PATHOLOGY

CELL INJURY

Cellular Adaptation

Adaptation Mechanism	Cause	Due to	Example
Hypertrophy (Increase in cell size)	Pathologic	Increase workload	Cardiac muscles
	Physiologic	Increase demand	Skeletal Muscles in athletes
		Hormonal Stimulation	Uterine smooth muscles in pregnancy
Hyperplasia (Increase in number of cells)	Pathologic (Constitutes a fertile soil for cancer arising)	Hormonal stimulation	Endometrial (estrogen) – can develop into cancer
			Benign Prostatic hyperplasia (androgen) – no cancer
		Viral infections	Warts (HPV) – Contagious
	Physiologic	Hormonal Stimulation	Uterus in pregnancy
			Breat during puberty/lactation
		Compensatory	Liver after resection
Atrophy (Decrease in cell size)	Pathologic	Denervation injury	Lower limp in diabetic neuropathy patients
			Multiple Sclerosis (MS)
		Diminished blood supply	Ischemia
	Physiologic	Loss of hormon stimulation	Endometrial atrophy – decreased estrogen
	Decrease workload (Immobilization after fracture)		
	Inadequate nutrition (Protein allergy malnutrition)		
	Aging (Senile atrophy)		
Metaplasia (Change into another type of cell)	Smoking		
	Vitamin A deficiency		
	GERD - Gastrointestinal reflux disease		

Reversible and Irreversible cell injury

Topic	Key Points
Cell Injury	Types: reversible and irreversible. Reversible injury allows recovery if the stimulus is removed; irreversible injury leads to cell death (necrosis).
Reversible Injury	Includes cellular swelling and fatty change. Observable through light and electron microscopy. Plasma membrane, mitochondria, and ER changes are common.
Irreversible Injury	Characterized by membrane rupture, organelle breakdown, enzyme leakage, and inflammatory response.
Necrosis	Uncontrolled cell death with inflammatory response.
Apoptosis	Controlled , 'clean' cell death with no inflammatory response. Cellular contents are packaged into apoptotic bodies and removed by phagocytes.
Patterns of Necrosis	Coagulative : ischemia-induced, tissue structure initially preserved. Liquefactive : CNS and infections, tissue liquifies. Gangrenous : tissue ischemia; dry or wet. Caseous : 'cheese-like' appearance in TB. Fat : enzymatic fat destruction in pancreatitis. Fibrinoid : immune complexes in vessel walls.

Inflammation 1

Definition of Inflammation

Inflammation is a protective response of vascularized tissue to injury, including infections and tissue damage. It involves the recruitment of immune cells and molecules to eliminate harmful agents.

Importance of Inflammation :

It is crucial for healing wounds and preventing severe consequences from infections. Without inflammation, infections can be fatal, and wounds may not heal.

Phases of Inflammation :

Acute Inflammation : Rapid onset characterized by the presence of neutrophils.

Chronic Inflammation : Slower onset involving persistent immune responses, often leading to tissue damage.

Five Steps of Inflammatory Response :

- Recognition : Detection of the offending agent.

- Recruitment : Infiltration of white blood cells to the site of injury.
- Removal : Elimination of the harmful agent.
- Regulation : Control and termination of the inflammatory response.
- Resolution : Repair of damaged tissue, either by regeneration or scar formation.

Causes of Inflammation :

Infections (bacterial, viral, etc.), necrosis, foreign bodies, and immune reactions (autoimmune diseases and allergies).

Consequences of Inflammation :

Inflammation can be beneficial but may also lead to excessive tissue damage, chronic diseases, or autoimmune conditions if misdirected or insufficient.

Clinical Implications :

Understanding inflammation is essential for diagnosing and managing various medical conditions.

Inflammation 4

Termination of Acute Inflammation :

The inflammation response consists of five steps : Recognize → Recruit → Remove → Regulate → Repair

After the first three steps, the body employs mechanisms to control and terminate inflammation to prevent side effects like pain and tissue damage.

Mechanisms of Termination :

- Rapid Mediator Production : Inflammatory mediators are produced quickly and not continuously.
- Stimulus-Dependent Release : Mediators are released in response to specific stimuli.
- Short Half-Lives : Most mediators have short lifespans, leading to rapid degradation.
- Apoptosis of PMNs : Neutrophils (PMNs) undergo programmed cell death after a few days.
- Production of Stop Signals : Factors like TGF-β and IL-10 inhibit and degrade earlier mediators.
- Neural Inhibition : Cholinergic signals can inhibit the release of tumor necrosis factor (TNF).

Mediators of Inflammation :

- Mediators include vasoactive amines (e.g., histamine), lipid products (e.g., prostaglandins), cytokines (e.g., IL-1, TNF), and complement proteins.

- Arachidonic acid metabolites play a crucial role in inflammation, with pathways leading to the production of prostaglandins and leukotrienes.

Cytokines :

Cytokines are proteins that regulate immune and inflammatory responses. They can have local effects (e.g., swelling and pain) and systemic effects (e.g., fever and increased white blood cell production).

Chemokines :

Chemokines are small proteins that act as chemoattractants to recruit white blood cells to sites of injury.

Complement System :

- The complement system consists of proteins that enhance inflammation, opsonization, and cell lysis. Activation of C3 is critical for the complement cascade, leading to inflammation and pathogen elimination.