GROWTH DISTURBANCES LECTURE

Theory lecture .9

2023-2024

- The terms agenesis, aplasia, hypoplasia, and atresia refer to growth anomalies (singular anomaly) that characterize by subnormal growth.
- They can occur in any organ.

Agenesis

Complete absence of an organ due to absence of the anlage (primordial tissue) absent since birth, e.g., one kidney might be absent since birth.

Unilateral renal agenesis

Aplasia

- The primordial tissue is present but it never develops into the organ.
- Example., lung aplasia with tissue containing rudimentary ducts and connective tissue.

Nota bene:

- Segmental aplasia is a term used to describe the absence of a localized region in a tubular organ, e.g., segmental aplasia of the uterine tube.

- The term “aplastic” is sometimes refers to certain conditions that characterize by no tendency to form new tissue, e.g., aplastic anemia

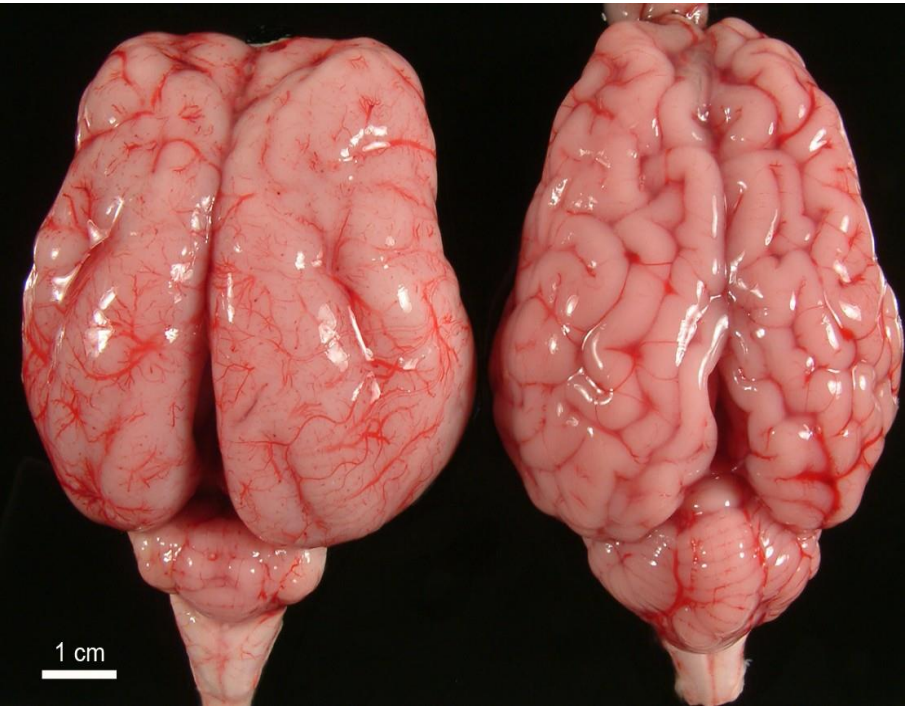
Atresia

- The term atresia refers to absence, or closure of a normal body opening, e.g., atresia ani which means absence of the anus at birth.

Hypoplasia

- Hypoplasia is a growth anomaly in which the affected tissue or organ did not reach its normal size or structure (i.e., incomplete growth).
- This term may used to describe a wide range of incomplete growth from just short of normal growth to agenesis. **Examples of hypoplasia are:**

1. Hypoplastic cerebellum
2. Hypoplastic testis or ovary (hypogonadism)
3. Hypoplastic kidney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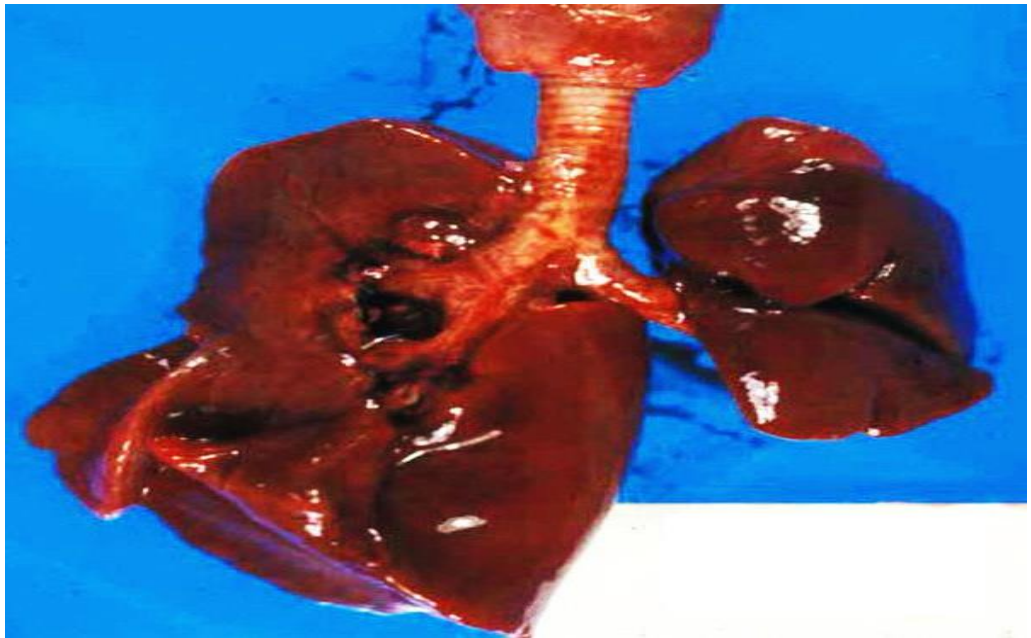
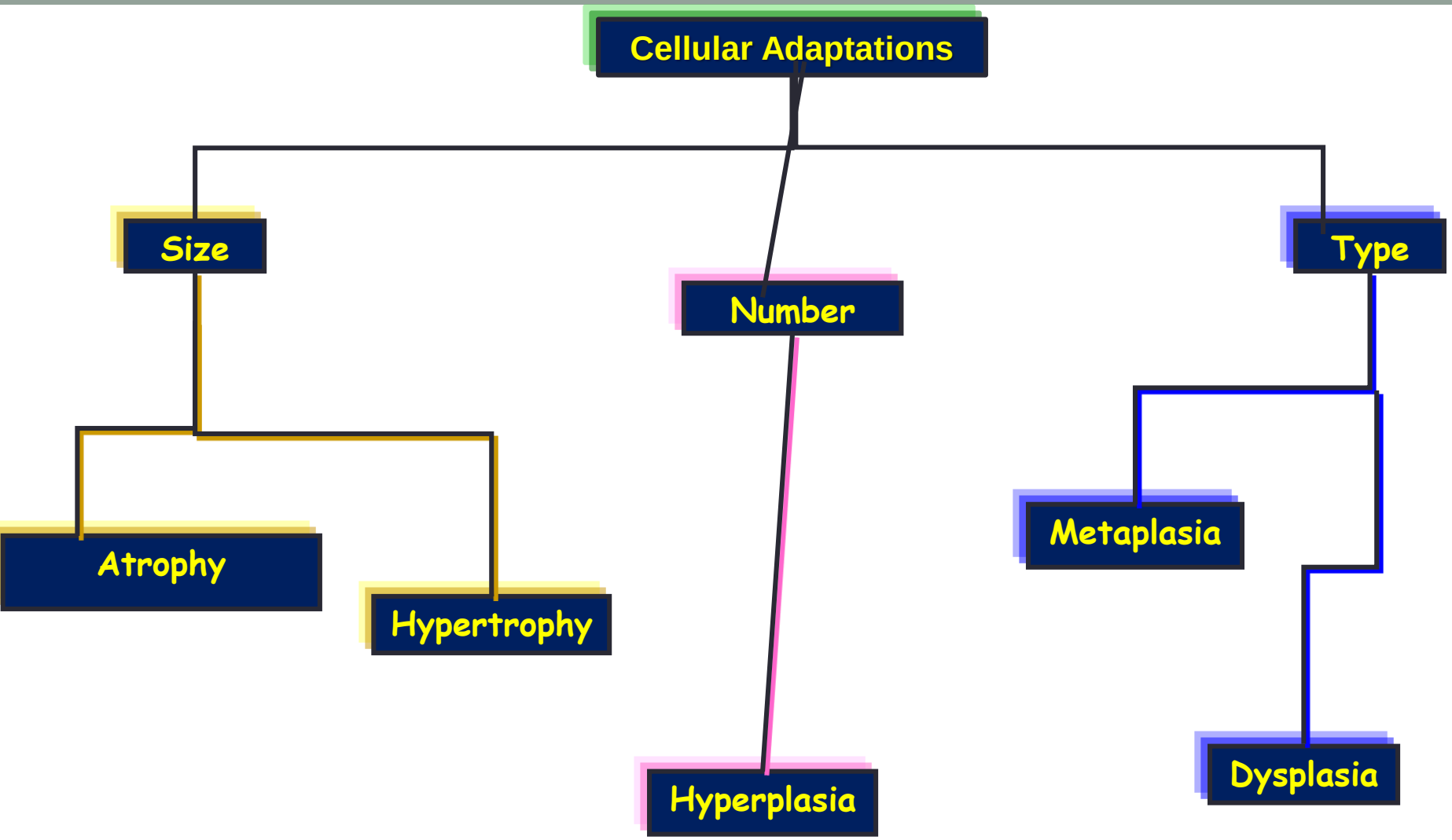


