

# CELL INJURY

→ Reversible & Irreversible.

Reversible cell injury  
causes: hypoxia, ischemia.  
↑  
genetic and acquired causes.

genetic causes

Ischemia due to obstruction  
to blood flow or diseases  
of RBCs, lungs, heart

Physical ailments → radiation,  
trauma, UV.

Chemical ailments → cyanide,  
poison, alcohol.

Microbial agents → bacteria,  
virus, fungus.

Nutritional causes → vitamin  
deficiencies, PEM, starvation  
age of cell, immunological  
causes.

Pathogens

type, duration & severity  
of contact with pathogens  
determine the severity  
of injury.

type of cell (eg. cardiac  
cells are more prone to  
hypoxia in comparison to  
skeletal cells)

Intracellular damages → MC damage  
ultrastructural changes in the  
cell visualized by microscope.

Energy path via aerobic &  
anaerobic pathways.  
anaerobic ↑, lactic acid ↑,  
pH ↓, chromatin form  
clumps - damage

Ischemia → both aerobic &  
anaerobic pathway blocked  
hypoxia → only aerobic is  
blocked. hence damage is  
less.

→ when ATP is reduced,  
damage to plasma  
membrane, nuclear membrane  
(hydraulic swelling)

FA will not convert to  
phospholipids & phospholipids  
degrade & holes are produced

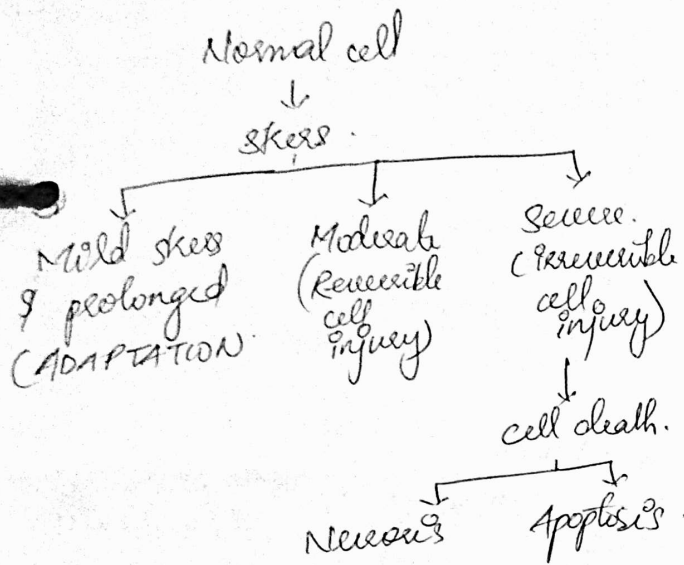
↓  
pumps open.  
increased conc. of  $Ca^{2+}$  in  
cytoplasm, get deposited on  
mitochondria.

protein synthesis  
prokaryotic enzyme attached,  
ribosomes detach from ER.  
and form monosomes  
which cannot form proteins  
hence membranes degrade!

## CELL INJURY

→ when the cell is exposed to an injurious agent or stress, a sequence of events follows - cell injury.

→ cell death is the ultimate result of cell injury.



## Adaptations (Question)

→ Reversible changes in the no, size, phenotype, metabolic activity or functions of cells in response to changes in their environment.

→ Hypertrophy, hyperplasia, atrophy & metaplasia.

## Hypertrophy

is an increase in the size of parenchymal cells resulting in enlargement of the organ or tissue

(1)

