

# CELLULAR ADAPTATION

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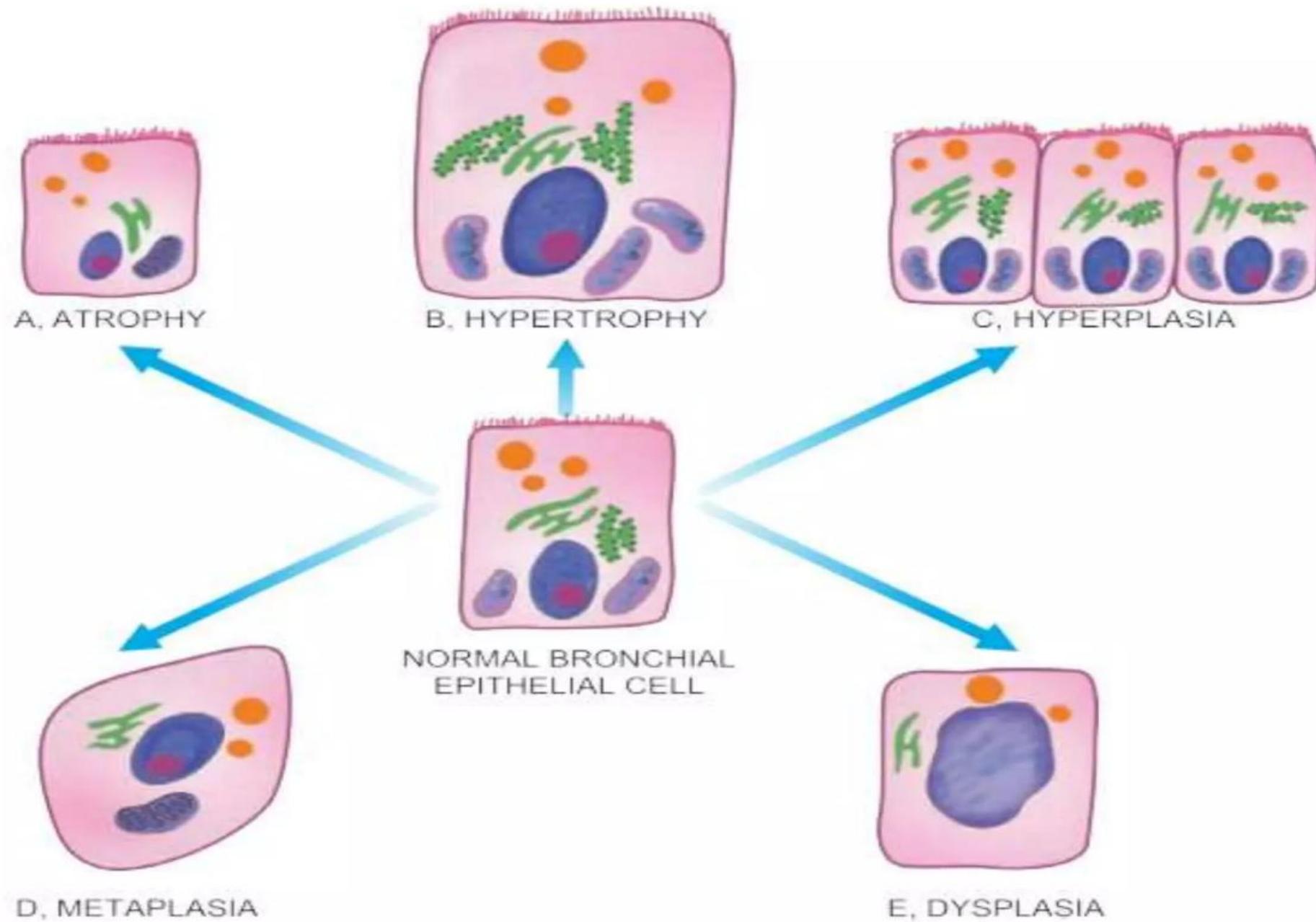
Cell adaptation is the reversible structural and functional response of cells to physiologic and pathologic stress.

Purpose: To maintain homeostasis and ensure cell survival.

If stress persists → progression to cell injury → cell death.

## Types of Cell Adaptation

1. **Atrophy** - decrease in cell size.
2. **Hypertrophy** - increase in cell size.
3. **Hyperplasia** - increase in cell number.
4. **Metaplasia** - replacement of one cell type with another.
5. **Dysplasia** - disordered cell growth (premalignant).



