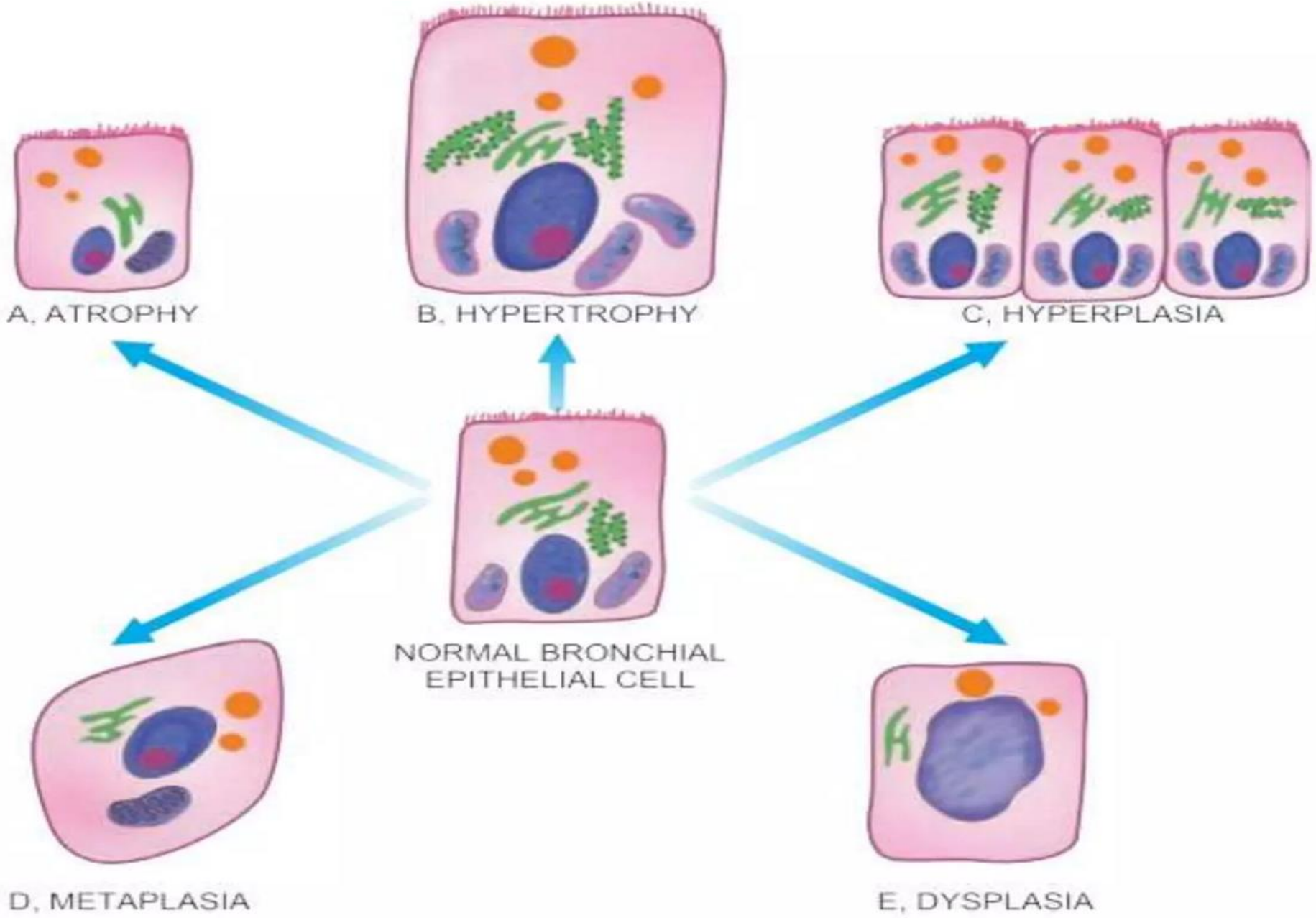
# CELLULAR ADAPTATION

practical

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).


