

**Islamic university**

**Radiology techniques Department**

**Theoretical Pathology**

**Third Stage**



## **PATHOLOGY LEC2**

### ***Cellular adaptation***

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**Objectives of this lecture: at the end of this lecture, you will be able to know**

- Define the homeostasis and adaptation
- Enumerate the four types of cellular adaptation
- Explaining the four types of adaptation

## ***HOMEOSTASIS***

❖ Normal cell is in a state of functional and structural balance with neighboring cells.

## ***ADAPTATION***

❖ Adaptations are reversible functional and structural responses to more severe physiologic stresses and some pathologic stimuli, during which new but altered steady states are achieved, allowing the cell to survive and continue to function .

❖ When the stress is eliminated the cell can recover to its original state without any harmful consequences

### ***ADAPTATION RESPONSE:***

❖ Adaptations are reversible changes in the size, number, phenotype, metabolic activity, or functions of cells in response to changes in their environment

***Hypertrophy***

***Hyperplasia***

***Atrophy***

***Metaplasia***

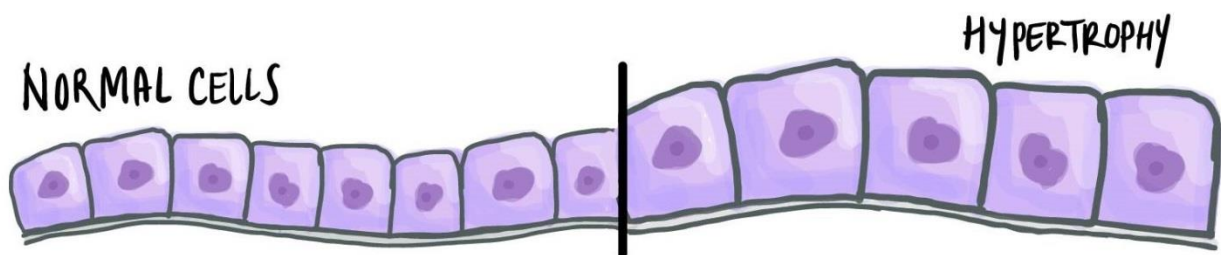
## ***HYPERTROPHY***

❖ Hypertrophy refers to an increase in the size of cells, resulting in an increase in the size of the organ.

❖ The increased size of the cells is due to the synthesis of more proteins and cell organelles.

❖ Hypertrophy can be physiologic or pathologic.

❖ Occurs as a response to increased functional demand (striated muscle cells in skeletal muscle & heart) or by hormonal stimulation (enlargement of the uterus during pregnancy) and growth factors.



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❖ ***Mechanism:***

activation of cell receptors, gens, growth factors leading to synthesis of proteins and cell organelles.

❖ In the heart, the stimulus for hypertrophy is usually chronic hemodynamic overload, resulting from either hypertension or faulty valves.

❖ The massive physiologic growth of the uterus during pregnancy due to hormone-induced increase in the size of an organ that results mainly from hypertrophy of muscle fibers.

### ***HYPERPLASIA***

❖ Hyperplasia is an increase in the number of cells in an organ or tissue, usually resulting in increased mass of the organ or tissue.

❖ Hyperplasia can be physiologic or pathologic.

❖ The same triggers for hypertrophy; Hyperplasia takes place if the cell population can divide .

#### ***Physiologic hyperplasia:***

✓ hormonal hyperplasia ( e.g. proliferation of the glandular epithelium of the female breast at puberty and during pregnancy, usually accompanied by enlargement (hypertrophy) of the glandular epithelial cells).

✓ Compensatory hyperplasia, which increases tissue mass after damage or partial resection.

#### ***Pathologic hyperplasia :***

caused by excesses of hormones or growth factors acting on target cells.

( e.g. Endometrial hyperplasia is an example of abnormal hormone-induced hyperplasia ; Hyperplasia is a characteristic response to certain viral infections, such as papillomaviruses, which cause skin warts and several mucosal lesions

composed of masses of hyperplastic epithelium. growth factors produced by viral genes or by infected cells may stimulate cellular proliferation ).