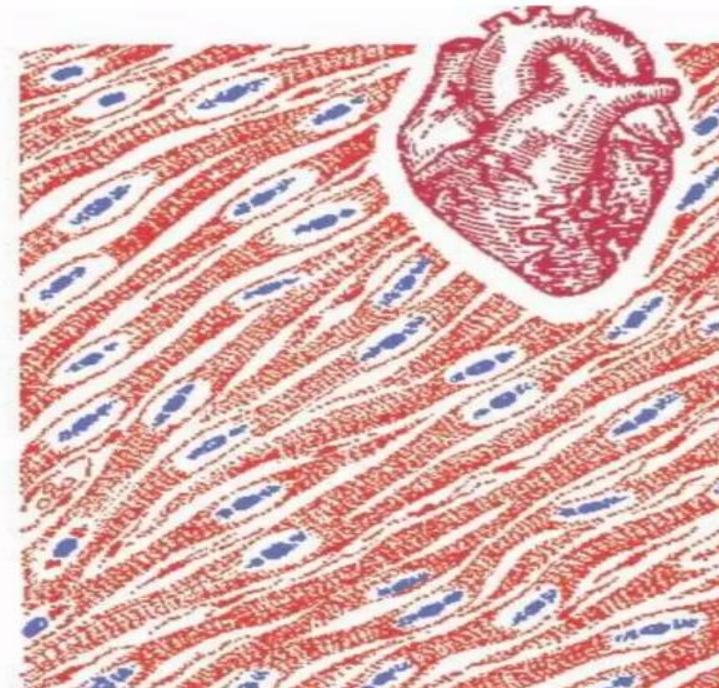
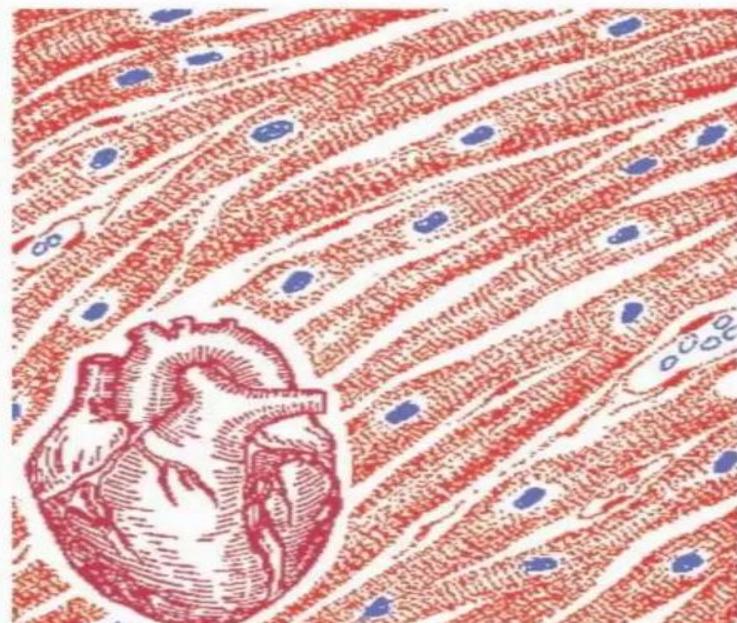
## Atrophy

- **Definition:** Reduction in cell size and organ volume.
- **Causes:**
  - Decreased workload (immobilization).
  - Denervation.
  - Ischemia or poor nutrition.
  - Aging.
- **Examples:** Brain atrophy in Alzheimer's disease, muscle atrophy in limb immobilization.

