AL-Mustaqbal University College

Pharmacy Department

Third stage

Practical Pathophysiology

(Cell injury & Degenerations)

Lab 2

Lecturer: M.Sc. Noor Muhsen Jawad

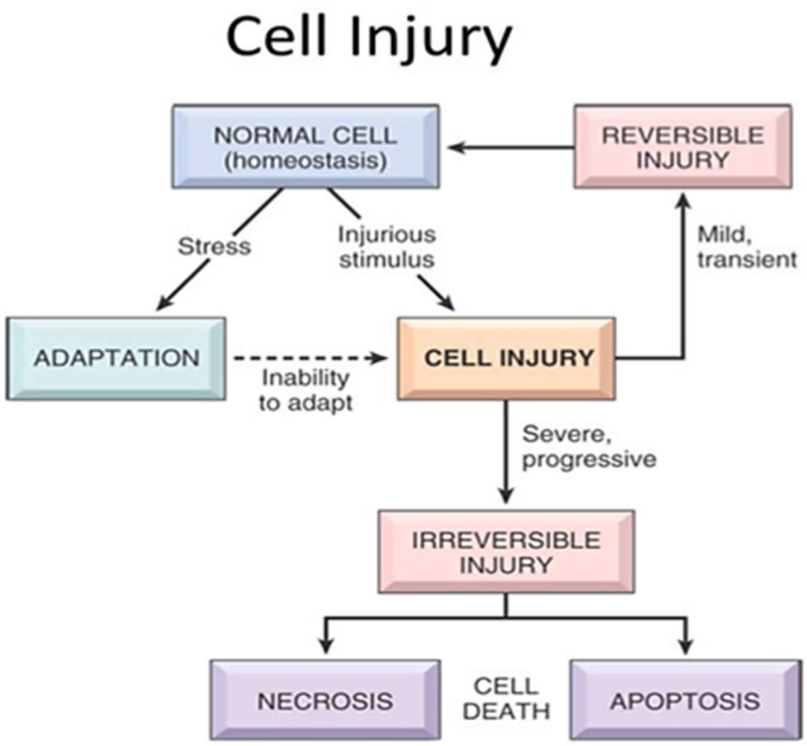
Cell injury & Degenerations

Cell injury: Is defined as a variety of stresses a cell encounters as a result of change in its internal and external environment.

Types of Cell injury:

1- Reversible cell injury (Degeneration): The morphological and structural changes are reversible, if the damaging stimulus is removed.

2- Irreversible cell injury and cell death: State in which the cell cannot recover (point of no return), and it's of two types (1- necrosis, 2- apoptosis).



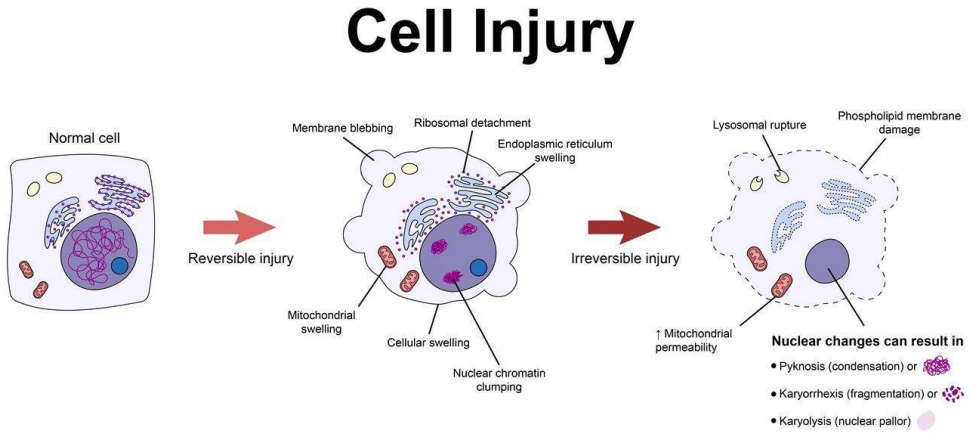
Stages of the cellular response to stress and injurious stimuli.