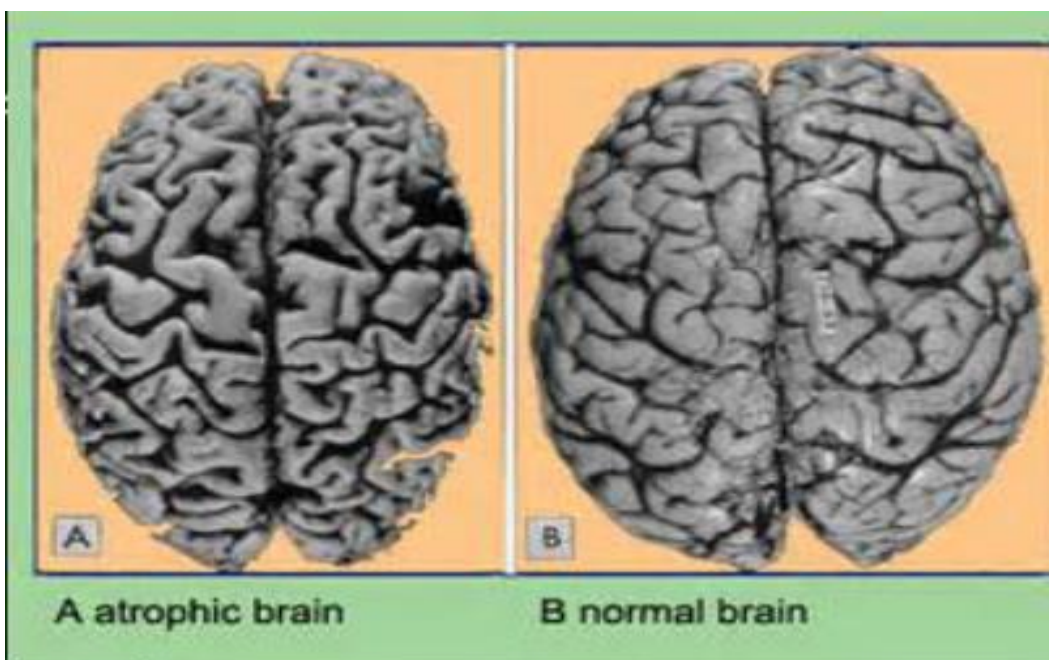
❖ ***Mechanism:***

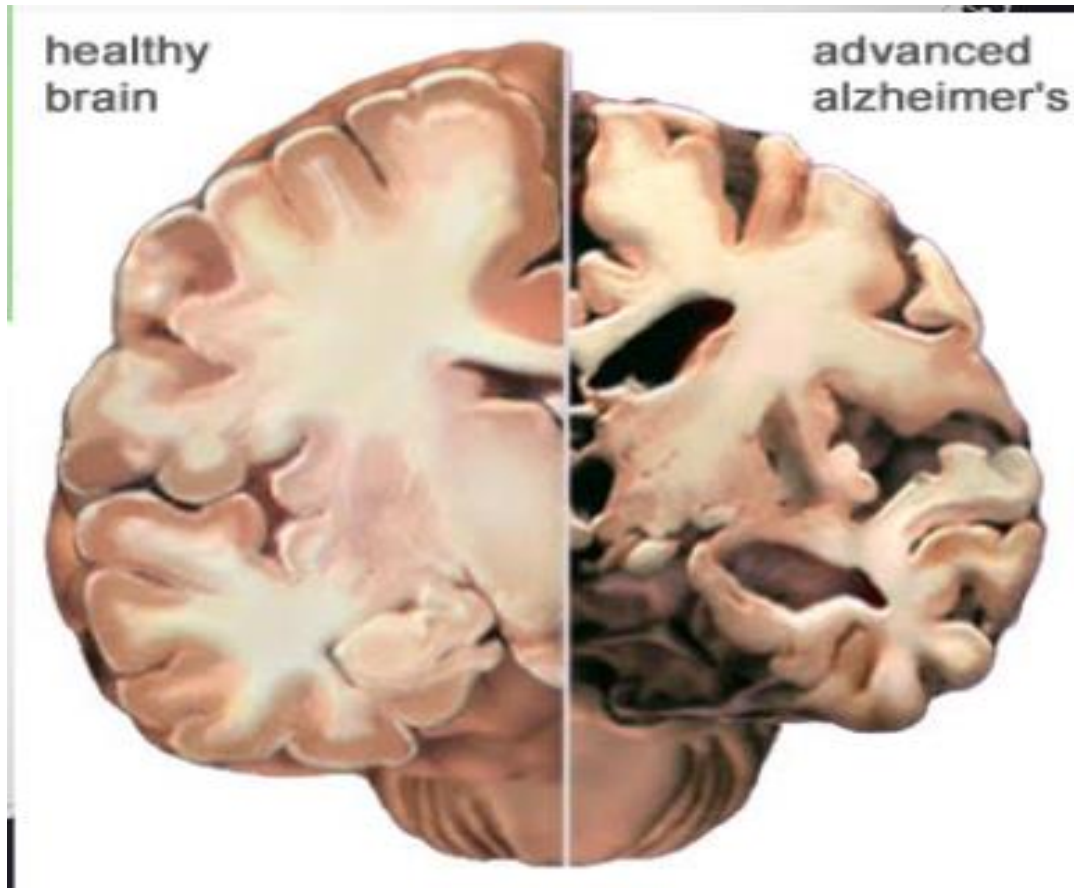
Hyperplasia is the result of growth factor–driven proliferation of mature cells and, in some cases, by increased output of new cells from tissue stem cells.