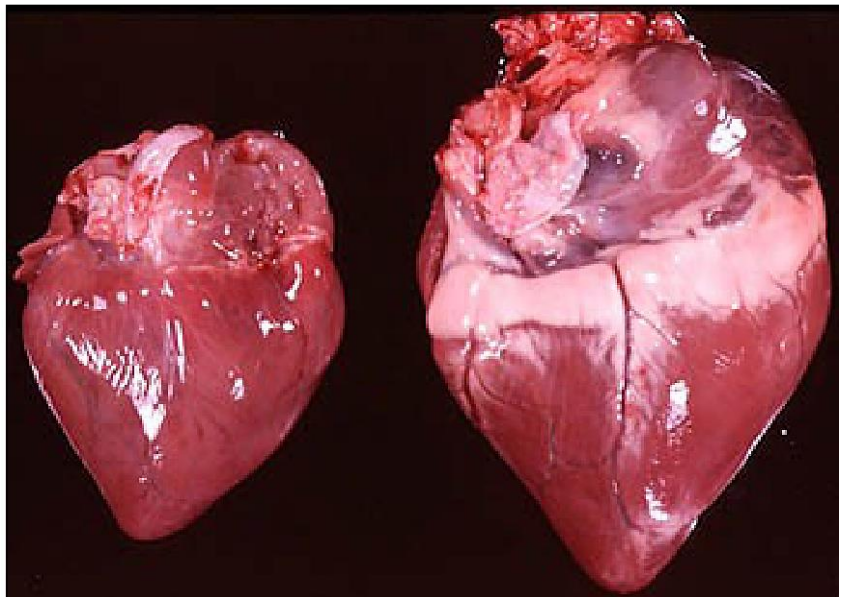
Causes of hypoplasia

- The reasons of hypoplasia are usually not well known.
- But the possible explanation is some failure in embryonic development caused either by an accident (such as an infection). Or by absence of the normal genetic coding.
- E.g., viral infection of the fetus *in utero* may results in cerebellar hypoplasia.
- The viruses that cause panleukopenia in cats and bovine viral diarrhea in cattle are responsible for development of such lesion (cerebellar hypoplasia).


Cellular Adaptations
Size
Number
Type
Atrophy
Hypertrophy
Hyperplasia
Metaplasia
Dysplasia

Atrophy

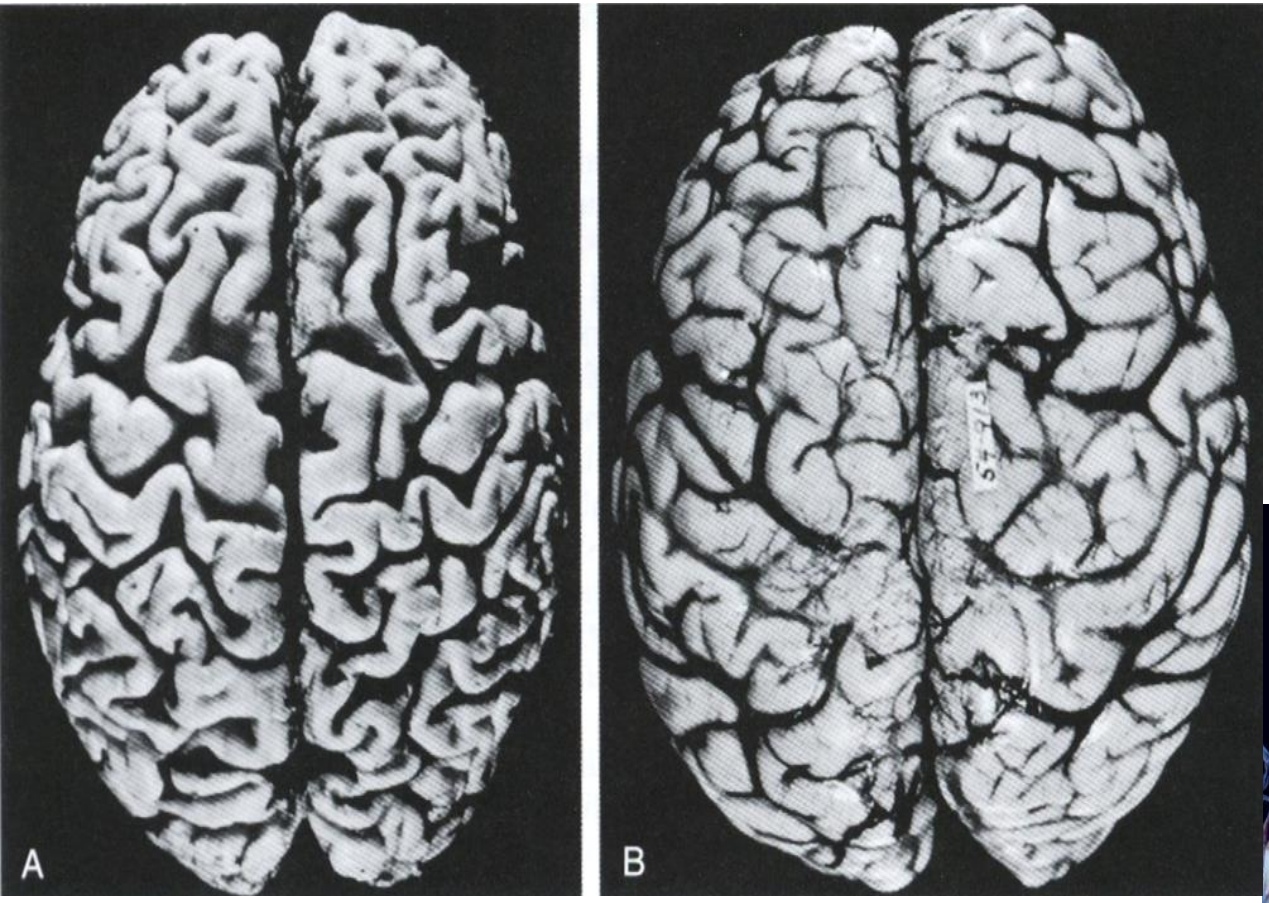
- Atrophy is a reversible growth disturbance, it is shrinkage in the size of cells by the loss of cell substance after normal growth has been achieved.
- It is usually caused by injury, disease, or lack of use.



