



# NOVA

Charting New Horizons in Education

Introduction to pathology & cellular injury I

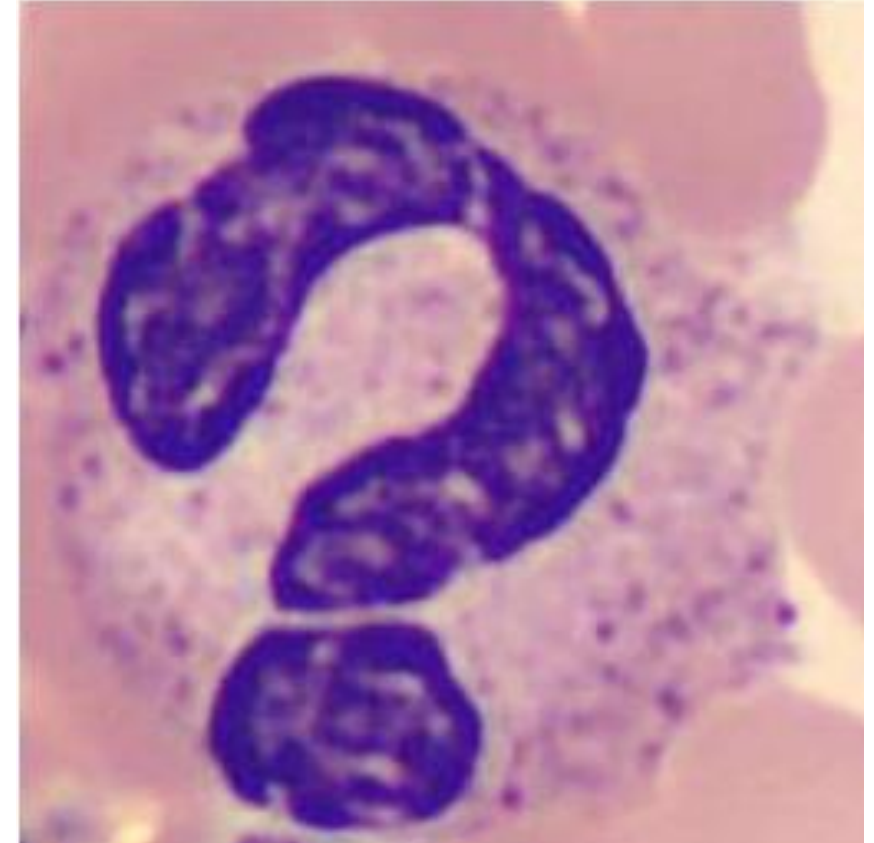
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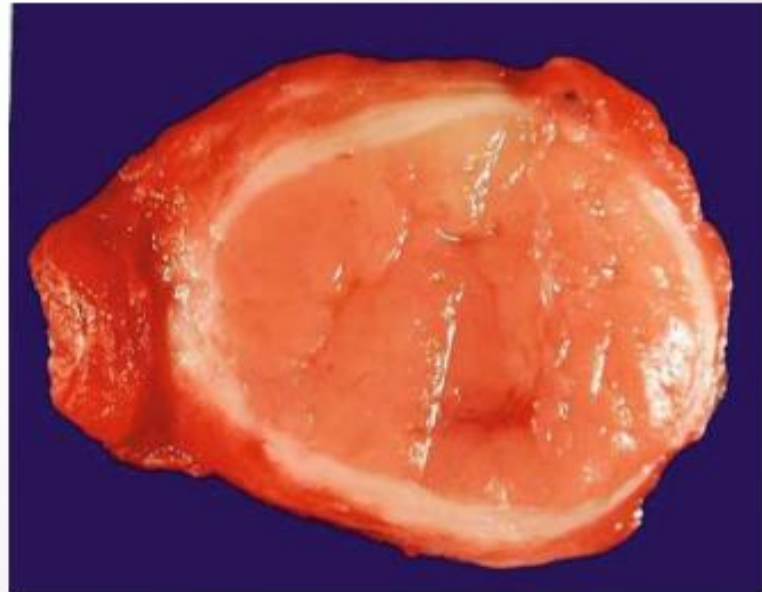
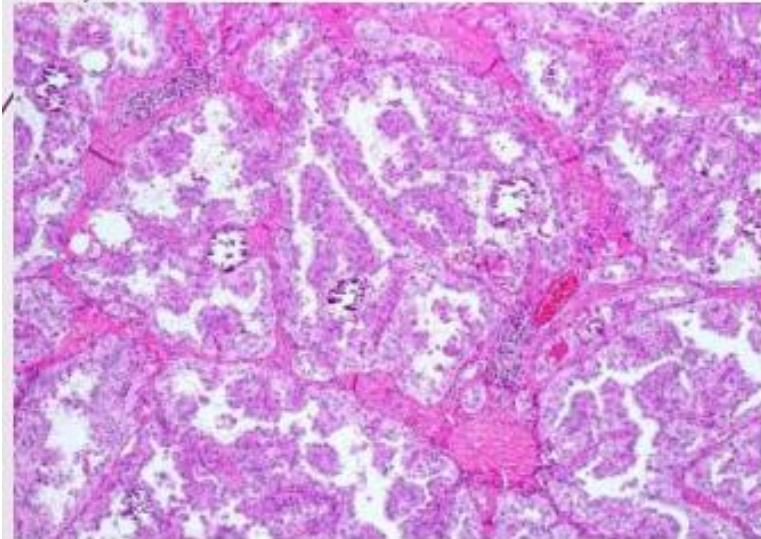
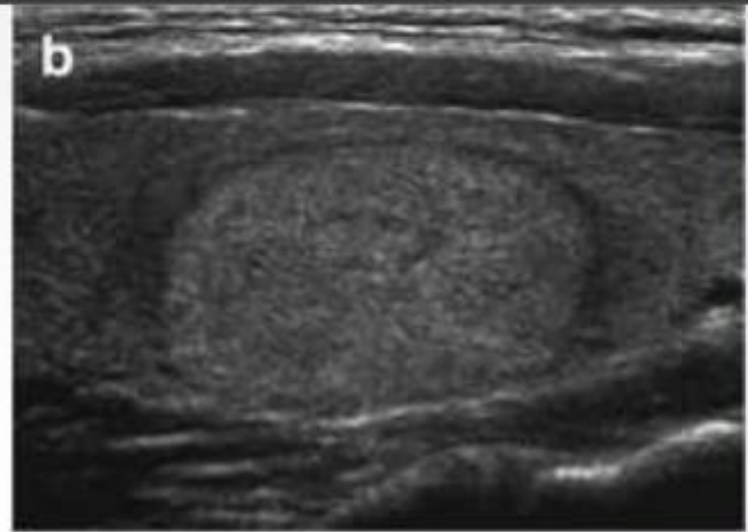
Pathology