A, ATROPHY
B, HYPERTROPHY
C, HYPERPLASIA
NORMAL BRONCHIAL
EPITHELIAL CELL
D, METAPLASIA
E, DYSPLASIA

**Atrophy**

•**Definition:** Reduction in cell size and organ volume.

•**Causes:**

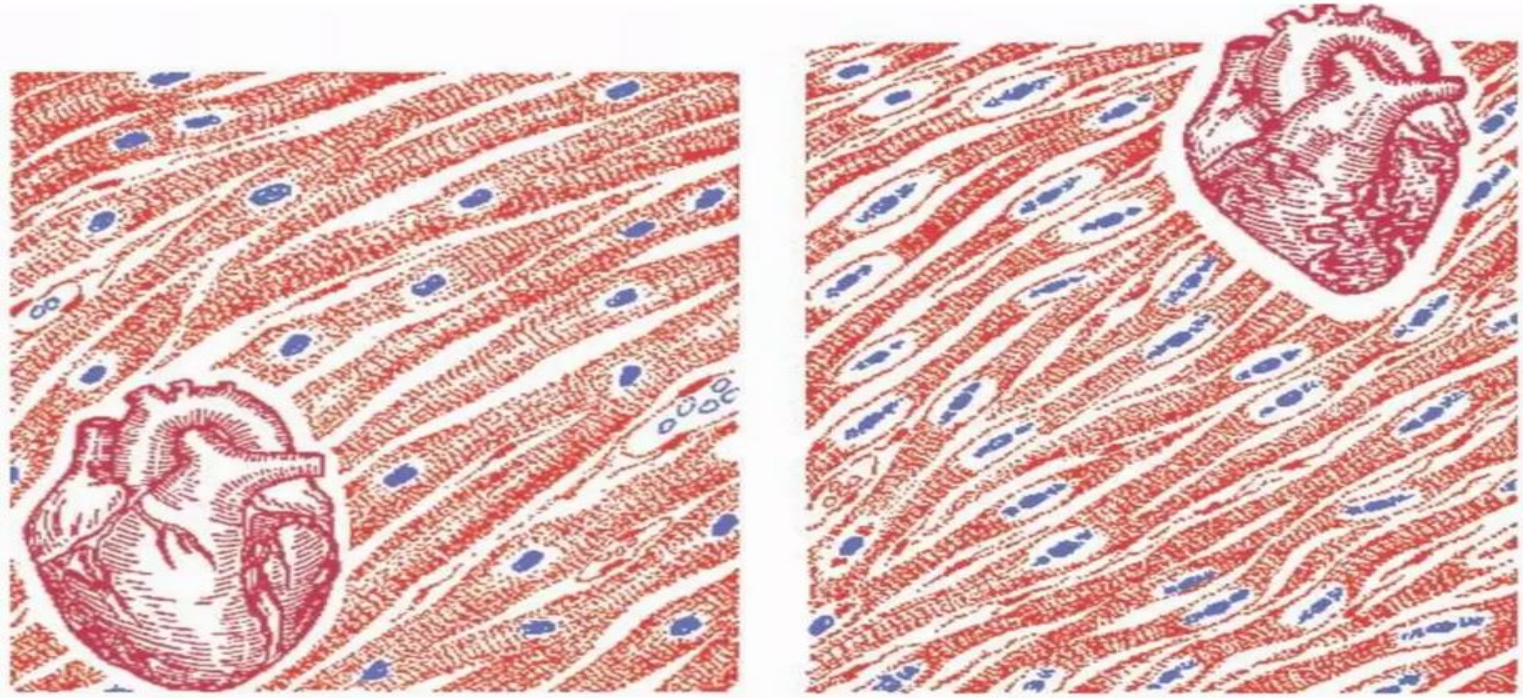
- Decreased workload (immobilization).
- Denervation.
- Ischemia or poor nutrition.
- Aging.

