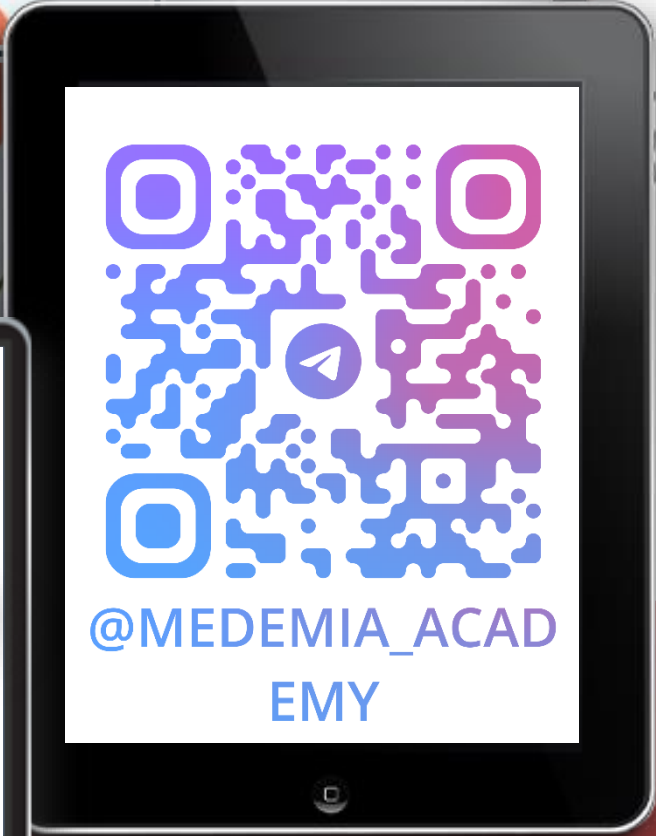


# Introduction to pathology



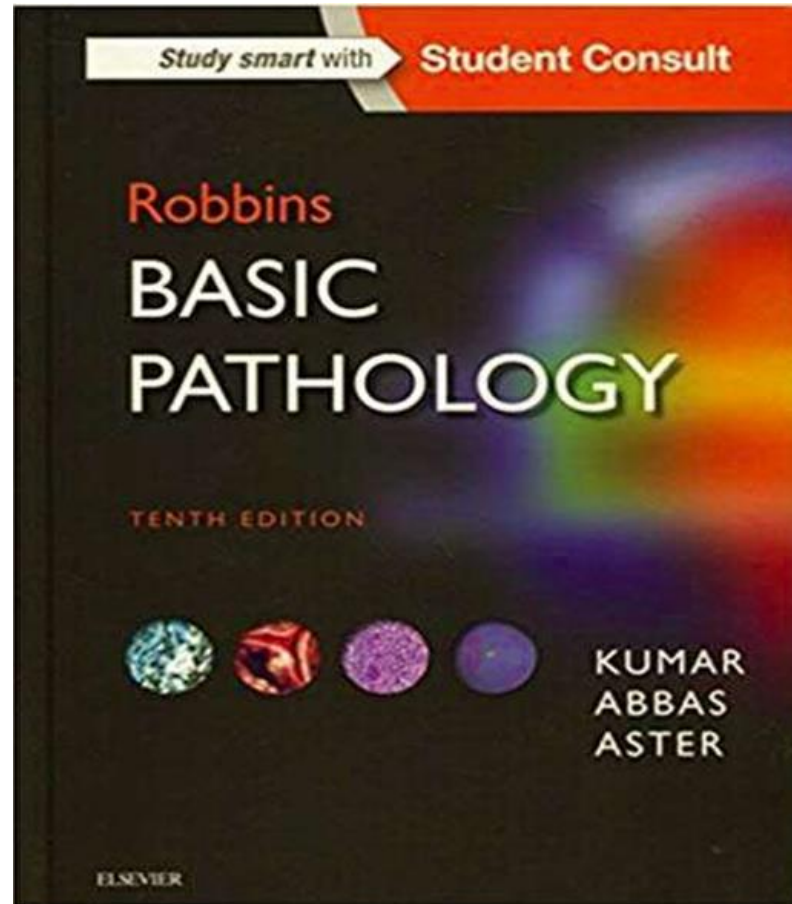


# MEDEmia ACADEMY



# The book ..

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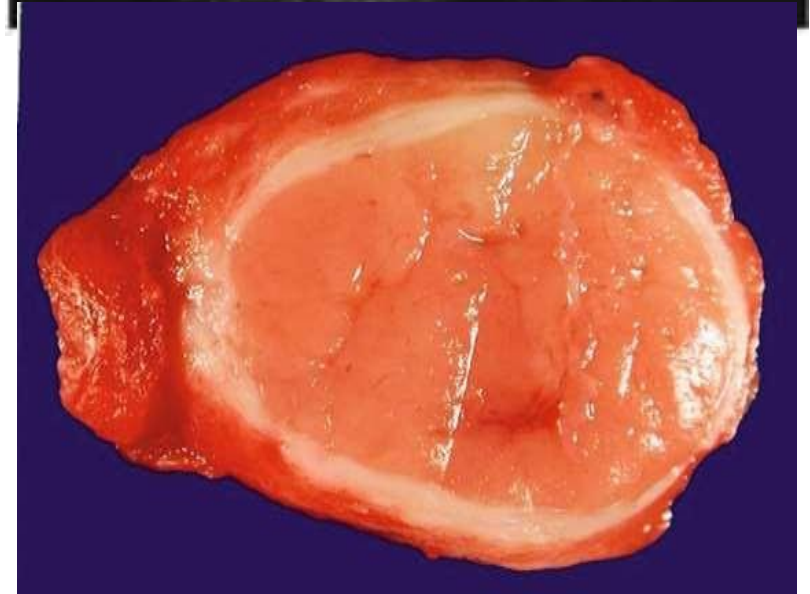
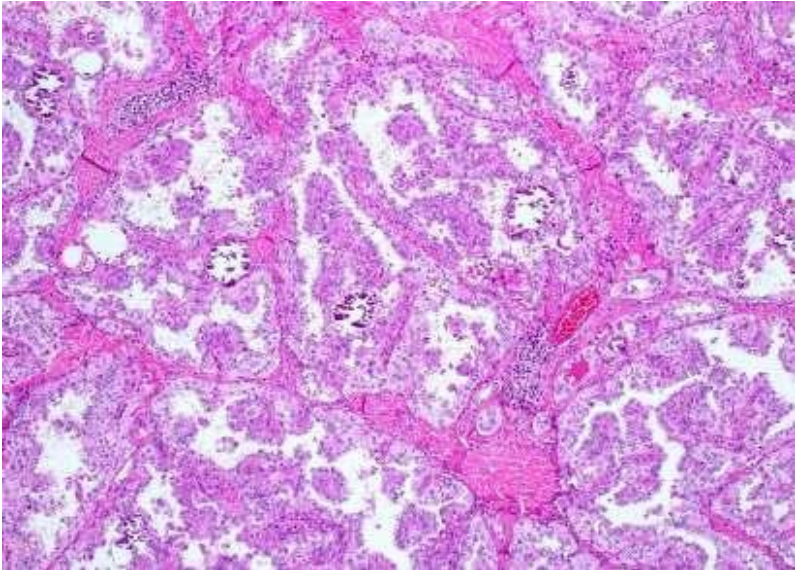
# So what is pathology ?

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- ❖ Pathology comes from an Ancient Greek words; literally to the study of suffering;
- ❖ pathos: "suffering" (disease) & logia "study of"
- ❖ **Definition:** is the study of structural , biochemical , functional changes in cell , tissues , organs that underlies the disease
- ❖ It branch of medicine it involves the examination of surgically removed organs, tissues (biopsy samples), bodily fluids, and, in some cases, the whole body (autopsy).







# Division of pathology

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## ❖ General pathology :

- Common reactions of cells & tissues to injurious stimuli
  - Eg.: edema , inflammations

## ❖ Systemic pathology :

- discuss pathology of diseases of a specific organs/systems
  - Eg.: CVS , GIT



- ❖ Anatomical pathology
- +Cytopathology
- +Dermatopathology
- +Forensic pathology
- +Histopathology
- +Neuropathology
- +Pulmonary pathology
- +Renal pathology
- +Surgical pathology
- ❖ Clinical pathology
- +Hematopathology
- +Immunopathology
- +Radiation pathology
- ❖ Molecular pathology

