

Cellular adaptation (**part 1**): Disorders of **CELL GROWTH**

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OUTLINES

By the end of this lecture; students should be able to learn the following:

- Definition and factors affecting cell growth
- Types of cellular adaptation
- Define atrophy and provide examples and differentiate between atrophy, hypoplasia and involution
- Define hypertrophy and provide examples.
- Define hyperplasia and provide examples.

INTRODUCTION

- **Definition of growth:** Growth is increase in size and/or weight of an organ or the whole body; resulting from
 -  NUMBER of the cells
 -  SIZE of the cells
 -  BOTH NUMBER AND SIZE of the cells
- **Definition of differentiation:**
Degree of **STRUCTURAL** and **FUNCTIONAL** maturity of the cells
- **Definition of adaptation:**
 - Adaptation refers to cellular changes in response to different environment conditions to adapt function.
 - These changes may be **PHYSIOLOGICAL** (normal) or **PATHOLOGICAL** (abnormal).

INTRODUCTION

- **Factors affecting growth and differentiation:**

1. **Age:** children have rapid rate of growth

2. **Type of tissue:**

- Thymus grows rapidly during childhood then stops growing or even regresses in adults.
- Sex organs grow rapidly after puberty.

3. **Type of cells:**

- Labile.....**???**
- Stable.....**???**
- Permanent.....**???**



INTRODUCTION



- **Factors affecting growth and differentiation:**

4. ***Genetic factors:*** Tall and short individuals

5. ***Nutritional state of the body.***

6. ***Hormones:***

 growth hormone  Gigantism

 growth hormone  Cretinism

7. ***Presence or absence of a chronic disease:***

Diabetes, TB & anemia  rate of growth

INTRODUCTION

- **Features of normal growth:**

- Coordinated growth
- Regular rate of growth
- Limited rate of growth

- **Reparative growth:**

- **Definition:** Physiological replacement of damaged cells with new healthy cells.
- **Features:**
 - It has a stimulus
 - It has a purpose
 - It is limited

CLASSIFICATION

Abnormal cell growth

↓ cell growth

- Agenesis
- Aplasia
- Hypoplasia
- Atrophy

↑ cell growth

Hypertrophy

Hyperplasia

Both

- Have a stimulus
- Are controlled

CLASSIFICATION

Abnormal cell differentiation

Metaplasia

Dysplasia

Both

- Have a stimulus
- Are controlled

Abnormal cell growth and differentiation

Neoplastic

TUMOURS
(Next chapter)

Abnormal DNA
No Stimulus
Not Controlled

Abnormal cell GROWTH

ABNORMAL CELL GROWTH

- **Agenesis:**

- Completely absent organ: e.g. absent kidney

- **Aplasia:**

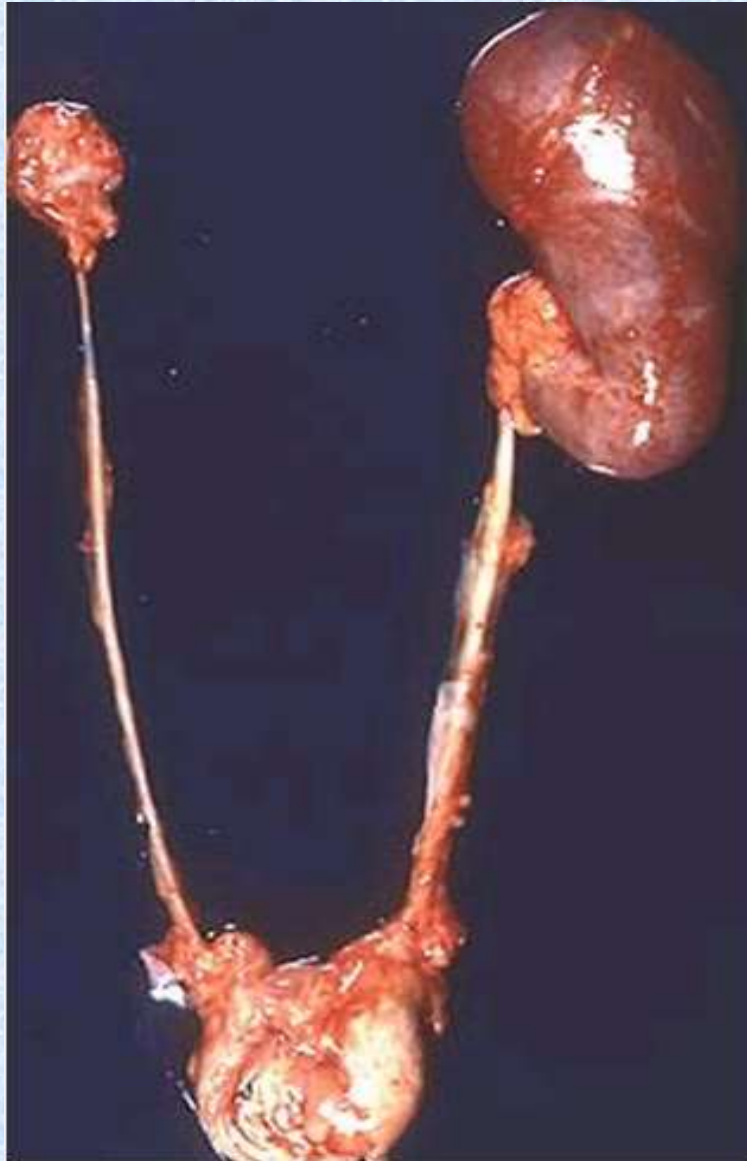
- Complete failure of development of an organ: e.g. Aplastic kidney

