Cellular Adaptation

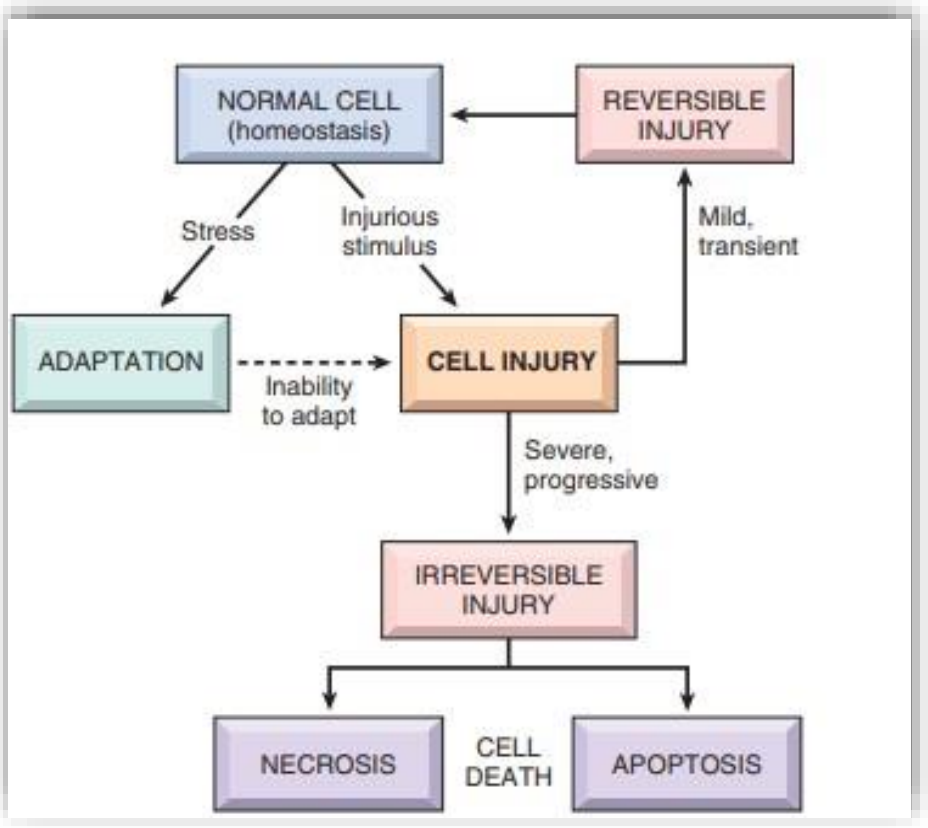
Cells are the basic units of tissues, which form organs and systems in the human body. Traditionally, body cells are divided in to two main types: epithelial and mesenchymal cells. In health, the cells remain in accord with each other. In 1859, Virchow first published cellular theory of disease, bringing in the concept that diseases occur due to abnormalities at the level of cells. Since then, study of abnormalities in structure and function of cells in disease has remained the focus of attention in understanding of diseases. Thus, most forms of diseases begin with cell injury followed by consequent loss of cellular function

- **Homeostasis** cells normally maintain a steady state .

Cellular adaptation

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

- **Physiologic adaptations** usually represent responses of cells to normal stimulation by hormones or endogenous chemical mediators (e.g., the hormone-induced enlargement of the breast and uterus during pregnancy).
- **Pathologic adaptations** are responses to stress that allow cells to modulate their structure and function and thus escape injury.



Stages of the cellular response to stress

Common forms of cellular adaptive responses along with examples of physiologic and pathologic adaptations are briefly discussed below

1-Hypertrophy

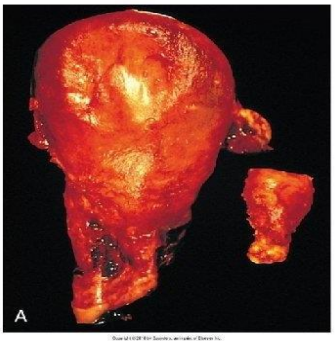
Hypertrophy is an increase in the size of parenchymal cells resulting in enlargement of the organ or tissue, without any change in the number of cells.

Causes. Hypertrophy may be physiologic or pathologic. In both cases, it is caused either by increased functional demand or by hormonal stimulation.