Types of atrophy

1- **Physiological atrophy:** Common during normal fetal development, and in adult life.

- During fetal development: e.g. atrophy of embryonic structures such as thyroglossal duct.
- During adult life: e.g. involution of thymus, atrophy of brain and heart due to aging (senile atrophy).



A: An atrophied brain of an old man.

B: Normal brain of a young man.

Atrophy associated with Alzheimer's Disease

Types of atrophy

2- **Pathological atrophy: Local or generalized.**

A. Local;

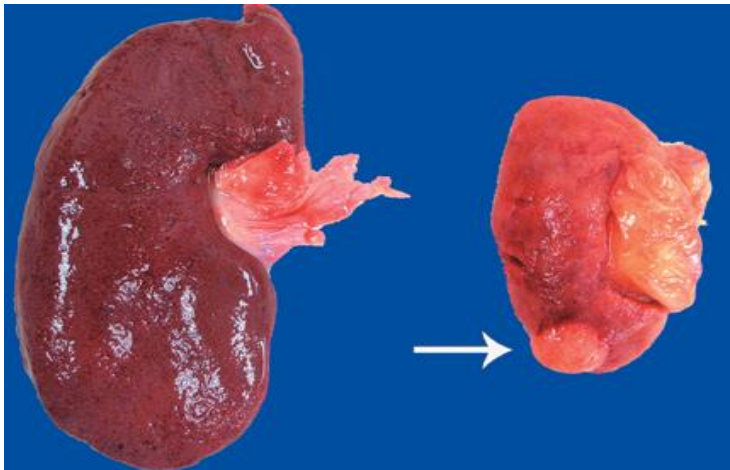
- Disuse atrophy (decreased workload): e.g. atrophy of limb muscles immobilized in a plaster cast (as treatment for fracture) or after prolonged bed rest.
- Denervation (loss of innervation) atrophy: e.g. atrophy of muscle due to damage to the nerves (e.g. poliomyelitis).

Types of atrophy

2- **Pathological atrophy (Local)**

- Ischemic (diminished blood supply) atrophy: e.g. brain atrophy produced by ischemia due to atherosclerosis of the carotid artery.
- Pressure atrophy: e.g. atrophy of renal parenchyma in hydronephrosis due to increased pressure.

Kidneys, normal (left) and ischemic atrophy (right)



Types of atrophy

2- Pathological atrophy (Generalized):

- *A* Starvation (inadequate nutrition) atrophy: e.g. protein-calorie malnutrition.

Atrophy associated with Malnutrition

Hypertrophy

- Hypertrophy is a reversible growth disturbance characterized by increase in the size of the tissue or organ due to increase in the size of cells.
- Hypertrophy is due to increased synthesis of cellular proteins, more (enzymes, mitochondria, and myofilaments).

Types of hypertrophy

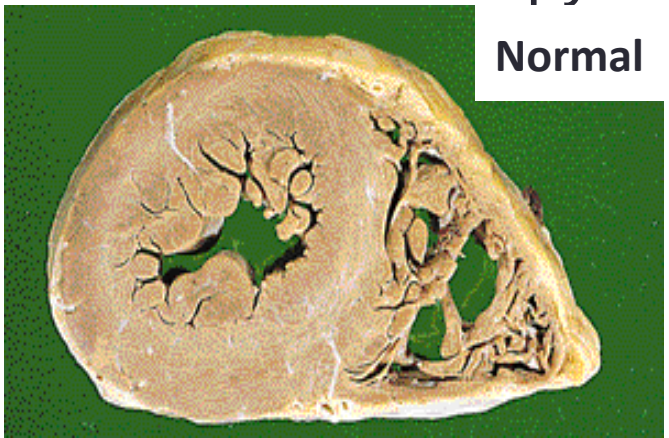
I. **Increased functional demand/workload.**

A- Physiological hypertrophy

- Hypertrophy of skeletal muscle: e.g. the bulging muscles of body builders and athletes.
- Hypertrophy of smooth muscle: e.g. enlargement of the uterus during pregnancy from estrogenic stimulation.

B- Pathological hypertrophy

- Hypertrophy of cardiac muscle: e.g. left ventricular hypertrophy due to hypertension or damaged valves (aortic stenosis and mitral incompetence).
- Hypertrophy of smooth muscle: e.g. hypertrophy of urinary bladder muscle in response to urethral obstruction (e.g. prostate hyperplasia), hypertrophy of muscular layer of stomach due to pyloric stenosis.

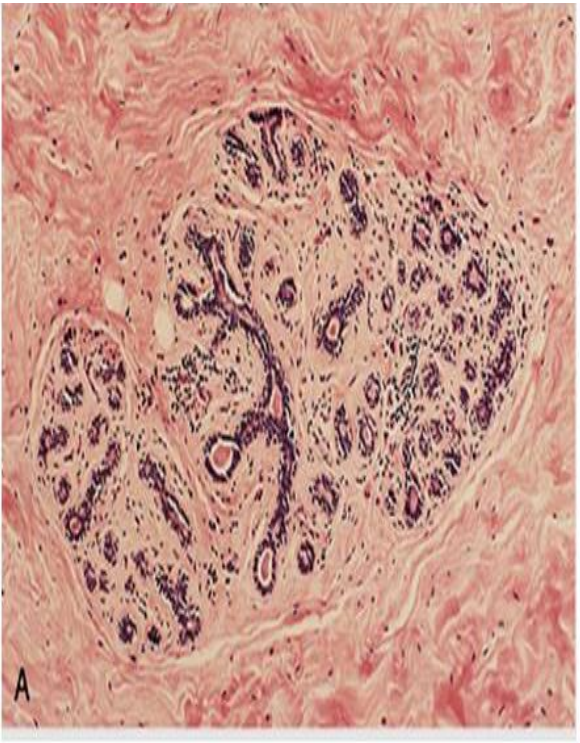


Normal

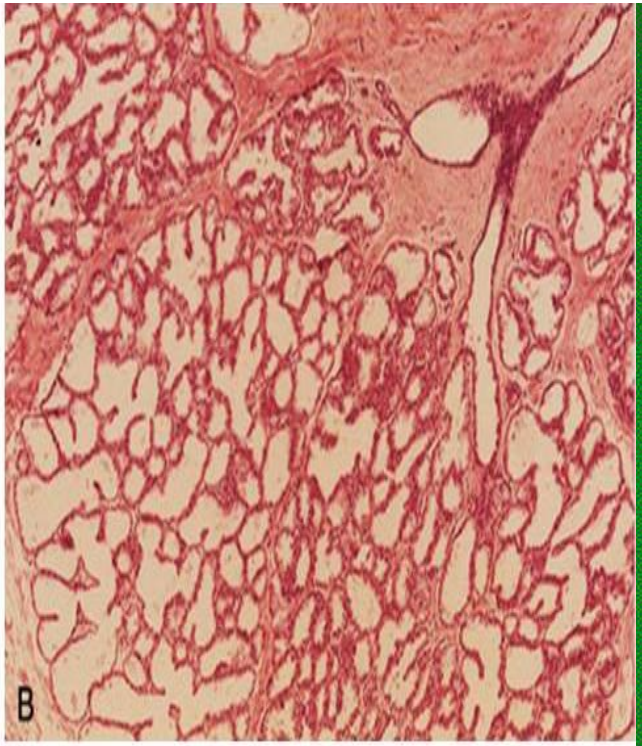
Left ventricular hypertrophy due to hypertension