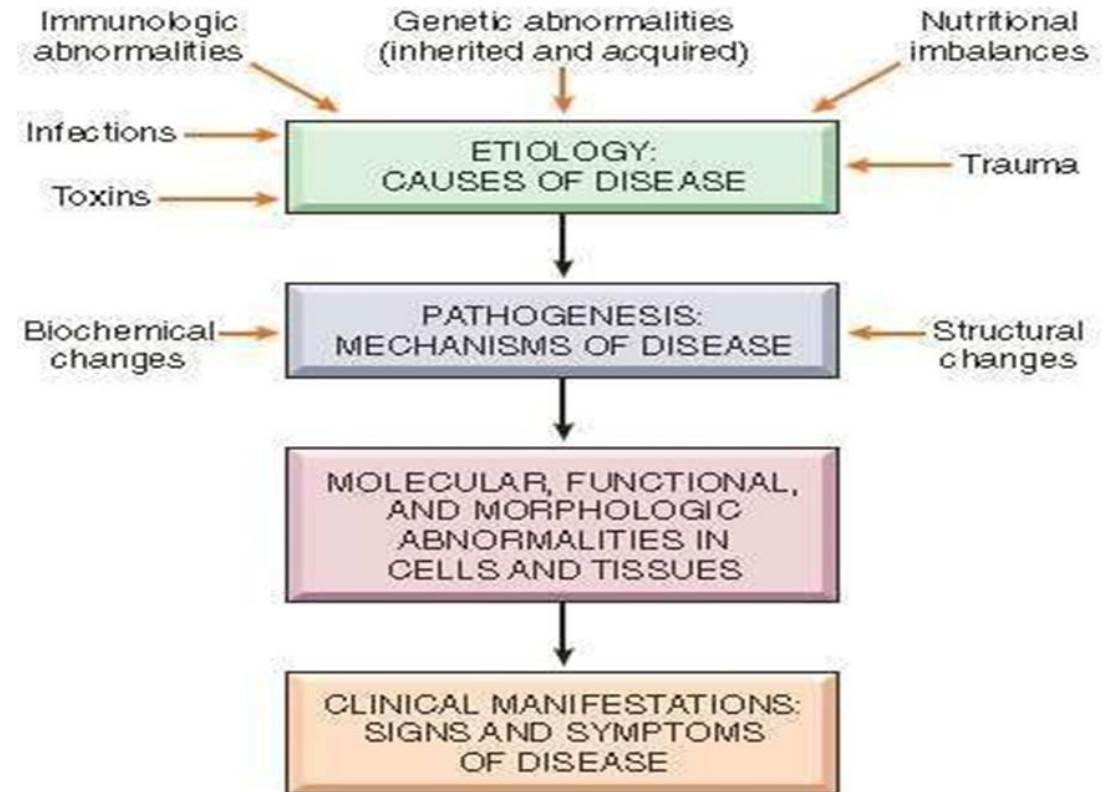
## Branches of pathology

Histopathology	Diagnosis of disease by gross & microscopic examination of tissue
Cytopathology	Diagnosis of disease on cellular level, by examination of isolated cell
Haematology	Blood related disorder
Clinical pathology	Diagnosis of disease based on laboratory analysis of bodily fluids such as urine, ascetic fluid
Chemical pathology	Diagnosis of disease by using the tools of chemistry
Immunopathology	Diagnosis of disease by detecting Ag-Ab specific reaction
Forensic pathology	Concerned with determining cause of death
Molecular pathology	Diagnosis of disease through the examination of molecules within organs, tissues or bodily fluids



❖ pathology addresses components of disease:

1. cause: why ?
2. mechanisms of development (pathogenesis): how ?
3. structural alterations of cells (morphologic changes)
4. the consequences of changes (clinical manifestations).





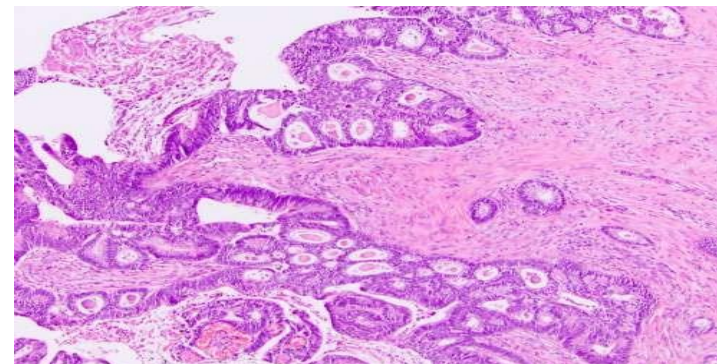
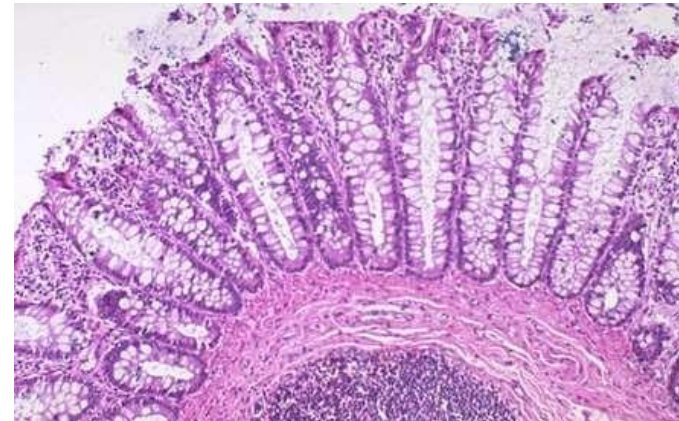
# Structural alterations of cells (morphologic changes):

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1. naked eye: Gross morphology