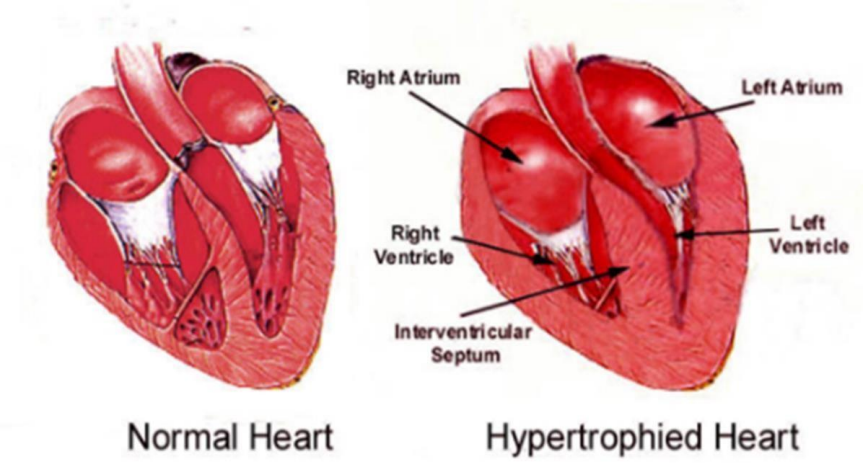
Hypertrophy without accompanying hyperplasia affects mainly muscles. In non dividing cells too, only hypertrophy occurs.

- **Physiologic hypertrophy**. Enlarged size of the uterus in pregnancy is an excellent example of physiologic hypertrophy as well as hyperplasia.
- **Pathologic hypertrophy.** An example of pathologic cellular hypertrophy is the cardiac enlargement that occurs with hypertension

Hypertrophy of Uterus During Pregnancy



Physiologic hypertrophy of the uterus during pregnancy. A, Gross appearance of a normal uterus (right) and a gravid uterus (left).

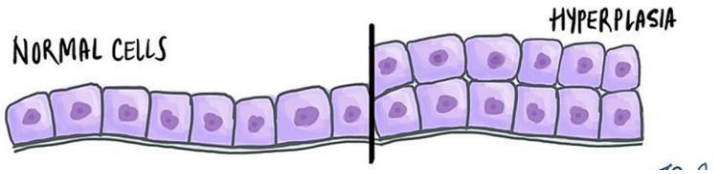


2- Hyperplasia

Hyperplasia is an increase in the number of parenchymal cells resulting in enlargement of the organ or tissue. Quite often, both hyperplasia and hypertrophy occur together.

Labile cells (e.g. epithelial cells of the skin and mucous membranes, cells of the bone marrow and lymph nodes) and stable cells (e.g. parenchymal cells of the liver, pancreas, kidney, adrenal, and thyroid) can undergo hyperplasia, while permanent cells (e.g. neurons, cardiac and skeletal muscle) have little or no capacity for regenerative hyperplastic growth.

Neoplasia differs from hyperplasia in having hyperplastic growth with loss of growth-regulatory mechanism due to change in genetic composition of the cell. Hyperplasia, on the other hand, persists so long as stimulus is present.



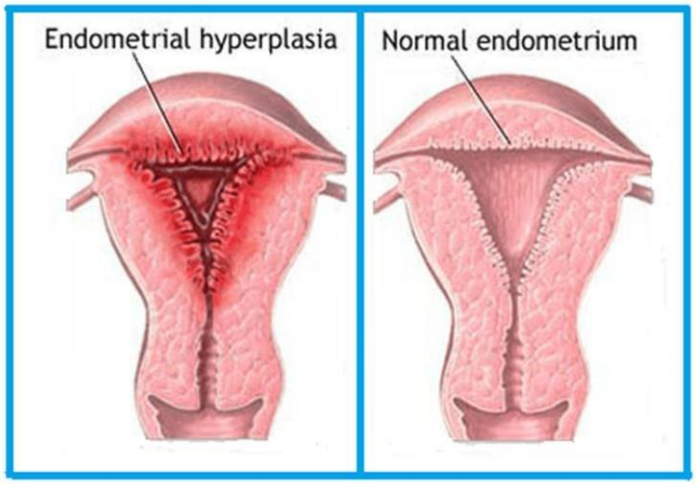
Causes. hyperplasia has also been divided into physiologic and pathologic.

- **Physiologic hyperplasia.** The two most common types are as follows:

1. Hormonal hyperplasia hyperplasia occurring under the influence of hormonal stimulation e.g. hyperplasia of female breast at puberty, during pregnancy and lactation and hyperplasia of pregnant uterus.

