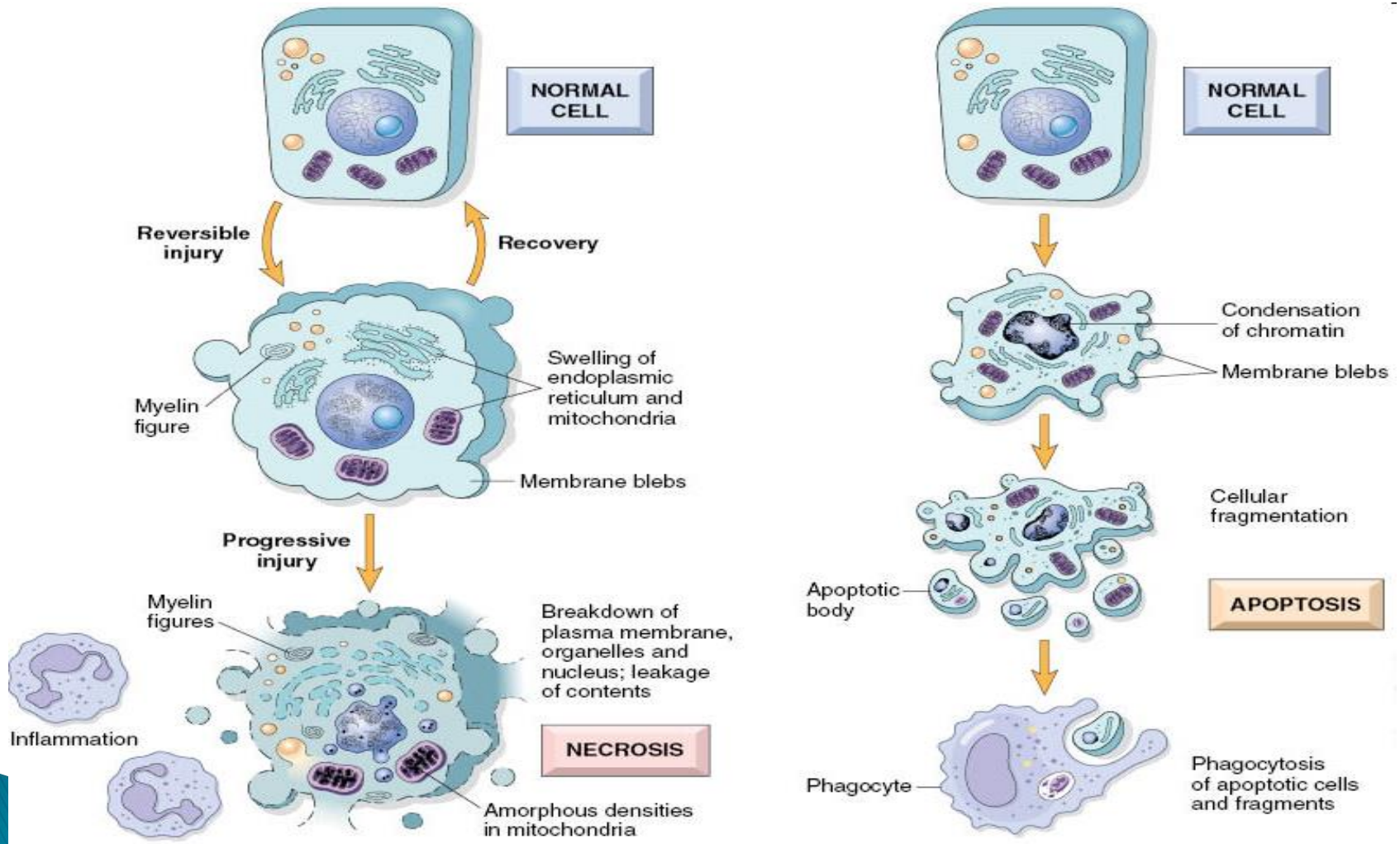
Cell injury, Cell death and Adaptations

Manar Hajeer, MD, FRCPath
University of Jordan , school of medicine

Cell injury:

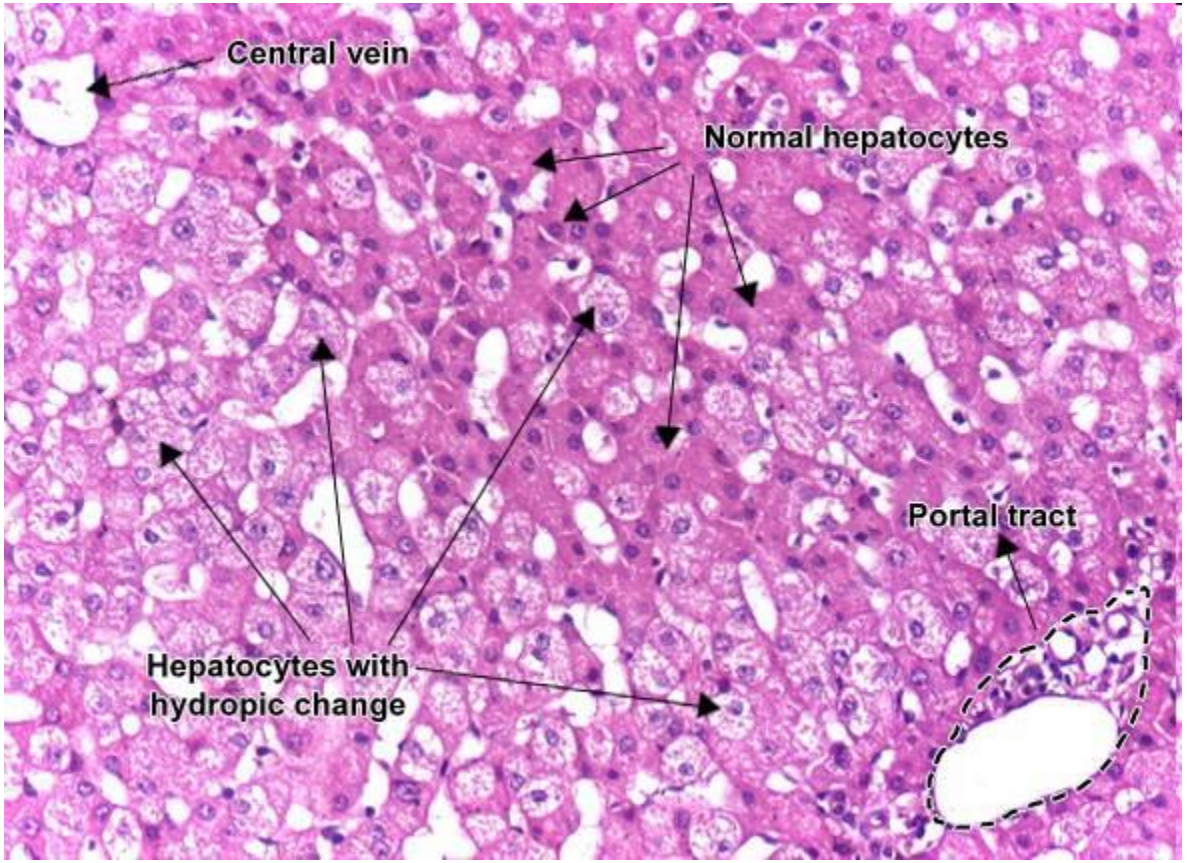


Reversible injury

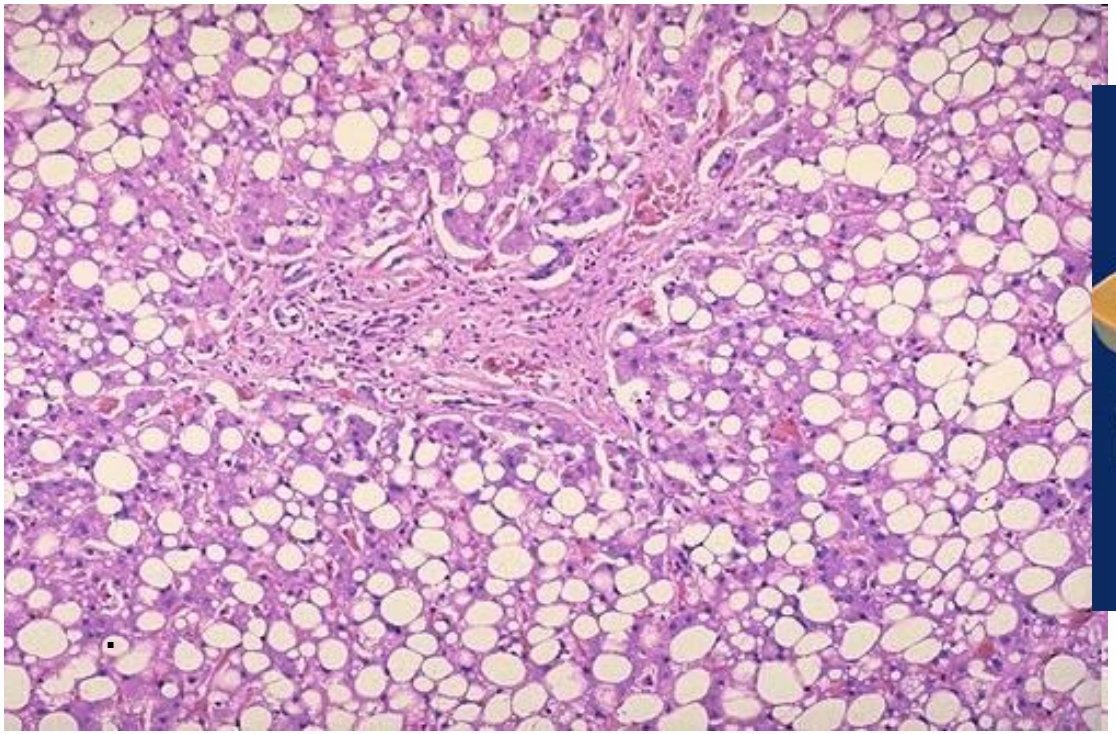
- If the damaging stimulus is removed >>>injured cells can return to normal

- **Morphology**:
- Cellular swelling
- Fatty change

Reversible damage – cellular swelling



Reversible damage – fatty change



Other changes

- (1) plasma membrane alterations (blebbing, blunting)
- (2) mitochondrial change (swelling and densities);
- (3) dilation of ER
- (4) nuclear clumping of chromatin.
- (5) Cytoplasmic myelin figures

Irreversible injury (necrosis)

1. **Irrversible Mitochondrial dysfunction**
2. Loss of **plasma membrane and intracellular membranes** >>> cellular enzymes leak out
3. Loss of **DNA and chromatin structural integrity**.