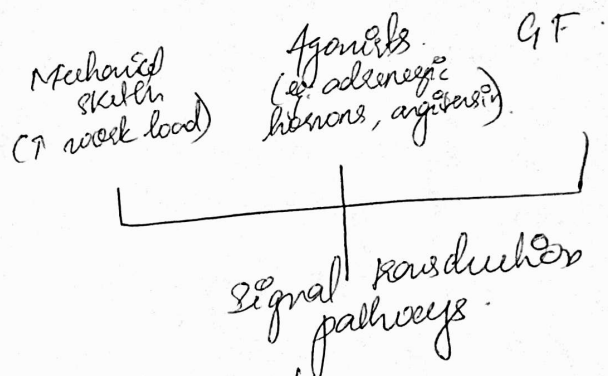
without any change in the no. of cells

① physiological : Uterus in pregnancy

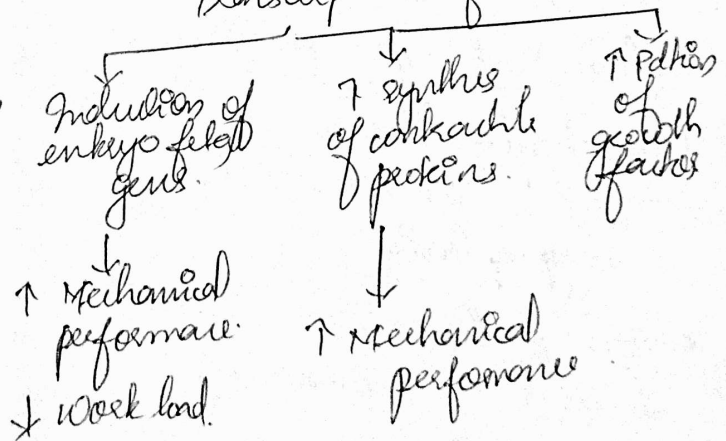
② Pathological : ventricular hypertrophy in hypertension.

## Mechanism

- Growth factors : TGF beta, IGF, EGF, fibroblast like.
- Hypertrophy agonists - NO, Endothelin -1, Angiotensin -II.
- Mechanical stretch.



## Transcription factors



## Hyperplasia

is an increase in the number of parenchymal cells resulting in enlargement of the organ

hyperplasia. Quite often, both are seen together.

## Physiological hyperplasia

① Hormonal hyperplasia i.e. hyperplasia occurring under the influence of hormonal stimulation.

eg. hyperplasia of female breast at puberty, during pregnancy and lactation.

② Compensatory hyperplasia i.e. hyperplasia occurring following removal of part of an organ or a contralateral organ in paired organs.  
eg. (i) Regeneration of liver following partial hepatectomy.

## Pathological hyperplasia

- Excessive hormonal stimulation - BPH, endometrial hyperplasia.
- Cell proliferation - growth factors & hormones.

## Akroph

Reduction of no. & size of parenchymal cells of an organ or its parts which occurs once or several times called akroph.

May be physiological and pathological change.  
physiological → akroph of testis with ageing.  
→ akroph of gonads after menopause.

## Pathological akroph

→ Starvation akroph: In starvation there is 1<sup>st</sup> depletion of carbohydrate & fat stores followed by protein catabolism.

→ Ischaemic akroph: eg. akroph of brain in cerebral atherosclerosis.

→ Disuse akroph eg. akroph of the pancreas in obstruction of pancreatic duct.

→ Neuropathic akroph eg. Poliomyelitis.

## Mechanism

- ↓ protein synthesis  
reduced metabolic activity
- ↑ protein degradation in cell ubiquitination - proteasome pathway

## Metaplasia

Reversible change in which one adult cell type (epithelial

of mesenchymal) is replaced by another adult cell type.

→ Adaptive response to chronic injury.

→ Reprogramming of precursor cells

## Epithelial metaplasia

① Squamous metaplasia: squamous metaplastic change due to chronic irritation that may be mechanical, chemical or infectious in origin.

eg: In bronchus (normally lined by pseudostratified columnar ciliated ep) in chronic smokers.

② Columnar metaplasia: There are some conditions in which there is transformation to columnar epithelium.

eg: Intestinal metaplasia in healed chronic gastric ulcer.

Barrett's oesophagus.

## B. Mesenchymal Metaplasia

Less often, there is transformation of one adult type of mesenchymal tissue to another

① Osseous metaplasia

eg: Cartilage of larynx &

bronchi in elderly people

② Cartilaginous metaplasia.

In healing fractures, cartilaginous metaplasia may occur where there is undue mobility.

## The morphology of cell & tissue injury

① Reversible: cellular derangements of reversible injury can be corrected and if the injurious stimulus abates, the cell can return to normal.

② Irreversible: Persistent or excessive injury - cells to pass the nebulous "point of no return" into irreversible injury and cell death.

## Reversible cell injury

Two main morphologic changes:

→ Cellular swelling and fatty change.

Intracellular changes:

membrane blebbing

ribosomal detachment

ER swelling

Nuclear chromatin clumping

cellular swelling

mitochondrial swelling

## cellular swelling

- 1<sup>st</sup> manifestation
- result of failure of energy dependent pumps in the plasma membrane ... inability to maintain ionic and fluid homeostasis
- Organ - pallor & increase in weight of the organ.
- ~~Microscopic~~ Microscopic Examination  
hydropic change or vacuolar degeneration

## Fatty change (steatosis)

- Abnormal accumulation of triglycerides within the parenchymal cells.
- Organs affected: liver (most common), heart, muscle, kidney

## Morphology

Gross: liver enlarged, yellow, soft, greasy.