Normal cell $\xleftrightarrow{\text{injuries}}$ Reversible changes (Degeneration)

Normal cell $\xleftrightarrow{\text{injuries}}$ Irreversible changes (Necrosis)

The ability of the cell or organ to tolerate injury depends on:

The severity, duration, and type of insult, as well as the adaptive capacity of the tissue.



Causes of cell injury

1- Hypoxia: deficiency of oxygen, due to (cardio-respiratory failure, anemia, and carbon monoxide poisoning).

2- Ischemia: decrease blood supply to the tissue either due to arterial block or reduced venous drainage.

3- Physical agents: burn, deep cold, mechanical trauma, radiation, electric shock.

4- Chemicals and drugs: poisons like cyanide, insecticides, drugs.

5- Microbiologic Agents: bacteria, parasites, viruses, and fungi

6- Immunologic Reactions: such as anaphylaxis or immune complex damage

7- Genetic defects: Sickle cell anemia causing red blood cell injury.

8- Nutritional imbalances: protein-calorie, vitamin deficiencies, excess lipid intake.

9- Aging: injury occurs via programmed cell death or Lipofuscin pigment excess.

Reversible cell injury

It is called also **degeneration**. It is accumulation of normal substances (glycogen, water) or abnormal (Amyloid) inside the cell due to injury agent.

Classification of degeneration

1. According to the localization:

a) Parenchymatous b) Mesenchymatous c) Mixed type.

2. According to the type of metabolism disturbance:

a) Albuminous (protein) b) Fatty (adipose), (lipidoses)

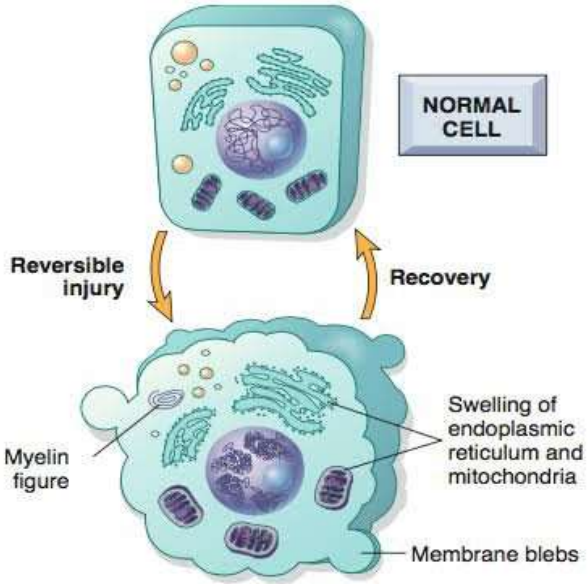
c) Carbohydrate d) Mineral.

3. According to the origin:

a) Acquired b) Inherited.

4. According to propagation:

a) General b) Local.



- If manifestations of cellular metabolism disturbance are present it is **parenchymatous degeneration**. If manifestations of the connective tissue and extracellular area are observed it is **mesenchymatous degeneration**. In mixed degeneration morphological manifestations of the disturbed metabolism are observed both in the cells and in the connective tissue (stroma), as well as in the vascular walls.

Morphological changes in reversible cell injury:

- **Grossly:** The affected organ is pale, increased turgor and increased weight.
- **Microscopically:** Ultrastructural morphological changes:

1- Plasma membrane alteration such as blebbing, distortion of micro-villi, and loosening of intracellular attachments.

2- Mitochondrial changes such as swelling and the appearance of phospholipids-rich small amorphous densities.

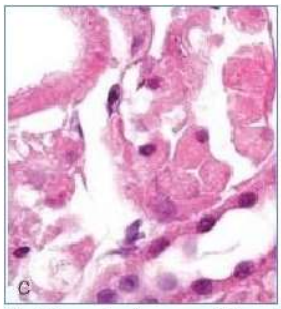
3- Dilation of **endoplasmic reticulum** with detachment of ribosomes.

4- Clumping of **nuclear chromatin**.