# Pathology



- Pathology word derived from the Ancient Greek words
- Pathology → Pathos (Suffering) + Logos (study of)...
- Definition: Pathology is the study of the structural , biochemical functional changes in cells, tissues and organs that underlies the disease.  
So it is The scientific study of disease!
- It involves the examination of surgically removed organs, tissues (biopsy samples), bodily fluids, and, in some cases, the whole body (autopsy).

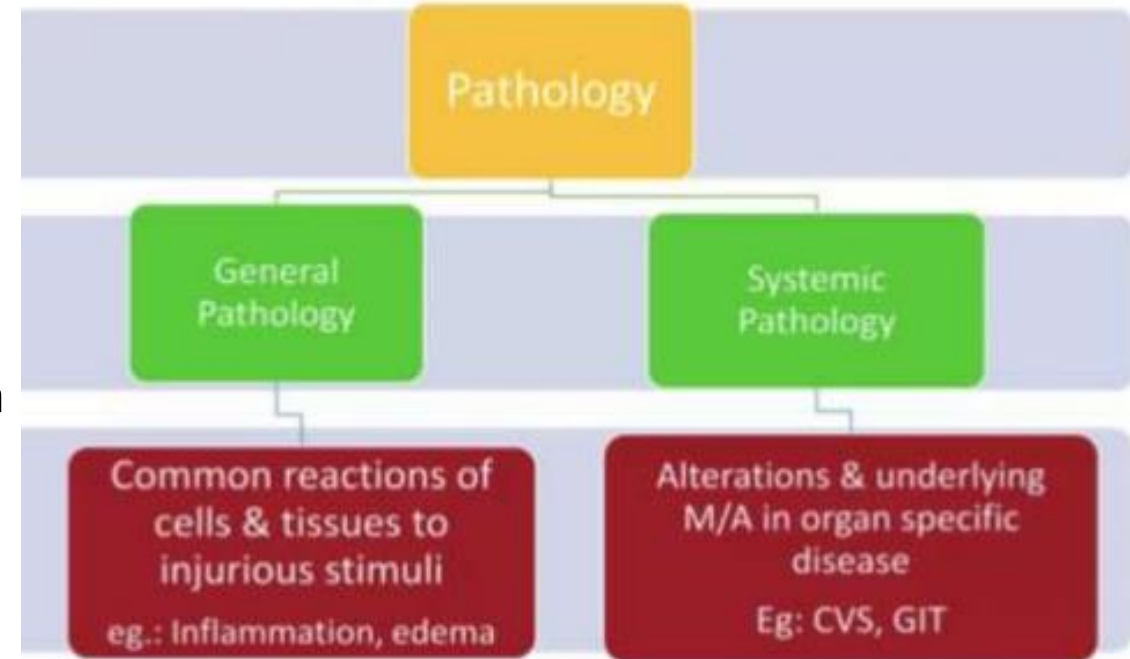




# ~ Divisions of Pathology:



- Pathology is fundamentally divided into two main branches:
1. **General Pathology:** basic concepts that are shared among various disease in multiple organs/systems (Ex: Inflammation, cell injury and neoplasia)
  2. **Systematic Pathology:** discuss pathology of diseases of a specific organs/systems



# ~ Branches of Pathology:



- **Anatomical Pathology**
  - ✓ Cytopathology
  - ✓ Dermatopathology
  - ✓ Forensic pathology
  - ✓ Histopathology
  - ✓ Neuropathology
  - ✓ Pulmonary pathology
  - ✓ Renal pathology
  - ✓ Surgical pathology
- **Clinical Pathology**
  - ✓ Hematopathology
  - ✓ Immunopathology
  - ✓ Radiation pathology
- **Molecular Pathology**

# ⚡ Disease

- What is disease?
- Disease may be defined as: an abnormal alteration of structure or function in any part of the body.





# Core Aspects of Disease Process:

## A. Causation (Etiology) “Why?”:

- The initiating cause of a disease, categorized into:
  1. Genetic Factors: Inherited mutations and disease-associated gene variants.
  2. Environmental Factors: Infectious agents, nutritional deficiencies, chemical exposures, and physical factors.
- Most common diseases (e.g., atherosclerosis, cancer) are multifactorial, involving both genetic susceptibility and environmental influences.

# ~ Core Aspects of Disease Process:



## B. Pathogenesis:

- The “HOW”, mechanisms of development and progression of disease, the cellular and molecular changes that give rise to the specific functional and structural abnormalities that characterize the disease.
- Etiology and pathogenesis of disease are essential for understanding disease, also is the basis for developing rational treatments and effective preventive measures.
- Thus, pathology provides the scientific foundation for the practice of medicine.