- **Hypoplasia:**

- Failure of development of an organ to a full mature size: e.g. hypoplastic kidney, hypoplastic testis

ABNORMAL CELL GROWTH

**Hypoplastic
kidney**



ABNORMAL CELL GROWTH

ATROPHY

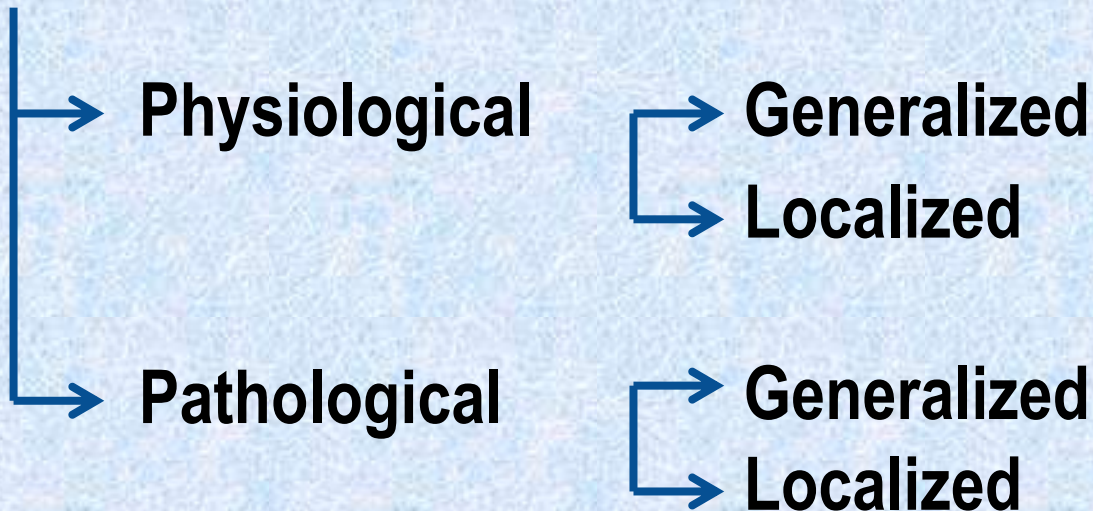
ABNORMAL CELL GROWTH

- **Atrophy:**

- **Definition:**

Acquired ↓ in size and weight of an organ due to ↓ number and/or size of its cell constituent (after reaching mature size).

- **Types**



ABNORMAL CELL GROWTH

● Atrophy:

Physiological atrophy: Also called INVOLUTION

- **Generalized**: ↓ size and weight of the whole body; e.g. senile atrophy in old age
- **Localized**: ↓ size and weight of a certain organ; e.g.
 - *In children:* Remnants of thyroglossal duct, ductus arteriosus and umbilical vessels
 - *In adults:*
 - Atrophy of thymus after the age of puberty.
 - Atrophy of breast and ovaries after menopause.

