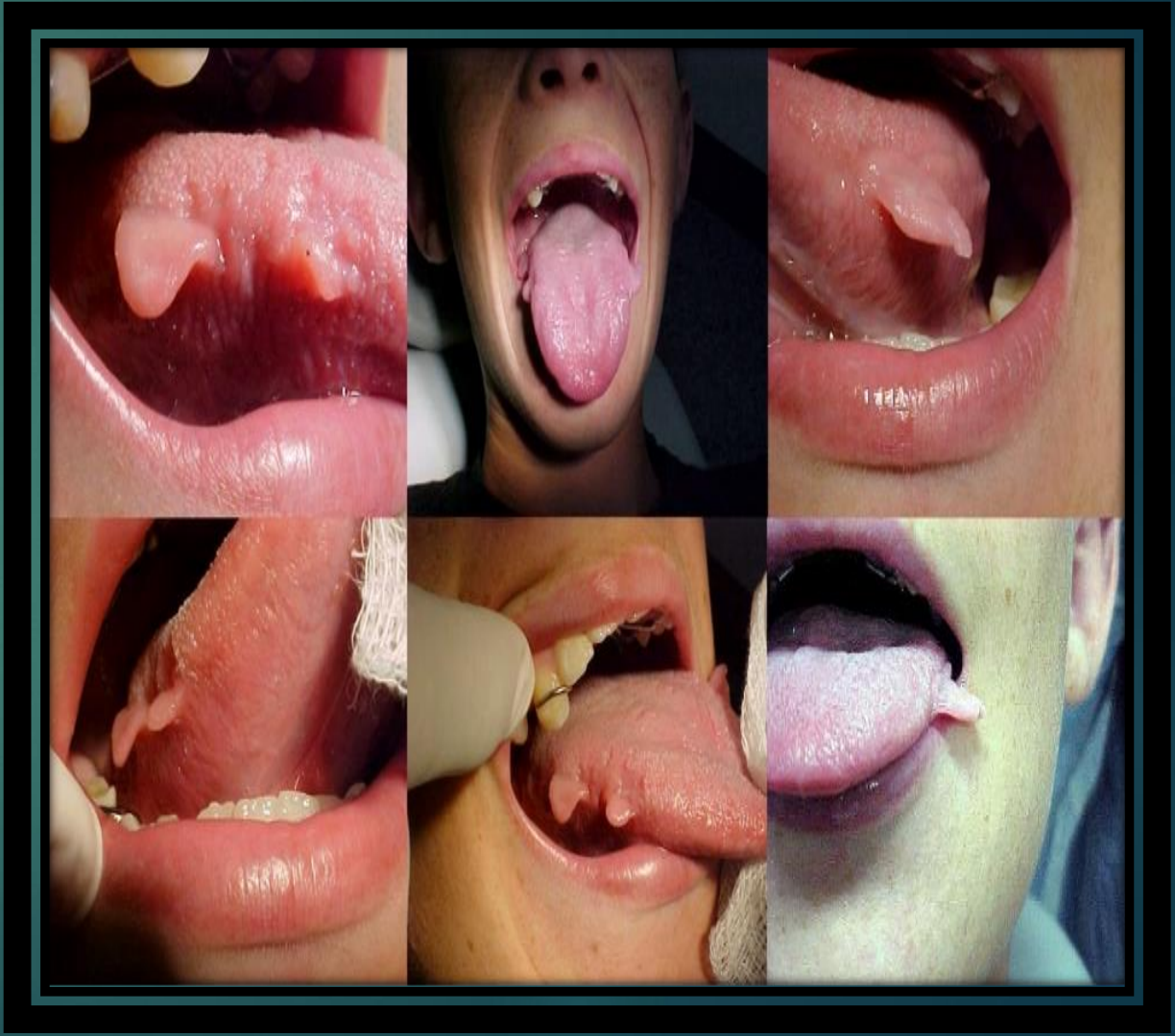




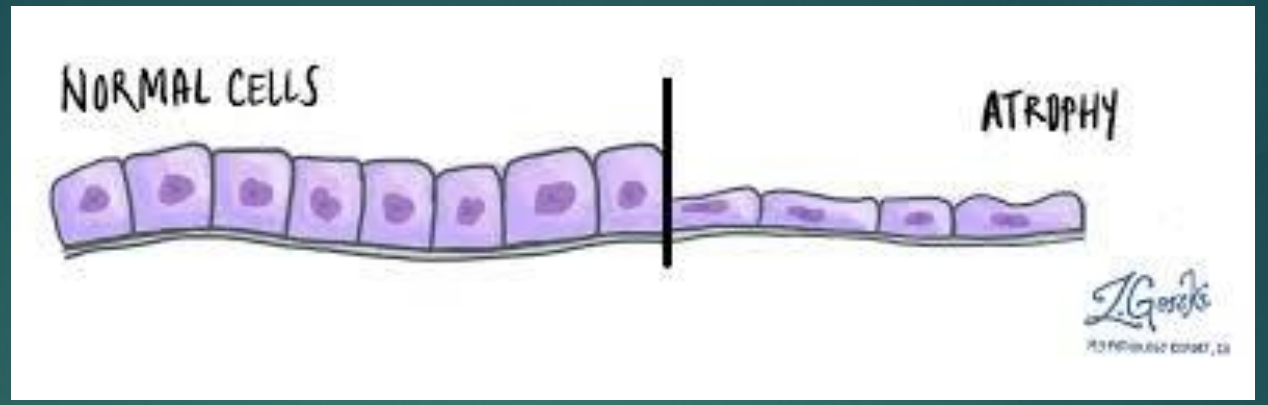


Connective tissue hyperplasia





Atrophy:



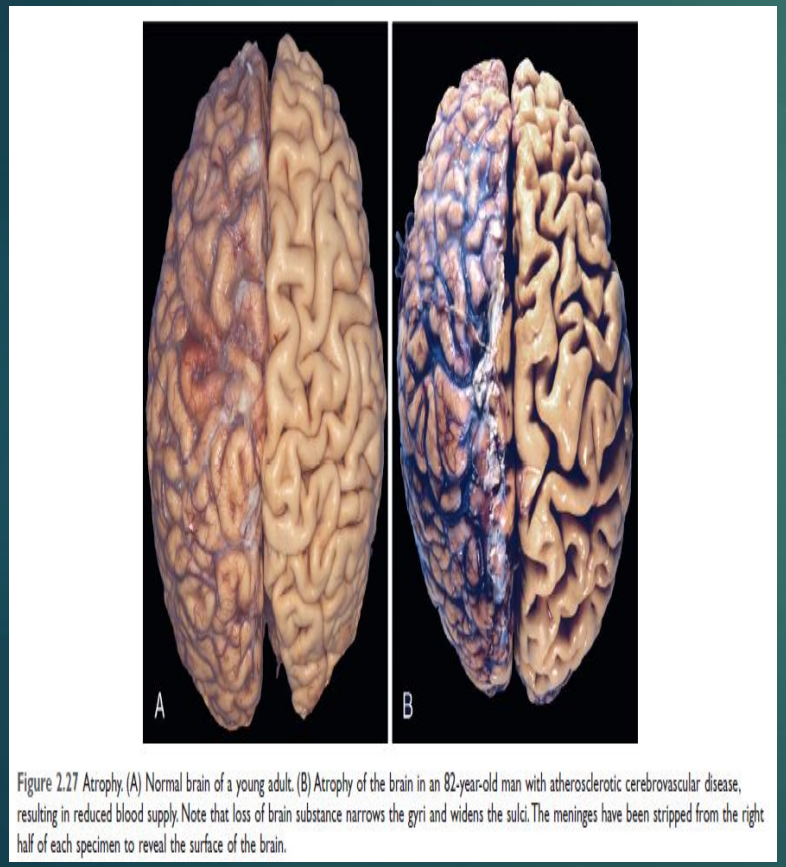
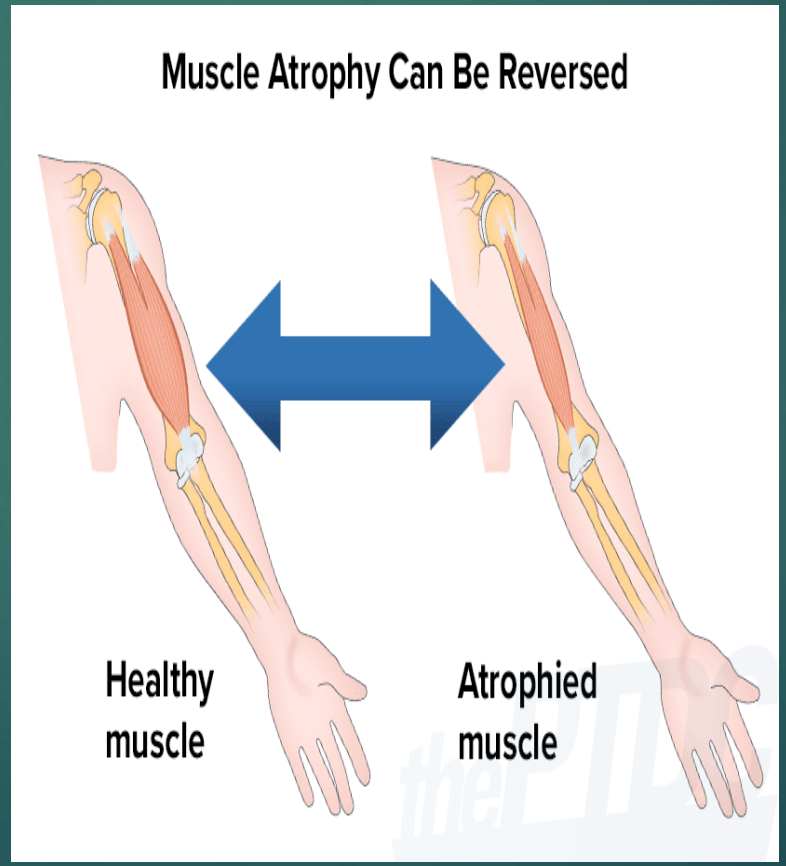
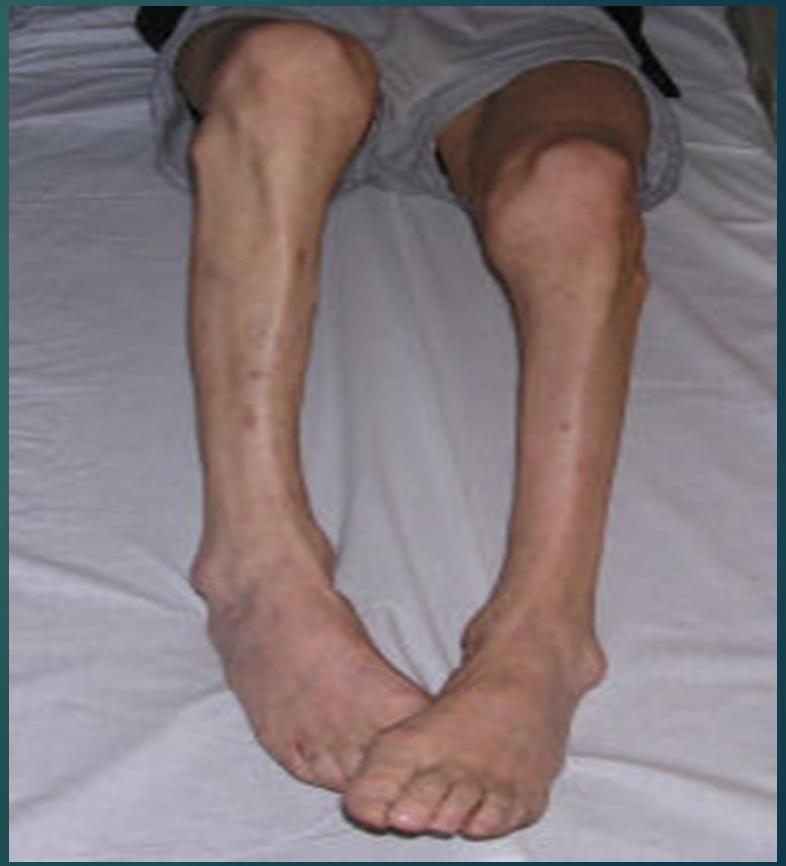
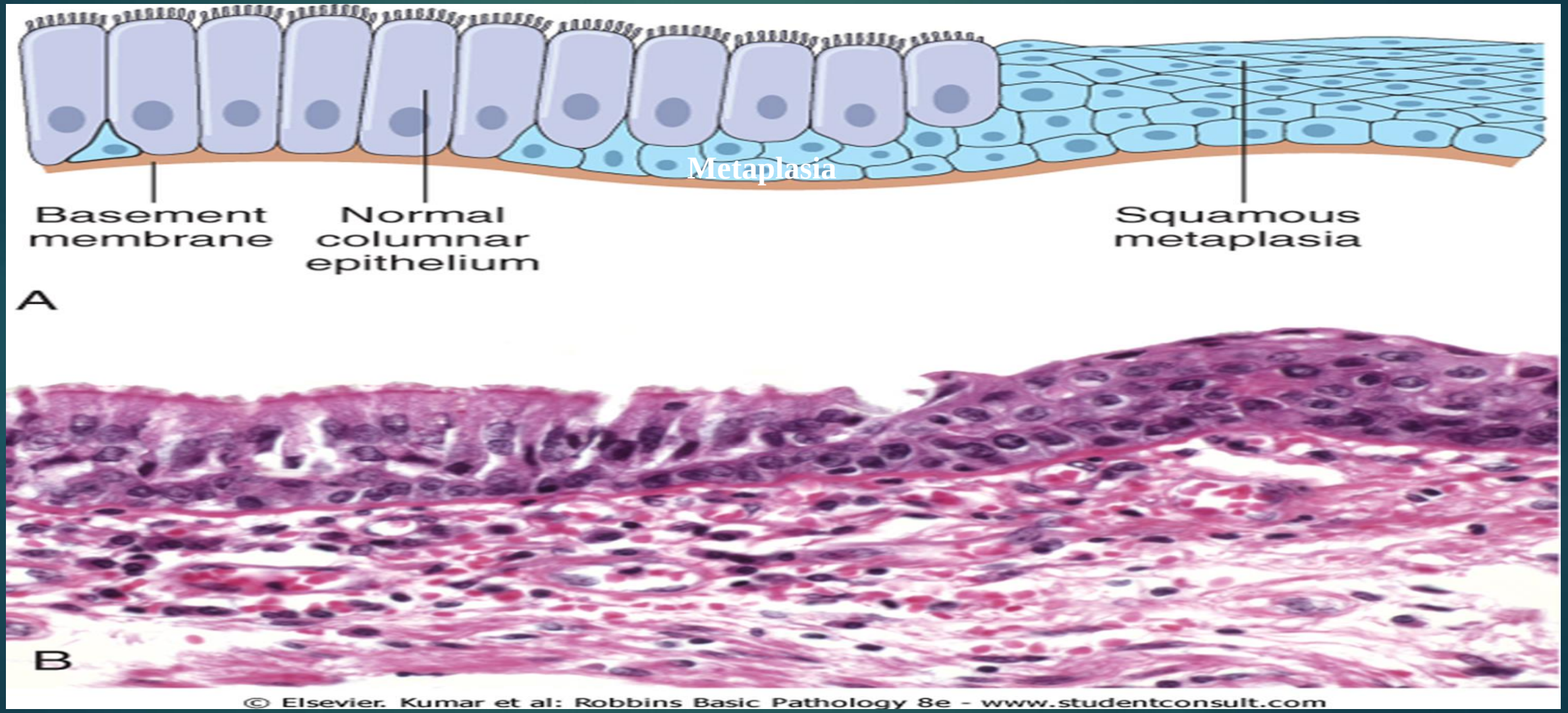