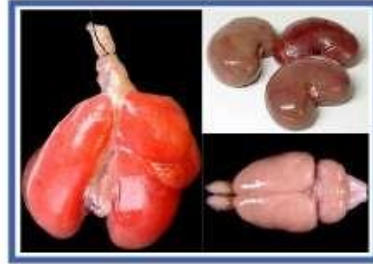


2. Morphology under microscope:  
Microscopic



Colon CA

Formalin solution  
(Formaldehyde) to  
prevent autolysis



Fixing

TP1020 Automatic Tissue Processor



Processing

EG1160 Paraffin Embedding Center



Embedding

RM2235 Rotary Microtome



VT1000S Vibrating-blade Microtome



Cutting

Leica CM 1900 Cryostat



Specimen journey in  
pathology  
lab

Microscopy

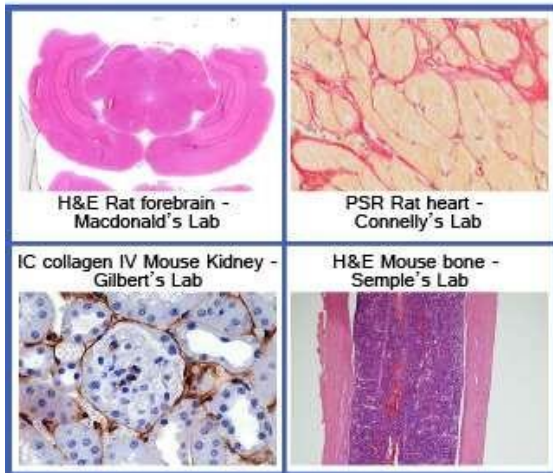


Olympus IMT-2 Microscope

Staining



Leica AutoStainer XL

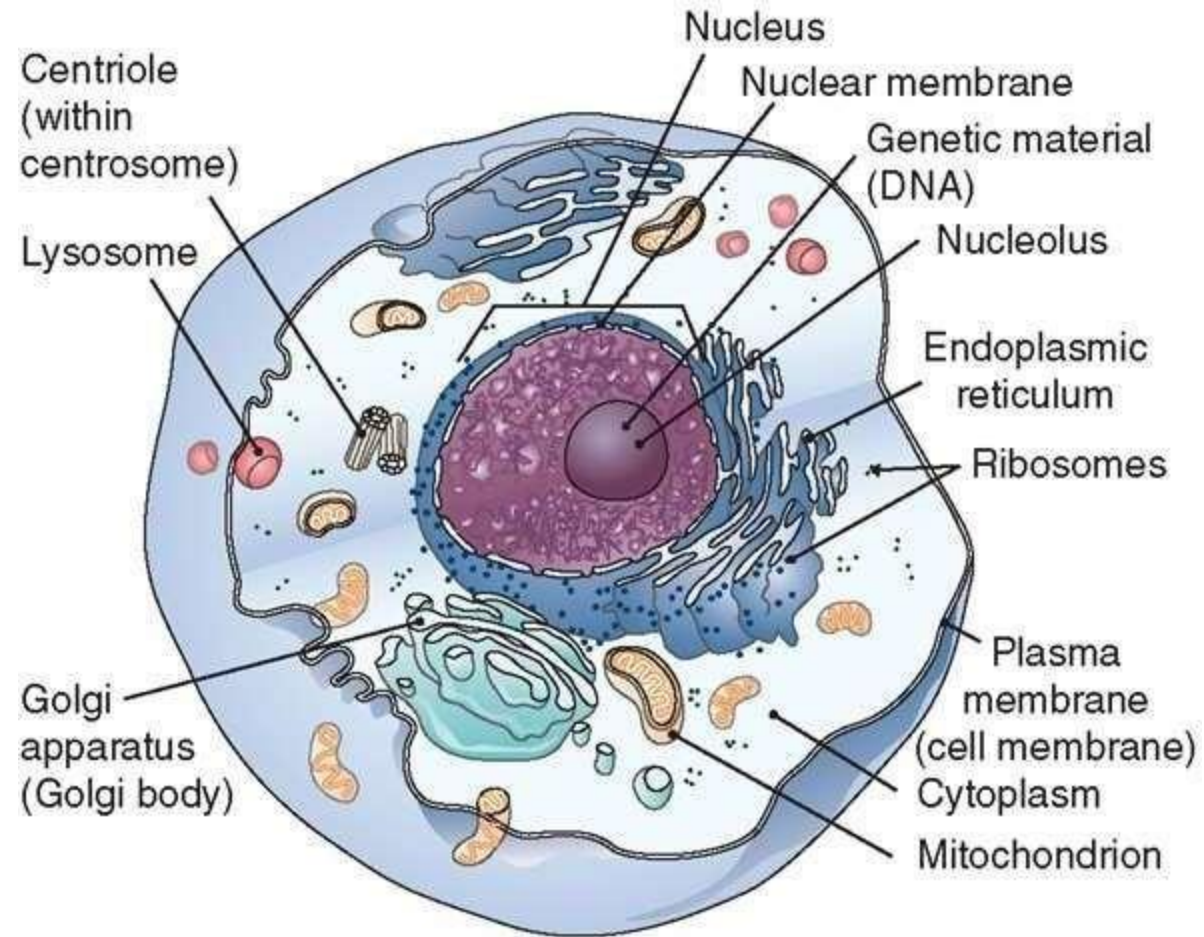




# Cell Injury and Necrosis - 1



# Normal cell





# Homeostasis & Cellular Adaptations

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- ❖ **Homeostasis (Maintaining Dynamic state):** is maintenance of normal internal environment, such as normal blood pressure, electrolytes levels, pH, body temperature, sugar level etc. Cells actively interact with their environment, constantly adjusting their structure and function to accommodate changing demands and extracellular stresses.
  - Any change of such (elevated or lowered) may lead or indicate a disease.
  - The intracellular milieu is normally tightly regulated and constant internal environment
- **Cellular adaptations:** new steady state with preserving viability are reversible functional and structural responses to changes in physiologic states stresses (such as increased workload in the heart) or potentially injurious conditions (such as nutrient deprivation).