•**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 Right

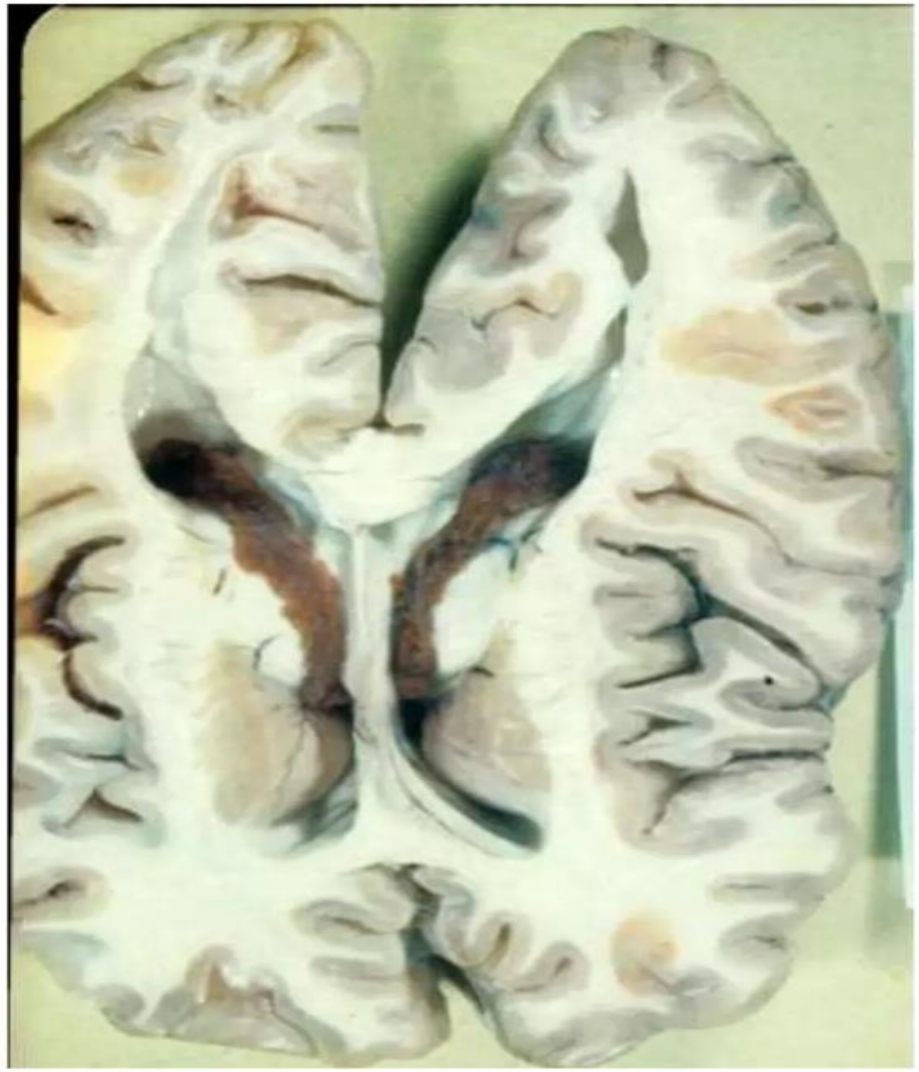
Atrophy

# ATROPHY

Atrophy may occur from physiologic and pathologic causes:

# 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**.



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# 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.