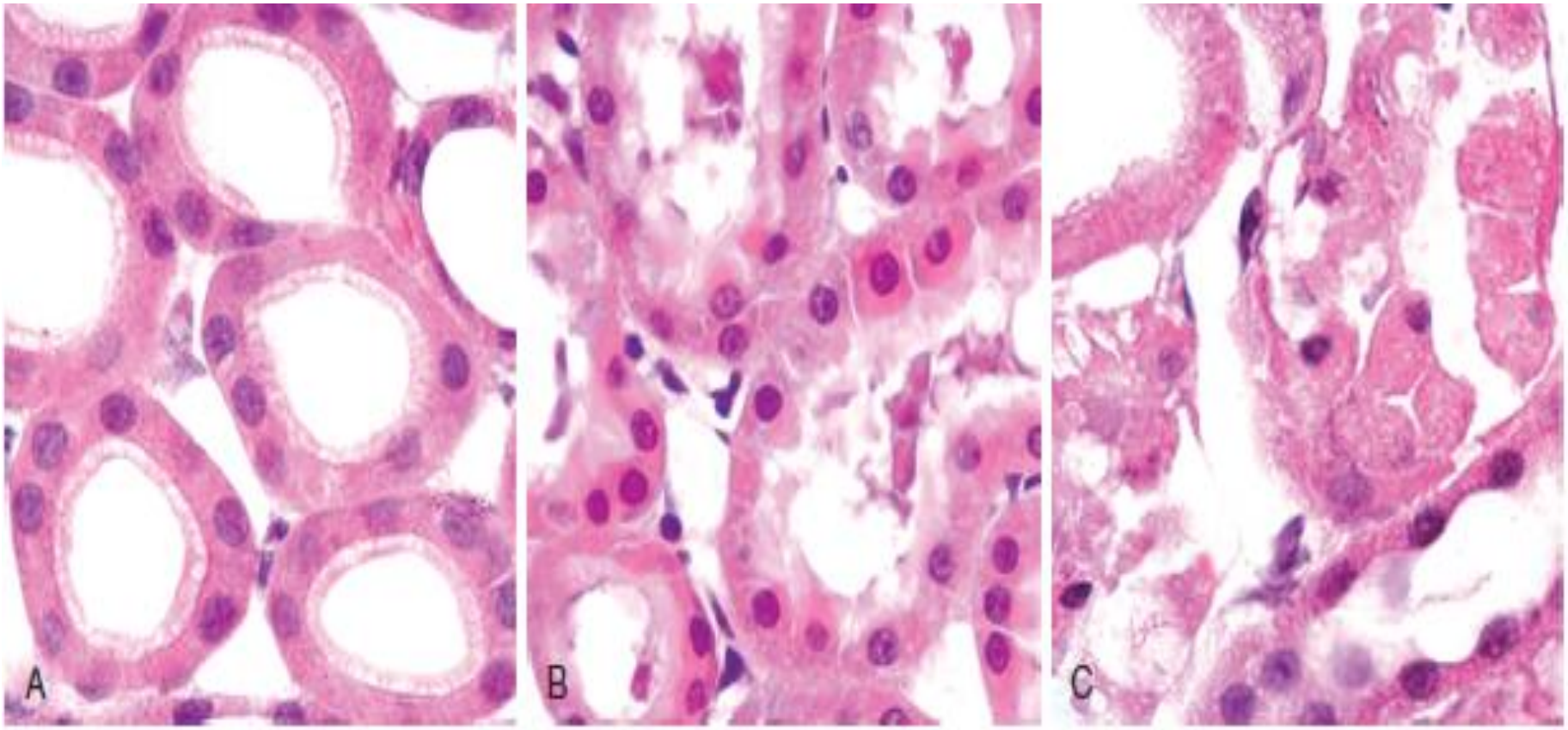
- Local inflammation.

Morphology irreversible injury (Necrosis)

- Increased cytoplasmic eosinophilia.
- Marked dilatation of ER , mitochondria.
- Mitochondrial densities.
- More myelin figures.

- **Nuclear changes:**
- **Pyknosis**: shrinkage and increased basophilia;
- **Karyorrhexis** :fragmentation;
- **Karyolysis**: basophilia fades

Normal, reversible and irreversible cell injury



Cell death

- Different mechanisms, depending on nature and severity of injury.

- **Necrosis**:
- Rapid and uncontrollable.
- Severe disturbances
- Ischemia, toxins, infections, and trauma

- **Apoptosis**:
- Less severe injury.
- Regulated by genes and signaling pathways
- Controlled.

- **Necroptosis.**

Table I-1 Features of Necrosis and Apoptosis

Feature	Necrosis	Apoptosis
Cell size	Enlarged (swelling)	Reduced (shrinkage)
Nucleus	Pyknosis → karyorrhexis → karyolysis	Fragmentation into nucleosome size fragments
Plasma membrane	Disrupted	Intact; altered structure, especially orientation of lipids
Cellular contents	Enzymatic digestion; may leak out of cell	Intact; may be released in apoptotic bodies
Adjacent inflammation	Frequent	No
Physiologic or pathologic role	Invariably pathologic (culmination of irreversible cell injury)	Often physiologic; means of eliminating unwanted cells; may be pathologic after some forms of cell injury, especially DNA and protein damage

DNA, deoxyribonucleic acid.