***ATROPHY***

❖ Atrophy is reduced size of an organ or tissue resulting from a decrease in cell size and number.

❖ Atrophy can be physiologic or pathologic. Physiologic atrophy is common during normal development, such as the notochord and thyroglossal duct, undergo atrophy during fetal development.





❖ Pathologic atrophy depends on the underlying cause:

- ✓ Decreased workload (atrophy of disuse).
- ✓ Loss of innervation (denervation atrophy).
- ✓ Diminished blood supply.
- ✓ Inadequate nutrition.
- ✓ Loss of endocrine stimulation.
- ✓ Pressure.

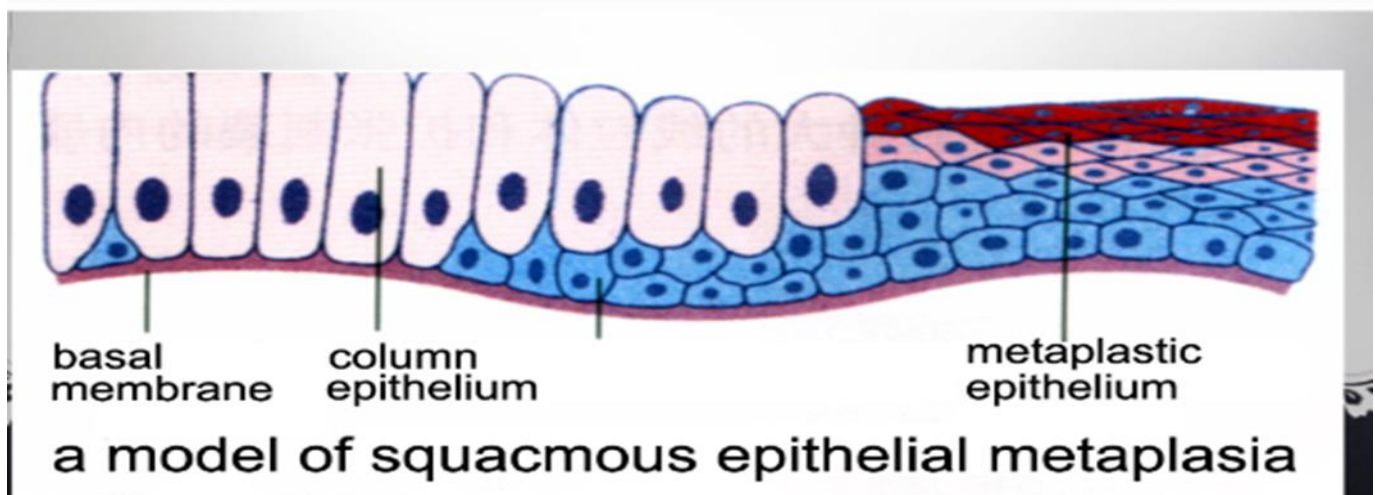
### ***MECHANISMS OF ATROPHY***

❖ Atrophied cells had decrease in cell size and organelles, which may reduce the metabolic needs of the cell sufficiently to permit its survival.

- ❖ Atrophy results from decreased protein synthesis and increased protein degradation in cells (ubiquitin-proteasome pathway).
- ❖ Protein synthesis decreases because of reduced metabolic activity.
- ❖ atrophy is also accompanied by increased autophagy, with resulting increases in the number of autophagic vacuoles.
- ❖ Autophagy (“self eating”) is the process in which the starved cell eats its own components in an attempt to find nutrients and survive.

## ***METAPLASIA***

- ❖ Metaplasia is a reversible change in which one differentiated cell type (epithelial or mesenchymal) is replaced by another cell type.
- ❖ It represent an adaptive substitution of cells that are sensitive to stress by cell types better able to withstand the stress.



- ❖ The most common epithelial metaplasia is columnar to squamous, as occurs in the respiratory tract in response to chronic irritation in cigarette smokers.
- ❖ Metaplasia from squamous to columnar type may also occur, as in Barrett esophagus.
- ❖ Metaplasia does not result from a change in the phenotype of an already differentiated cell type; instead it is the result of a reprogramming of stem cells that are known to exist in normal tissues, or of undifferentiated mesenchymal cells present in connective tissue.

### Normal Cells May Become Cancer Cells