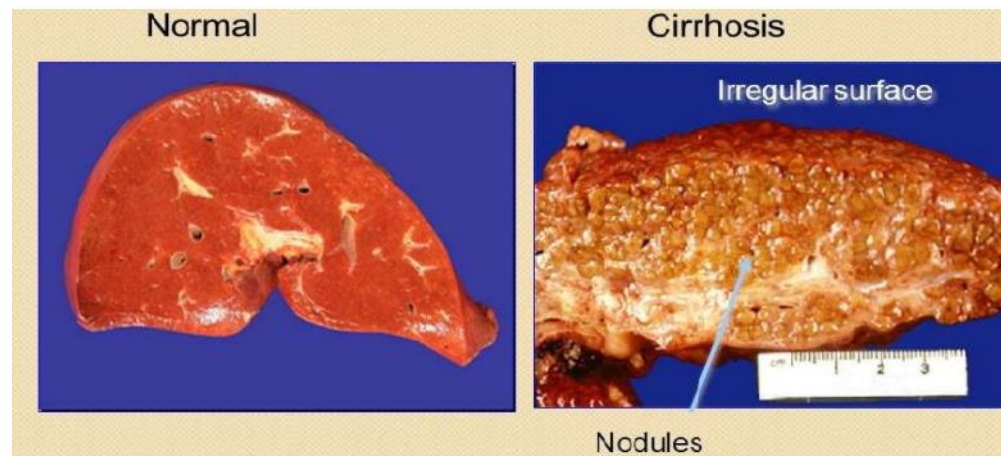


# Core Aspects of Disease Process:

## C. Morphology:

- Is structural alteration of cell and tissue as a result of the pathogenesis:
- ✓ Gross: naked eye
- ✓ Microscopic
- *Pathologists also use a variety of molecular, and other techniques to define the biochemical, structural, and functional changes that occur in cells, tissues, and organs in response to injury.*
- *Diagnostic pathology relies on morphology, supplemented by protein expression and genetic analysis. In neoplasms (tumors), similar morphologies can arise from different genetic abnormalities, impacting prognosis and therapy responses.*

## Morphology, Gross (Naked eye)



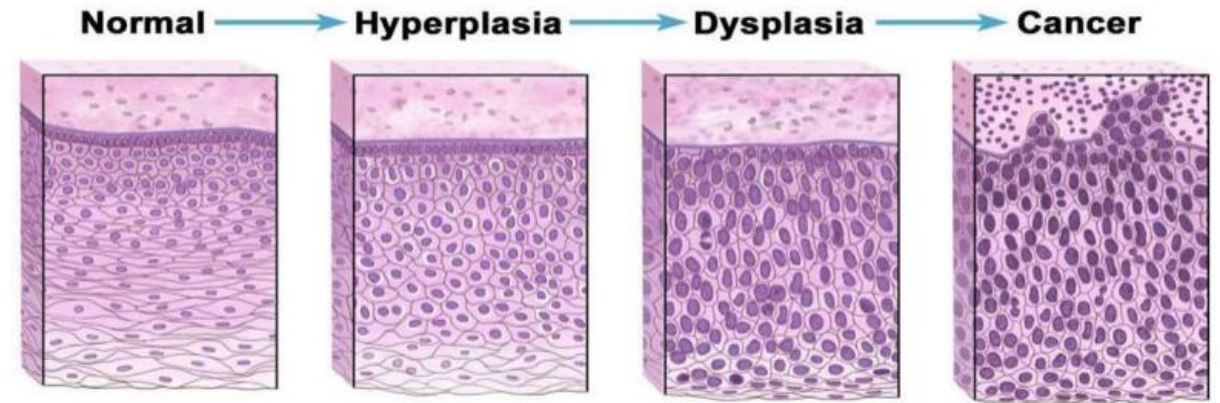


# Core Aspects of Disease Process:

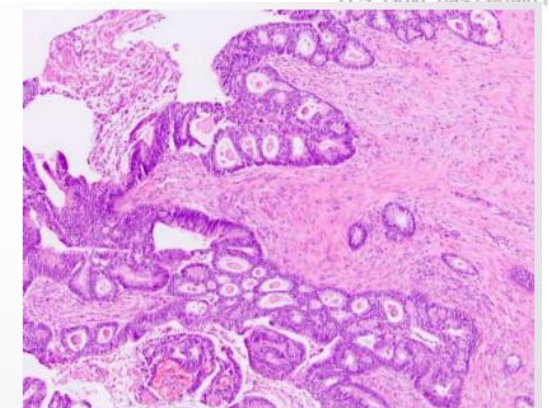
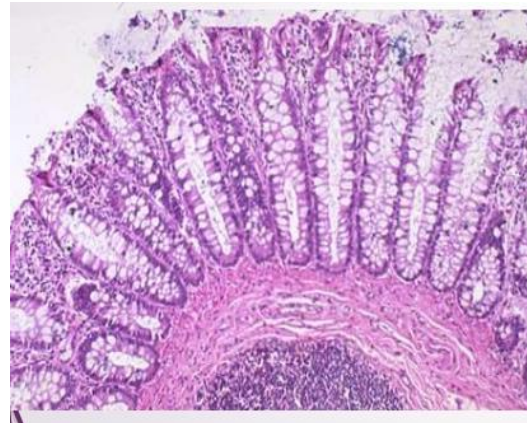
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## Morphology, microscopic



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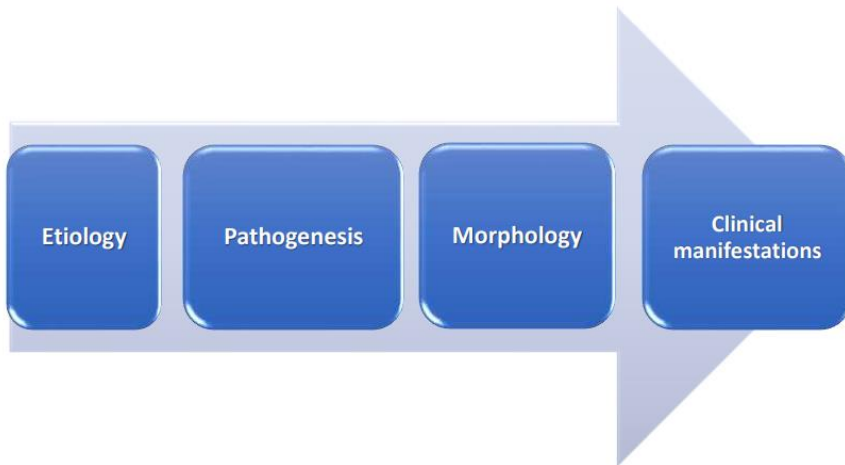