II. Compensatory hypertrophy

- Compensatory hypertrophy is the type of hypertrophy that occurs in conditions in which part of an organ or one of a paired organ (such as the kidneys) is lost.
- In such conditions, the remaining part (or organ) undergoes hypertrophy in order to compensate the function of the lost part (or organ).



Inactive mammary gland



Physiological hyperplasia of the mammary gland during pregnancy

enlargement of the uterus during pregnancy

Causes or types of hyperplasia:

A / Physiological hyperplasia e.g.:

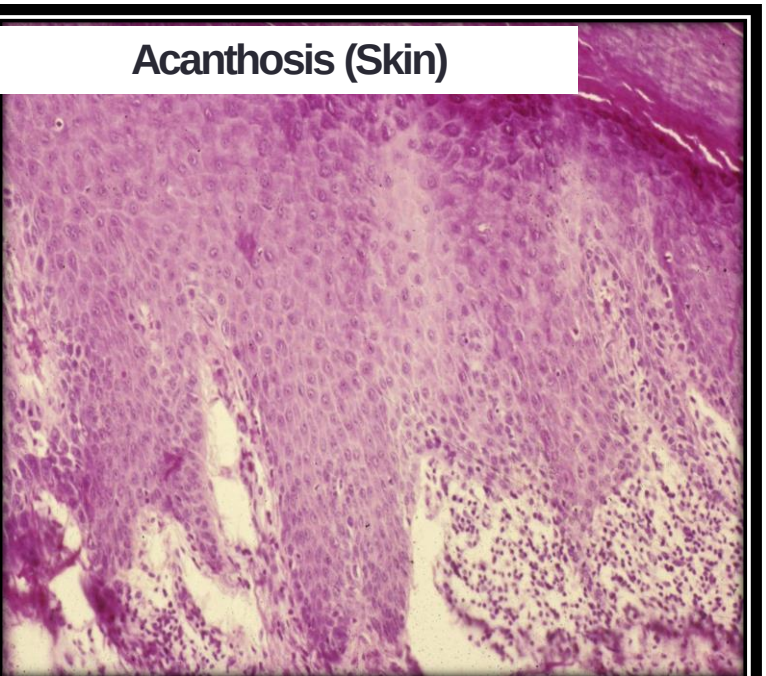
- e.g. hyperplasia of glandular epithelium of mammary gland (breast) at puberty, pregnancy, and lactation.

B/ Compensatory hyperplasia: e.g. in liver following partial hepatectomy in cases of anemia.

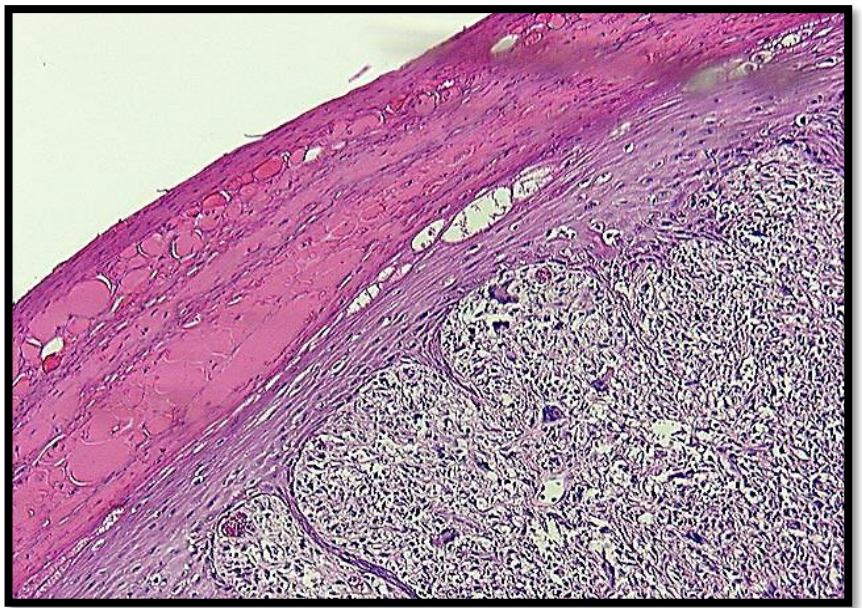
C / Pathological hyperplasia, Due to excess endocrine stimulation or chronic injury/irritation.

C / Pathological hyperplasia

- Acanthosis (hyperplasia of the epithelial cells in the stratum spinosum of the stratified squamous epithelium) due to chronic irritation.
- Hyperkeratosis (hyperplasia of the epithelial cells in the stratum cornium of the keratinized stratified squamous epithelium) due to chronic irritation.
- Lymphoid hyperplasia due to a bacterial infection.