2. Compensatory hyperplasia. hyperplasia occurring following removal of part of an organ e.g regeneration of the liver following partial hepatectomy and regeneration of epidermis after skin abrasion

- **Pathologic hyperplasia**. an examples in wound healing, there is formation of granulation tissue due to proliferation of fibroblasts and endothelial cells.



3-Atrophy: decreased cell and organ size, as a result of decreased nutrient supply or disuse; associated with decreased synthesis of cellular building blocks and increased breakdown of cellular organelles

Causes. Atrophy may occur from physiologic or pathologic causes:

- **Physiologic atrophy**. Atrophy is a normal process of aging in some tissues, which could be due to loss of endocrine stimulation or

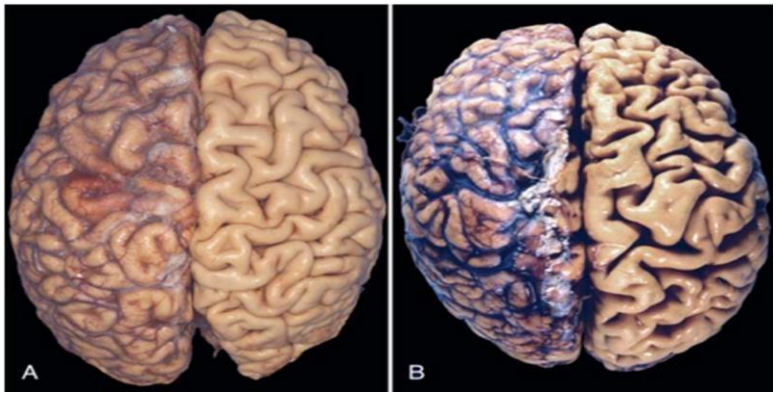
arteriosclerosis. For example: Atrophy of gonads after menopause and and atrophy of brain with aging

- **Pathologic atrophy** The causes are as under:

1. Starvation atrophy. In starvation, there is first depletion of carbohydrate and fat stores followed by protein catabolism. There is general weakness, emaciation and anaemia

2. Ischaemic atrophy. Gradual diminution of blood supply due to atherosclerosis may result in shrinkage of the affected organ e.g. atrophy of brain in cerebral atherosclerosis.

3. Neuropathic atrophy. Interruption in nerve supply leads to wasting of muscles



Atrophy. A, Normal brain of a young adult. B, Atrophy of the brain in an 82-year-old male with atherosclerotic cerebrovascular disease.

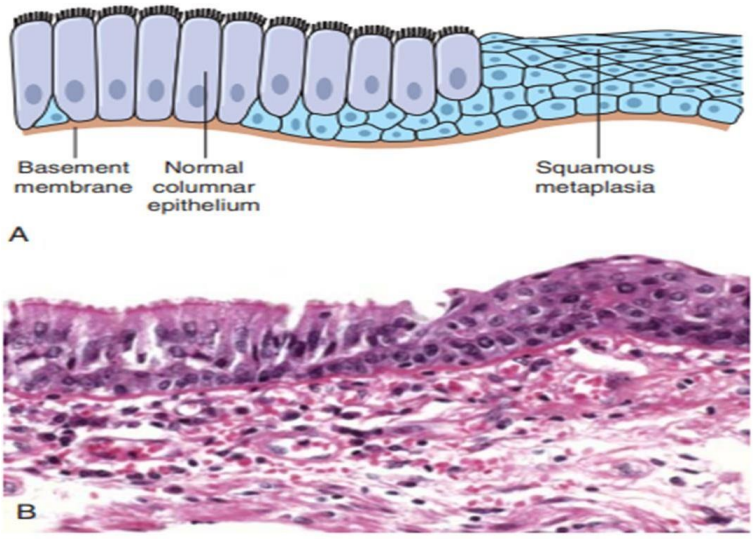
4- Metaplasia: is defined as a reversible change of one type of epithelial or mesenchymal adult cells to another type of adult epithelial or mesenchymal cells, usually in response to abnormal stimuli, and often reverts back to normal on removal of stimulus. However, if the stimulus persists for a long time, epithelial metaplasia may transform into cancer. Metaplasia is broadly divided into 2 types: epithelial and mesenchymal.