# Cell injury

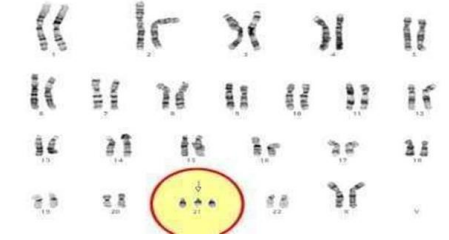
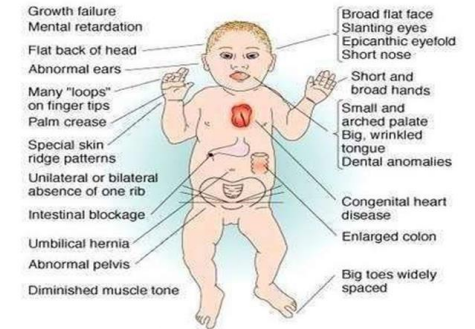
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- ❖ **Cell injury:** occur when stress exceed cell ability to adapt due to exposure to toxic agents, mutations and/or deprived of nutrients.
- ❖ Cell injury is reversible up to a point, but if the injurious stimulus is persistent or severe, the cell suffers irreversible injury and ultimately undergoes cell death.
- ❖ **What determines whether the cell will adapt or become injured?**
  - Type of stress
  - Severity of stress
  - Type of affected cells
- ❖ **Causes of cell injury can be classified into**
  - Genetic causes
  - Acquired causes



# Genetic cause

- ❖ Genetic aberrations as extreme as an extra chromosome, as in Down syndrome, or as subtle as a single base pair substitution leading to an amino acid substitution, as in sickle cell anemia.
- ❖ Genetic defects may cause cell injury because of deficient protein function, such as enzyme defects in inborn errors of metabolism, or accumulation of damaged DNA or misfolded proteins, both of which trigger cell death when they are beyond repair.



	Normal	Missense Mutation
Partial DNA Sequence of Beta Globin Gene:	CCT GAG GAG GGA CTC CTC	CCT GTG GAG GGA CAC CTC
Partial RNA Sequence:	CCU GAG GAG	CCU GUG GAG
Partial Amino Acid Sequence for Beta Globin:	Pro-Glu-Glu	Pro-Val-Glu
Hemoglobin Molecule:		
Red Blood Cell:		



# Acquired causes

<b>Hypoxia and ischemia</b>	<ul style="list-style-type: none"><li>• Most common cause of injury</li><li>• <b>Hypoxia:</b> tissue oxygen deficiency due to ischemia, anemia, lung disease, CO, etc.</li><li>• <b>Ischemia:</b> reduce blood supply (e.g., arterial obstruction or vasospasm.)</li><li>• NOTE :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 a anemia .</li></ul>
<b>Infectious Agents</b>	<ul style="list-style-type: none"><li>• These agents range from submicroscopic viruses to tapeworms several feet in length.</li><li>• In between are rickettsiae, bacteria, fungi, and higher forms of parasites.</li></ul>
<b>Immunologic Reactions</b>	<ul style="list-style-type: none"><li>• Autoimmune reactions</li><li>• Allergic reactions: innocuous environmental substances.</li><li>• Excessive response to microbes</li><li>• Inflammatory reaction that damage cells and tissue</li></ul>
<b>Nutritional Imbalances</b>	<ul style="list-style-type: none"><li>• Protein-calorie insufficiency: countries in Poverty</li><li>• Specific vitamin deficiencies</li><li>• Excessive dietary intake may result in obesity, anorexia nervosa, DM-2, atherosclerosis</li></ul>





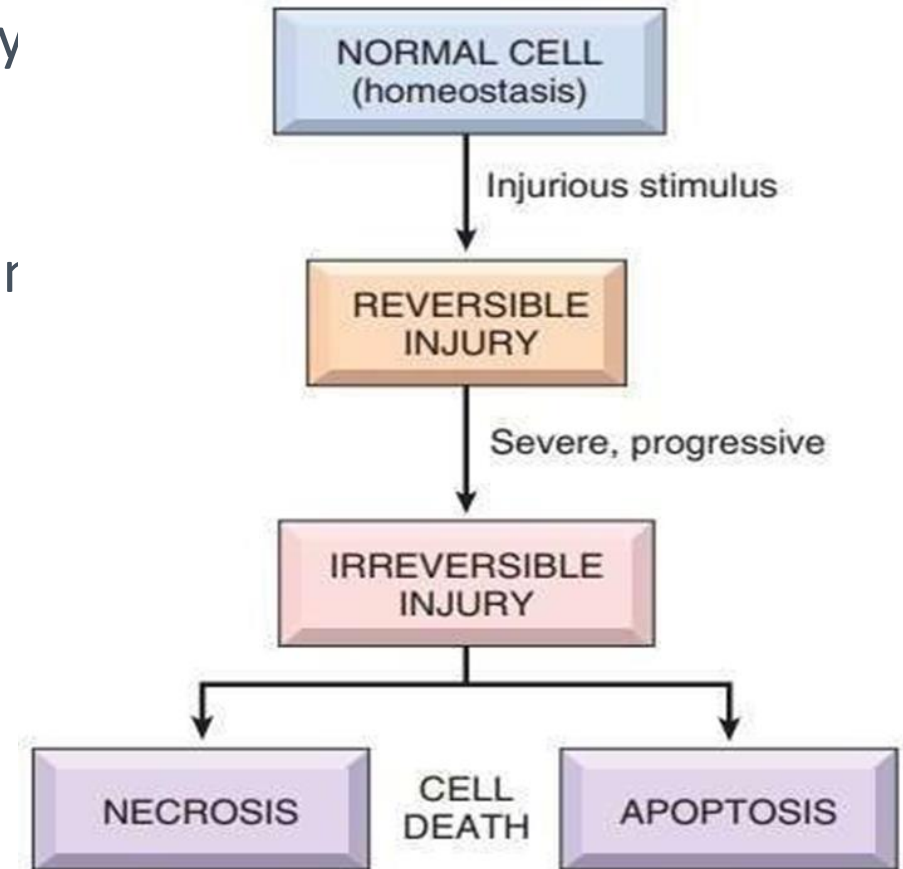
# Acquired causes cont.