# Atrophy

**Definition:** Acquired loss of size due to reduction of cell size or number of parenchyma cells in an organ

**Types:** Physiologic or Pathological



Left Normal  
Atrophy

Right

# ATROPHY

Atrophy may occur from physiologic and pathologic causes:

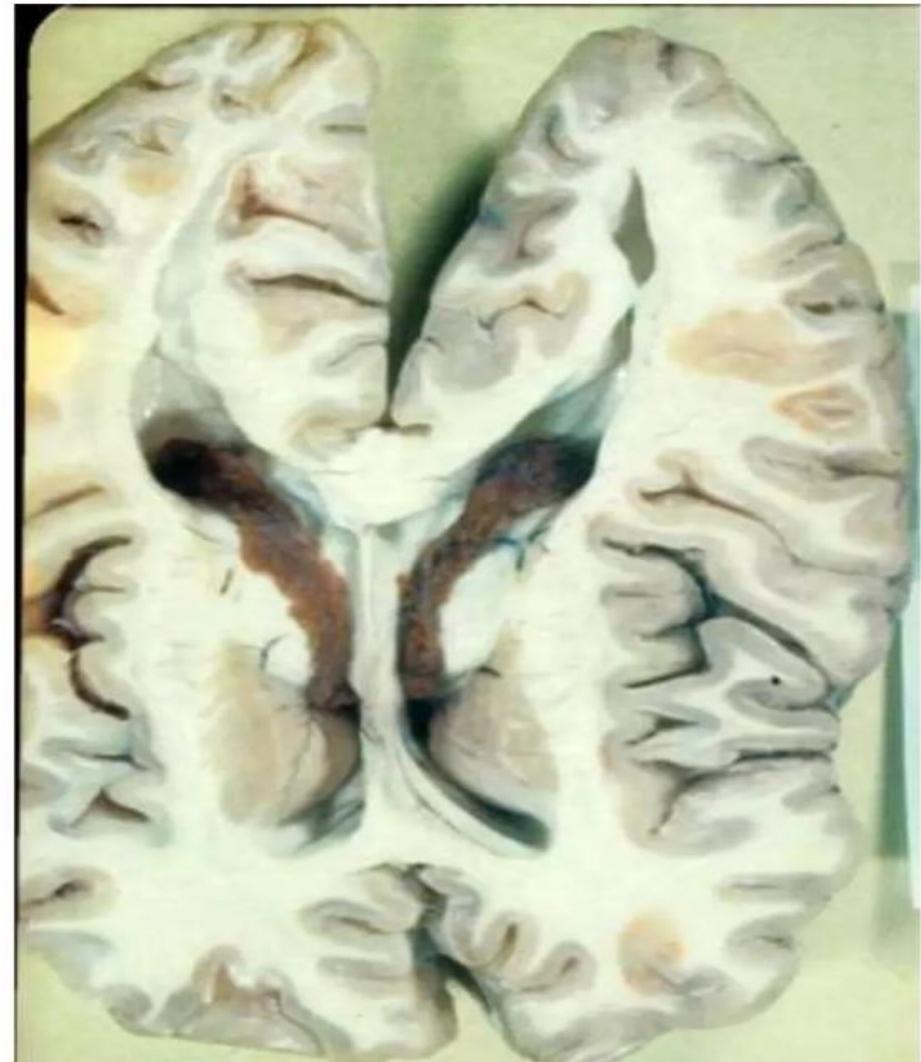
PHYSIOLOGIC  
ATROPHY

Atrophy of brain with  
aging.

Atrophy of gonads after  
menopause.

# Physiologic atrophy

- ▶ A normal process of aging in some tissues, which could be due to loss of endocrine stimulation or arteriosclerosis.
  - Atrophy of **lymphoid** tissue in lymph nodes, appendix and thymus.
  - Atrophy of **gonads** after **menopause**.
  - Atrophy of **brain** with **aging**.



# Pathologic atrophy.

- ▶ Starvation atrophy.
- ▶ Ischaemic atrophy
- ▶ Disuse atrophy.
- ▶ Neuropathic atrophy.
- ▶ Endocrine atrophy
- ▶ Pressure atrophy.
- ▶ Idiopathic atrophy

