

SNS COLLEGE OF ALLIED HEALTH SCIENCE
Affiliated to The Tamil Nadu Dr MGR Medical University, Chennai



DEPARTMENT OF CARDIAC TECHNOLOGY

**COURSE NAME: PATHOLOGY RELATED TO CARDIAC
TECHNOLOGY**

UNIT : 1

TOPIC : CELL INJURY - REVERSIBLE

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Cellular Injury

Contents

- Definition
- Causes of Cell Injury
- Pathogenesis and Morphology of Cell Injury
- Types of Cell Injury

Reversible - Cell Swelling & Fatty Change

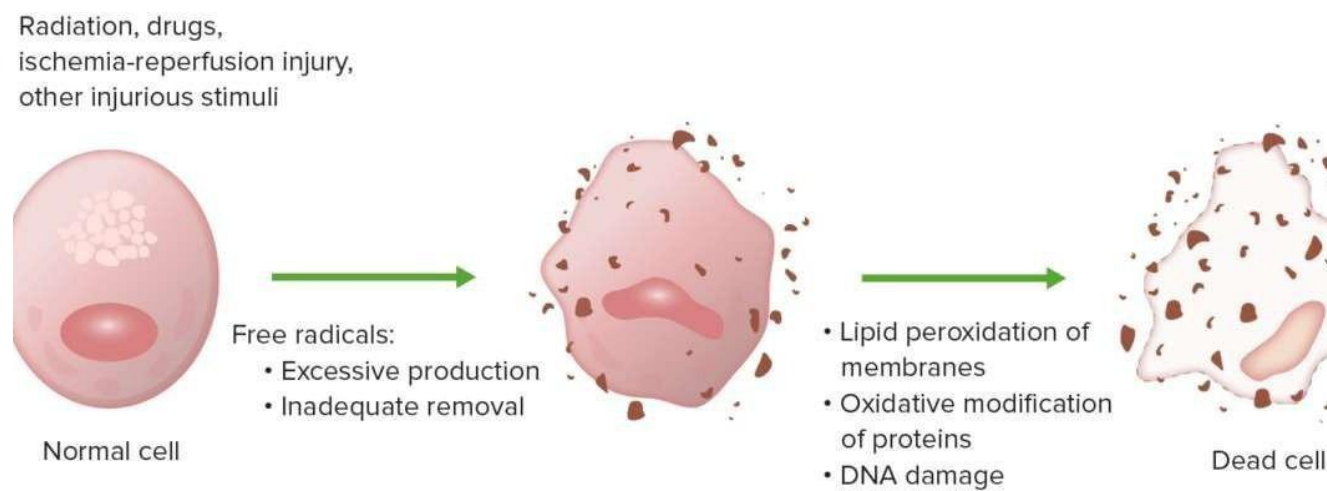
Irreversible - Apoptosis and Necrosis

Definition

Cell injury occurs when cells are exposed to stress or harmful stimuli that exceed their ability to adapt. It can be:

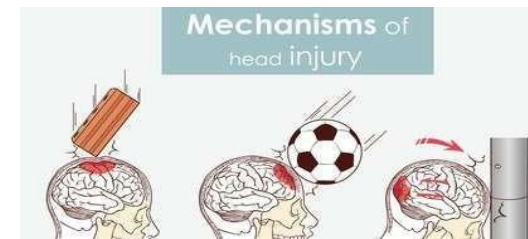
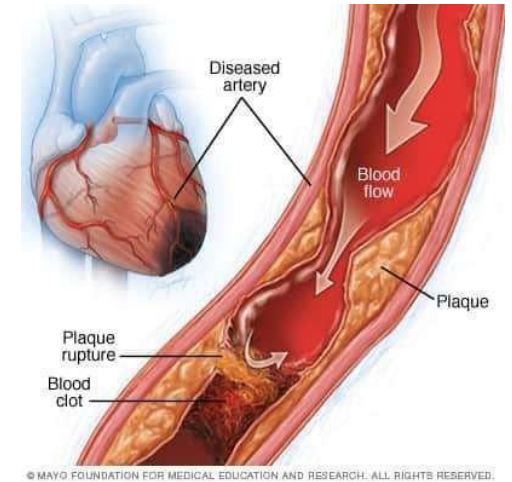
Reversible: Cell recovers once the stimulus is removed.