Figure 2.27 Atrophy. (A) Normal brain of a young adult. (B) Atrophy of the brain in an 82-year-old man with atherosclerotic cerebrovascular disease, resulting in reduced blood supply. Note that loss of brain substance narrows the gyri and widens the sulci. The meninges have been stripped from the right half of each specimen to reveal the surface of the brain.





Metaplasia:


Metaplasia
Basement membrane
Normal columnar epithelium
Squamous metaplasia
A
B
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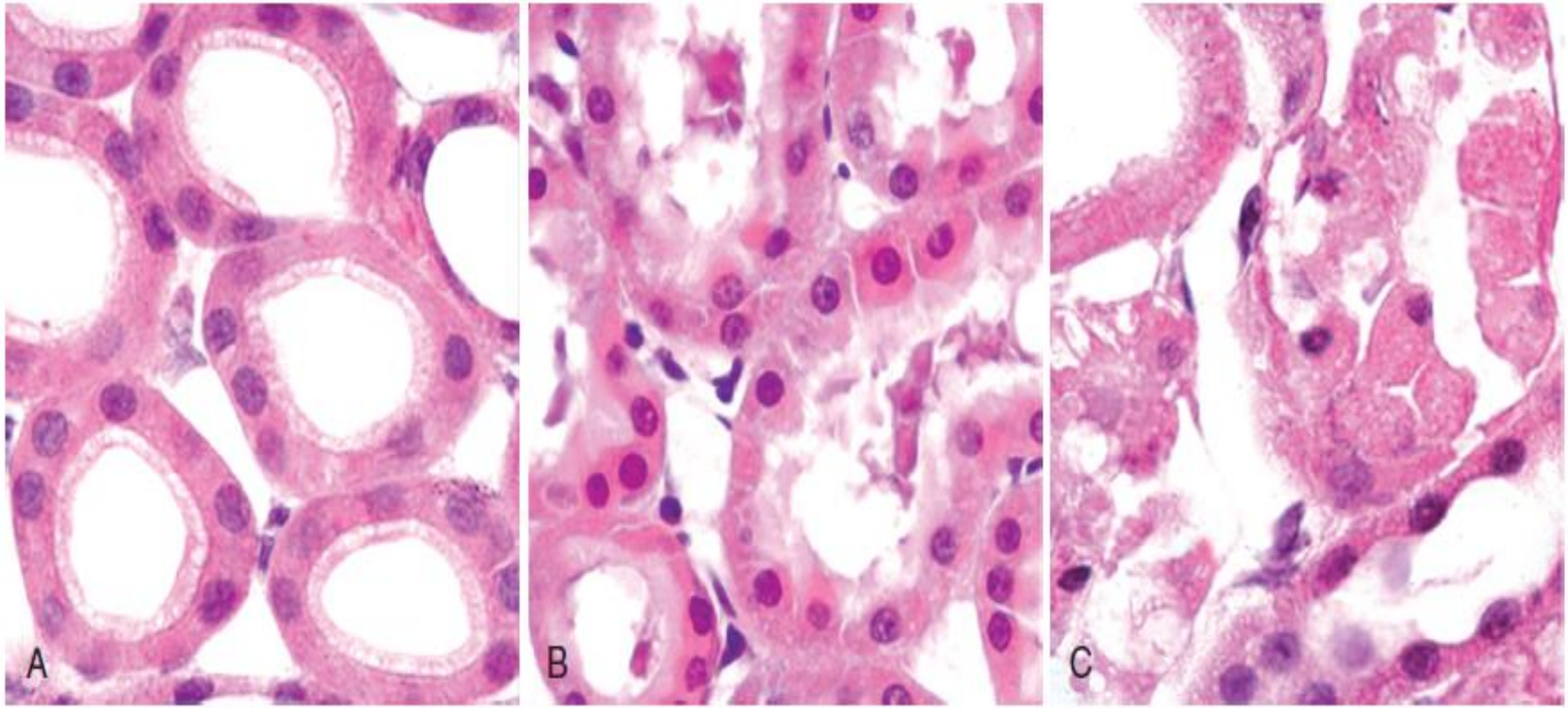
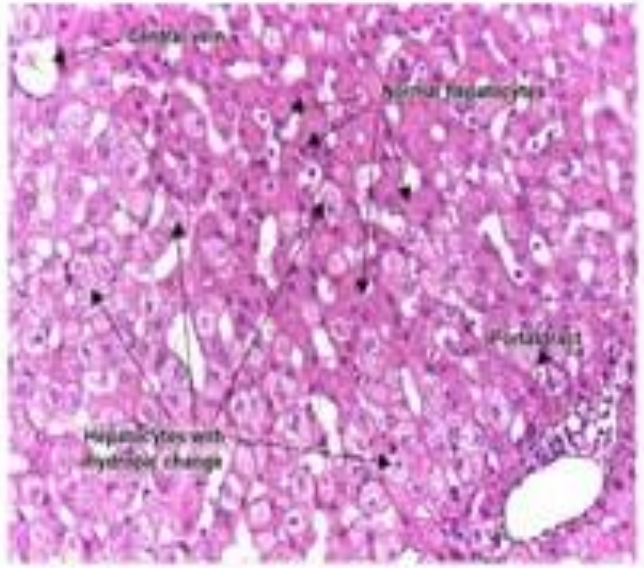


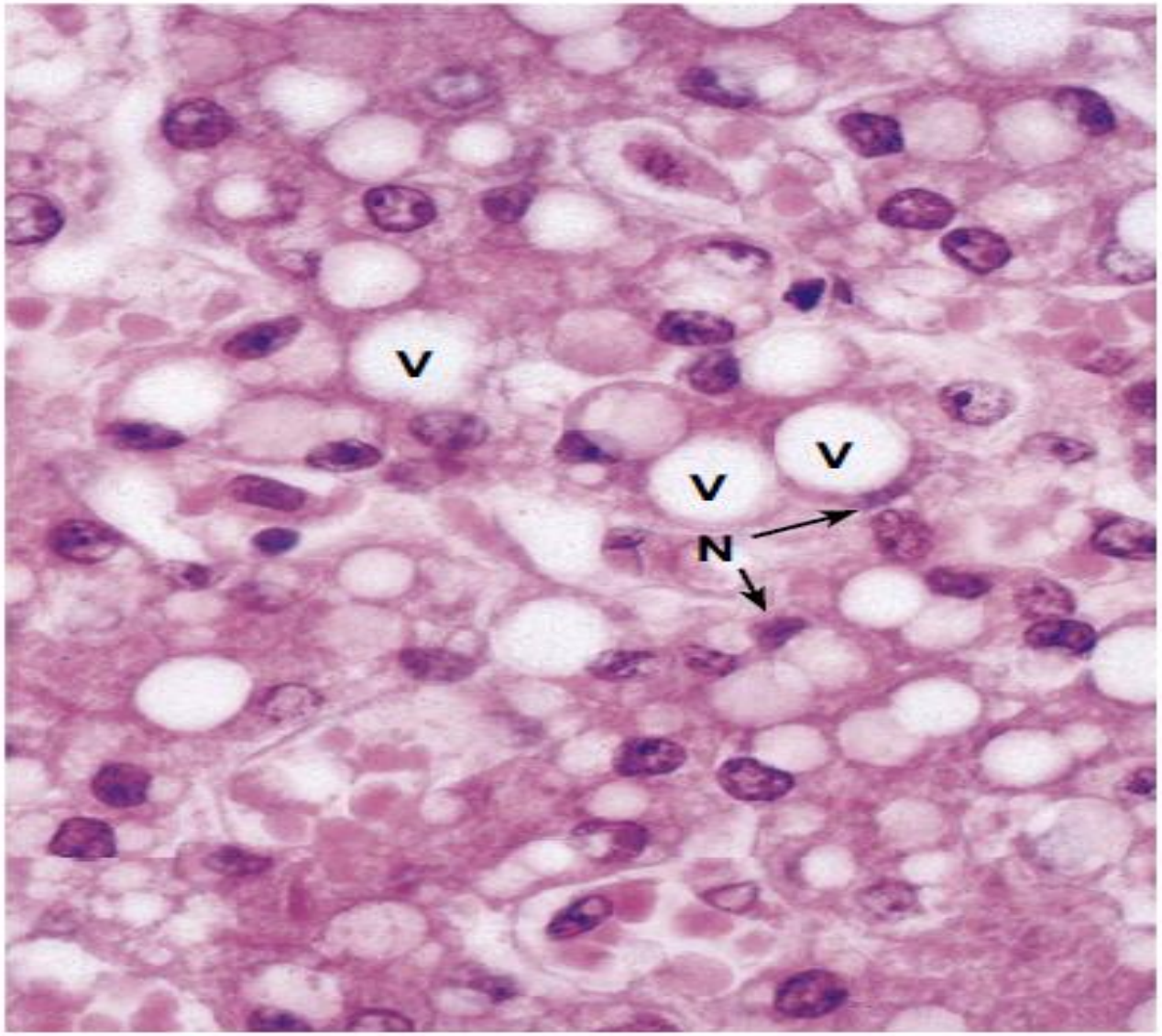
Figure 2.5 Morphologic changes in reversible cell injury and necrosis. (A) Normal kidney tubules with viable epithelial cells. (B) Early (reversible) ischemic injury showing surface blebs, increased eosinophilia of cytoplasm, and swelling of occasional cells. (C) Necrosis (irreversible injury) of epithelial cells, with loss of nuclei, fragmentation of cells, and leakage of contents. The ultrastructural features of these stages of cell injury are shown in Fig. 2.6. (Courtesy Drs. Neal Pinckard and M.A. Venkatachalam, University of Texas Health Sciences Center, San Antonio, Tex.)

Cellular swelling…. Fatty change

Reversible damage – cellular swelling



Cellular swelling (synonyms: hydropic change, vacuolar degeneration, cellular edema) is an acute reversible change resulting as a response to nonlethal injuries. It is an intracytoplasmic accumulation of water due to incapacity of the cells to maintain the ionic and fluid homeostasis. It is easy to be observed in parenchymal organs : liver (hepatitis, hypoxia), kidney (shock), myocardium (hypoxia, phosphate intoxication). It may be local or diffuse, affecting the whole organ.