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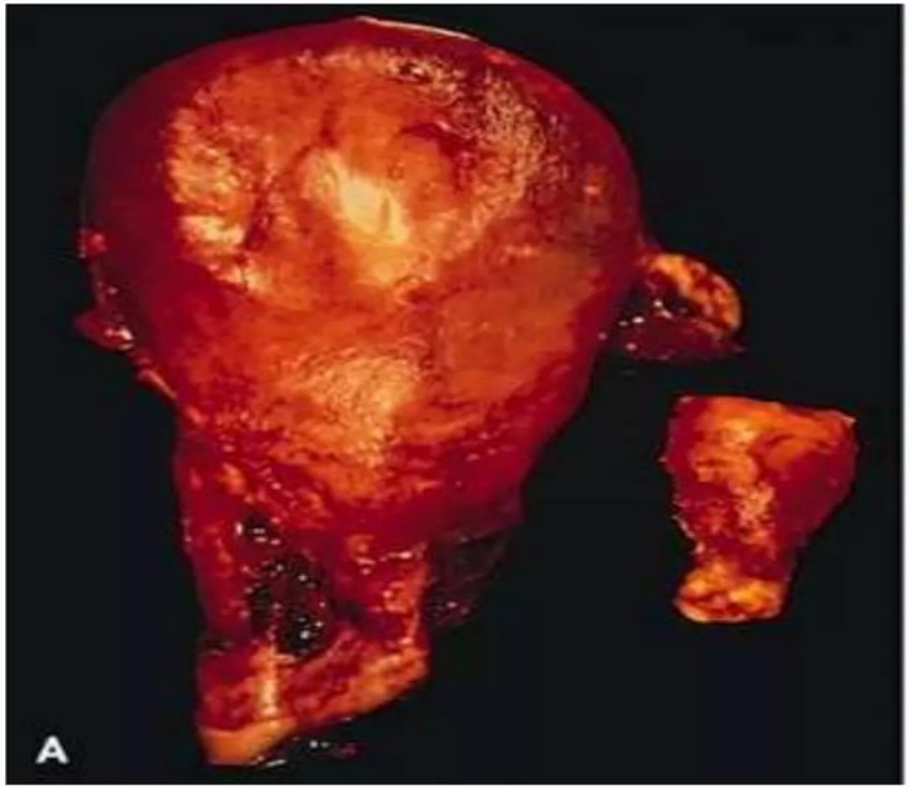
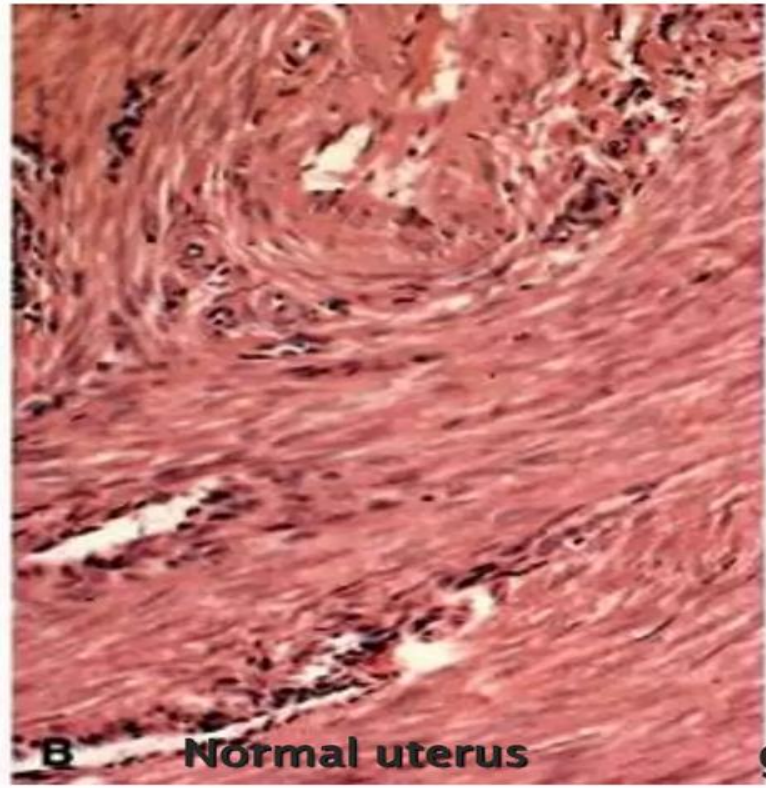
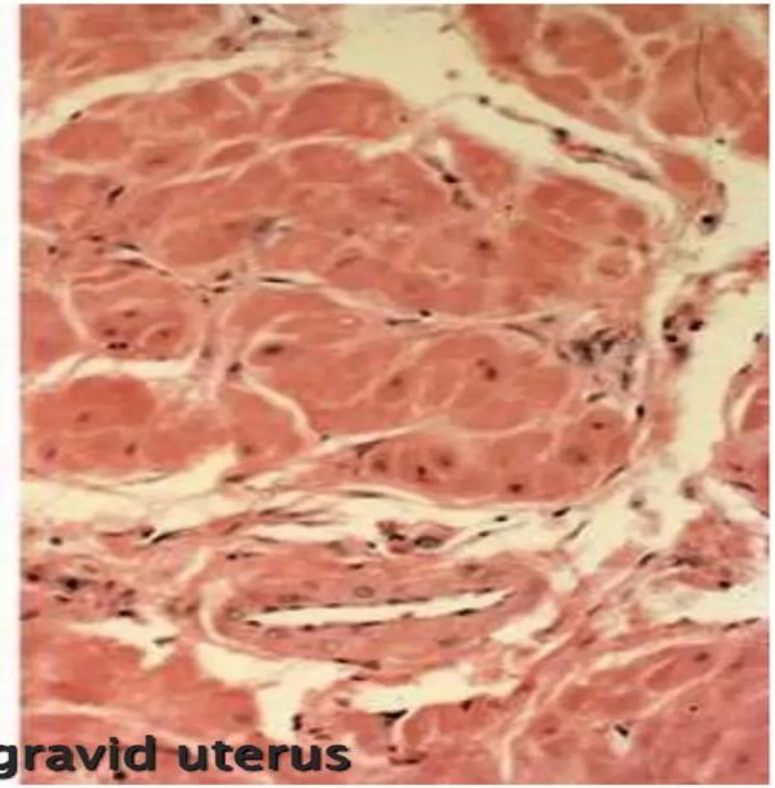
**Hypertrophied heart**

