**Cellular Adaptations**

Adaptations are reversible changes in the cell size, number, shape and metabolic activity in response to the environmental stimuli.

Cellular adaptations may be:-

1. Physiological adaptations
2. Pathological adaptations

**Physiological adaptations:**

They occur in response to the normal stimulation by hormones or other endogenous chemical substance. e.g enlargement of breast

**Pathological adaptations:**

They occur in response to some pathological stimuli. e.g change of normal ciliated columnar epithelium of respiratory tract into stratified squamous epithelium by smoking.

**Types of cellular adaptations**

* Atrophy
* Hypertrophy
* Hyperplasia
* Metaplasia

**Atrophy:**

Atrophy refers to the shrinkage of cell size by loss of cell substance.

**Physiological causes:**

1. Decrease workload
2. Inadequate nutrition
3. Aging

**Decrease workload**: If a patient has fracture, Dr advises him bed rest and his limbs are immobilize. To permit healing of fracture that results in the shrinkage of cell size.

**Inadequate nutrition**: Due to inadequate nutrition to the body.

**Aging**: Due to aging, there is loss of reproduction functions in men and women. In old age there is formation of senile plaque that is called senile atrophy, formed in brain.

**Pathological causes**:

1. Loss of innervation
2. Loss of blood supply
3. Loss of endocrine stimulation

**Loss of innervation**: Loss of innervation results in denervation atrophy.

**Loss of blood supply**: Ischemic atrophy is due to loss of blood supply.

**Loss of endocrine stimulation**: It results in hormonal atrophy.

**Mechanism of Atrophy**

Atrophy is due to:

* Ubiquitin proteasome pathway
* Autophagy

When there is starvation, there is activation of ubiquitin ligase that attach ubiquitin protein to the target proteins. Then these proteins are available for degradation by proteasomes.

**Hypertrophy**

Hypertrophy is the increase in size of cells resulting in increased in size of organs. Hypertrophy usually occurs in those cells that have limited capacity to divide whereas hyperplasia occurs in those cells that have higher ability to proliferate.

Hypertrophy and hyperplasia can occur together but difference is that hypertrophy occurs in response to functional demand, growth factor and hormonal stimulation and hypertrophy can be physiological and pathological.

**Physiological hypertrophy:**

**Example 01:-** In this case, there is increase in size of uterus during pregnancy as a consequence of estrogen stimulated smooth muscle that cause hypertrophy and hyperplasia.

**Example 02:-** In response to functional demand, the striated muscle in the heart and skeletal can become hypertrophic because they have limited proliferated cells.

**Pathological hypertrophy:**

**Example:** - Cardial hypertrophy due to hypertension or aortic valve disease.

**Mechanism:**

Mechanism of cardiac hypertrophy is involvement of two signals:-

1. Mechanical triggers i-e stretch
2. Trophic factor

These signals turn on transduction pathway that lead to induction of gene, responsible for synthesis of some growth factors and structural protein that results in increased synthesis of more proteins and microfilament per cell which increase the force of contraction to overcome the demand. Hypertrophy have some limitations that it cannot continue to occur due to:-

* Limited vascular supply to the enlarged fibers
* Diminished oxidative capacity of mitochondria
* Altered protein functions