<b>Chemical Agents and Drugs</b>	<p>The list of chemicals that may produce cell injury defies compilation.</p> <ul style="list-style-type: none"><li>• <b>Simple chemicals:</b> such as glucose or salt in hypertonic concentrations may cause cell injury directly or by deranging electrolyte and fluid balance in cells. Even oxygen at high concentrations is toxic.</li><li>• <b>Trace amounts of poisons:</b> such as arsenic, cyanide, or mercury, may damage sufficient numbers of cells within minutes or hours to cause death.</li><li>• <b>Other potentially injurious substances are our daily companions:</b> environmental pollutants, insecticides, and herbicides; industrial and occupational hazards, such as carbon monoxide and asbestos; recreational drugs such as alcohol; and the ever increasing variety of therapeutic drugs, many of which have toxic side effects.</li></ul>
<b>Physical Agents</b>	<ul style="list-style-type: none"><li>• Mechanical trauma,</li><li>• Extremes of temperature (burns and deep cold),</li><li>• Sudden changes in atmospheric pressure,</li><li>• Radiation</li><li>• Electric shock</li></ul>



# The Progression of Cell Injury and Death

- ❖ Adaptation, reversible injury, and cell death may be stages of progressive impairment following different types of insults.
- ❖ Reversible cell injury is characterized by functional and structural alterations in early stages or mild forms of injury, which are correctable if the damaging stimulus is removed.
- ❖ Two features are consistently seen in reversibly injured cells (early alterations):
  1. Generalized swelling of the cell
  2. Fatty change.



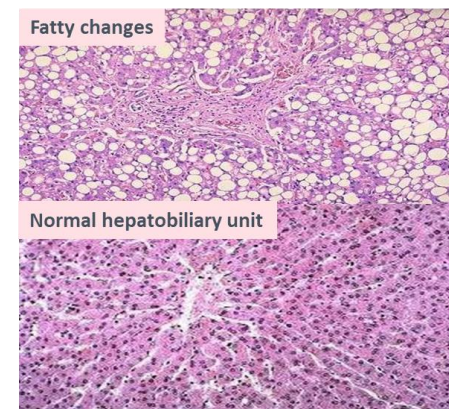
# Features of reversibly injured cells

## Cellular swelling

- Results from failure of the sodium potassium pump due to ATP depletion
- **Microscopy:** small clear vacuoles within the cytoplasm (hydropic change or vacuolar degeneration), the organelles within the cells are also swollen
- **Gross :** pallor,  $\uparrow$ turgor ,  $\uparrow$ weight
- Gross changes are more prominent than microscopic