（From ROBBINS BASIC PATHOLOGY，2003）




**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.

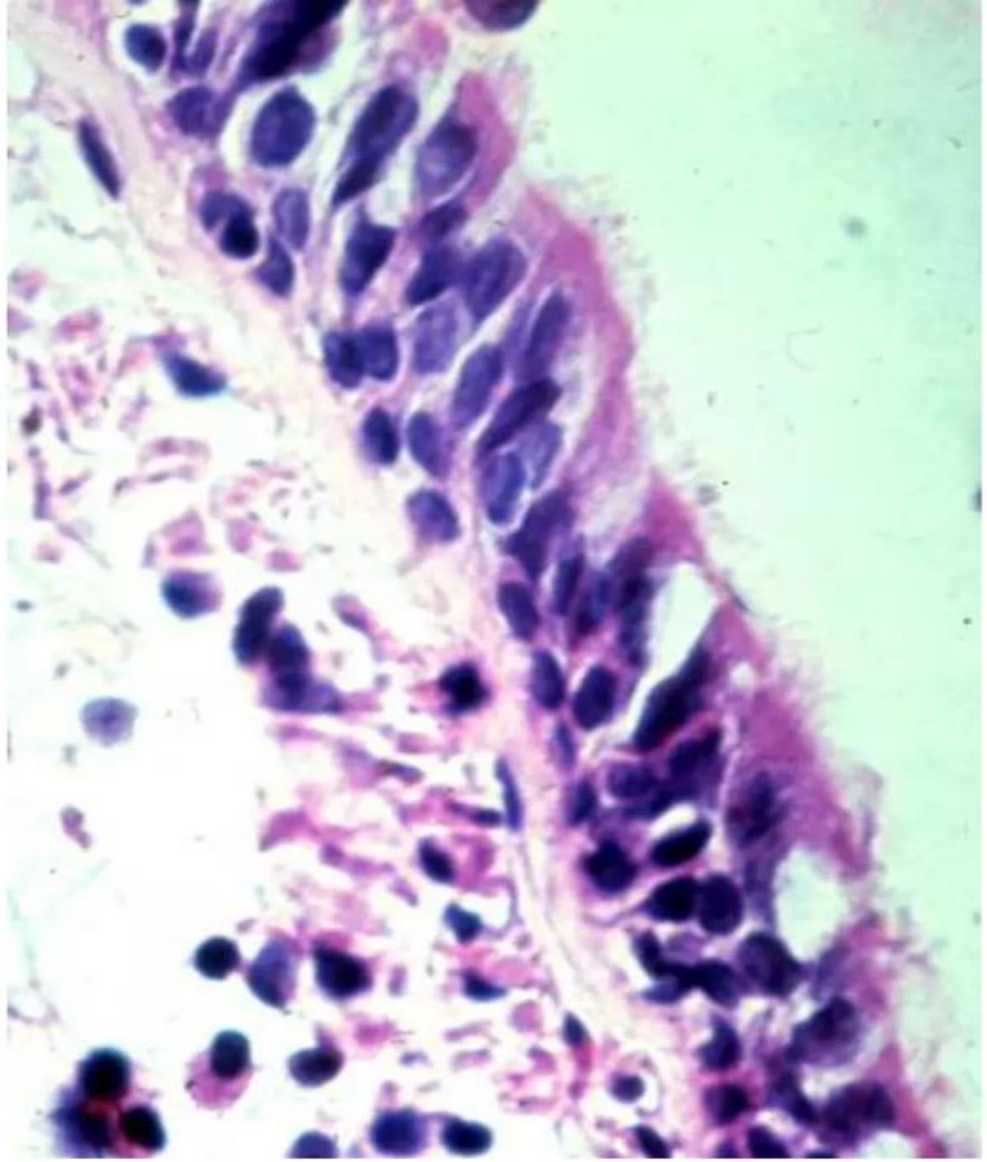