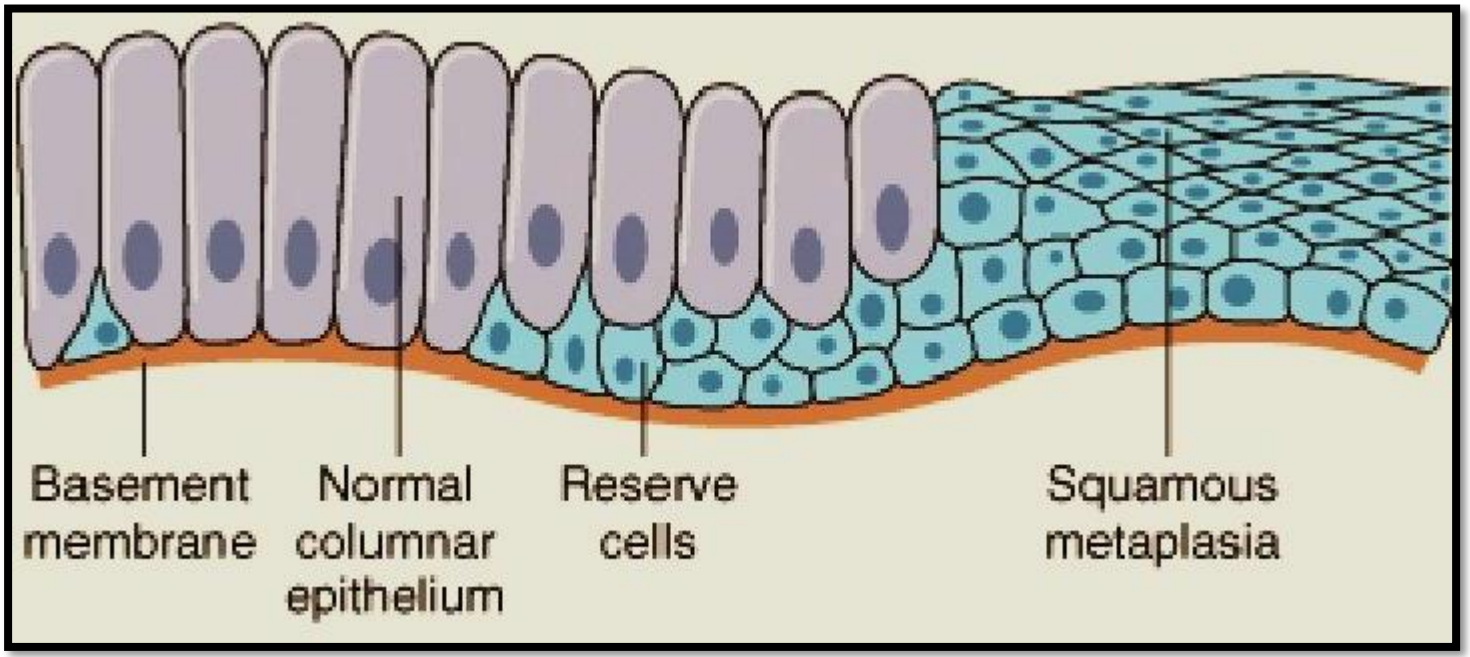


Hyperkeratosis



Metaplasia

Metaplasia is a reversible change in which one adult cell type is replaced by another adult cell type.



Causes of Metaplasia

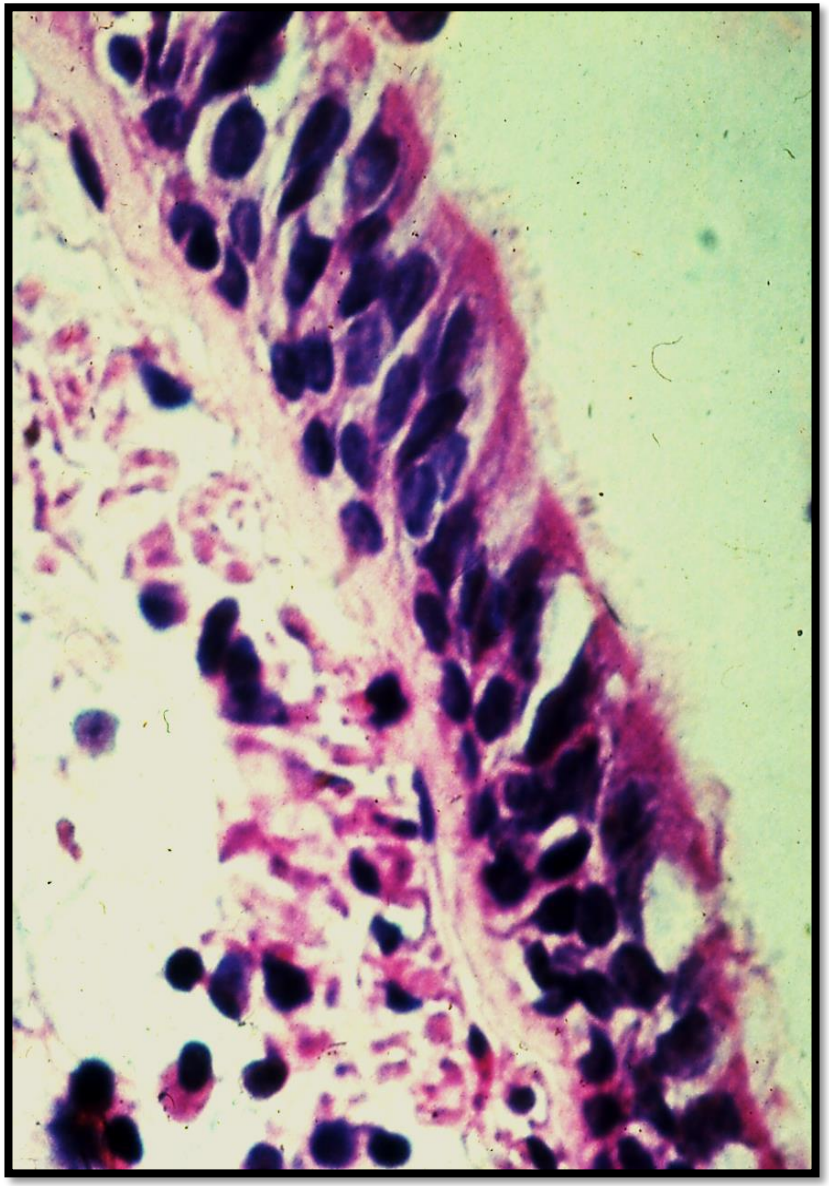
- Metaplasia is usually fully reversible adaptive response to chronic persistent injury. If the noxious stimulus is removed (e.g. cessation of smoking), the metaplastic epithelium may return to normal.
- Metaplasia is mainly seen in association with tissue damage, repair, and regeneration.
- The replacing cell type is usually more suited to a change in environment.

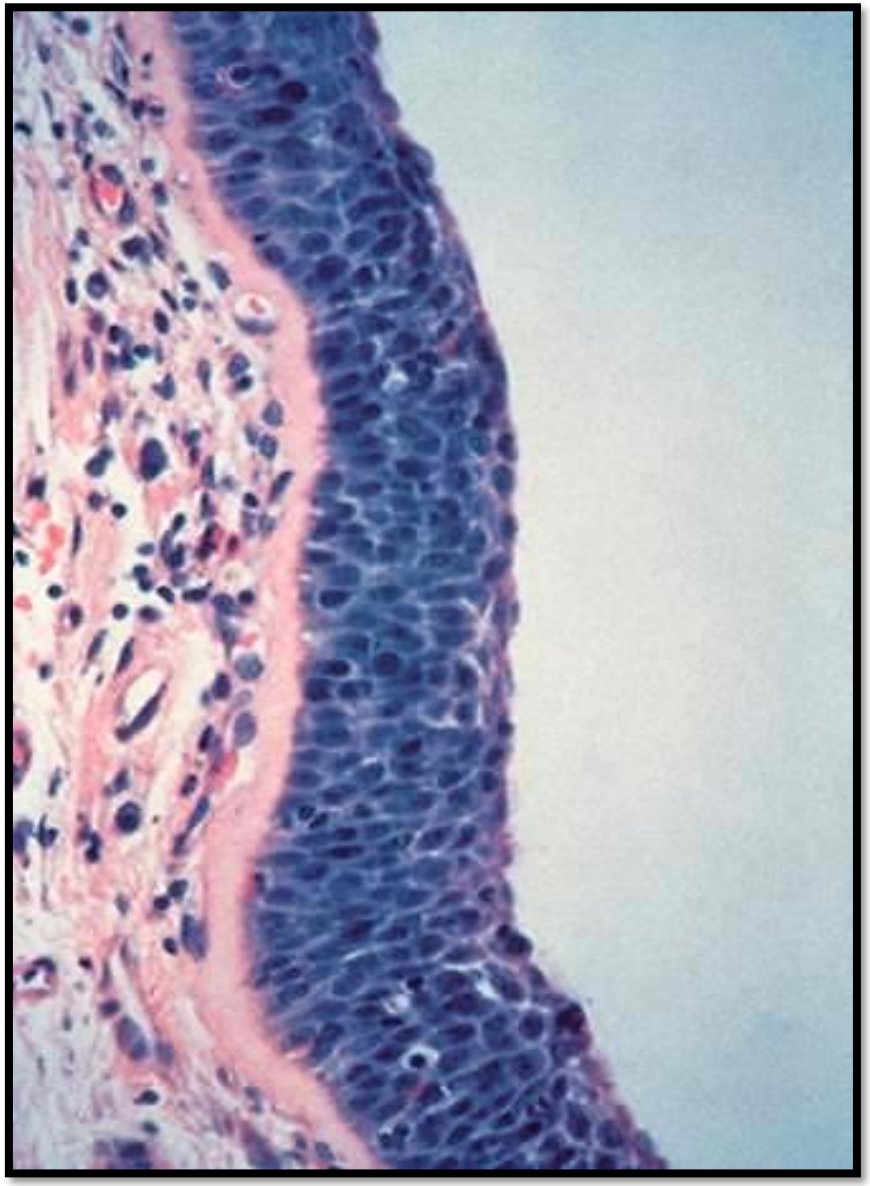
Types of Metaplasia:

1. Epithelial Metaplasia: Most common types are;

A. Squamous metaplasia: Original epithelium is replaced by squamous epithelium.

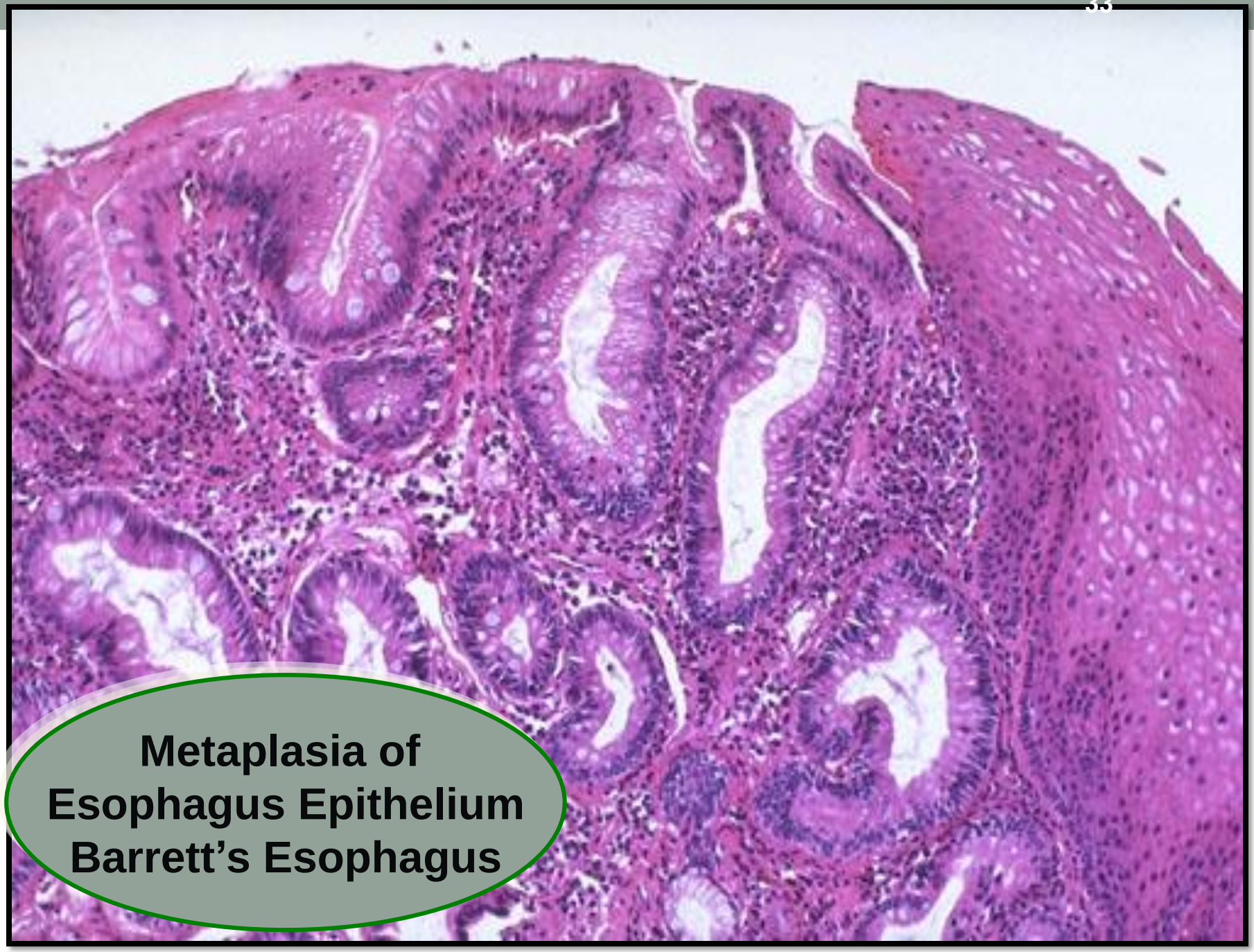
- Respiratory tract: e.g. chronic irritation due to tobacco smoke,
- Squamous metaplasia of the gallbladder epithelium due to chronic gallstone irritation.
- Cervix: Squamous metaplasia in cervix is associated with chronic infection.