Clinical implications

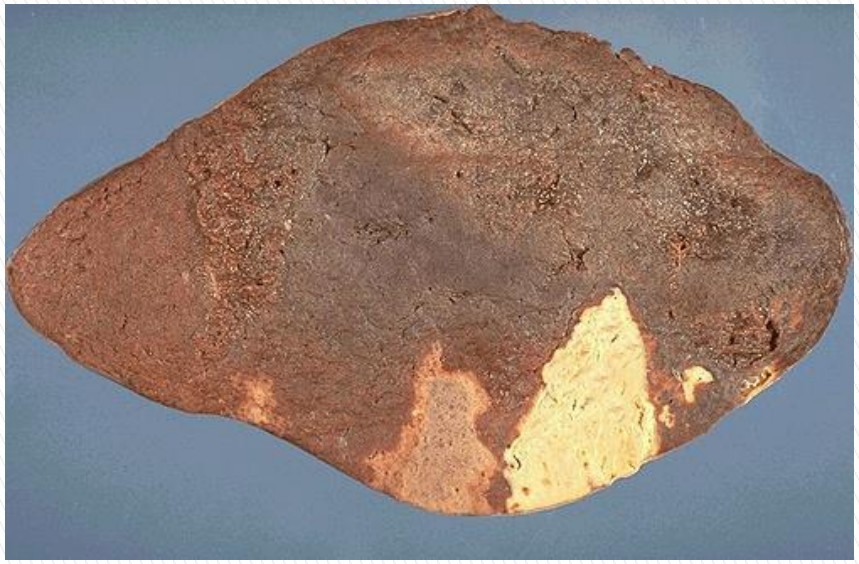
- Leakage of intracellular proteins through the damaged cell membrane and ultimately into the circulation provides a means of detecting tissue-specific necrosis using blood or serum samples.

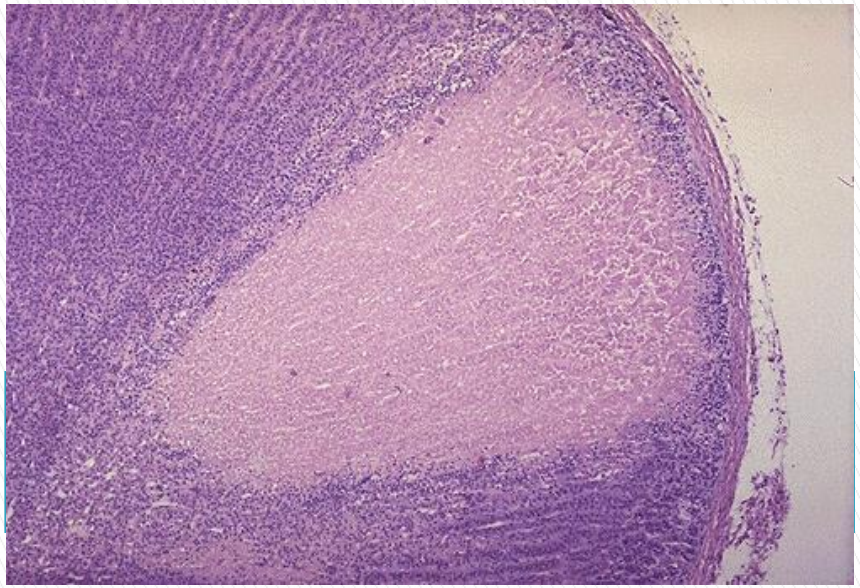
- Cardiac enzymes, liver enzymes.