**Metaplasia**

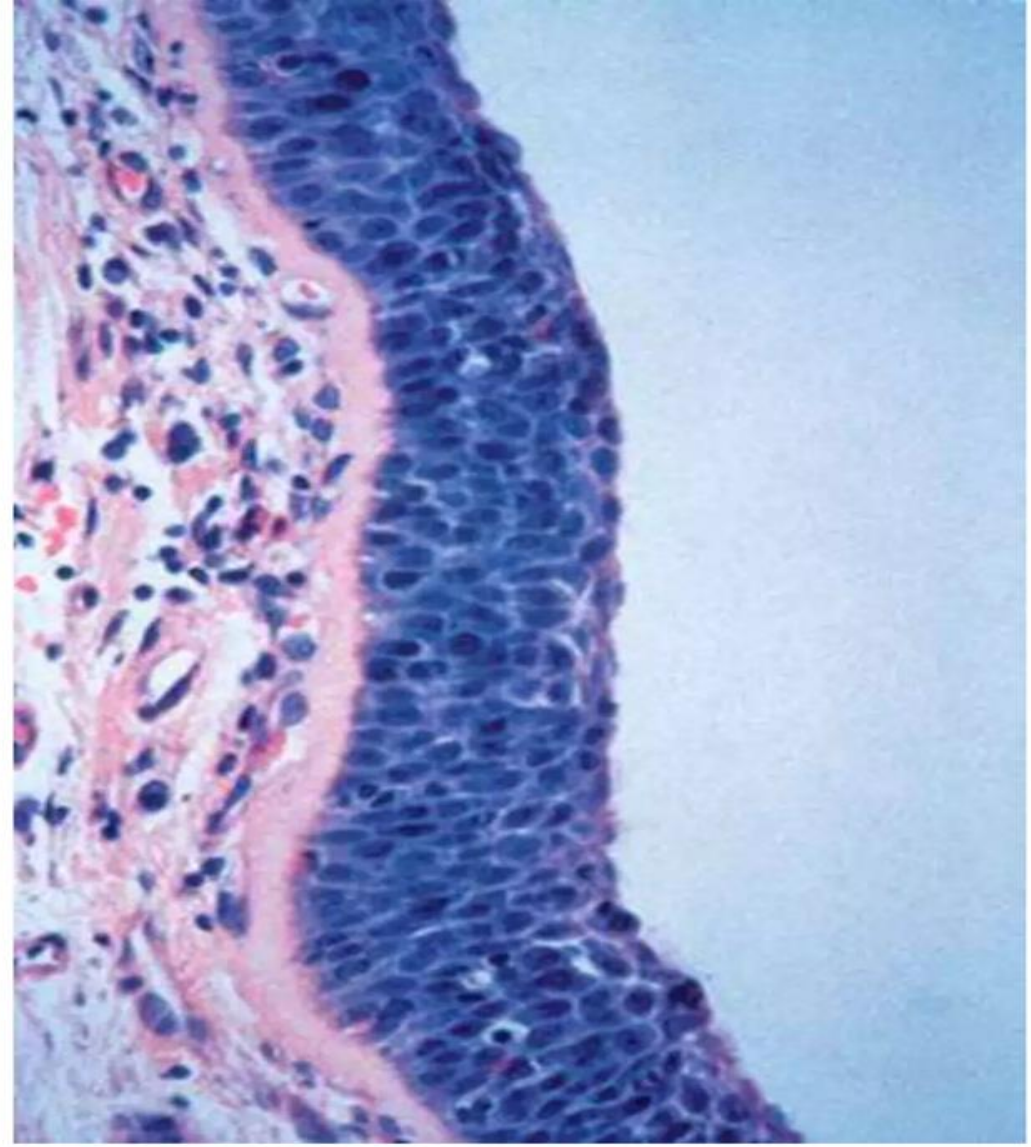
•**Definition:** Replacement of one differentiated cell type by another more resilient type.