- **Epithelial Metaplasia** This is the more common type. The metaplastic change may be patchy or diffuse and usually results in replacement by stronger but less well specialised epithelium.
  Depending upon the type epithelium transformed, two types of epithelial metaplasia are seen squamous and columnar.

1. Squamous metaplasia. This is more common. Various types of specialised epithelium are capable of undergoing squamous metaplastic change due to chronic irritation that may be mechanical, chemical or infective in origin. common examples of squamous metaplasia are seen at bronchus (normally lined by pseudostratified columnar ciliated epithelium) in chronic smoker*)*

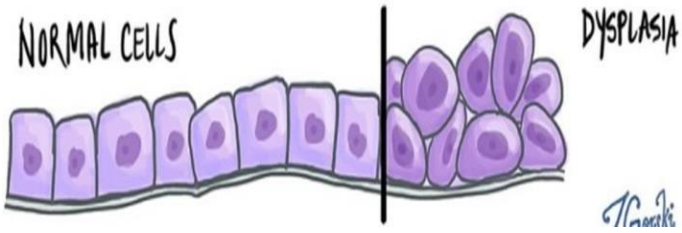
2. Columnar metaplasia. There are some conditions in which there is transformation to columnar epithelium. For example: Conversion of pseudostratified ciliated columnar epithelium in chronic bronchitis

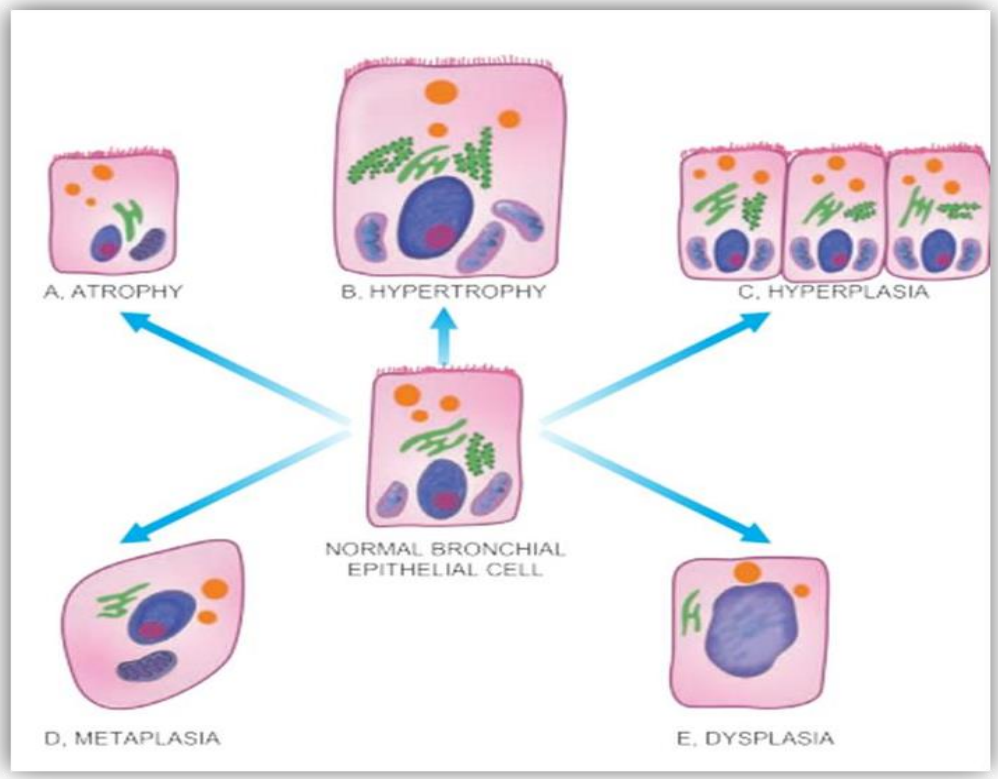
- **Mesenchymal metaplasia**. Less often, there is transformation of one adult type of mesenchymal tissue to another. An examples scar of chronic inflammation



Metaplasia of columnar to squamous epithelium.
A, Schematic diagram
. B, Metaplasia of columnar epithelium (left)
to squamous epithelium (right) in a bronchus

5-Dysplasia means 'disordered cellular development', often accompanied with metaplasia and hyperplasia. Dysplasia occurs most often in epithelial cells. Epithelial dysplasia is characterised by cellular proliferation and cytologic changes. Dysplastic changes often occur due to chronic irritation or prolonged inflammation





Adaptive disorders