FATTY CHANGES IN LIVERS


Apoptosis
Necrosis

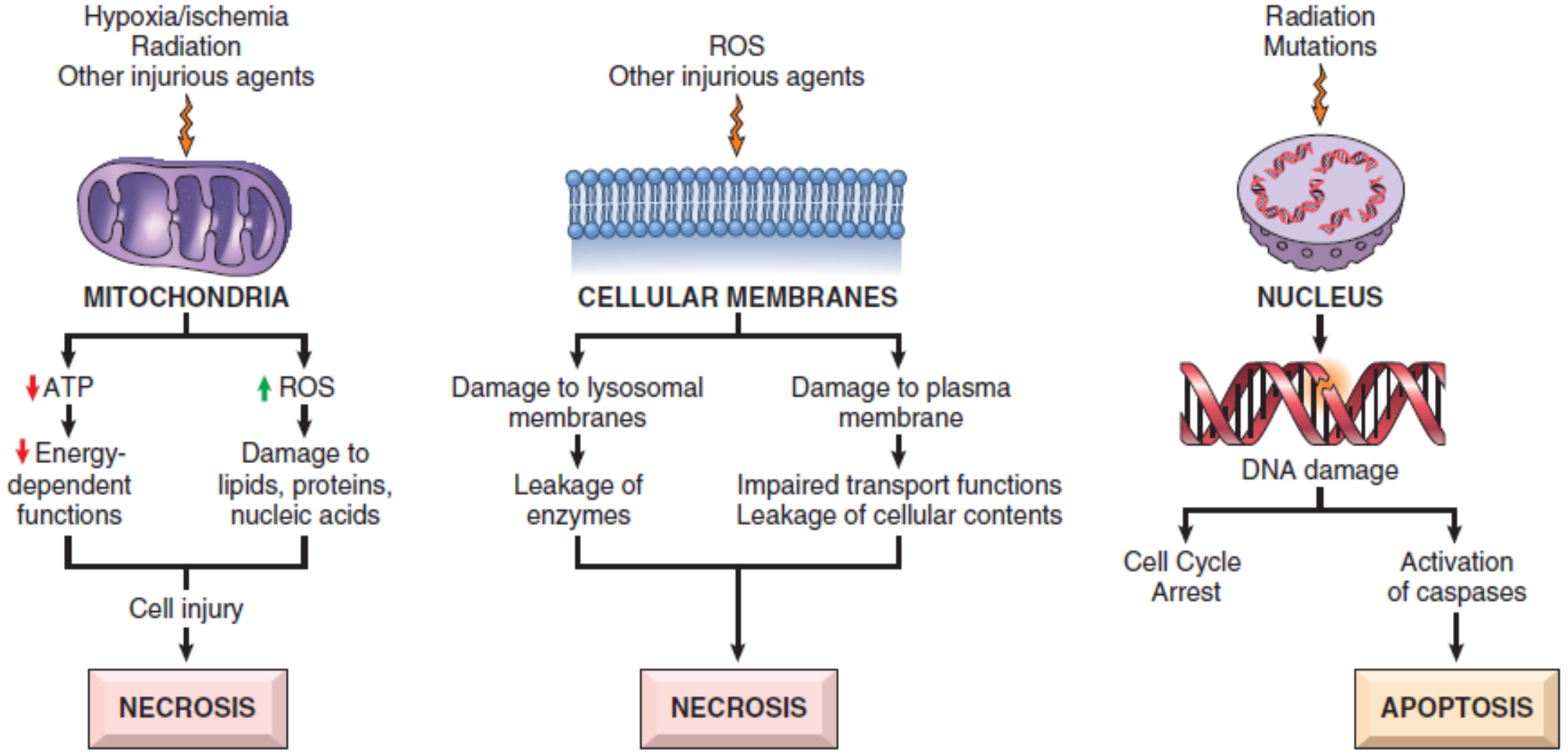


Figure 2.18 The principal forms and sites of damage in cell injury. *ATP*, Adenosine triphosphate; *ROS*, reactive oxygen species.

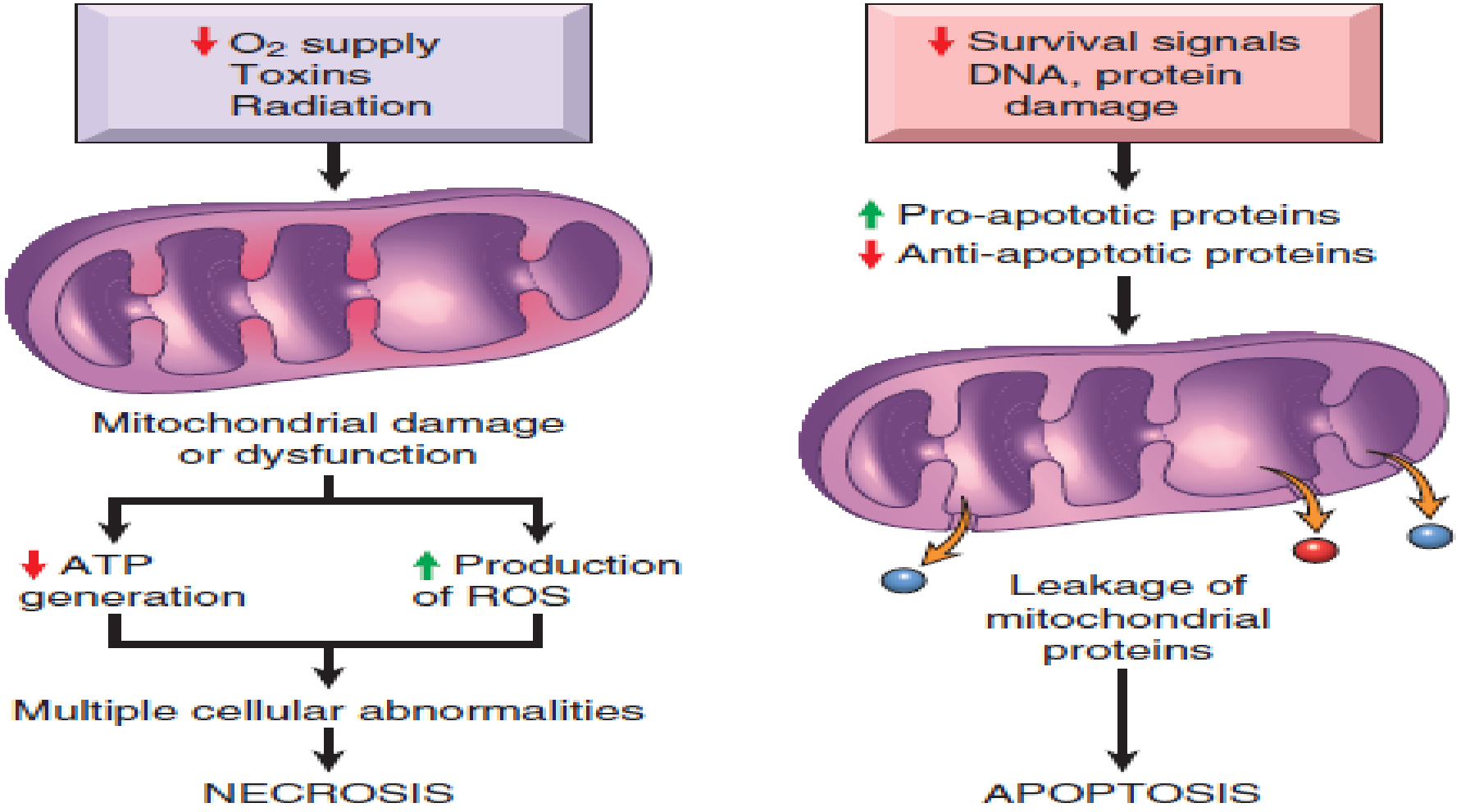
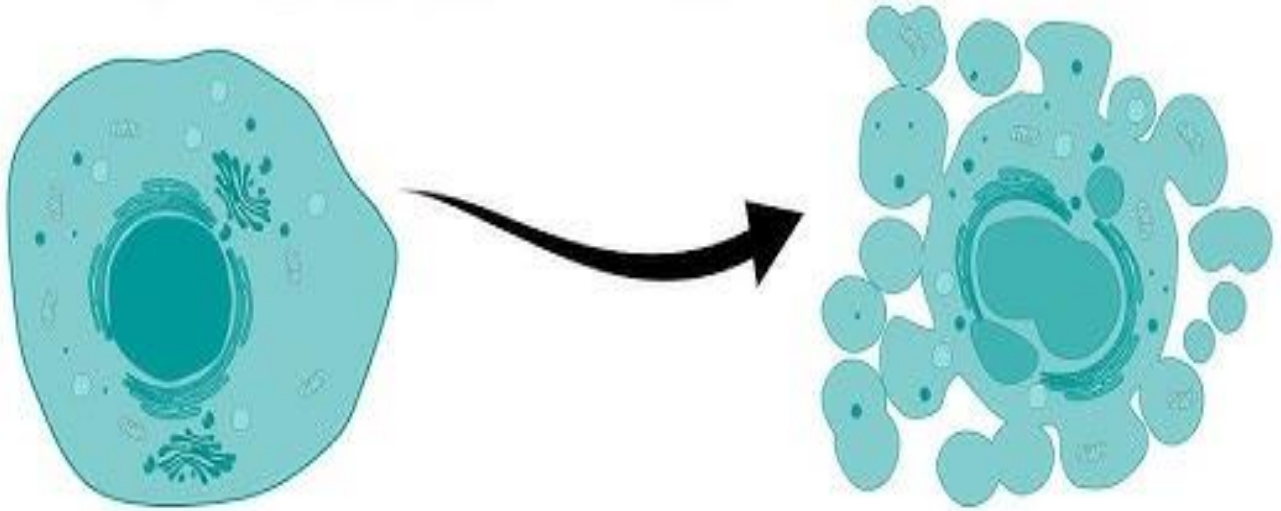


Figure 2.19 Role of mitochondria in cell injury and death. Mitochondria are affected by a variety of injurious stimuli, and their abnormalities lead to necrosis or apoptosis. *ATP*, Adenosine triphosphate; *ROS*, reactive oxygen species.

Apoptosis

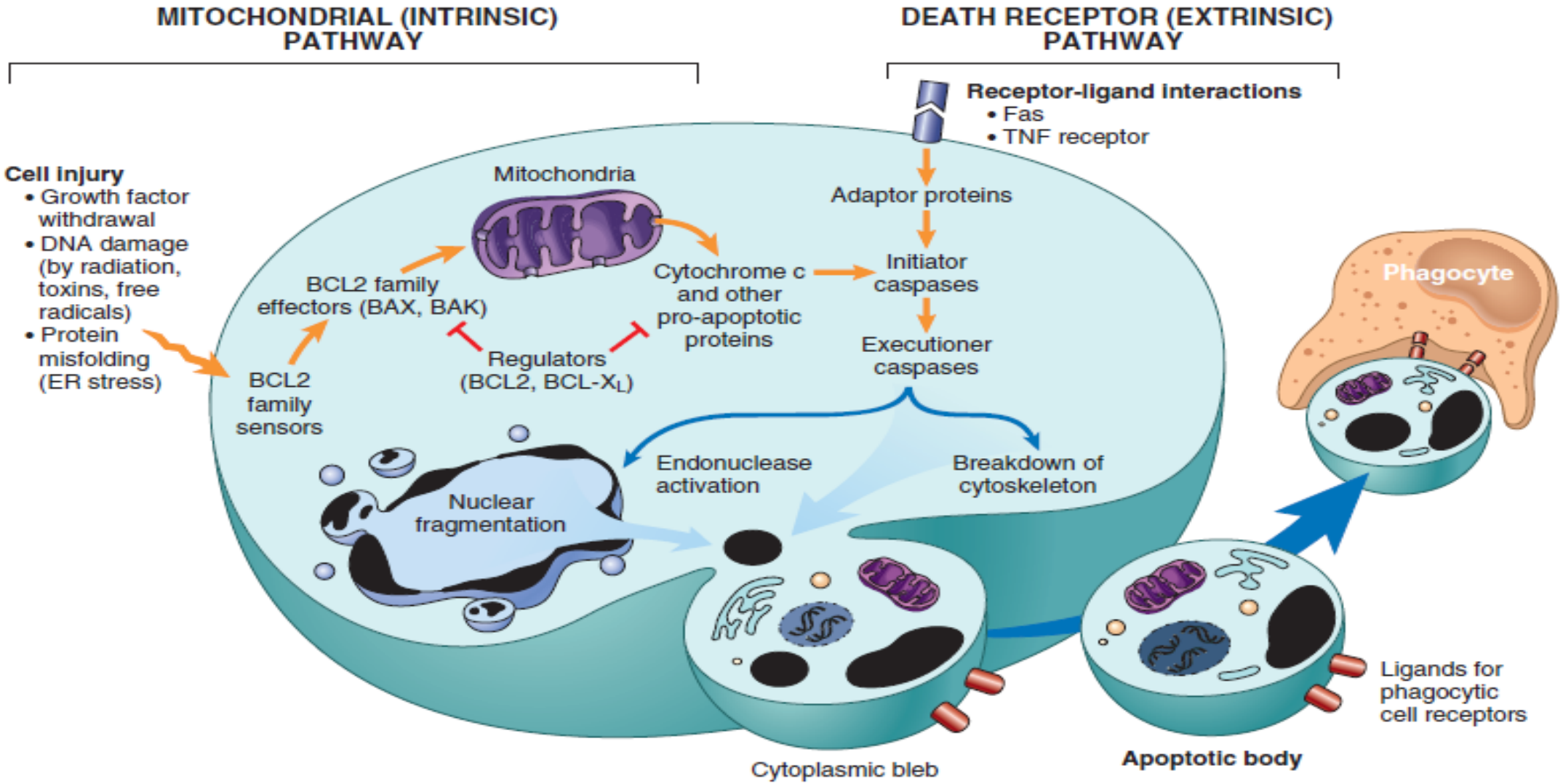
The word came from Ancient Greek ἀπόπτωσις (apóptōsis, "a falling off"),

Programmed cell death



Apoptosis:

Regulated mechanism of cell death that serves to eliminate unwanted and irreparably damaged cells, with the least possible host reaction. Characterized by enzymatic degradation of proteins and DNA, initiated by caspases, and by recognition and removal of dead cells by phagocytes.