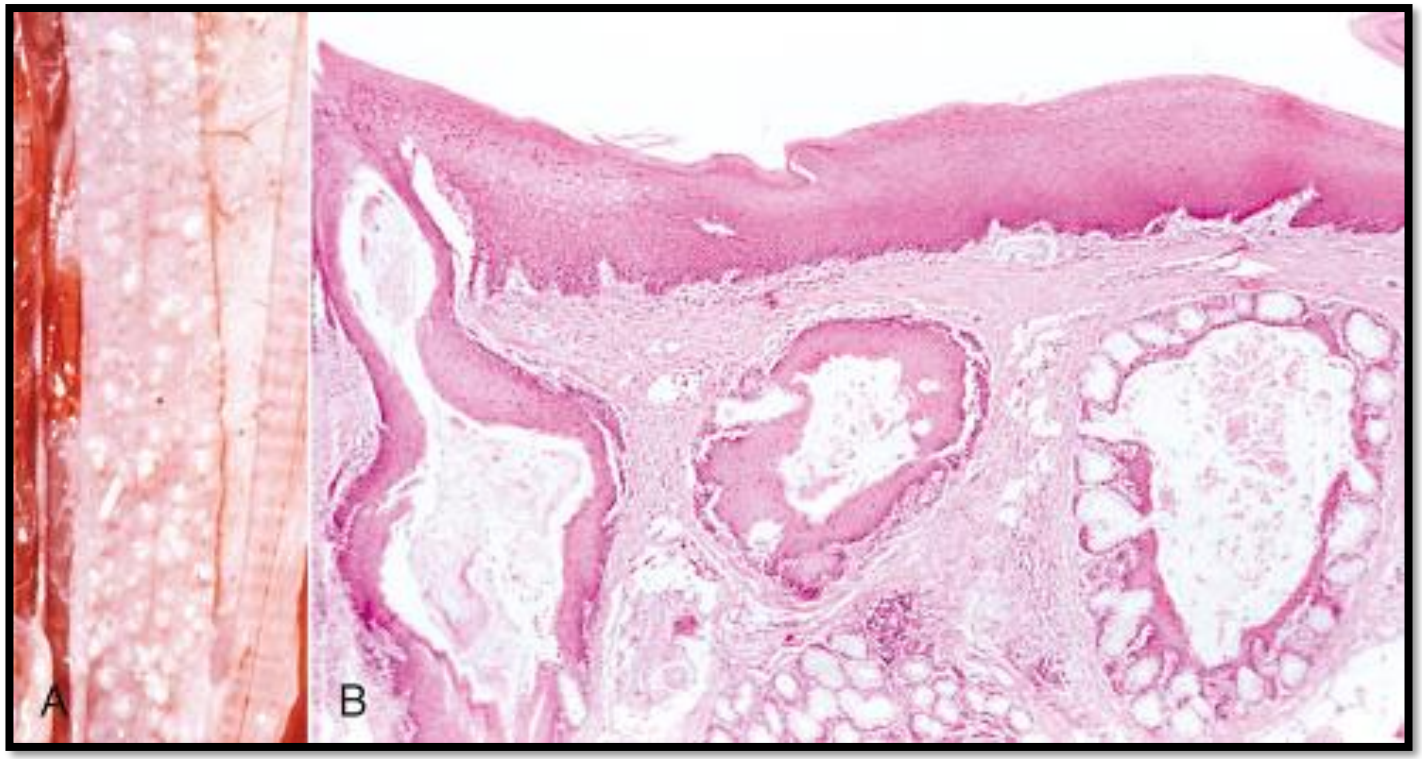


Squamous metaplasia in bronchitis

Metaplasia of Respiratory Epithelium



Metaplasia of Esophagus Epithelium Barrett's Esophagus



Squamous Metaplasia, Esophagus, Parrot

A: The esophageal mucosa has multiple white raised nodules from squamous metaplasia of mucosal glands. Metaplasia arose from the lack of dietary vitamin A (avitaminosis A).

B: The replacement of normal mucosal epithelium and goblet cells in the glands by keratinized stratified squamous epithelium. H&E stain.

2. Mesenchymal metaplasia

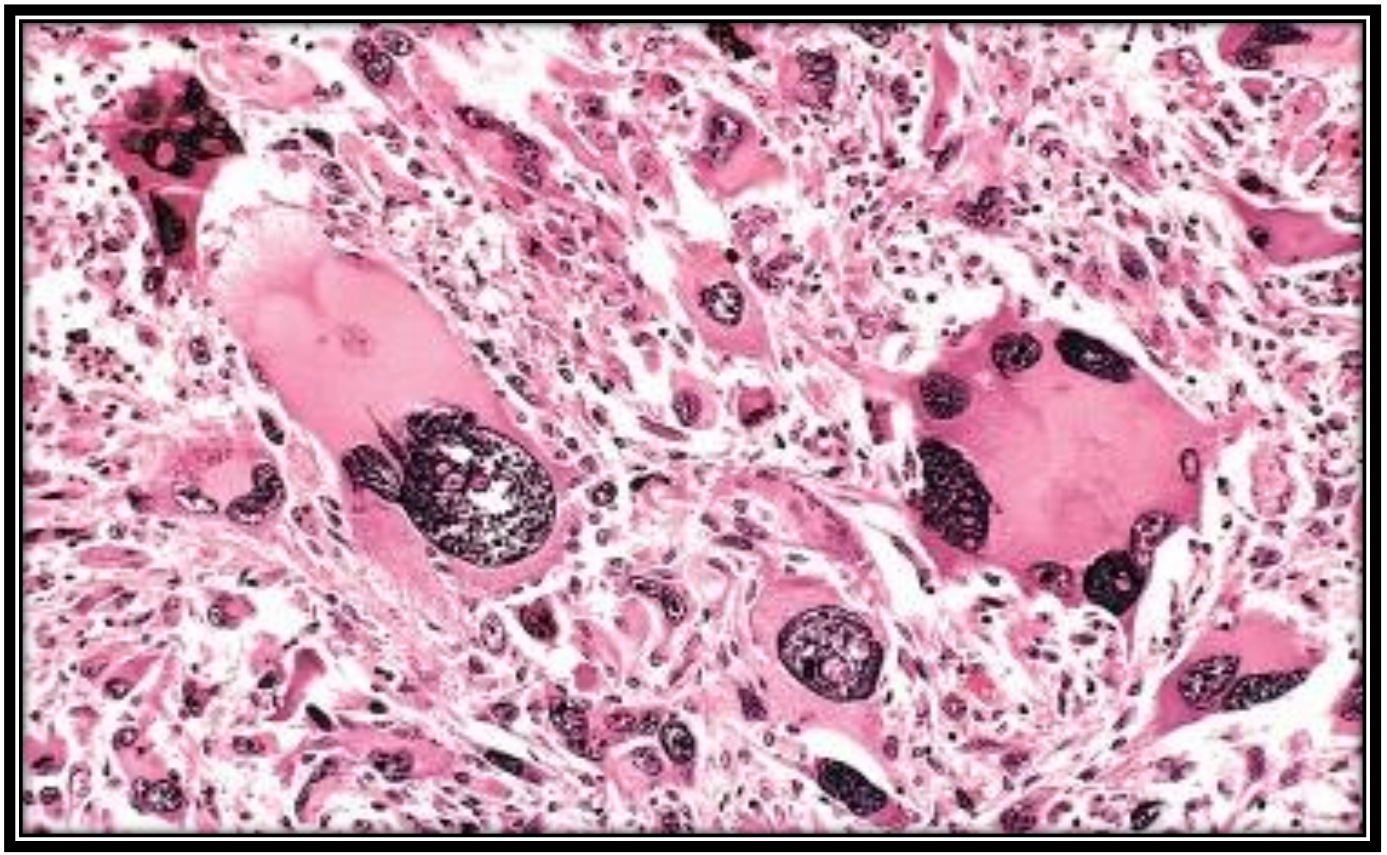
- Osseous metaplasia: Formation of new bone at sites of tissue injury is known as osseous metaplasia.
- Bone formation in muscle, known as myositis ossificans, occasionally occurs after intramuscular hemorrhage.

Dysplasia

The cells that show some cytological features of malignancy and the term dysplasia is used for these changes. It literally means disordered growth. The changes of dysplasia include:

1. Cellular pleomorphism
2. Large hyperchromatic nuclei
3. High nuclear-to-cytoplasmic ratio
4. Loss of polarity (architectural orientation)

Pleomorphism is a variation in size and shape of cells and nuclei within the neoplasm and hyperchromatism with giant cell.