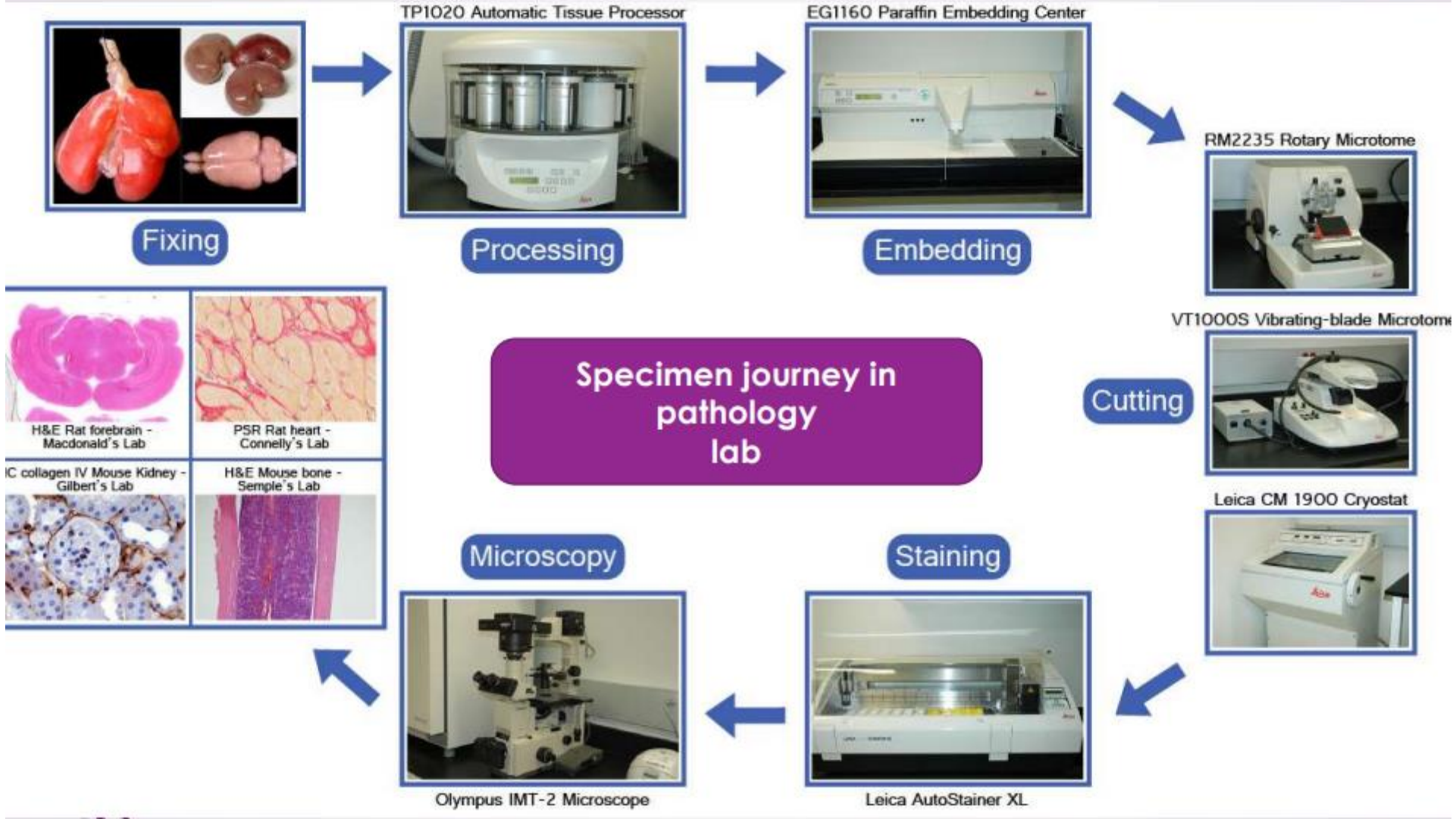
# Core Aspects of Disease Process:

## D. Clinical Manifestations:

- The consequences of changes
- Functional abnormalities resulting from genetic, biochemical, and structural changes lead to symptoms and signs of disease.