Mechanisms of apoptosis

Apoptosis is important in the following physiologic situations:

a. The removal of supernumerary cells (in excess of the required number) during development.

b. b. Involution of hormone-dependent tissues on hormone withdrawal. (e.g. menstrual cycle, menopause and regression of the lactating breast after weaning).

c. c. Cell turnover in proliferating cell populations.e.g. immature lymphocytes in the bone marrow and thymus.

d. Elimination of potentially harmful self-reactive lymphocytes to prevent immune reactions against one's own tissues.

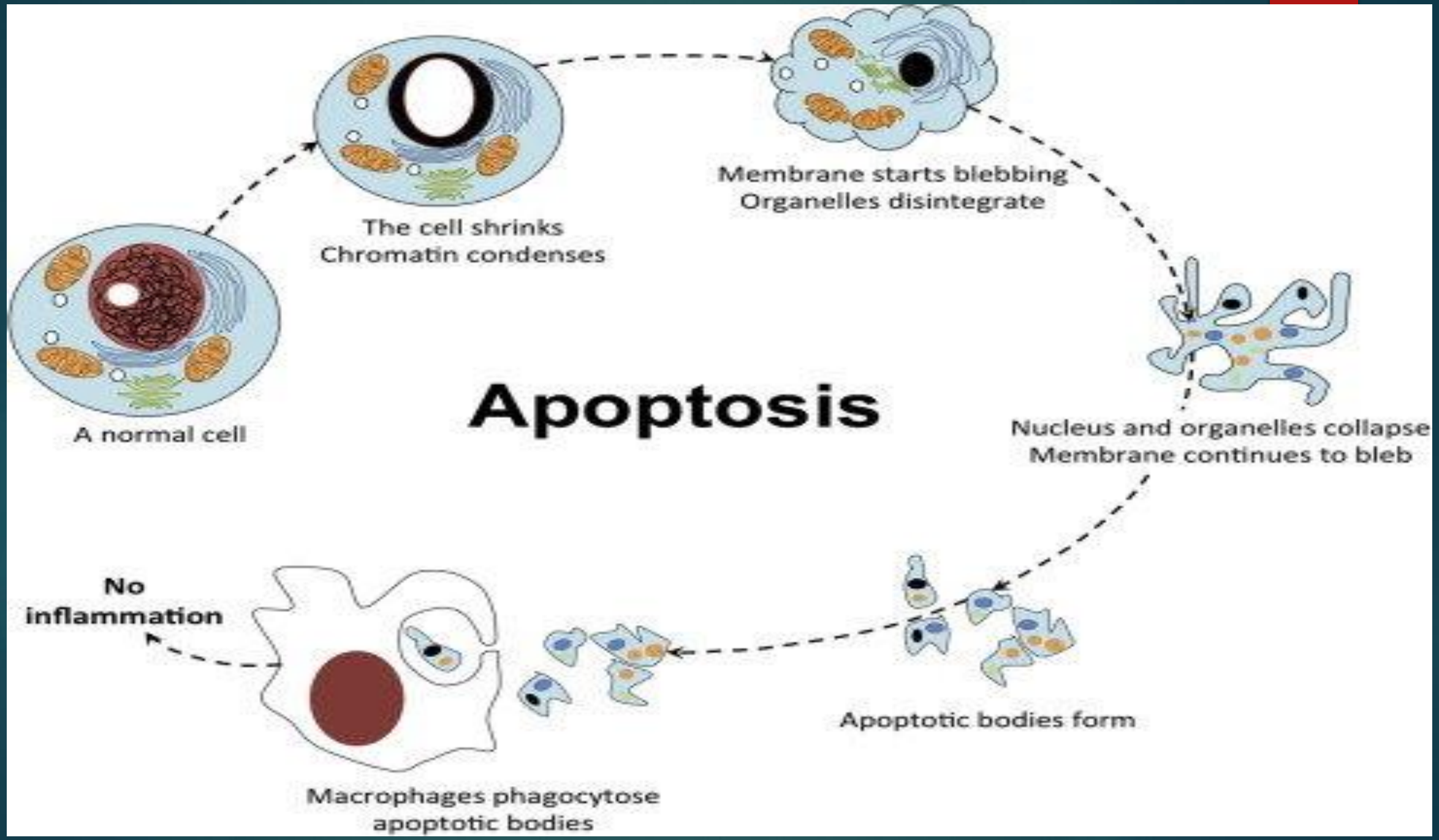
Apoptosis in Pathologic Conditions:.

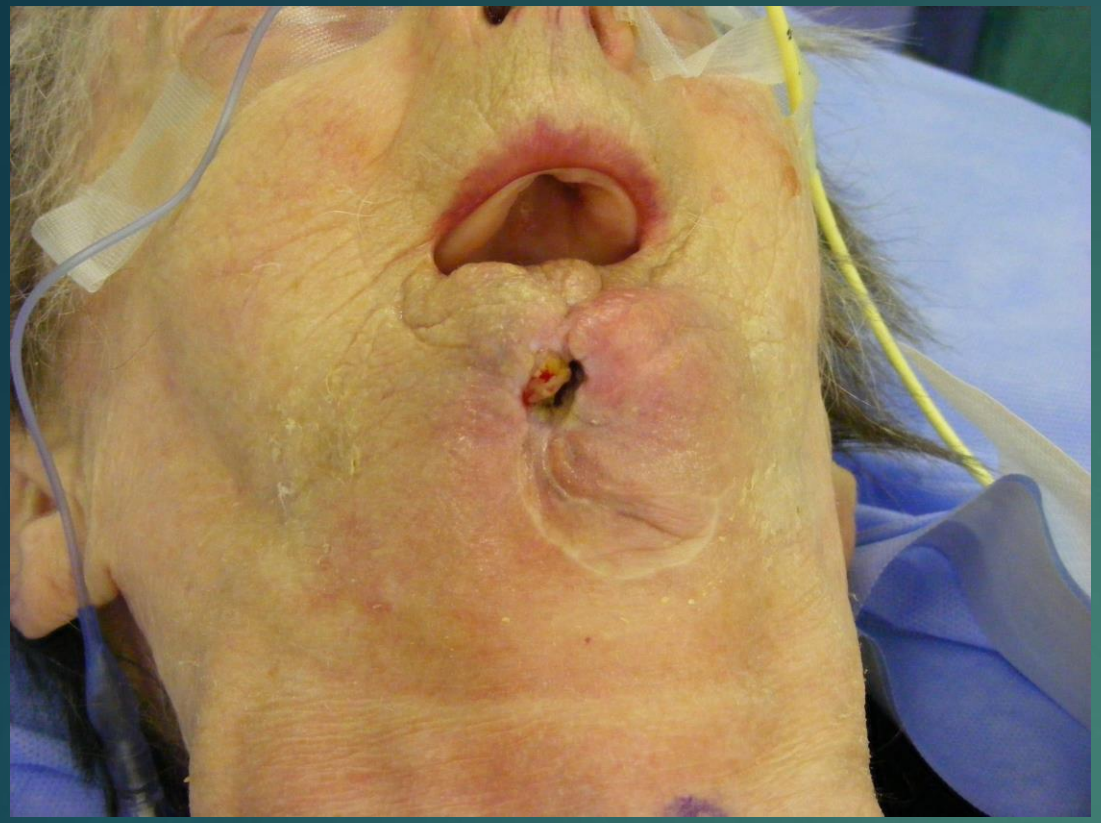
a. DNA damage. Radiation and cytotoxic anticancer drugs can damage DNA, either directly or via production of free radicals.

b. Accumulation of misfolded proteins. Cell death triggered by improperly folded intracellular proteins and the subsequent endoplasmic reticulum (ER) stress response.

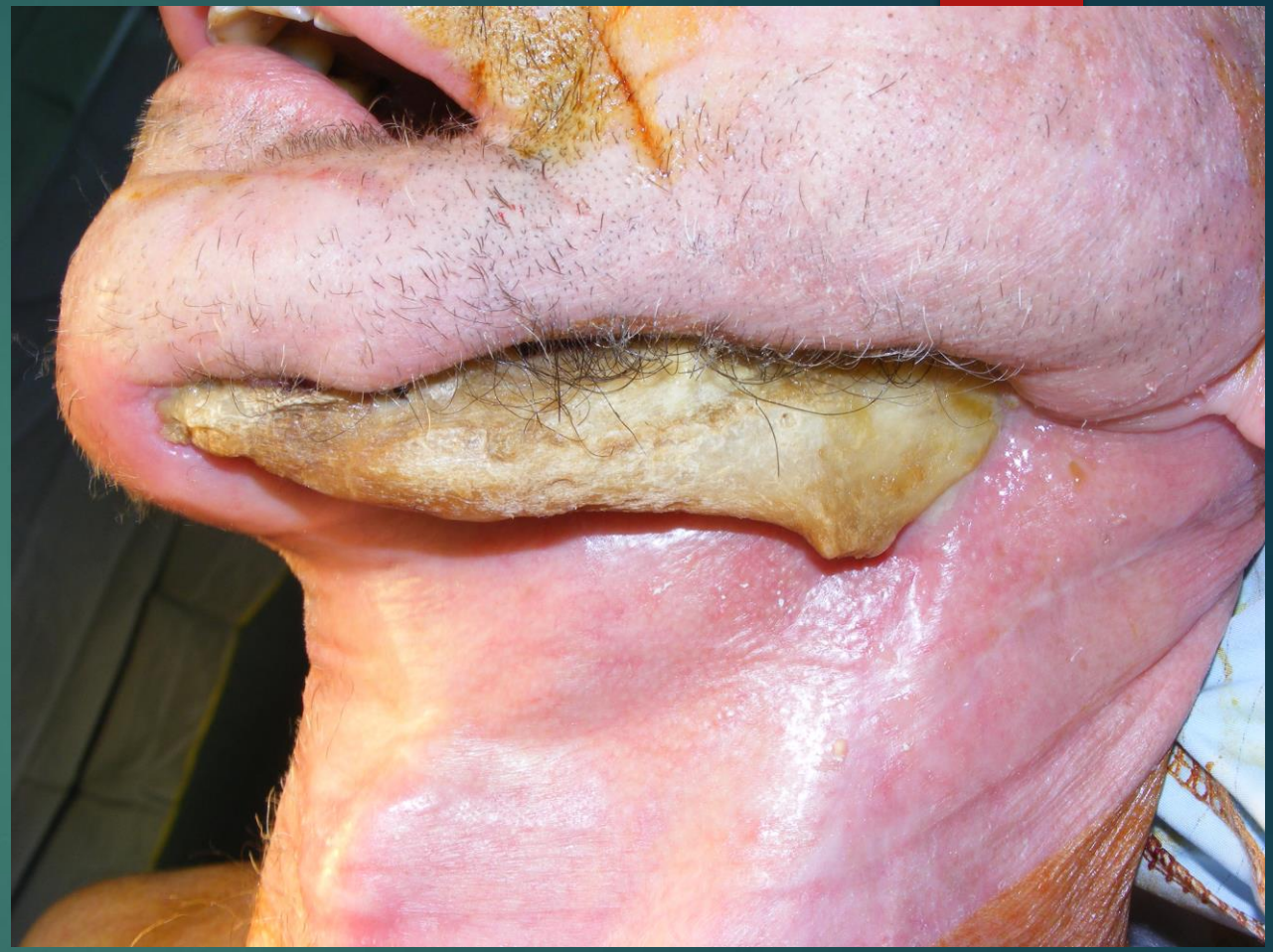
c. Apoptosis can be induced during certain infections, particularly viral infections e.g. HIV, HBV infections, killing of tumor cells, cellular rejection of transplants, and tissue damage in graft-versus-host disease (commonly associated with bone marrow transplants and steam cells transplants).

d. Apoptosis may also contribute to pathologic atrophy in parenchymal organs after duct obstruction, such as occurs in the pancreas, parotid gland, and kidney.