•**Examples:**

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

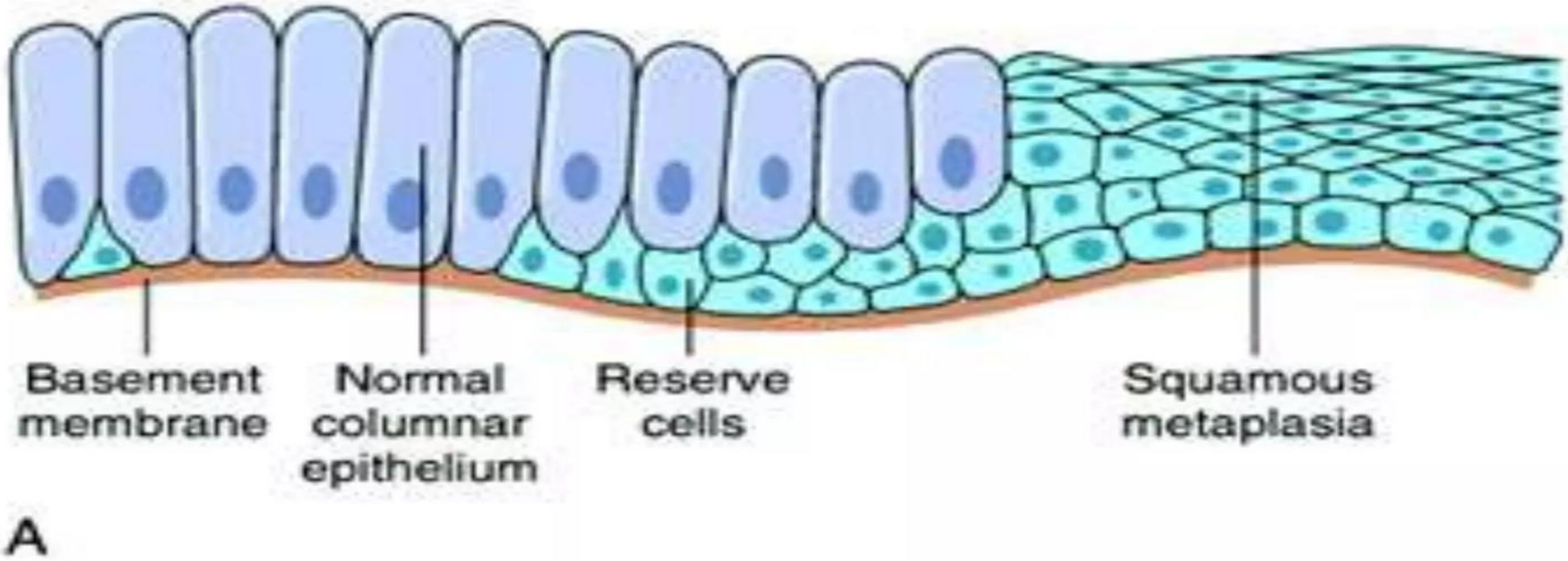
•**Significance:** May progress to dysplasia and malignancy.





Squamous metaplasia in bronchitis

(offered by Prof.Orr)




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**.


Thank you