# NOVA

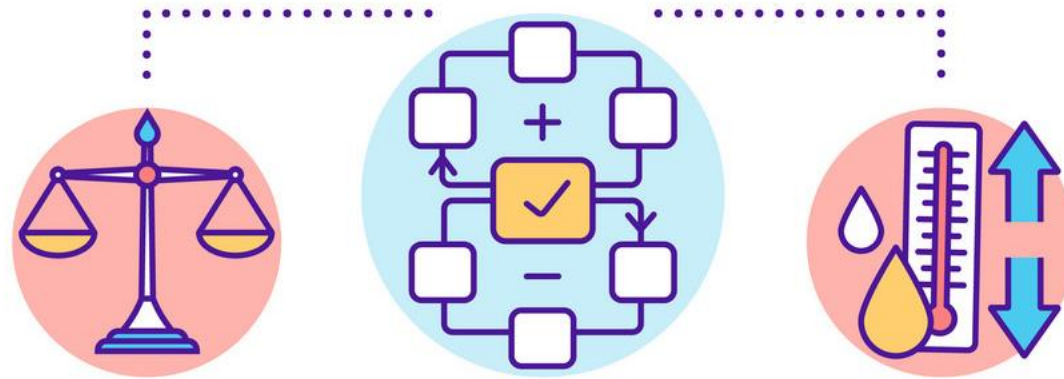
Charting New Horizons in Education

Cell injury I

# 📶 Homeostasis

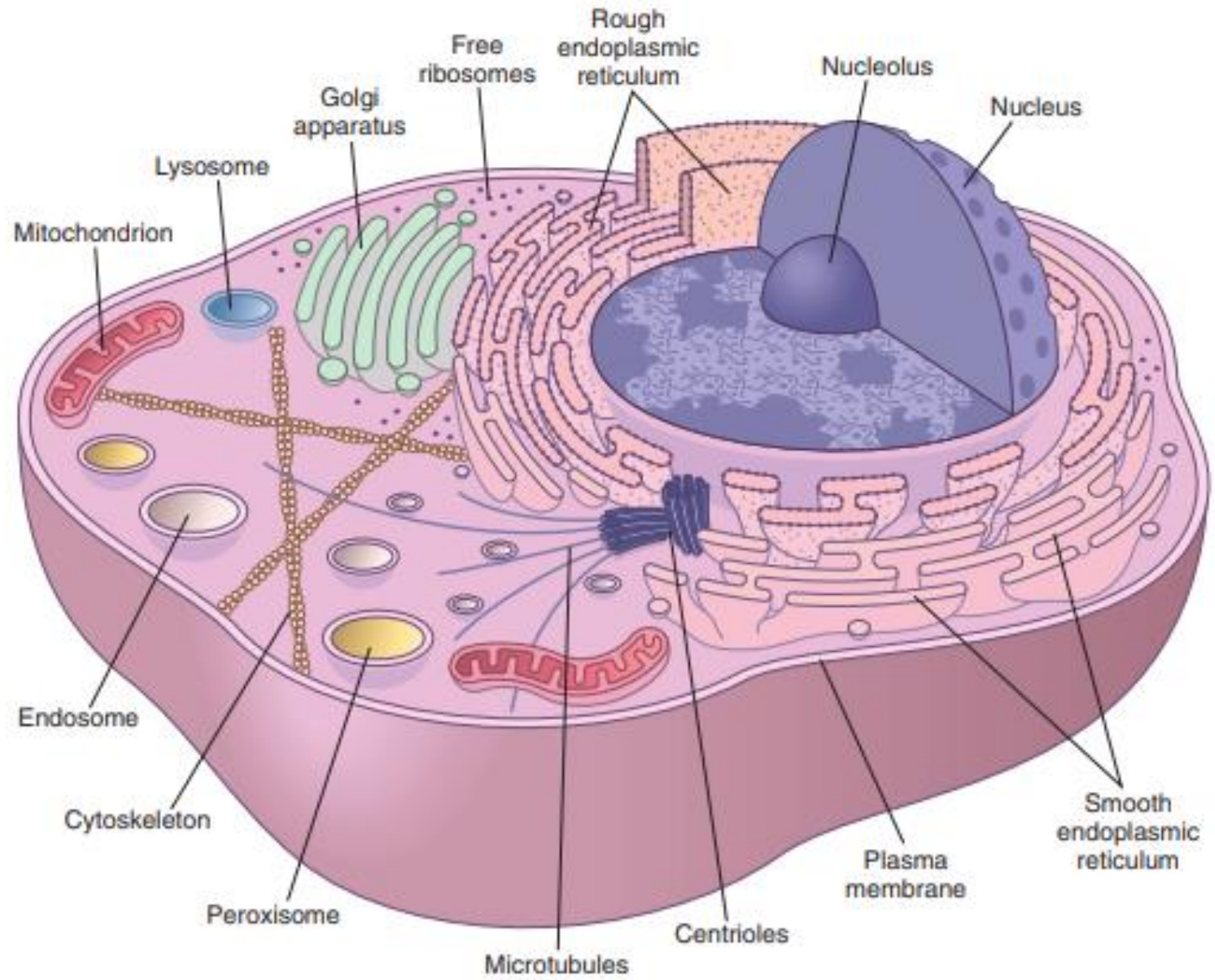


- Cells actively interact with their environment, constantly adjusting their structure and function to accommodate changing demands and extracellular stresses.
- The intracellular milieu of cells is normally tightly regulated such that it remains fairly constant, a state referred to as homeostasis.