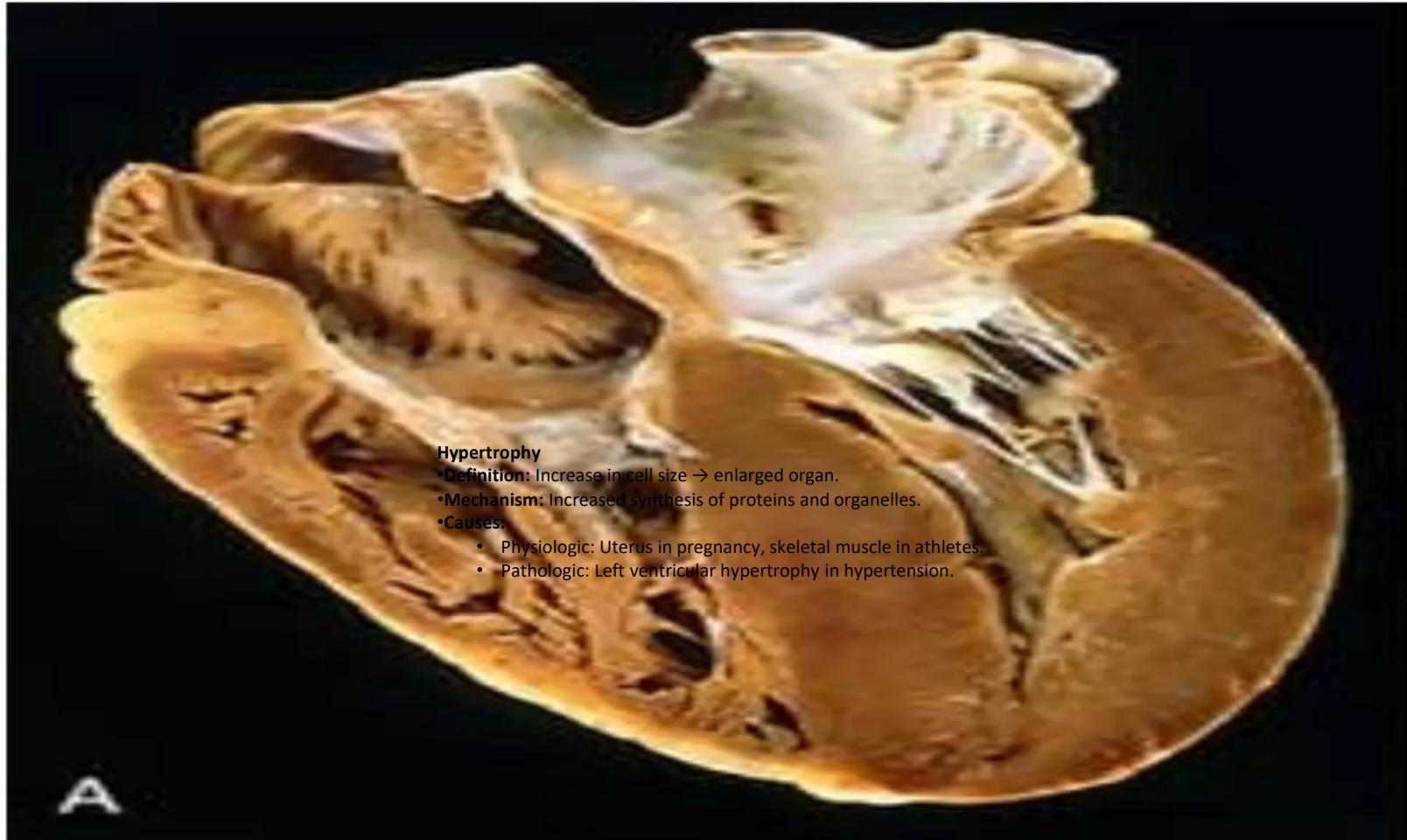
# **Hypertrophy**

- **Definition:** Increase in cell size → enlarged organ.
- **Mechanism:** Increased synthesis of proteins and organelles.
- **Causes:**
  - Physiologic: Uterus in pregnancy, skeletal muscle in athletes.
  - Pathologic: Left ventricular hypertrophy in hypertension.