Irreversible: Cell undergoes death—either by **necrosis** or **apoptosis**.



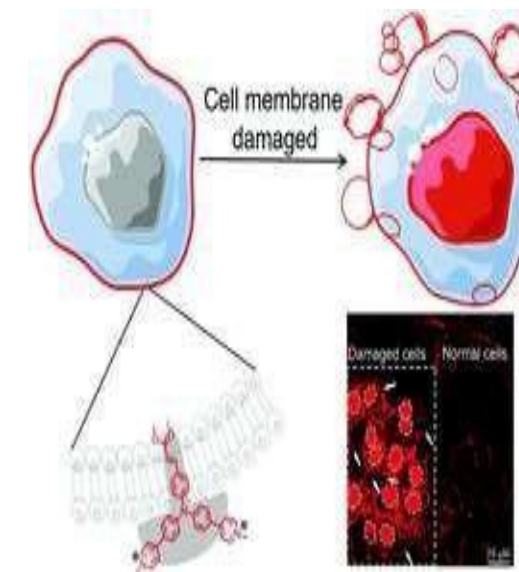
Causes of Cell Injury

- **Hypoxia/Ischemia:** Most common cause—lack of oxygen due to decreased blood flow.
- **Physical Agents:** Trauma, temperature extremes, radiation, electric shock.
- **Chemical Agents and Drugs:** Toxins, alcohol, pollutants, chemotherapy drugs.
- **Infectious Agents:** Bacteria, viruses, fungi, parasites.
- **Immunologic Reactions:** Autoimmune diseases, allergic reactions.
- **Genetic Defects:** Congenital disorders, enzyme deficiencies.
- **Nutritional Imbalances:** Deficiencies (e.g., vitamins), excess (e.g., obesity).
- **Aging:** Gradual decline in cellular function over time.



Pathogenesis of Cell Injury

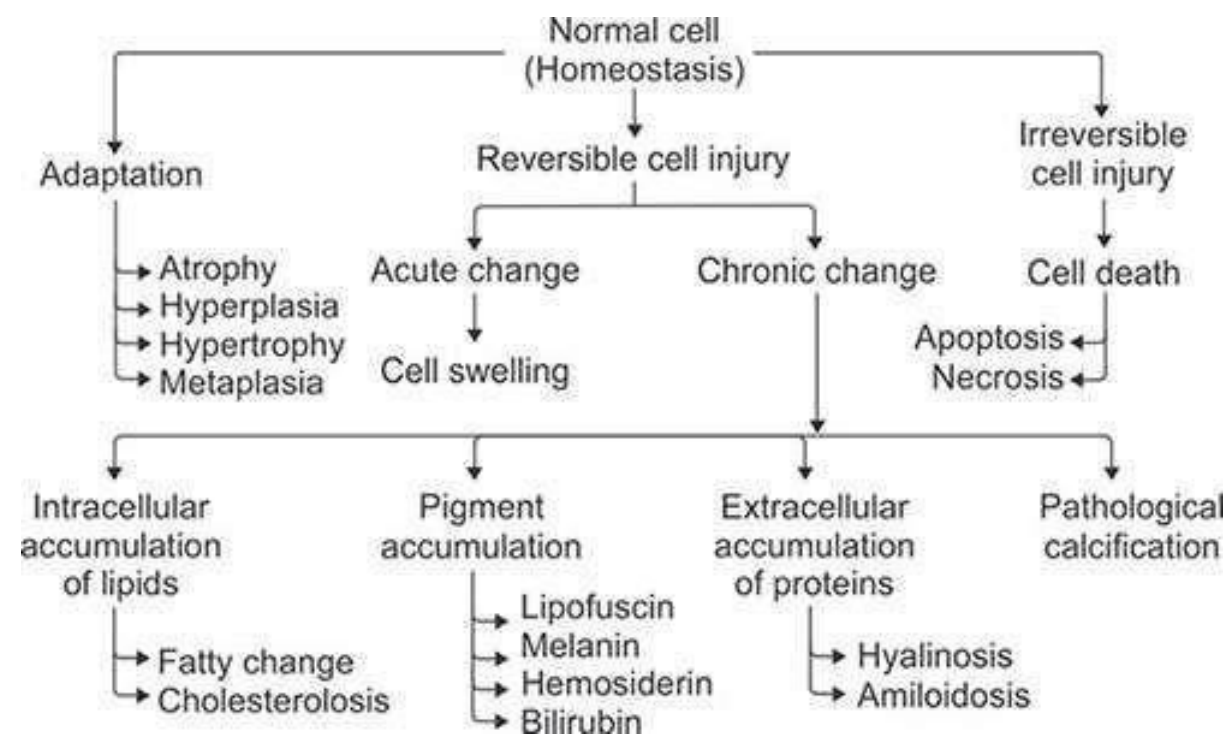
- **Pathogenesis of Cell Injury**
- The key cellular targets and mechanisms:
- **ATP Depletion:** Mitochondrial dysfunction → failure of Na⁺/K⁺ pump → swelling.
- **Mitochondrial Damage:** Loss of membrane potential → apoptosis.
- **Increased Intracellular Ca²⁺:** Activates destructive enzymes.
- **Oxidative Stress:** Free radicals damage DNA, lipids, proteins.
- **Membrane Damage:** Loss of cellular and organelle integrity.
- **Protein/DNA Damage:** Triggers cell death (esp. apoptosis).