## Fatty change

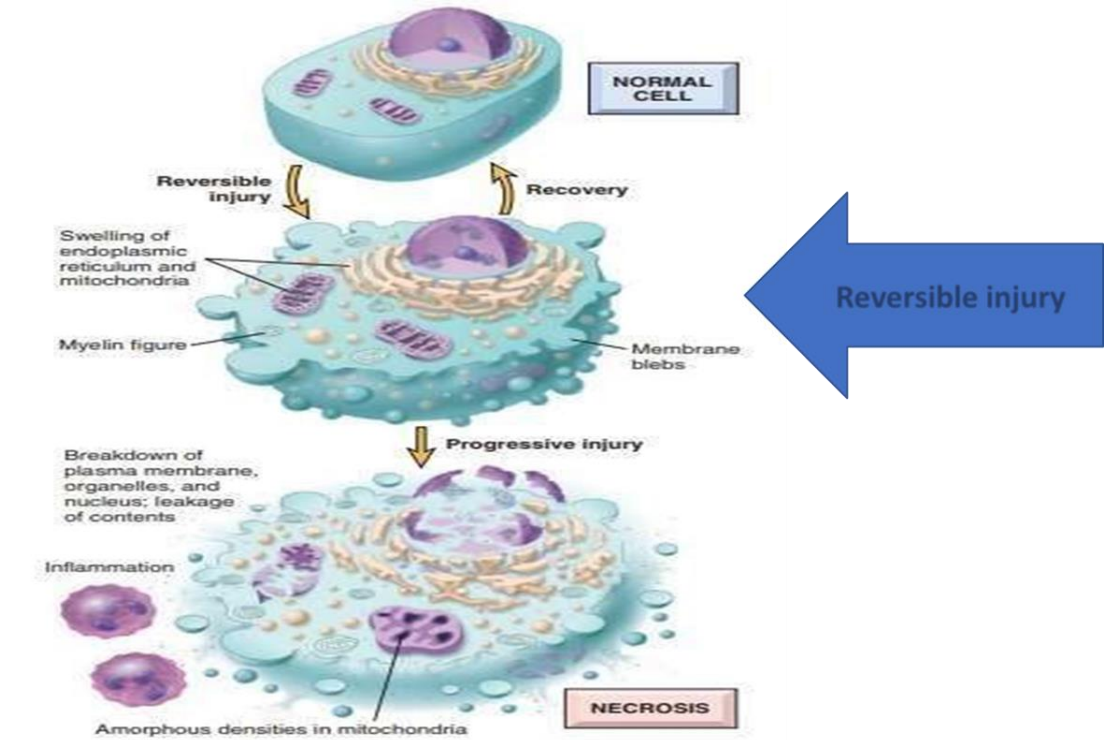
- Occurs mainly in hypoxic, toxic and metabolic injuries
- Seen mainly in organs that involved in fat metabolism like hepatocytes (liver) and myocardial cells (heart)
- **Microscopy:** lipid (triglyceride) vacuoles in the cytoplasm



# Features of reversibly injured cells

❖ On the ultra-structure include

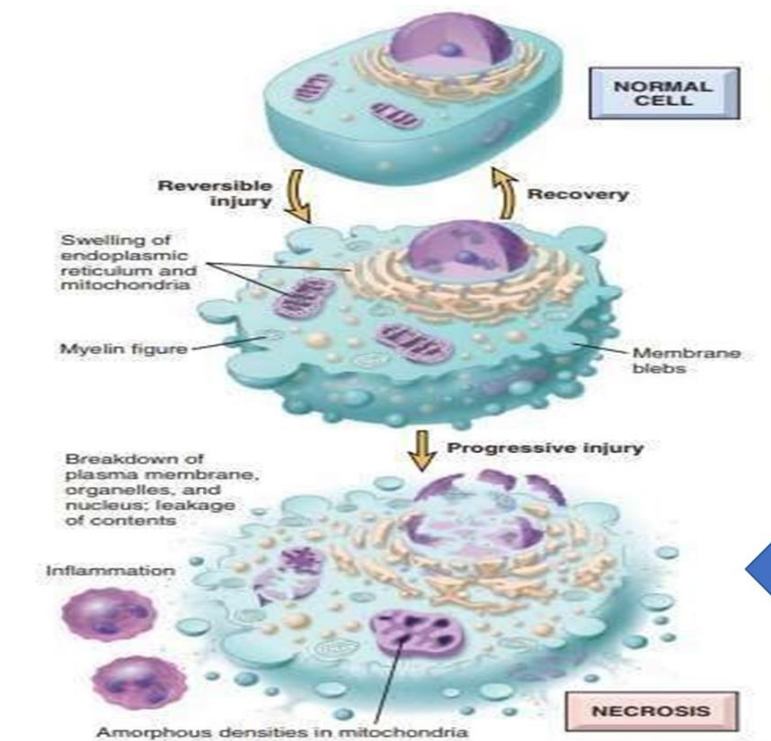
1. Plasma membrane alteration
2. Blebbing and blunting
3. Mitochondrial swelling and amorphous densities
4. Dilation of ER and detachment of ribosomes
5. Clumping of nuclear chromatin
6. Cytoplasmic Myelin figures





# Irreversible cell injury

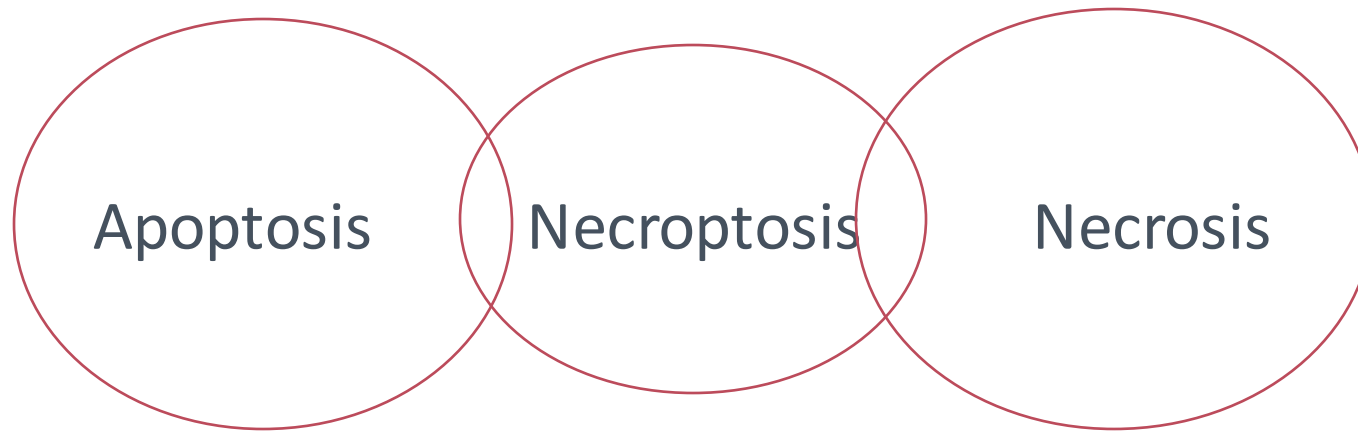
- ❖ if the stress is severe, persistent, or rapid in onset, injured cells pass a nebulous “point of no return” and undergo cell death.
- ❖ Although there are no definitive morphologic or biochemical correlates of irreversibility, it is consistently characterized by three phenomena:
  - The inability to restore mitochondrial function even after resolution of the original injury
  - The loss of structure and functions of the plasma membrane and intracellular membranes
  - The loss of DNA and chromatin structural integrity.