Morphologic Patterns of tissue necrosis

Coagulative necrosis

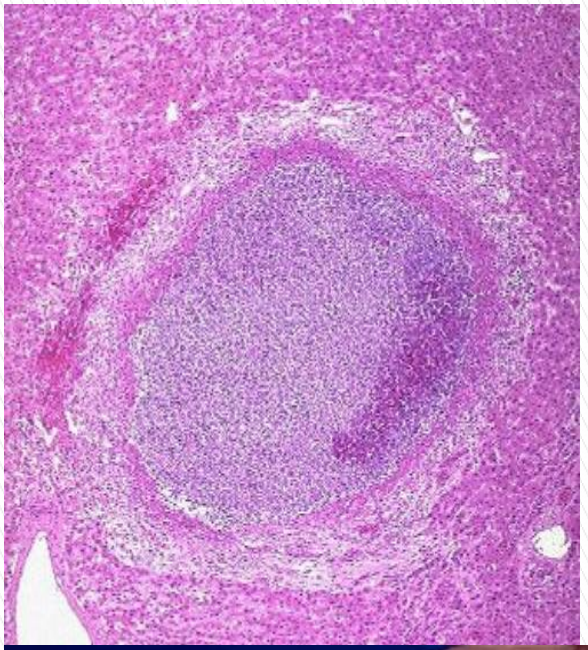
- Conserved tissue architecture initially
- Anuclear eosinophilic on LM
- Wedge shaped following blood supply usually
- Leukocyte lysosomes and phagocytosis required for clearance
- Characteristic of all solid organ infarcts except the brain





Liquefactive necrosis

- Focal infections (pus)
- CNS infarcts
- Center liquefies and digested tissue is removed by phagocytosis