# 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.



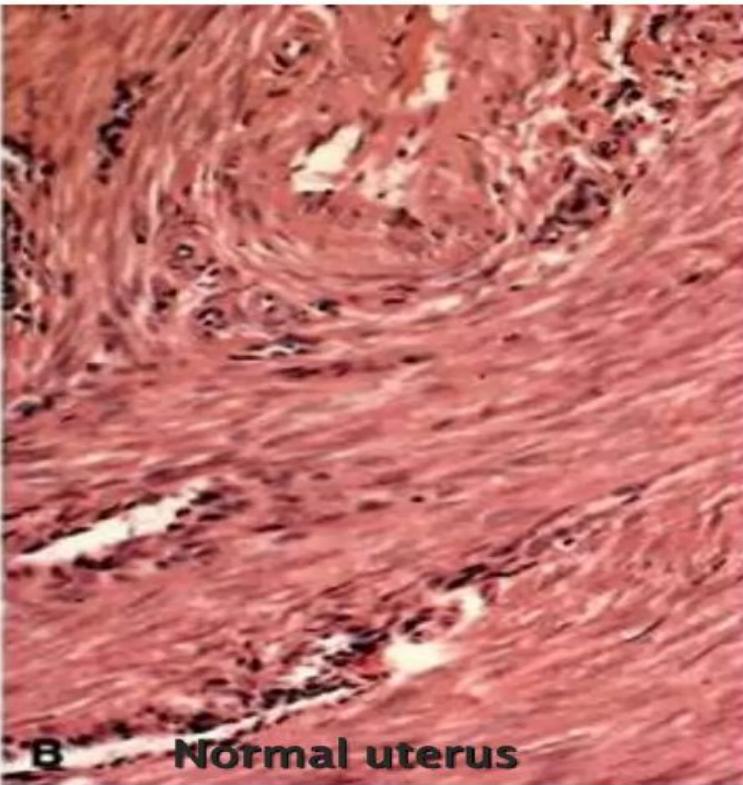
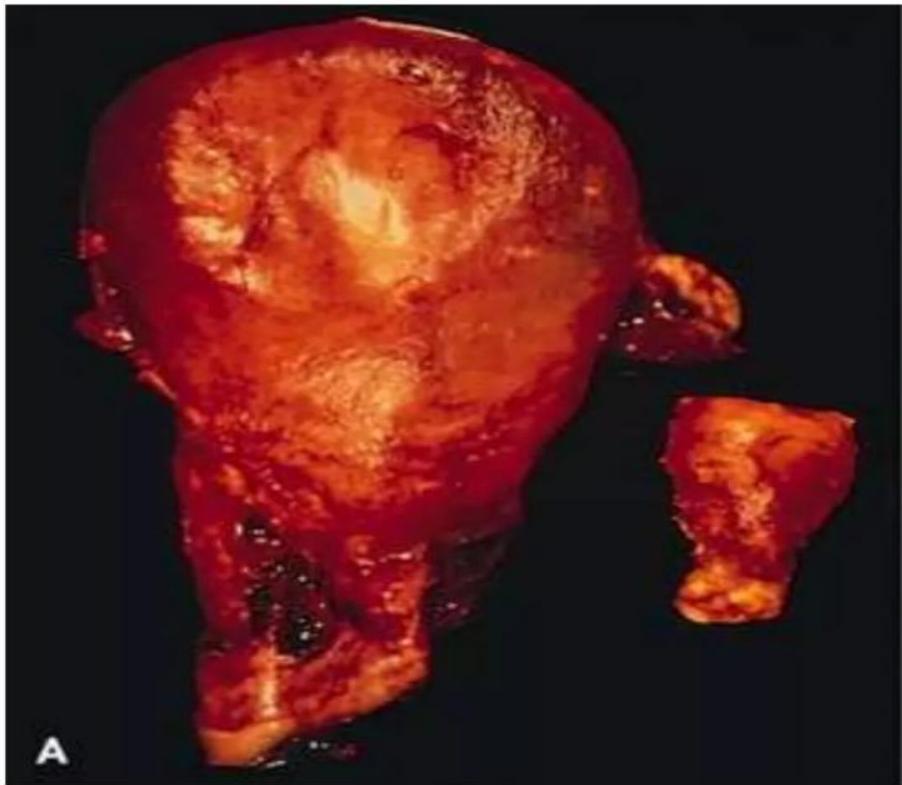