Homeostasis

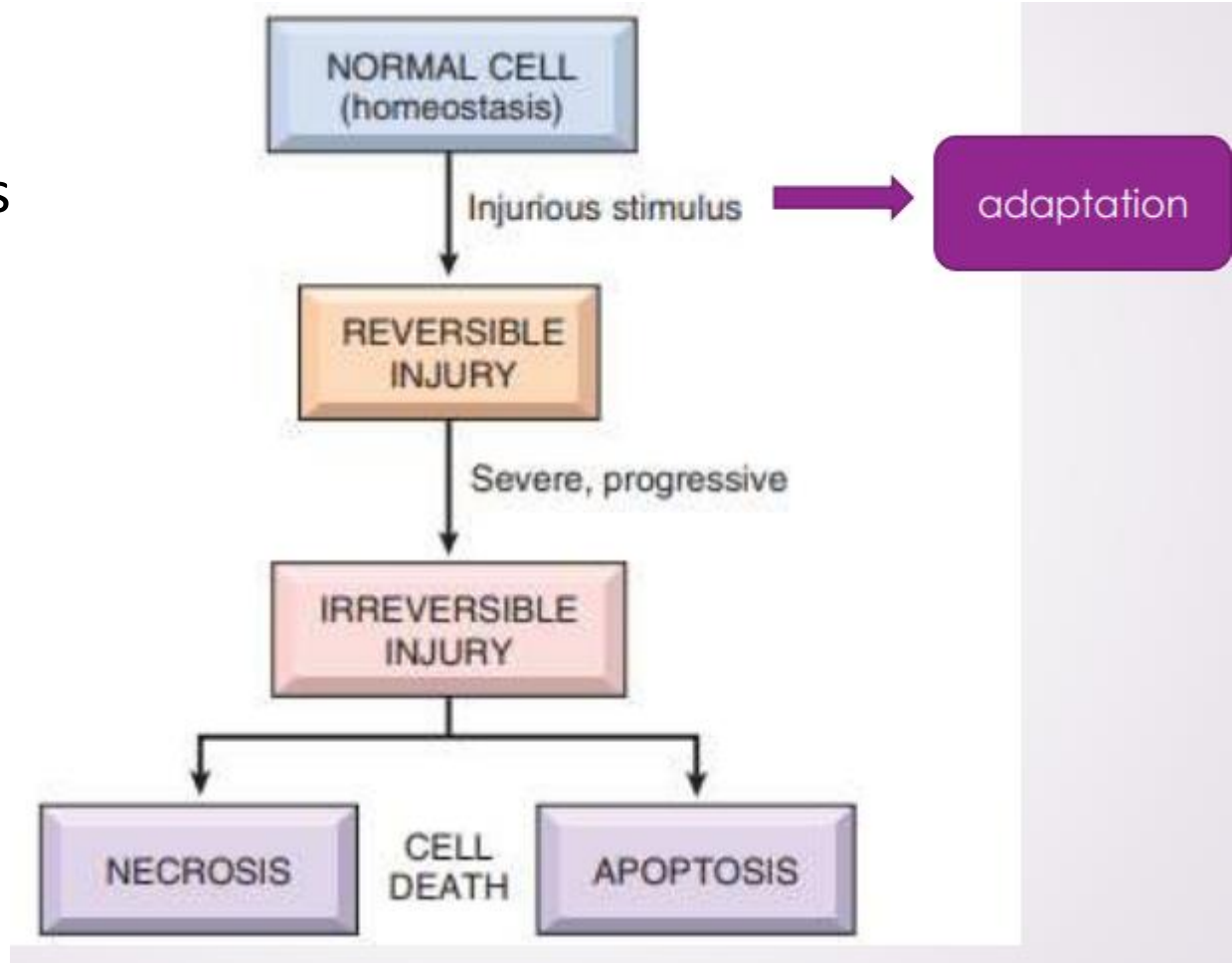
# Normal cellular components



# Stress



- So in any:
- Physiologic stresses (such as increased workload in the heart) / Potentially injurious conditions (such as nutrient deprivation) → The cells undergo adaptation: new steady state with preserving viability and function.
- If the adaptive capability is exceeded or if the external stress is inherently harmful or excessive, cell injury develops







## ~ Causes of cell injury

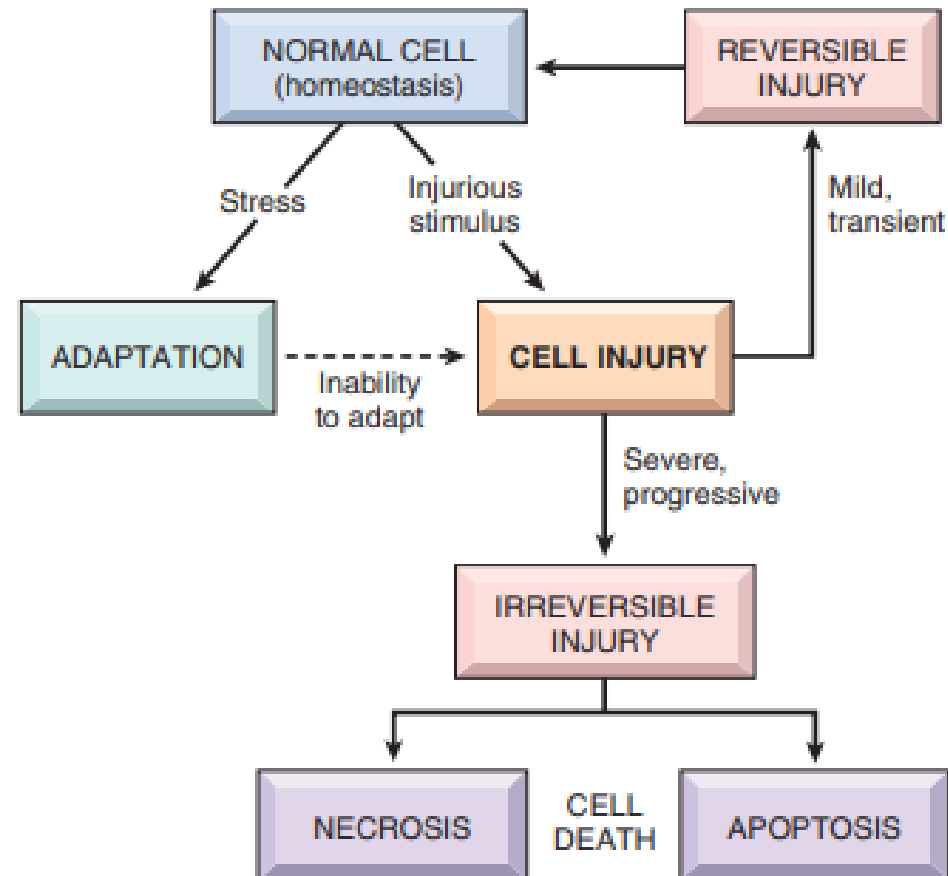
1. Oxygen Deprivation (Hypoxia Vs ischemia) : most common causes of injury
2. Toxins: smoking, alcohol
3. Infectious Agents
4. Immunologic Reactions :autoimmune disease
5. Genetic Abnormalities
6. Nutritional Imbalances :
7. Over intake: obesity, diabetes
8. Insufficiency: protein, vitamins
9. Physical Agents : trauma, burn
10. Aging



# ~ Stress and Its Causes of Adaptations

- Definition of Stress: Stress refers to any external or internal factor that disrupts cellular homeostasis, prompting a response from the cell.
- **What Are Adaptations?**
  1. Definition: Adaptations reversible functional and structural responses to changes in physiologic states (e.g., pregnancy) and some pathologic stimuli, during which new but steady states are achieved, allowing the cell to survive and continue to function
  2. Types of Adaptations:
    - ✓ Hypertrophy: Increase in cell size and functional capacity due to increased workload (e.g., muscle growth).
    - ✓ Hyperplasia: Increase in cell number in response to stimuli (e.g., tissue repair).
    - ✓ Atrophy: Decrease in cell size and function due to reduced demand or injury (e.g., muscle wasting)..
    - ✓ Metaplasia: Change in cell type or phenotype in response to chronic irritation (e.g., bronchial cells adapting in smokers).