Apoptosis
A normal cell
The cell shrinks
Chromatin condenses
Membrane starts blebbing
Organelles disintegrate
Nucleus and organelles collapse
Membrane continues to bleb
Apoptotic bodies form
Macrophages phagocytose
apoptotic bodies
No
inflammation

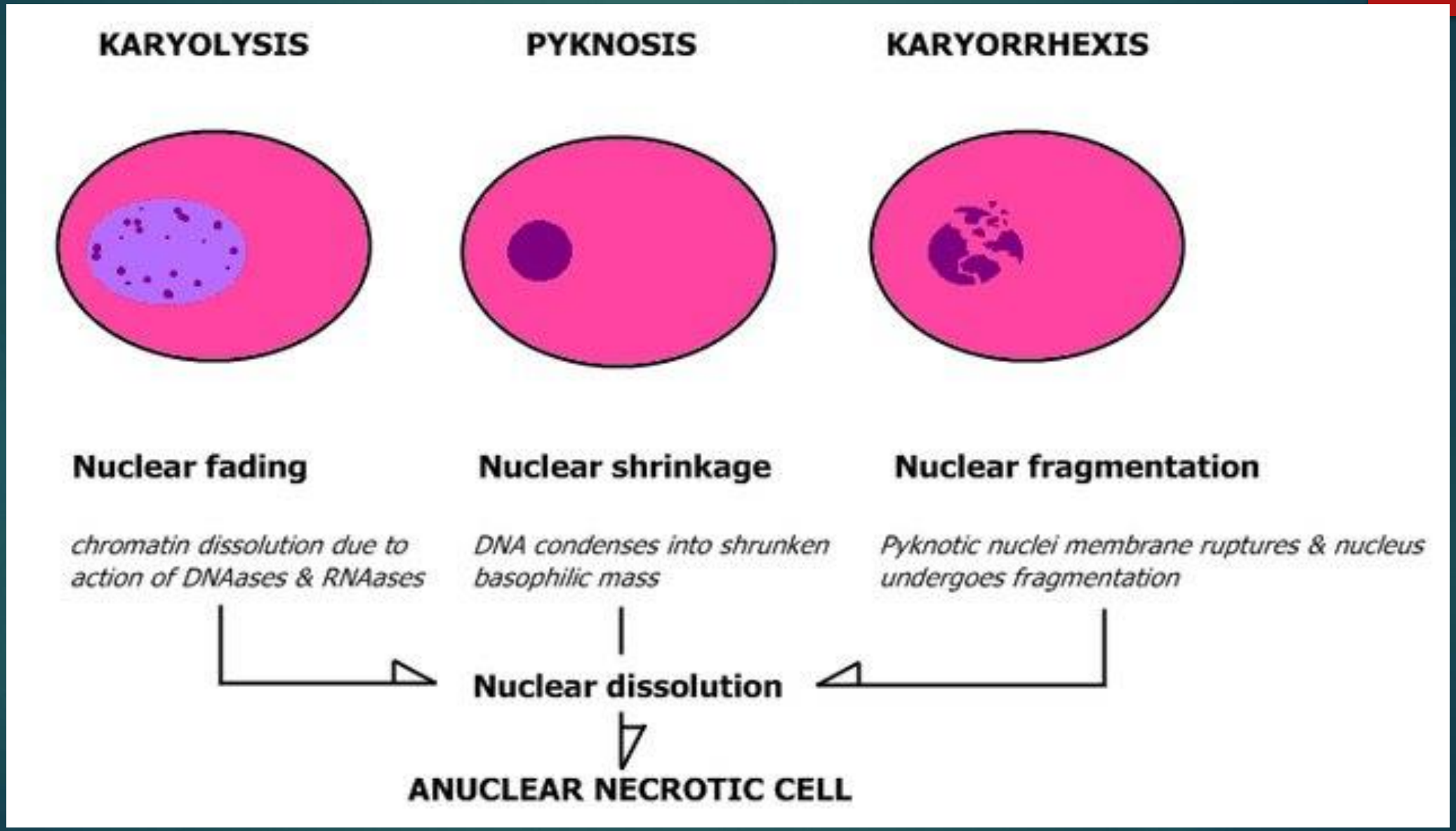


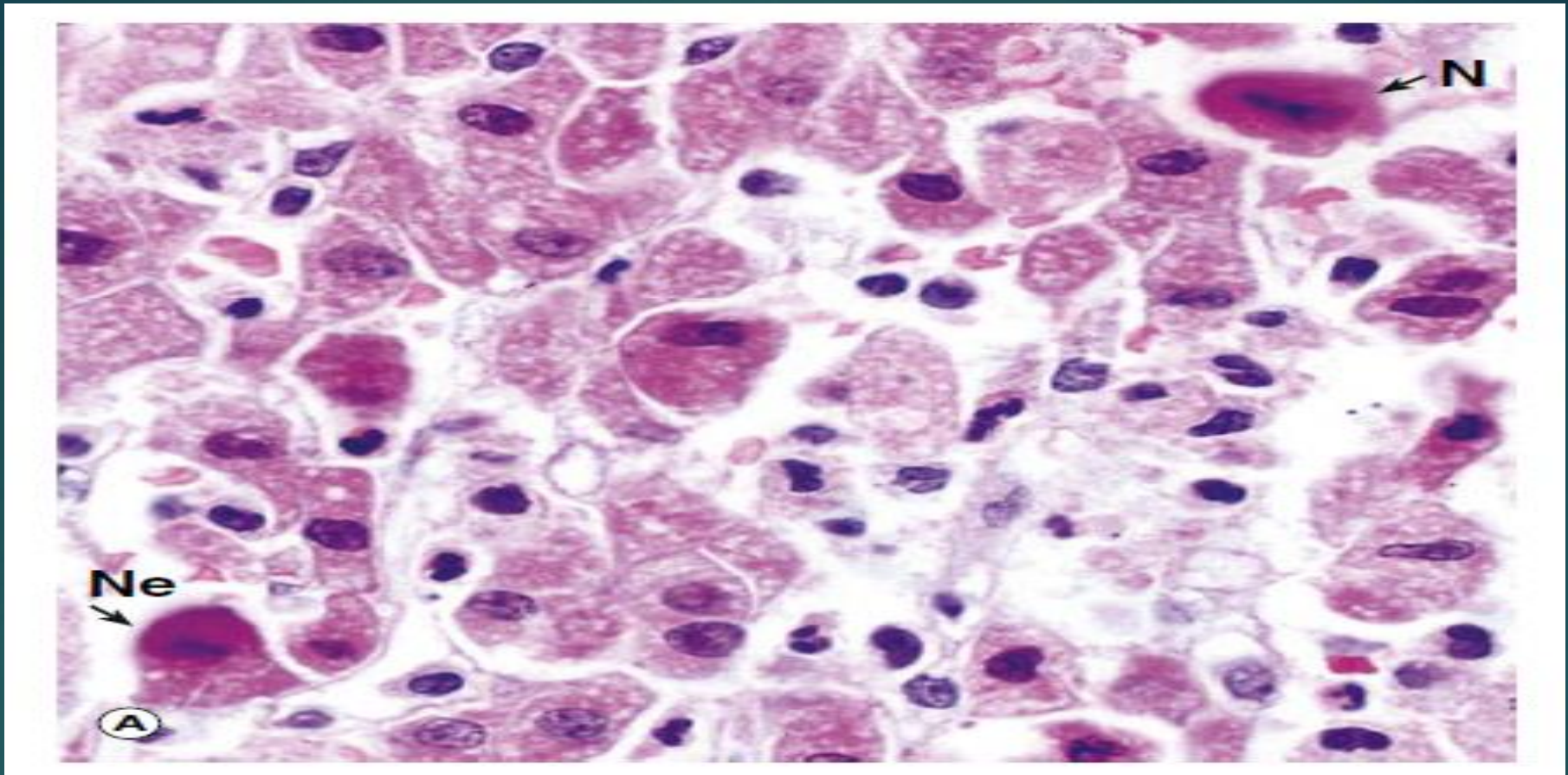
Fistula from mouth to chin secondary to mandibular ORN.



An extreme example of ORN of the left mandible caused by extraction of a molar tooth.

Morphology of irreversible injury





LIVER NECROSIS

(NE)THE DEAD CELLS STAIN A BRIGHT PINK (EOSINOPHILIA) AND STAND OUT FROM THE OTHER CELLS, DUE TO DEGENERATION OF STRUCTURAL PROTEINS THAT FORM A COMPACT HOMOGENEOUS MASS

COAGULATIVE NECROSIS

- Most common type of necrosis
- Mostly from sudden cessation of blood flow (ischaemia)
- Less often from bacterial and chemical agents.
- It's characteristic of **infarcts** (areas of ischemic necrosis) in all solid organs except the brain.
- The organs commonly affected are the heart, kidney, and spleen

Coagulative necrosis of the left ventricular wall

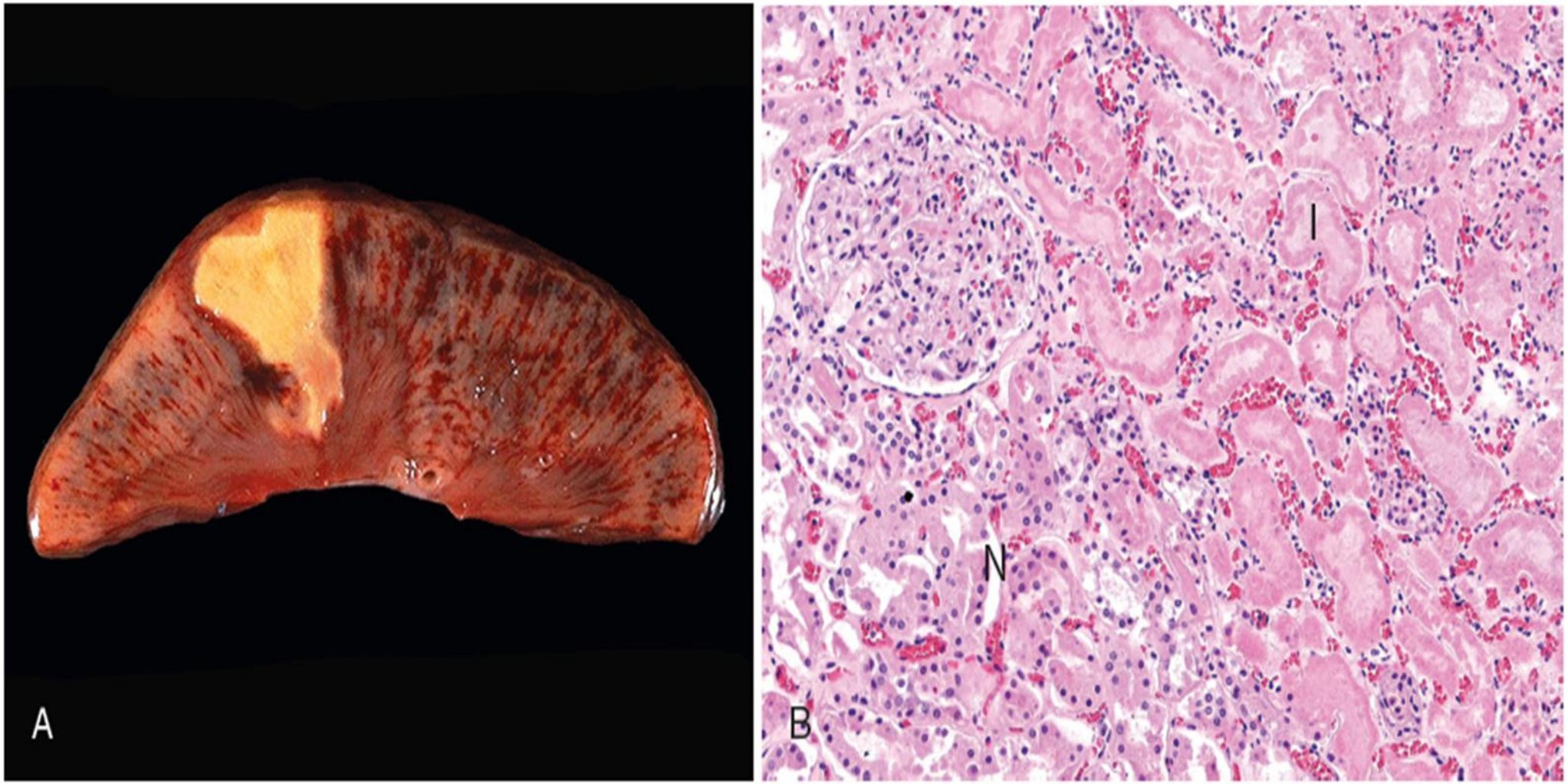
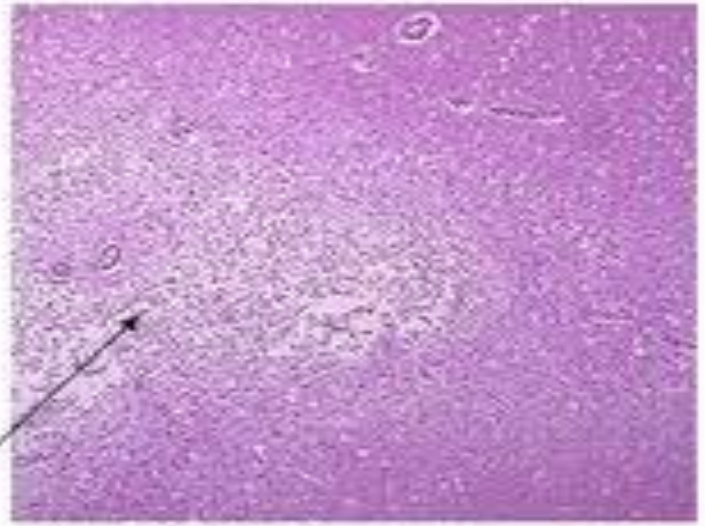
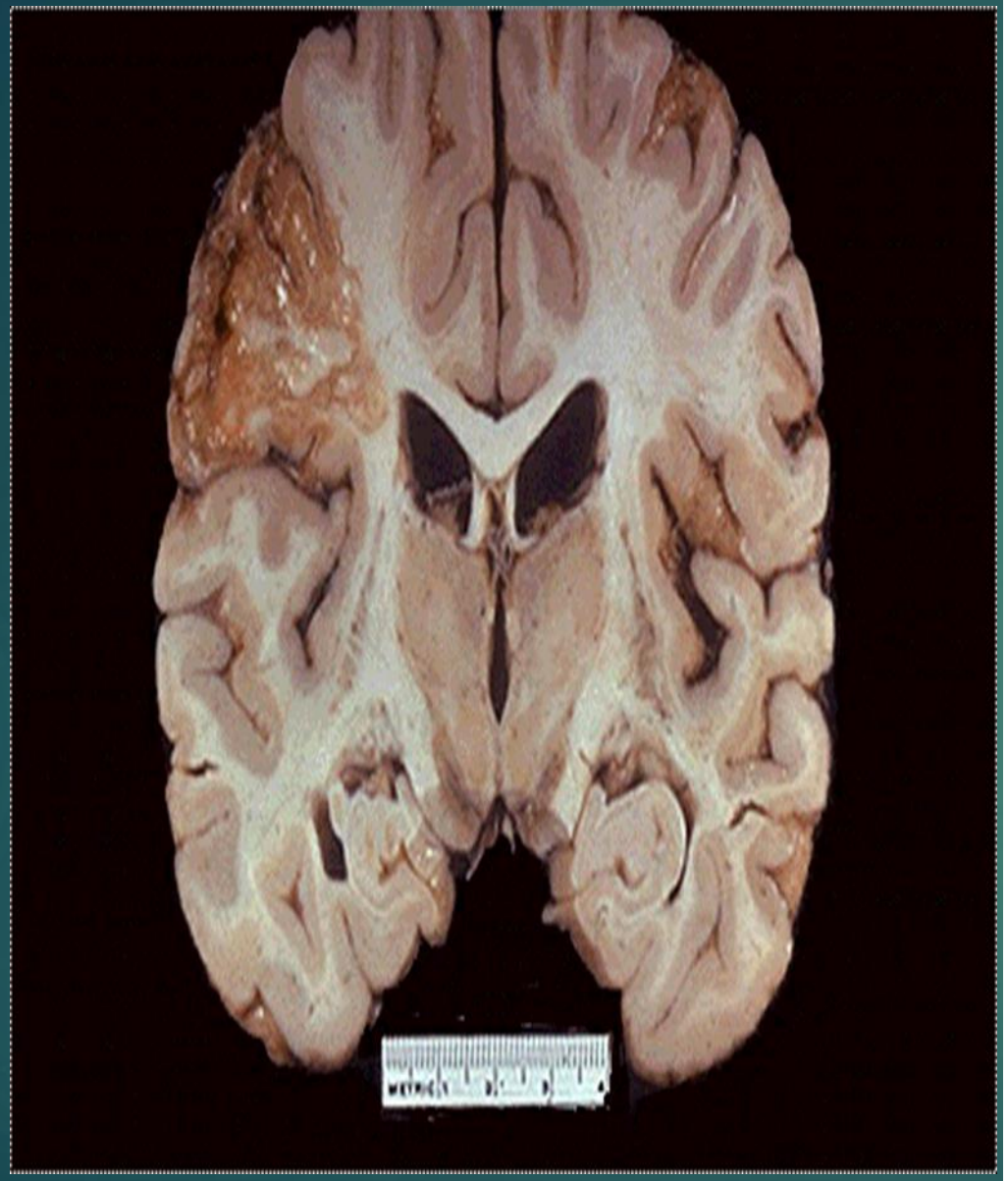