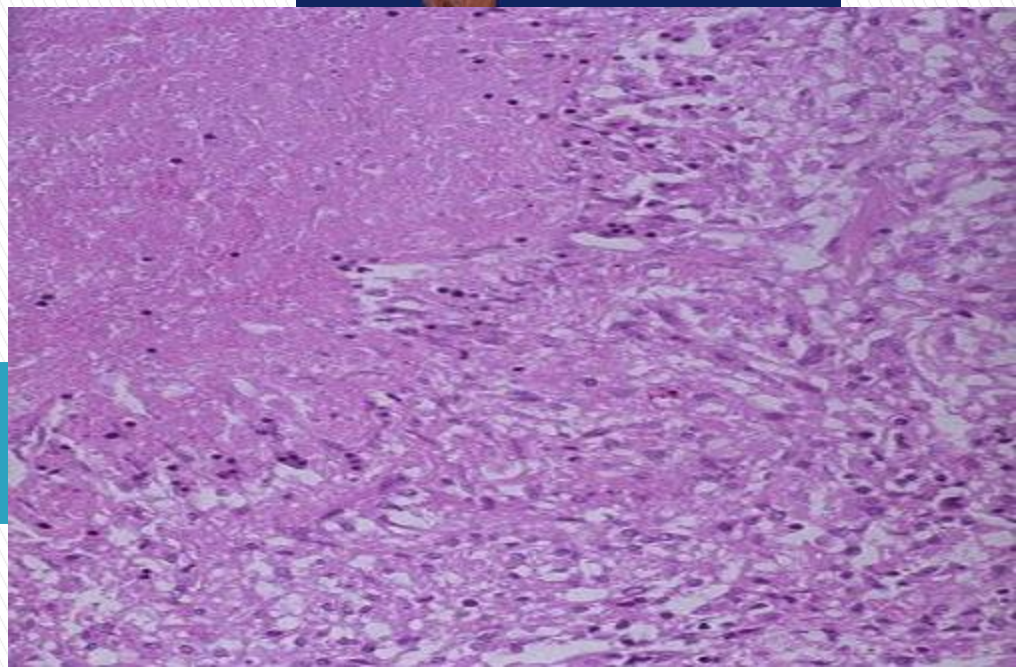


Gangrenous necrosis

- Clinical term
- It is coagulative necrosis
- Dry vs wet

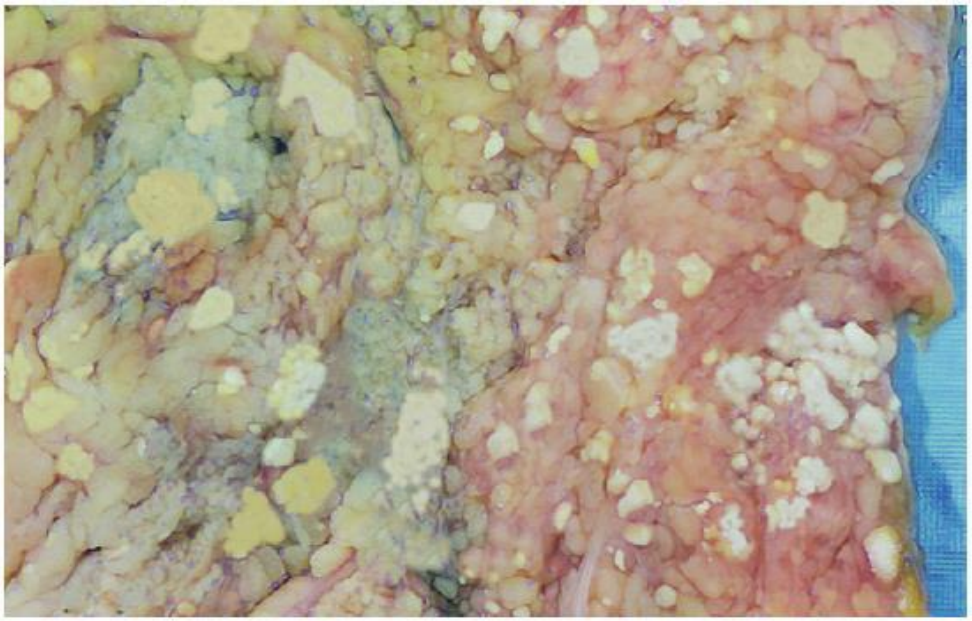
Caseous necrosis

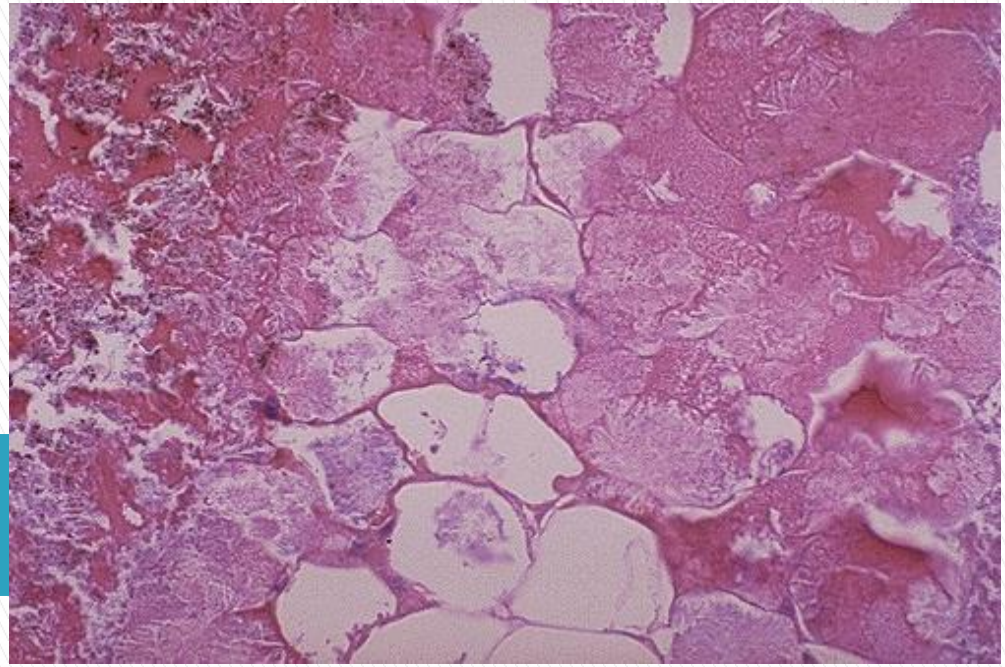
- “Cheese like”
- Combination of coagulative and liquefactive necrosis
- Tissue architecture is not preserved
- Acellular center
- Usually enclosed in an granulomatous inflammatory border
- Most often seen in TB



Fat necrosis

- Occurs in acute pancreatitis
- Due to release of pancreatic lipases
- Focal fat destruction
- Released FA's combine with Ca2+ (saponification) to produce the whitish chalky appearance





Fibrinoid necrosis

- Visible by LM
- Deposits of antigen – antibody and fibrin complexes in arterial walls
- Seen in vasculitis