**Hypertrophy**

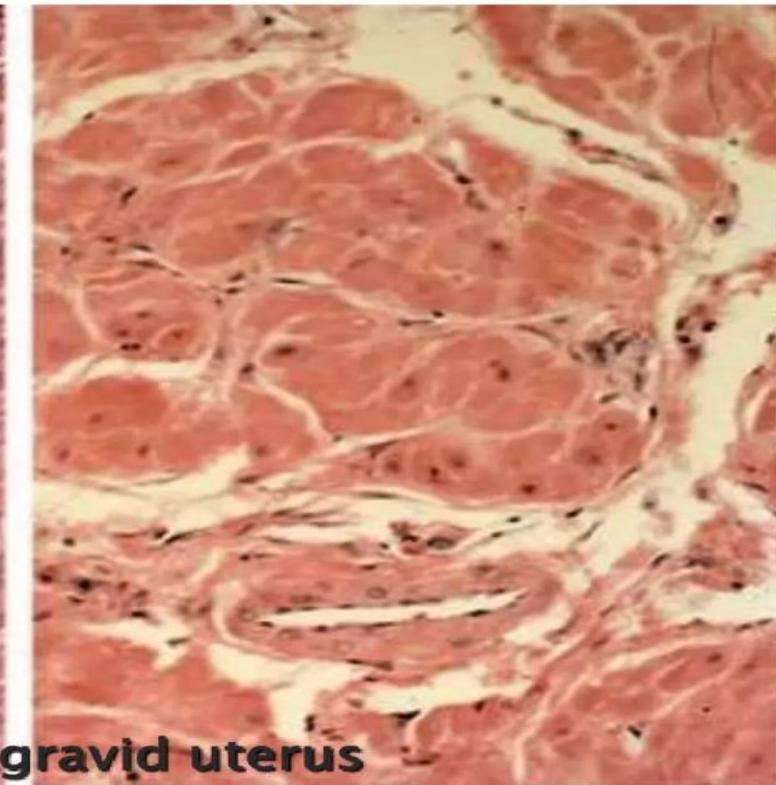
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## **Hypertrophied heart**

(From ROBBINS BASIC PATHOLOGY, 2003)



**B** Normal uterus



**gravid uterus**

**Physiologic hypertrophy of the uterus during pregnancy.** A, gross appearance of a normal uterus (right) and a gravid uterus (left) that was removed for postpartum bleeding,

(From ROBBINS BASIC PATHOLOGY, 2003)

## Hyperplasia

- **Definition:** Increase in the number of cells.
- **Causes:**
  - Physiologic: Hormonal (endometrial proliferation in menstrual cycle), compensatory (liver regeneration).
  - Pathologic: Endometrial hyperplasia, benign prostatic hyperplasia (BPH).
- **Note:** Controlled process, but can predispose to cancer.