Figure 2.7 Coagulative necrosis. (A) A wedge-shaped kidney infarct *(yellow)*. (B) Microscopic view of the edge of the infarct, with normal kidney *(N)* and necrotic cells in the infarct *(I)* showing preserved cellular outlines with loss of nuclei and an inflammatory infiltrate (seen as nuclei of inflammatory cells in between necrotic tubules).

Liquefactive necrosis

- This is liquefactive necrosis in the brain in a patient who suffered a "stroke" with focal loss of blood supply to a portion of cerebrum. This type of infarction is marked by loss of neurons and neuroglial cells and the formation of a clear space at the centre left.





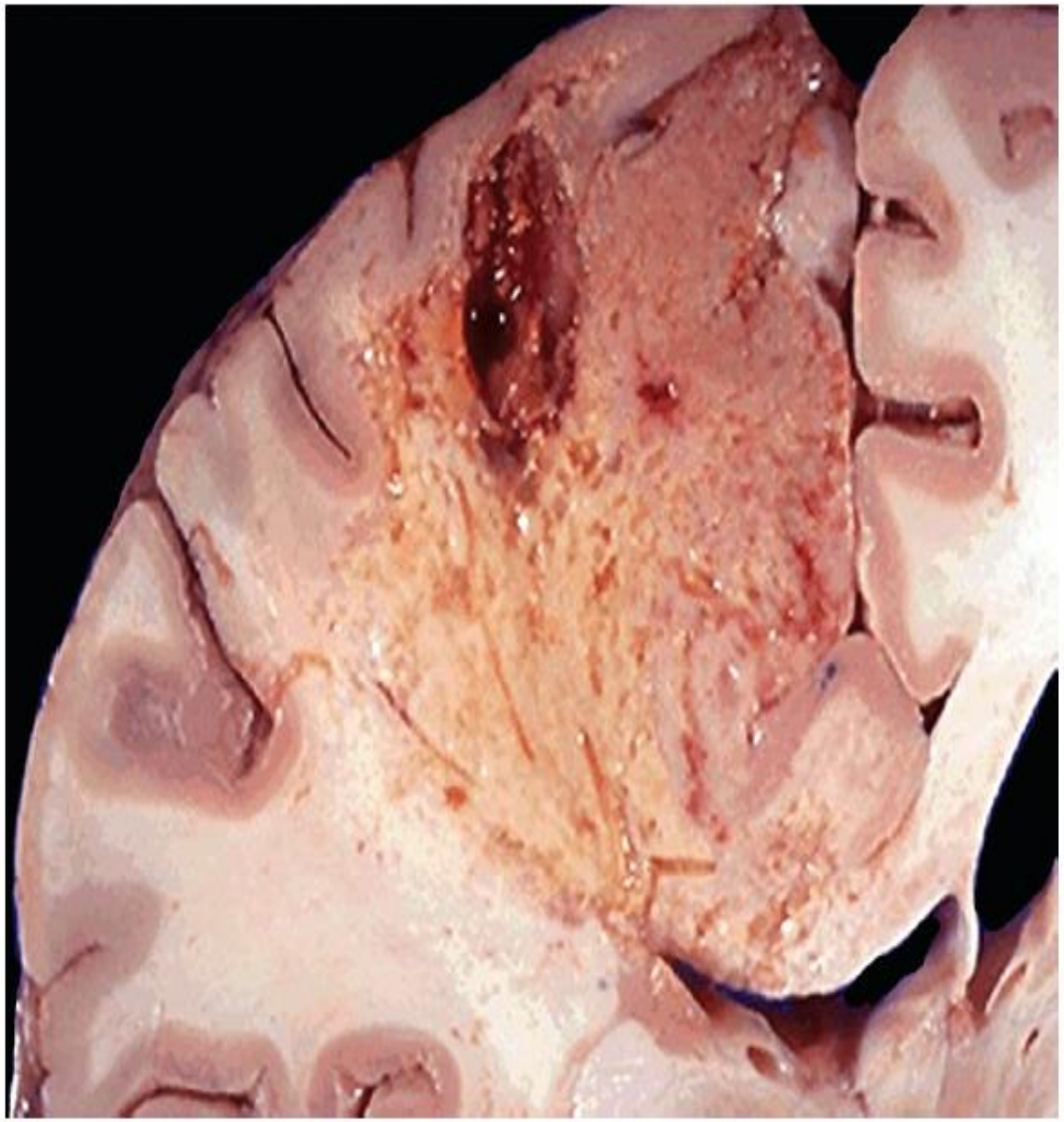
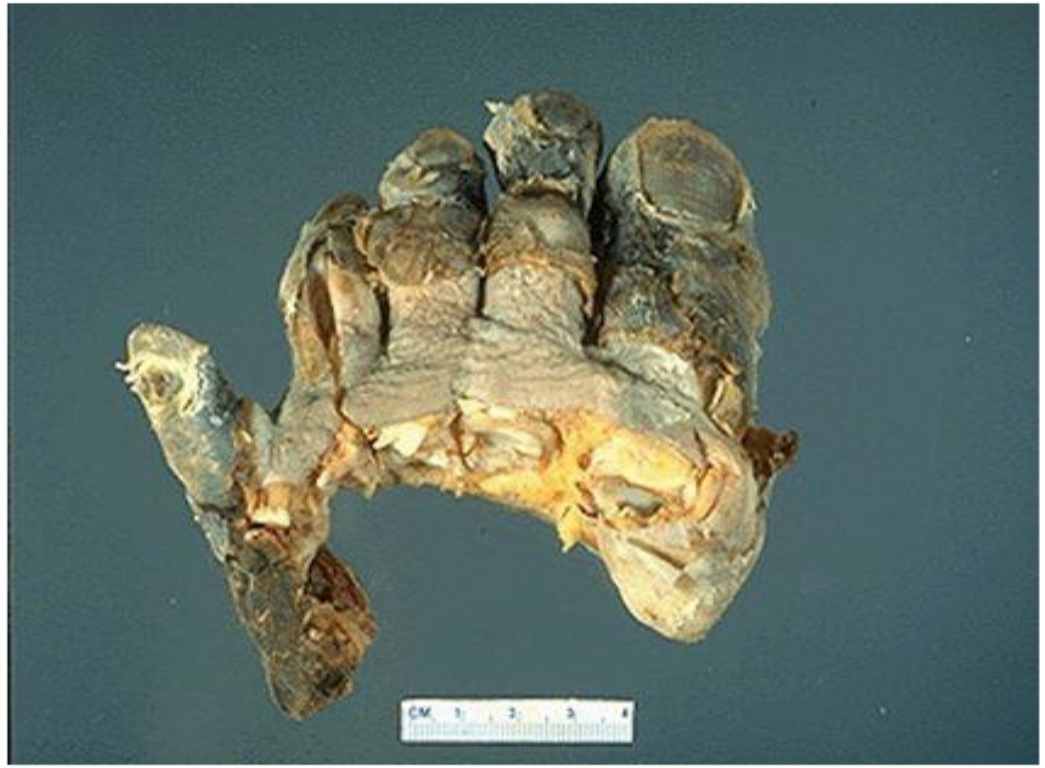


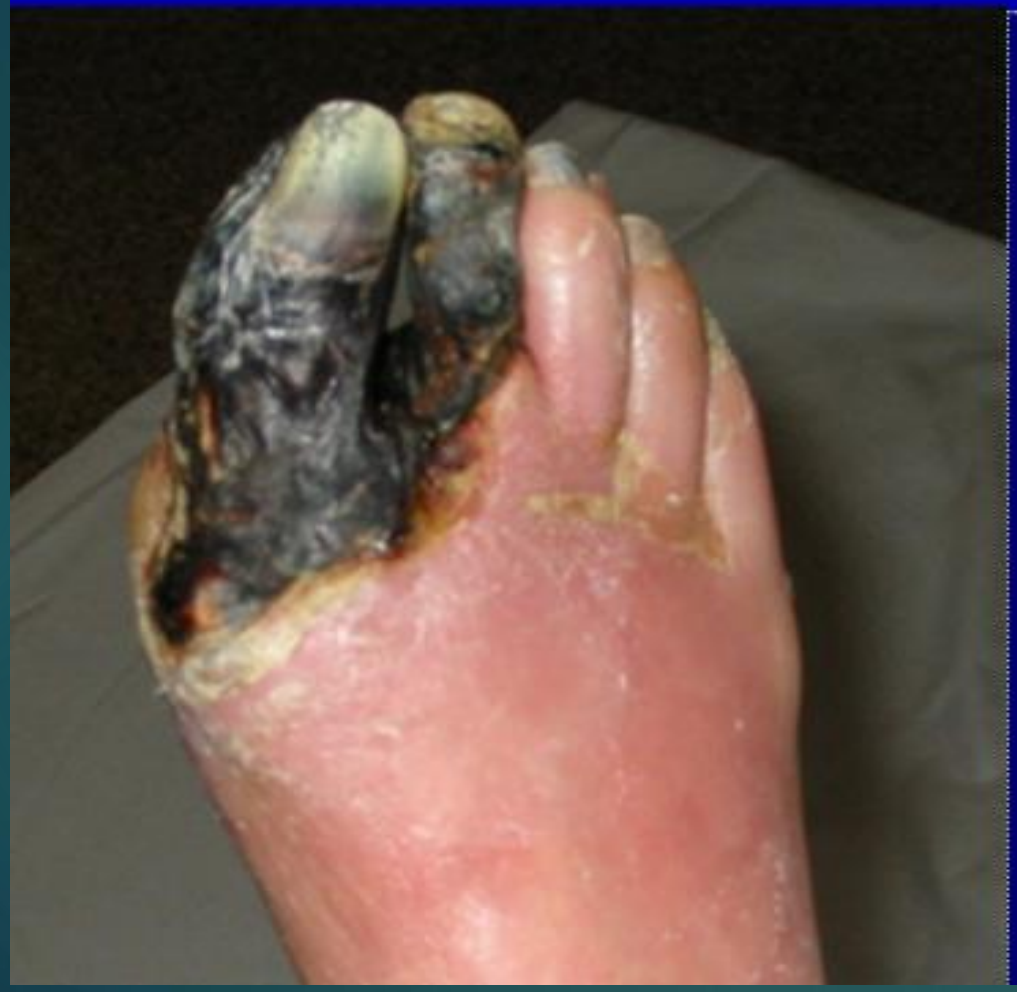
Figure 2.8 Liquefactive necrosis. An infarct in the brain, showing dissolution of the tissue.

