

# CELLULAR ADAPTATION



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## **CELLULAR ADAPTATION**

Cellular adaptation refers to changes made by a cell in response to various types of stimuli or different environmental changes. The adaptation may be physiologic (normal) or pathologic (abnormal).

**TYPES:** Four types of morphological adaptations include **atrophy, hypertrophy, hyperplasia, and metaplasia.**

### **ATROPHY:**

Atrophy is a decrease in cell size. If enough cells in an organ undergo atrophy the entire organ will decrease in size.

### **MORPHOLOGY:**

Gross Anatomy- Decrease in size of the organ.

Microscopic- Decrease in no of the cell.

### **Physiological Causes:**

- 1. Atrophy of Thymus:** Thymus plays an important role in the production of antibodies in childhood. In adult stage the size of thymus decreases and converts in to muscular tissue.
- 2. Atrophy of Gonads:** After menopause atrophy of gonads occurs, which leads to decrease in size of gonads and inability in reproduction.
- 3. Atrophy of Brain:** With rising age atrophy of brain occurs, which leads to decrease in the size of the brain.

### **Pathogenic Causes:**

- 1. Muscle Atrophy:** Muscle atrophy is the loss or thinning of your muscle tissue. Muscles look smaller than normal. It can occur due to malnutrition, age, genetics, a lack of physical activity or certain medical conditions.

2. **Disuse Atrophy:** It occurs when we don't use our muscles enough.
3. **Cerebral Atrophy: The loss of nerve cells (neurons)** occurs in many disorders that affect the brain, such as stroke, Alzheimer's, disease, traumatic brain injury, multiple sclerosis, or infections.
4. **Endocrinal Atrophy:** A destructive process that affect the pituitary gland with loss of hormones leads to atrophy of the thyroid gland, adrenal glands, and gonads. The decrease in size of the endocrine glands may be extreme.

### **HYPERTROPHY:**

Hypertrophy is an increase in cell size and volume. If enough cells of an organs having hypertrophy, the whole organ will increase in size. Hypertrophy may involve an increase in intracellular protein as well as cytosol (intracellular fluid) and other cytoplasmic components.

### **MORPHOLOGY:**

Gross Anatomy- Increase in size of the organ.

Microscopic- Enlargement of muscle fibers.

### **Physiological Causes:**

1. **Uterus Hypertrophy:** Uterus Hypertrophy occurs during pregnancy. It give space for baby development inside the uterus.
2. **Breast Hypertrophy:** Breast Hypertrophy occurs during lactation period. It stores milk for baby.
3. **Muscle Hypertrophy:** Muscle Hypertrophy occurs in athletes and bodybuilder, in which muscle enlargements occurs.

### **Pathogenic Causes:**

1. **Cardiac Hypertrophy:** Cardiac hypertrophy occurs due to heart disease including ischemic disease, hypertension, heart failure, and

valvular disease. In this condition thickening and enlargement of cardiac muscle occurs.

2. **Smooth muscle Hypertrophy:** Smooth muscle hypertrophy occurs due to asthma, pyloric stenosis etc.. In this condition thickening and enlargement of smooth muscle occurs.
3. **Compensatory Hypertrophy:** surgical removal of one kidney, the other enlarges and increases its function.

## **HYPERPLASIA:**

Hyperplasia is an increase in the number of cells. It is the result of increased cell mitosis or division (also referred to as cell proliferation).

## **MORPHOLOGY:**

Gross Anatomy- Increase in size of the organ.

Microscopic- Increase in number of the organ.

**Physiological Causes:** There are two types of physiological hyperplasia are compensatory and hormonal.

1. **Compensatory Hyperplasia:** Compensatory hyperplasia permits tissue and organ to regenerate. It is common in epithelial cells of the epidermis and intestine, liver hepatocytes, bone marrow cells, and fibroblasts.
2. **Hormonal Hyperplasia:** Hormonal hyperplasia occurs mainly in organs that depend on estrogen.  
For example: the progesterone-dependent uterine cells undergo hyperplasia during pregnancy. The oxytocin-dependent breast cells undergo hyperplasia during lactation.

## **Pathogenic Causes:**

1. **Endometrial Hyperplasia:** Due to excess secretion of hormone like estrogen, it leads to endometrial hyperplasia.

Endometrial Hyperplasia also leads endometrial cancer further.

2. **Cell Hyperplasia:** Pathologic hyperplasia occurs in any part of organ that leads to an abnormal increase in cell number or division leads to cancer.

## **METAPLASIA:**

Metaplasia (Greek: "change in form") is the reversible transformation of one differentiated cell type to another differentiated cell type. The change from one type of cell to another may be part of a normal maturation process, or caused by some sort of abnormal stimulus. If the stressor is eliminated, the cells may be able to return to their normal patterns.

- Metaplasia is not considered cancerous and is categorized as a premalignant condition. If it left unnoticed or untreated, it can be a precursor to cancer.

## **MORPHOLOGY:**

Gross Anatomy- Changes in structure and size of the cell.

Microscopic- Mature cellular development from specialized to less specific.

## **Pathogenic Causes:**

1. **Skin Metaplasia:** In relation to skin cancer, If skin is overexposure to UV rays. Prolonged sunlight exposure causes skin cells to speed up their reproduction rate, which can lead to unwanted lesions or sores. Proper sun skin care such as applying sunscreen or wearing protective clothing can reduce the harmful effects of this stressor.
2. The change of the cuboidal/columnar/transitional epithelium of air way into stratified epithelium due to vitamin A deficiency.

3. The change of transitional cells into stratified squamous epithelium in kidney due to kidney stones.
4. The change of the squamous epithelium into columnar epithelium in esophagus (Barrett's esophagus) due to acid reflux.
5. The change of the glandular epithelium into squamous epithelium in vagina due to the low pH of the vagina.

### **DYSPLASIA:**

Dysplasia is a ir-reversible transformation. It involves abnormal cell development caused by internal issues. Dysplasia has a higher chance of leading to cancer than metaplasia.

### **MORPHOLOGY:**

Gross Anatomy- Changes in structure and size of the cell.

Microscopic- Immature cellular development from specialized to less specific.

### **Pathogenic Causes:**

#### **Epithelial dysplasia:**

Epithelial dysplasia consists of an expansion of immature cells (such as cells of the ectoderm) in skin, with a corresponding decrease in the number and location of mature cells.

#### **Myelodysplastic syndrome:**

Myelodysplastic syndromes (MDS) are a group of cancers in which immature blood cells in the bone marrow do not mature and therefore do not become healthy blood cells.

#### **Fibrous dysplasia of bone:**

Fibrous dysplasia of bone is a disorder where normal bone and marrow is replaced with fibrous tissue, resulting in formation of bone that is weak.

As a result, most complications result from fracture, deformity, functional impairment and pain.

## METAPLASIA VERSUS DYSPLASIA

METAPLASIA	DYSPLASIA
Conversion of a mature, differentiated cell into another form of a mature cell type, often following injury or insult	Development of abnormal types of cells within a tissue, which may signify a stage preceding the development of cancer
Conversion in cell type	Change in the phenotype of cells or a tissue
Occurs in various types of tissues	Mainly occurs in the epithelium
An adaptive process that occurs due to an external stimulus	Occurs due to the alteration of genetic material
A reversible process	An irreversible process
Does not lead to the formation of cancers	May cause cancers

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