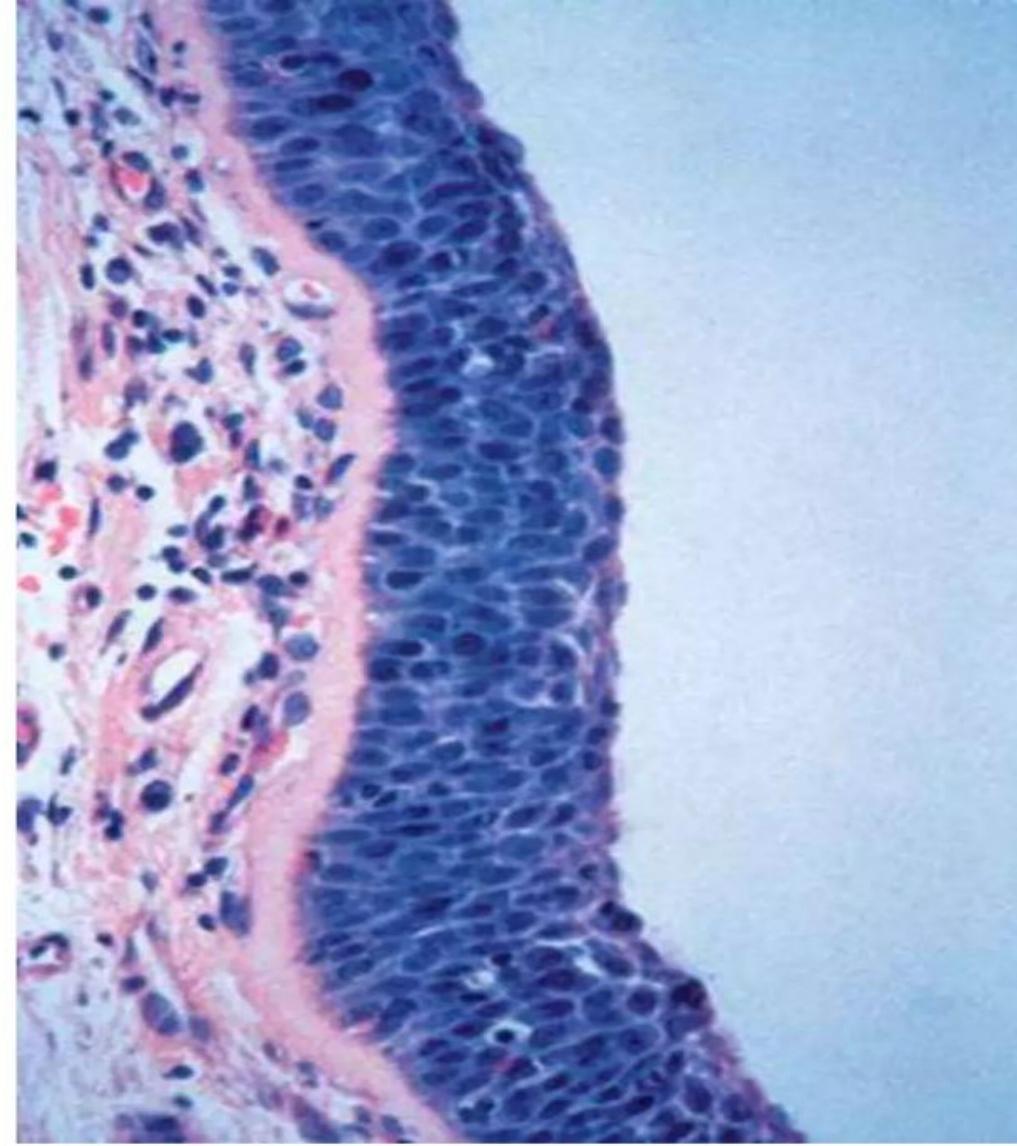
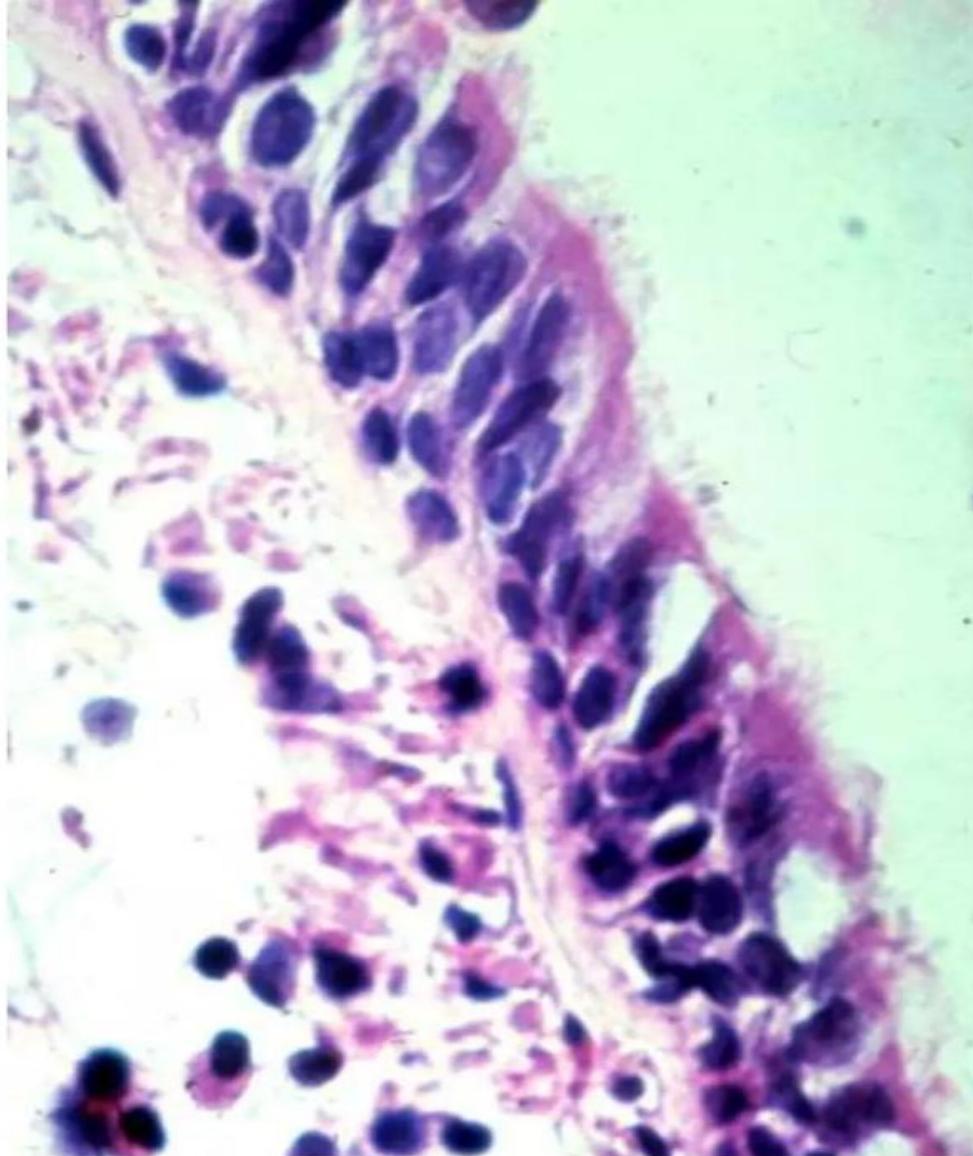
## Metaplasia