Gangrenous Necrosis

- In this case, the toes were involved in a frostbite injury. This is an example of "dry" gangrene in which there is mainly coagulative necrosis from the anoxic injury.



Dry Gangrene gross



Wet gangrene gross

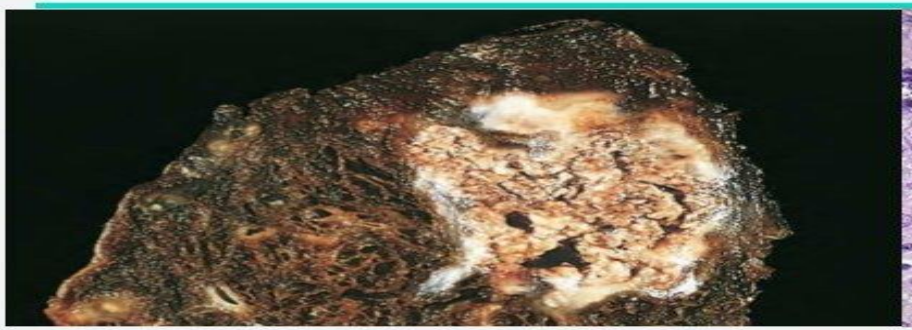
Tittle

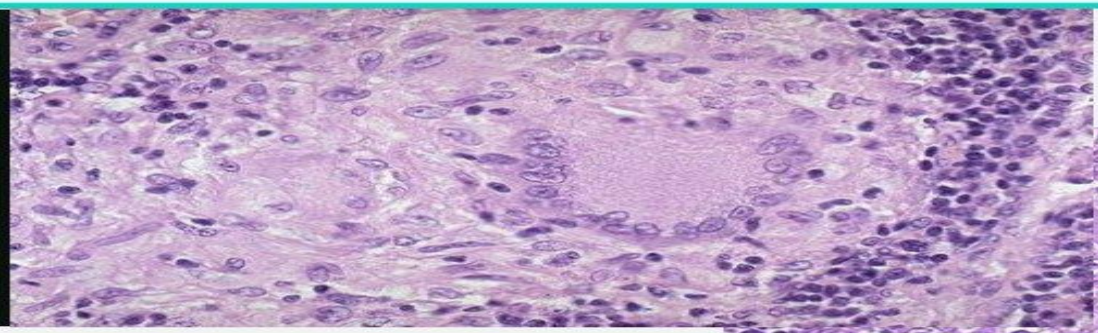
Caseous necrosis

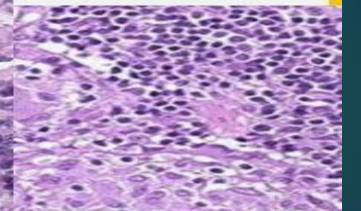
Pathology discussion forum

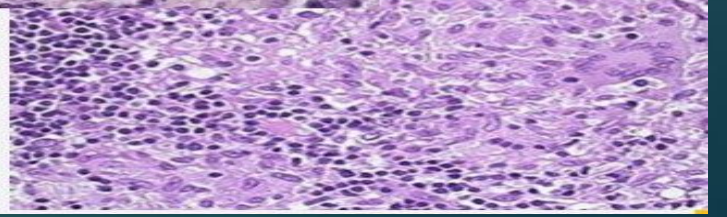
Description....

-Induced by cell mediated immunity.
-Tissue appears cheesy.
- Histologically consists of granular material surrounded by epithelioid cells and multinucleated giant cells.
- Seen in tuberculosis, fungal granulomas (histoplasmosis and coccidioidomycosis).
- Consists of both coagulative and liquefactive necrosis.









#NEETPG

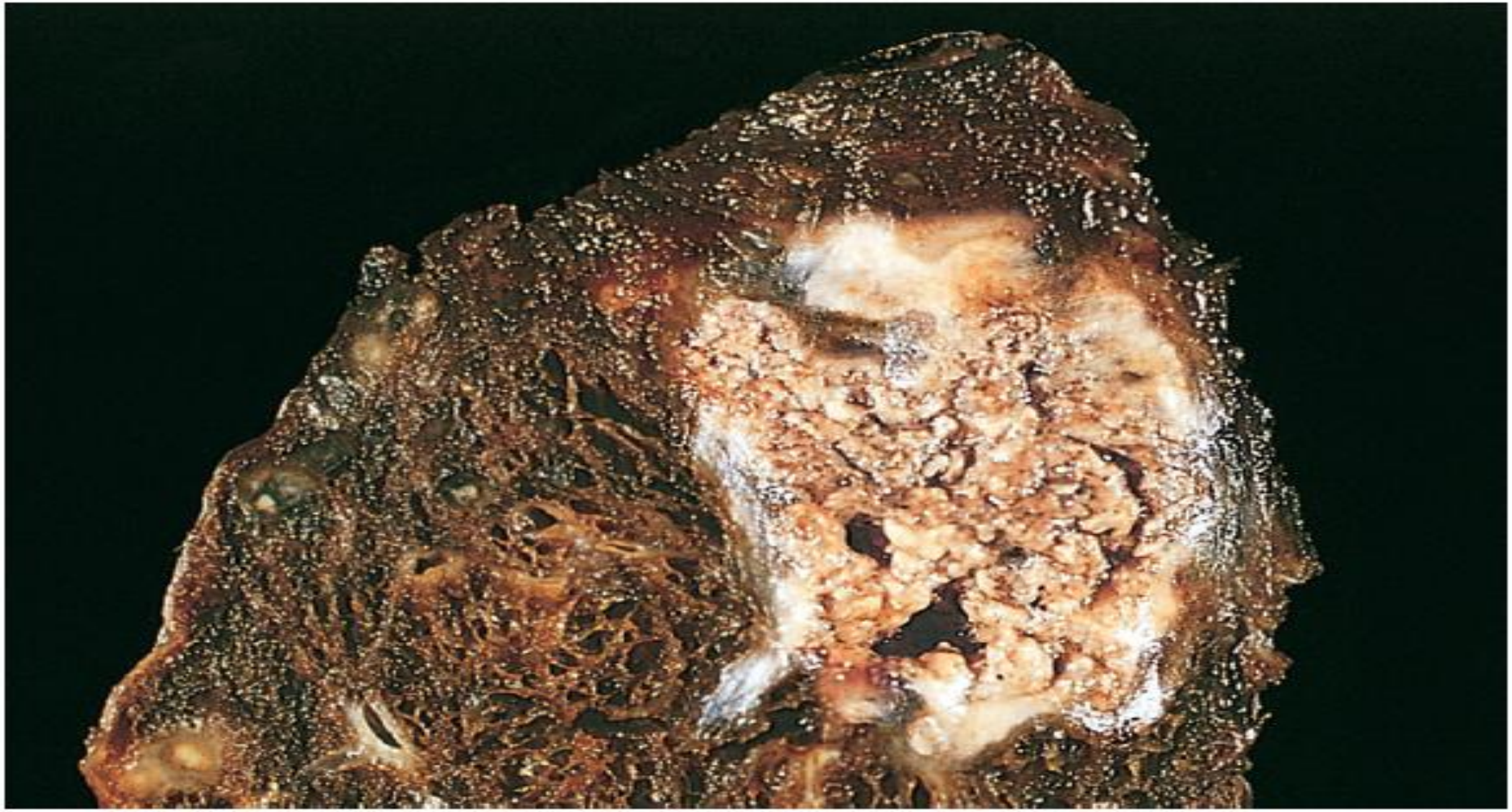
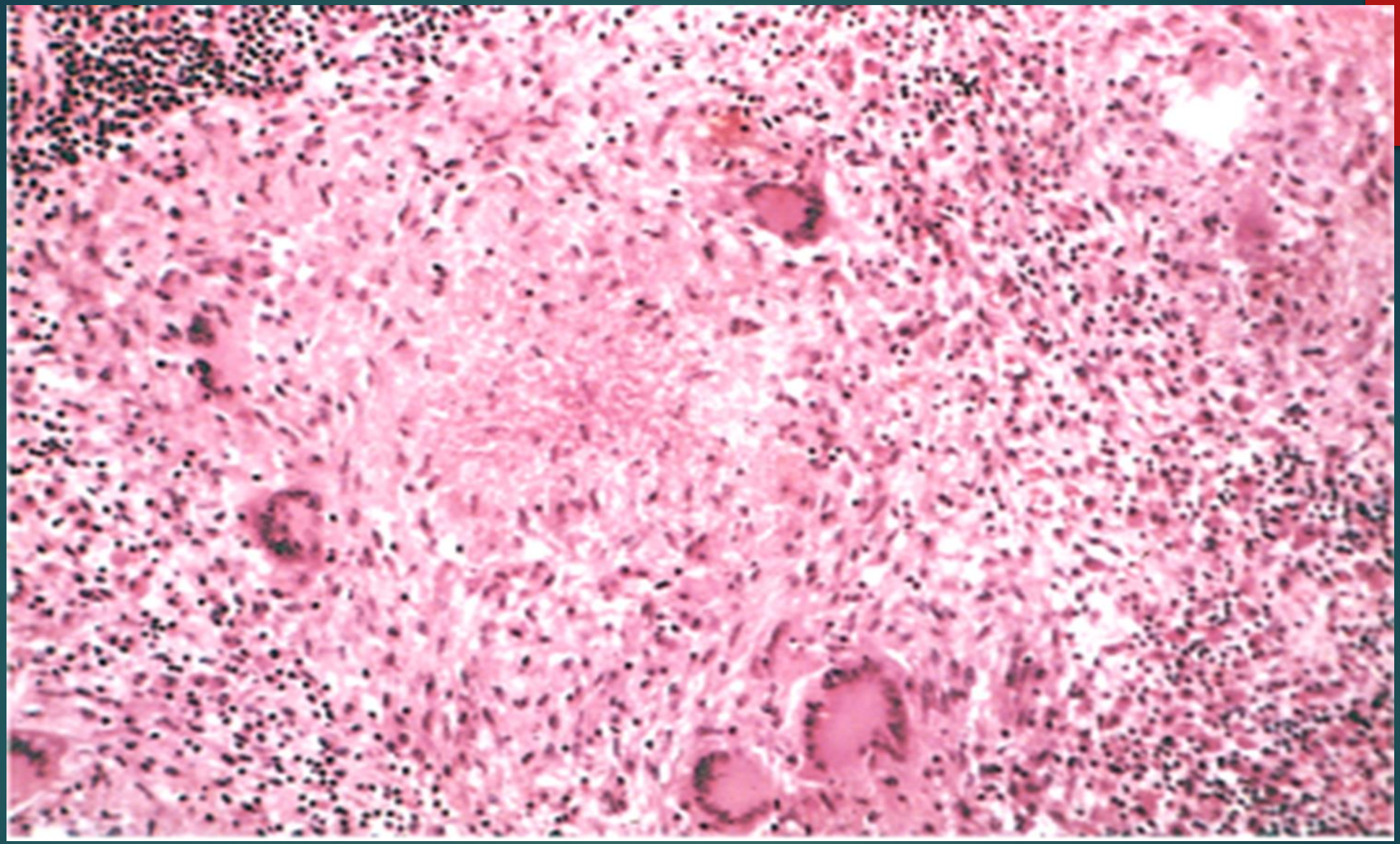