Types of Cell Injury

Injury at one point induces a cascade of effects:

- Cellular Adaptation
- Reversible Cell Injury
- Irreversible Cell Injury
- Subcellular changes and Intracellular Changes



MORPHOLOGY

1. Reversible Injury:

Cell swelling (hydropic change)

Plasma membrane blebbing

Fatty change (especially in liver, heart)

2. Irreversible Injury:

Membrane rupture

Nuclear changes (pyknosis, karyorrhexis, karyolysis)

Mitochondrial swelling with amorphous densities

Reversible Cell Injury

- Reversible cell injury refers to **early-stage damage** to cells that can be **reversed** if the harmful stimulus is removed. It does **not** result in cell death and retains the cell's functional integrity
- **1. Cell Swelling (Hydropic Change)**
- **Definition:**
- Hydropic change is a form of reversible cell injury marked by **accumulation of water inside the cell**, causing it to swell.
- **Mechanism (Pathogenesis):**
 - Injury to the cell (e.g., hypoxia, toxins) → ↓ ATP production
 - ATP depletion impairs the **Na⁺/K⁺ ATPase pump** in the plasma membrane
 - **Na⁺ accumulates inside** the cell, and **water follows osmotically**
 - Leads to **intracellular edema** and organelle swelling

- **Morphological Features:**
 - Cell becomes enlarged and pale
 - **Vacuolated cytoplasm** due to distended endoplasmic reticulum and mitochondria
 - May show blebbing of plasma membrane
 - Nucleus remains intact (no karyolysis)
- **Organs Commonly Affected:**
 - Liver
 - Kidney
 - Myocardium (heart muscle)
- **Reversibility:**
 - If the stimulus is removed early, the **cell returns to normal structure and function.**

Steatosis (Fatty Change)

- **Definition:**
- Fatty change refers to the **abnormal accumulation of triglycerides** within **parenchymal cells**, especially in organs involved in fat metabolism.
- **Mechanism (Pathogenesis):**
 - Excess delivery or impaired metabolism/export of lipids within cells
 - Lipid droplets accumulate in the cytoplasm
 - Associated with **hypoxia, alcohol, toxins, malnutrition, and metabolic disorders**
- **Morphological Features:**
 - Presence of **clear lipid vacuoles** in the cytoplasm (seen under light microscope)
 - Nucleus may be pushed to the cell periphery in severe cases
 - Affected cells appear enlarged and pale (greasy appearance in gross pathology)