# Stress and Its Causes of Adaptations





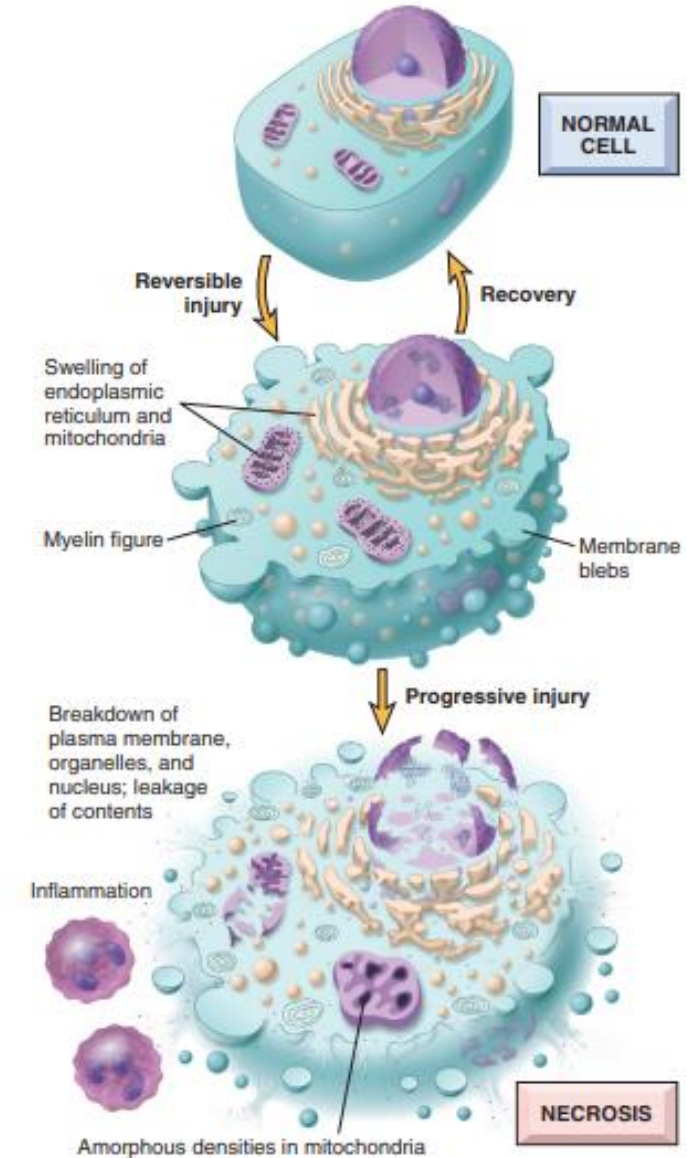
## ~ Ischemia vs Hypoxia

- Ischemia is insufficient blood flow to provide adequate oxygenation → Usually caused by arterial thrombus formation or vasospasm.
- Hypoxia: oxygen deficiency, can be caused by:
- Ischemia, anemia, lung disease, CO poisoning.
  
- Ischemia results in hypoxia; however, hypoxia can occur with normal (or elevated) blood flow if, for example, the oxygen content of the arterial blood is decreased by anemia.



# SEQUENCE OF EVENTS IN CELL INJURY AND CELL DEATH

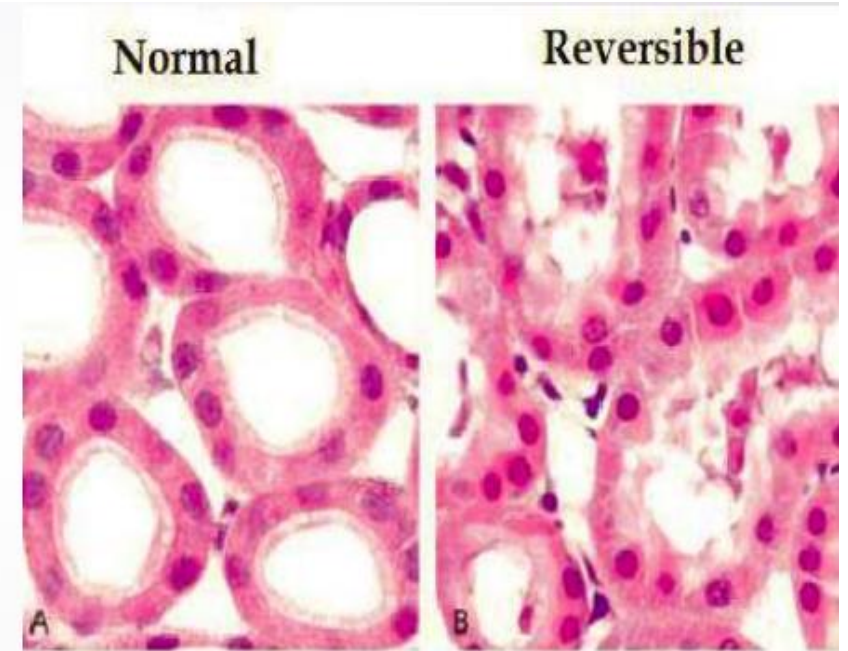
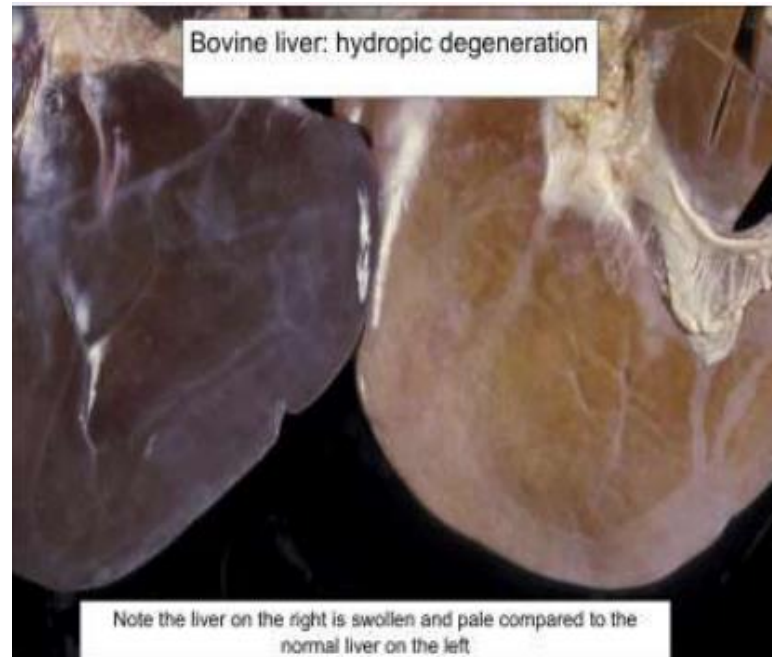
- Reversible Cell injury: the stage of cell injury at which the deranged function and morphology of the injured cells can return to normal if the damaging stimulus is removed
- Irreversible Cell injury: the stage of cell injury at which the injured cells pass a nebulous “point of no return” and undergo cell death.
- Occur if the stress is severe, persistent, or rapid in onset