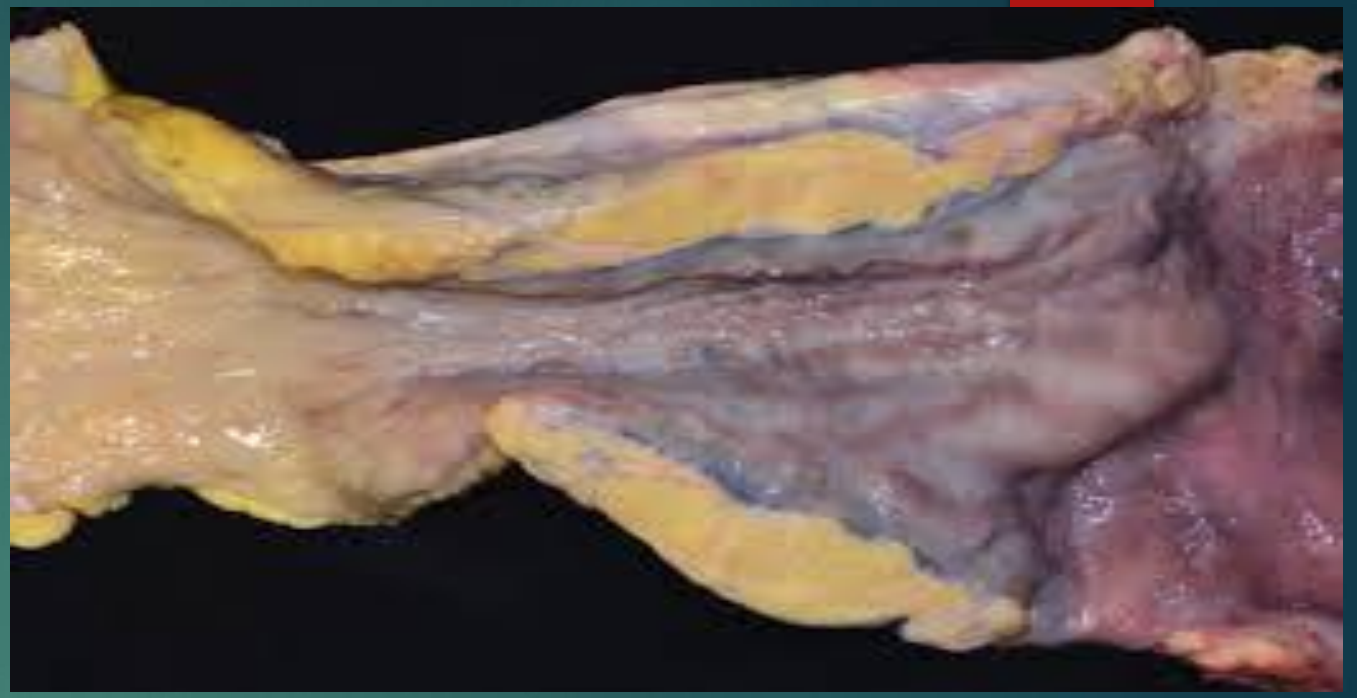
Figure 2.9 Caseous necrosis. Tuberculosis of the lung, with a large area of caseous necrosis containing yellow-white and "cheesy" appearing debris.

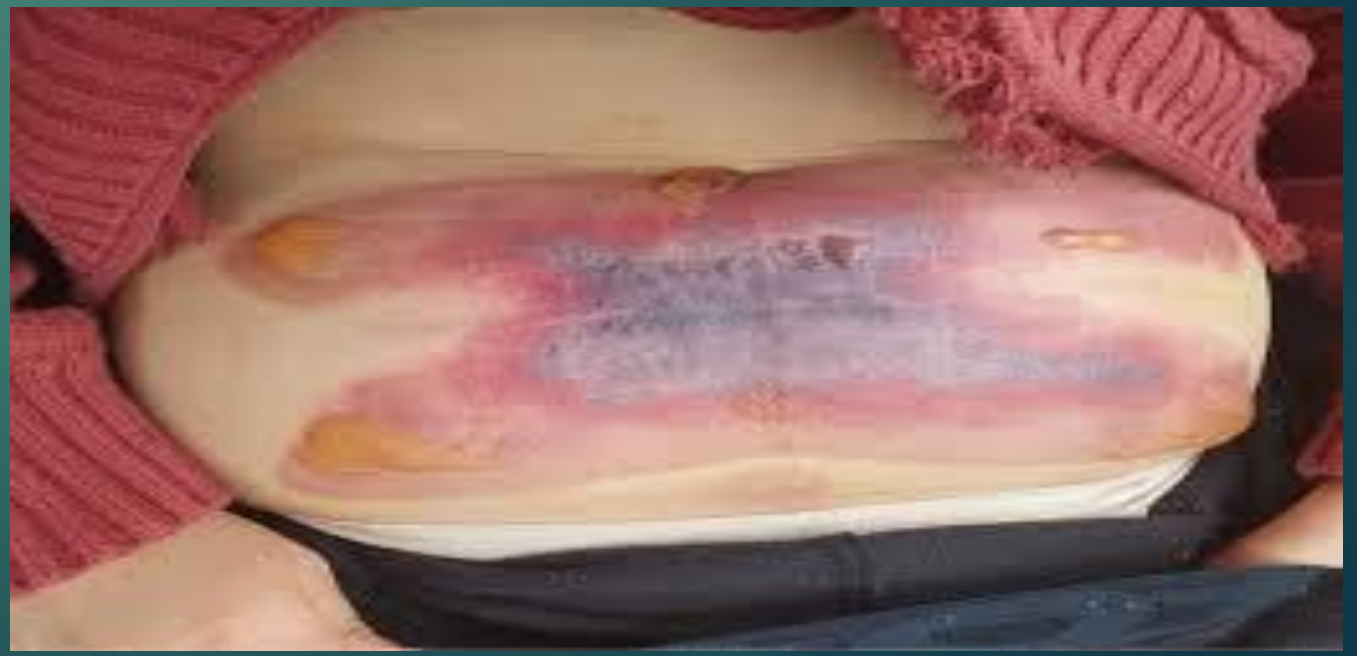


Caseous necrosis -- micro

FAT NECROSIS

- Refers to focal areas of fat destruction
  - *Acute pancreatic necrosis,*
  - *traumatic fat necrosis* commonly in breasts
- Pancreatic enzymes that have leaked out of acinar cells and ducts
  - liquefy the membranes of fat cells in the peritoneum.
  - lipases split the triglyceride esters contained within fat cells to fatty acid.
  - These combines calcium to produce grossly visible chalky white areas (fat saponification)





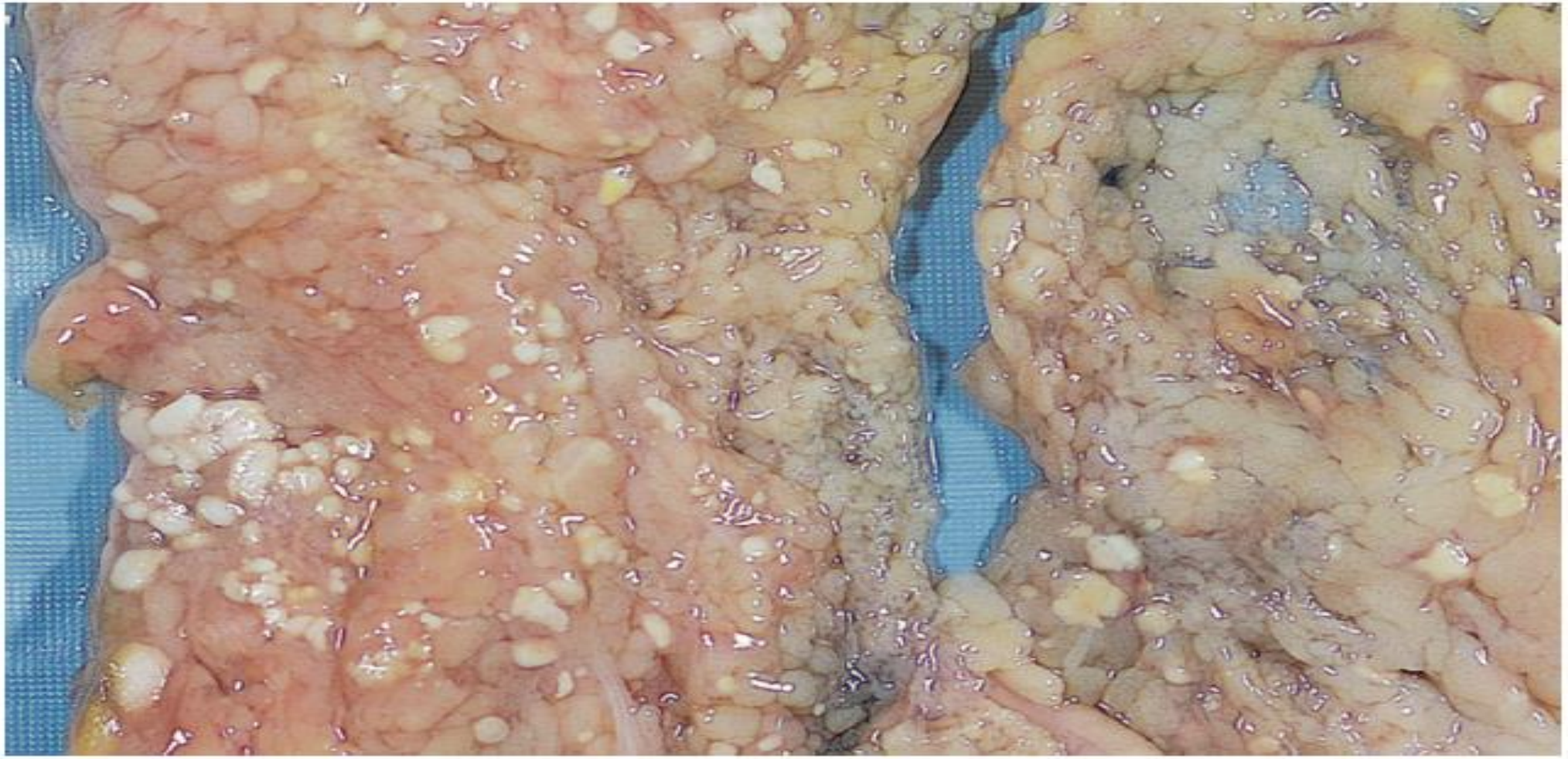


Figure 2.10 Fat necrosis. The areas of white chalky deposits represent foci of fat necrosis with calcium soap formation (saponification) at sites of lipid breakdown in the mesentery.

Fibrinoid Necrosis:-

Deposition of fibrin-like material

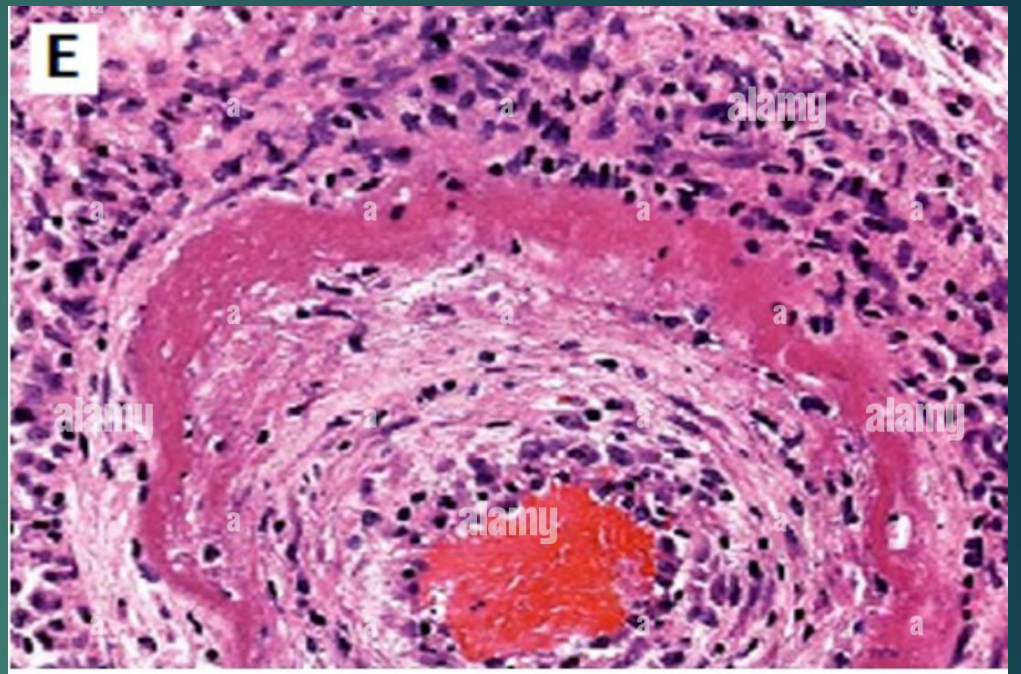
Having staining properties of fibrin ex:- PTAH Stain

(Phosphotungstic acid Haematoxylin stain)

Seen in

Immunological reactions
Hypertension (arterioles)
Peptic Ulcer Disease

Autoimmune vasculitis
Arthus Reaction



Fibrinoid necrosis in an artery. The wall of the artery is bright pink with dark neutrophils