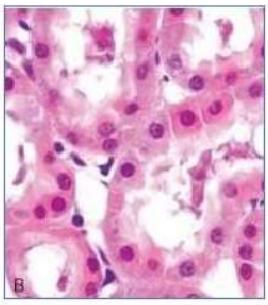
Light microscopic morphological changes:

1- Cell swelling, hydropic changes: Small, clear vacuoles seen within the cytoplasm, these represent distended and pinched-off segments of endoplasmic reticulum.

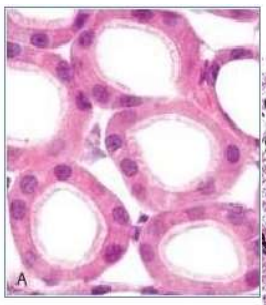
2- Fatty changes: Manifested by the appearance of lipid vacuoles within the cytoplasm.



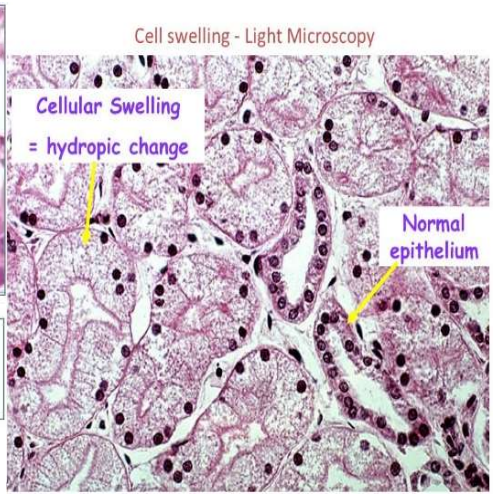
C- Necrosis (irreversible injury) of epithelial cells, with loss of nuclei, fragmentation of cells, and leakage of contents.



B- Early (reversible) ischemic injury showing surface blebs, increased eosinophilia of cytoplasm, and swelling of occasional cells.



A- Normal kidney tubules with viable epithelial cells.



Irreversible cell injury (Necrosis)

Necrosis: refers to a sequence of morphological changes that follow cell death in living tissue (not fixed specimens).

Morphological changes in Irreversible cell injury (Necrosis):

The morphological appearance of necrosis is due to two processes:

1- Enzymatic digestion of the cell.

2- Denaturation of the proteins.

The hydrolytic enzymes may be derived either from the dead cells themselves, in which case the digestion is referred as autolysis, or from the lysosomes of invading inflammatory cells termed heterolysis.

Cytoplasmic changes

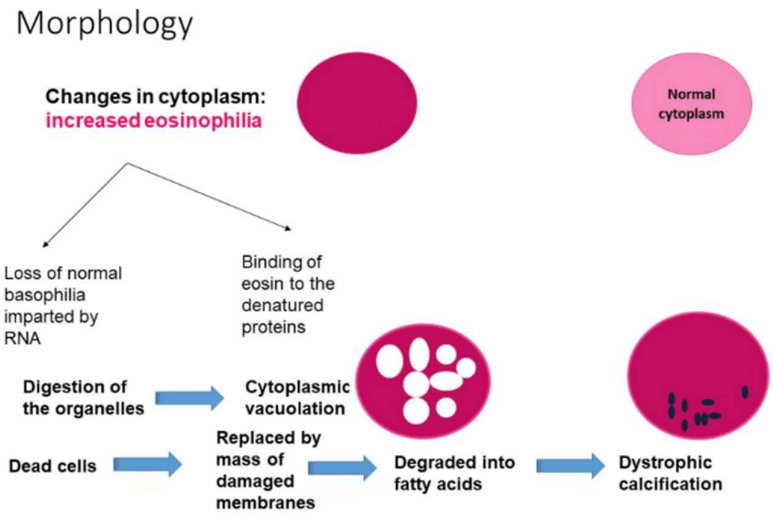
1-Appears homogenous

2-Intensely eosinophilic because:

A- loss of basophilic effect of RNA.

B- binding of eosin to denatured proteins

3-Sometimes vacuolation or calcification



Nuclear changes:

1-Pyknosis (condensation of nuclear chromatin)

2-Karyolysis (dissolution of nuclear chromatin)

3-Karyorrhexis (fragmentation)