- **Definition:** Replacement of one differentiated cell type by another more resilient type.

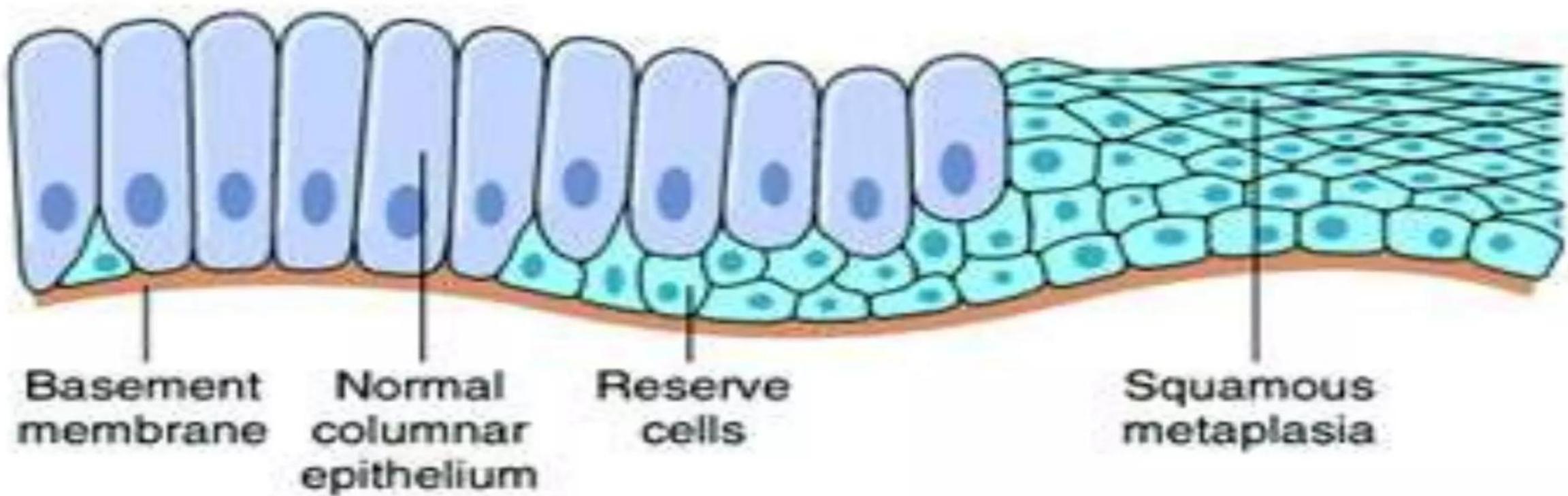
- **Examples:**

- Bronchial squamous metaplasia in smokers (columnar → squamous).
- Barrett's esophagus (squamous → columnar epithelium).

- **Significance:** May progress to dysplasia and malignancy.



**Squamous metaplasia in bronchitis**  
(offered by Prof.Orr)



A

Schematic diagram of columnar to squamous metaplasia

(From ROBBINS BASIC PATHOLOGY, 2003)

## **Dysplasia**

- **Definition:** Disordered growth and maturation of cells with loss of uniformity.
- **Causes:** Often due to chronic irritation or infection (e.g., HPV in cervix).
- **Examples:** Cervical intraepithelial neoplasia (CIN).
- Considered a **precancerous lesion**.