# Irreversible cell injury

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- ❖ When cells are injured they die by different mechanisms, depending on the nature and severity of the insult





# ARCHIVE Questions



# ARCHIVE Questions

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**Q1: An injury to the skin causes vacuolated degeneration of the basal layer, which of the following is wrong?**

- A. This injury seems mild
- B. The morphological changes will not recover even if the injurious stimulus is removed**
- C. The injury is caused due to Na/K pump failure
- D. Myelin figures are noticed within the cytoplasm
- E. These morphological changes are the first to occur after the injurious stimulus is applied

**Q2: Fatty Chang seen in :**

- A.Reversible injury** B.Irreversible injury C.Adaptation D.Necrosis





# ARCHIVE Questions

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**Q3: All of the following is correct about hypoxia and ischemia EXCEPT? Select one:**

- a. They are both among the most common causes of cell injury.
- b. Hypoxia can also be caused variety of diseases affecting the lung.
- c. Arterial obstruction is the most common cause of ischemia.
- d. Every case of ischemia is associated with hypoxia.
- e. Anemia is the most common cause of hypoxia

**Q4: One of the following is Incorrect about fatty changes observed in cellular injury? Select one:**

- a. Occurs mainly in hypoxic injury.
- b. Seen in organs that involved in fat metabolism.
- c. It results from failure of the sodium potassium pump.
- d. Most common site is the liver.
- e. Manifested by triglyceride containing lipid vacuoles in the cytoplasm



# ARCHIVE Questions

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**Q5: The state of constant internal environment that make the cell doing its function :**

A-hemostasis    B-Homeostasis

**Q6:wrong About irreversible cell injury phenomena :**

A-loss of DNA and chromatin structural integrity

B- loss of lisosomal membranes

C- loss of plasma membrane

D- Failure of Na-K pump

E- inability to restore mitochondrial function



# ARCHIVE Questions

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**Q7-What is true about Hypoxic injuries:**

- a. Arterial obstruction decrease the blood supply so is a cause of Ischemia

**Q8: One of the following is INCORRECT about Homeostasis?**

- a. A state of constant internal environment
- b. A state in which intracellular milieu is normally tightly regulated
- c. It is important to cell to function
- d. It is process to stop and prevent bleeding
- e. Body temperature is an example of body homeostasis



# ARCHIVE Questions

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**Q9: One of the Following is Correct about cellular swelling observed in cellular Injury?**

- a. Occurs mainly in metabolic liver injury
- b. Changes are easier to identify through light microscopy than the naked eye
- c. It is irreversible
- d. It results from failure of the sodium potassium pump due to ATP depletion
- e. manifested by triglyceride containing vacuoles in the cytoplasm

**Q10: All true except: Cellular swelling is common in fat metabolism organs**





# ARCHIVE Questions

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Q11: The cellular and molecular changes that give rise to functional and structural abnormalities : **pathogenesis**

Q12: Which of the following does not relate to pathology?

- a. **Pathology is a branch of psychology**
- b. Pathology is a separate science in itself
- c. Pathology is a branch of physiology



# ARCHIVE Questions

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**Q13 : One of the following is CORRECT about the study of pathology?**

- a. Etiology is defined as the mechanism through which diseases develop and progress.
- b. Pathology is a branch of Histology.
- c. Morphology: The basic structural and functional changes associated with disease.**
- d. Morphological changes are only observed through microscopy.
- e. Histopathology is a sequence of events that leads from structural abnormalities to clinical manifestations.



# ARCHIVE Questions

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❖ **Q14: All the following is correct about the study of pathology EXCEPT?**

- a. Pathogenesis: cellular and molecular changes give rise to abnormalities that characterize the disease
- b. Morphological changes: could be either observed with the naked eye or through microscopy
- c. Morphology: the basic structural and functional changes associated with disease
- d. Pathogenesis: is the basis of developing rational treatments and effective preventive measures
- e. Etiology: the mechanism through which diseases develop and progress