- Morphology of reversible cell injury;
  1. Cellular Swelling:
    - Reversible process results from failure of the sodium potassium pump (energy-dependent ion pumps) due to ATP depletion.

- Gross: pallor, turgor.
- Microscopy:
- ✓ Cellular swelling.
- ✓ Hydropic change







- Morphology of reversible cell injury;

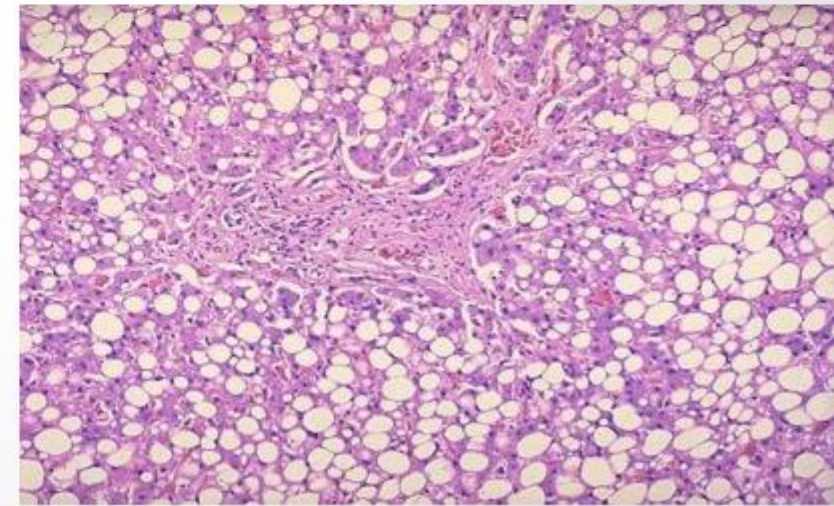
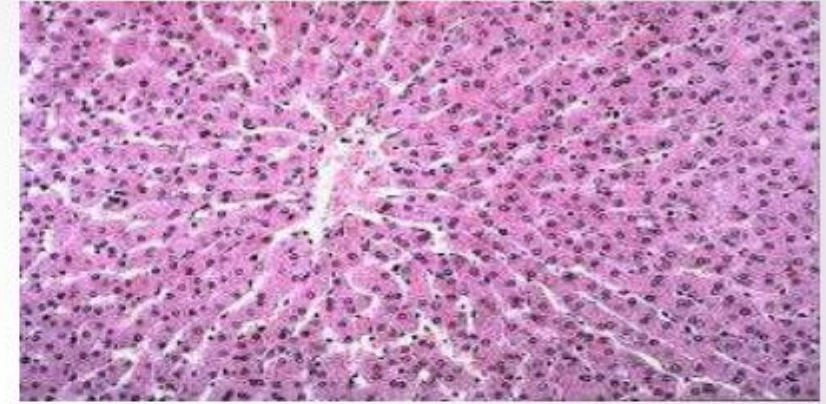
- 2. Fatty change

- It is reversible process, seen mainly in organs that involved in fat metabolism like Hepatocytes and myocardial cells .

- Occurs mainly in hypoxic injury, toxic and metabolic injury.

- Microscopy:

- ✓ Lipid (triglyceride) vacuoles in the cytoplasm





- Irreversible cell injury
- Consistently characterized by three phenomena:
  1. The inability to restore mitochondrial function even after resolution of the original injury
  2. Loss of structure and functions of the plasma membrane and intracellular membranes
  3. Loss of DNA and chromatin structural integrity.





- Cell death
- Depending on the nature and severity of the insult, cellular death may in form of:
  1. Necrosis: Uncontrolled cell death due to severe damage, often resulting in inflammation and tissue injury.
  2. Apoptosis: Programmed cell death that occurs in a controlled manner, leading to the removal of cells without causing inflammation.
  3. Necroptosis: A `that combines features of necrosis and apoptosis, resulting in cell swelling and inflammation.



«Education is the passport to the future, for tomorrow  
belongs to those who prepare for it today»

- Maclom X-