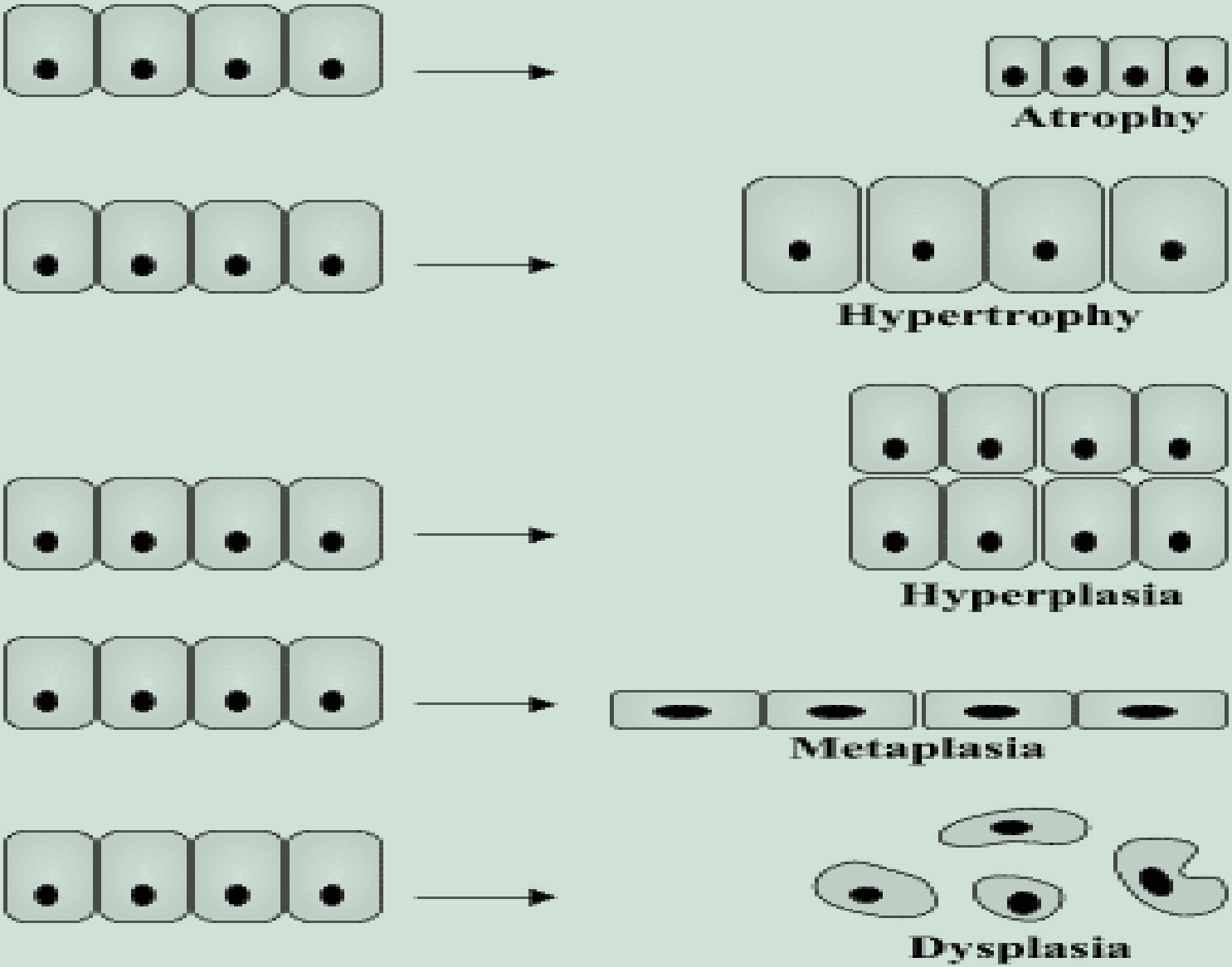
Classification of Dysplasia:

I. Mild
II. Moderate, and
III. Severe depending on the thickness of epithelium involved by the dysplastic cells.

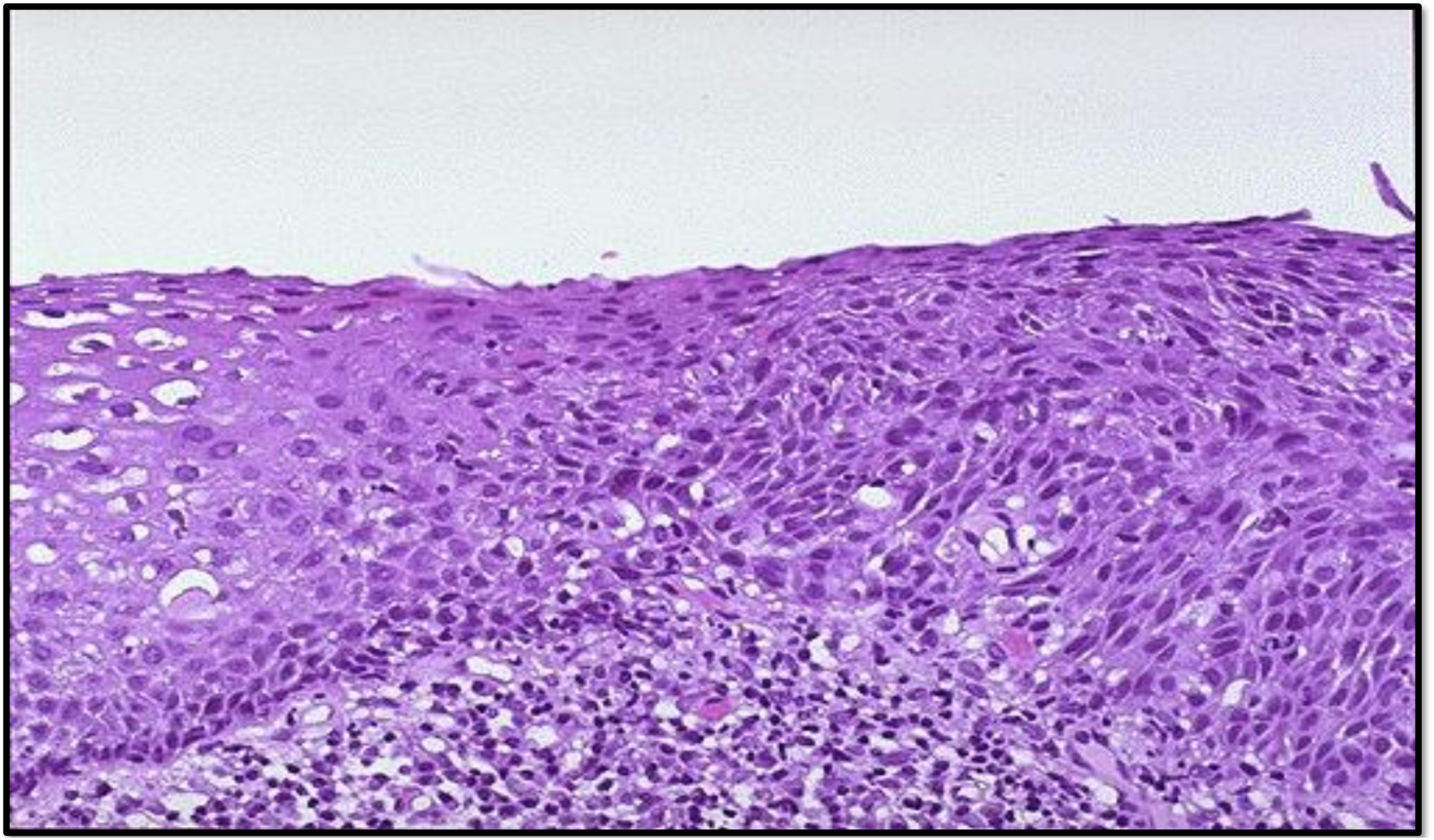
Examples of dysplasia

1. Chondrodysplasia which causes abnormal endochondral bone growth and dwarfism.
2. Dysplasia of adult epithelial tissues especially the epidermis, mucous membranes, respiratory epithelium, GIT epithelium, and epithelia of the vagina and cervix.

Cellular Adaptation to Stress



Dysplasia Cervix



This is dysplasia. The normal squamous epithelium at the left transforms to a disorderly growth pattern at the right. This is farther down the road toward neoplasia.