ABNORMAL CELL GROWTH

- **Atrophy:**

- Pathological atrophy:*

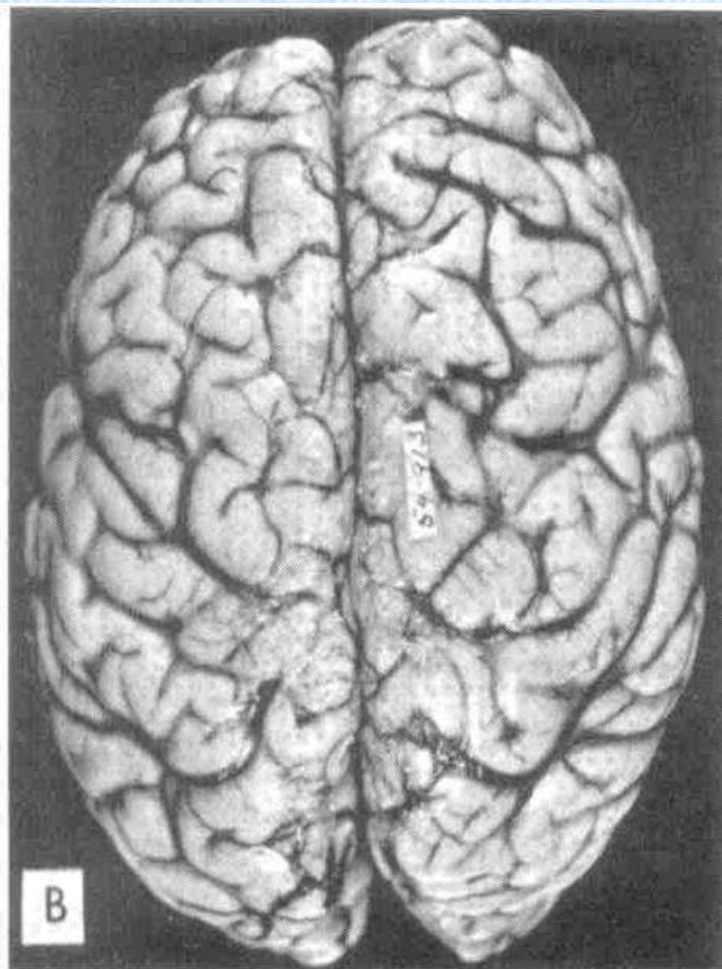
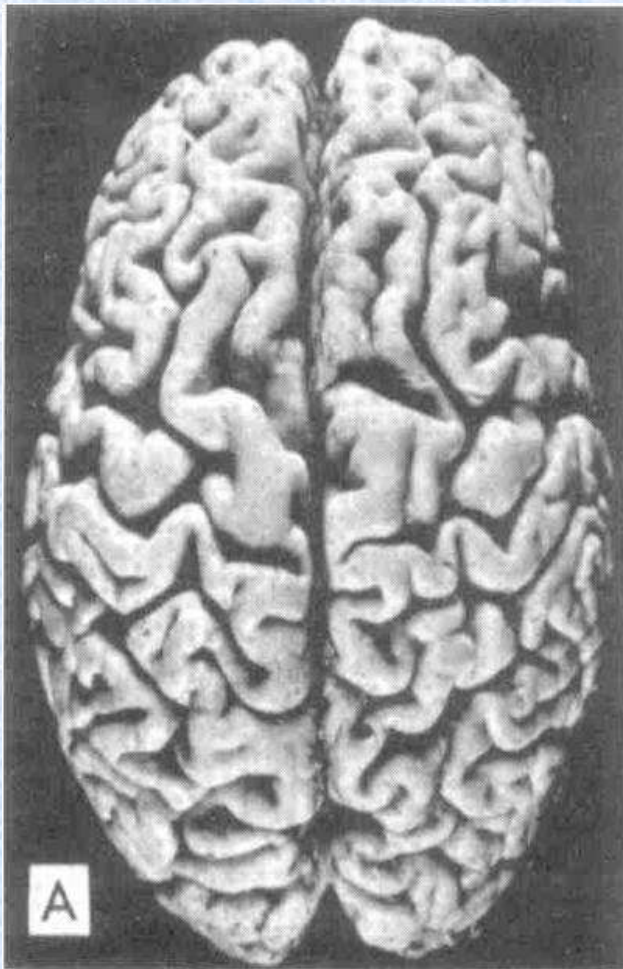
- Generalized:

- **Definition:** ↓ size and weight of the whole body due to a disease process.
 - **Examples:**
 1. Starvation atrophy: in chronic malnutrition
 2. Chronic debilitating disease (due to ↑ rate of catabolism): e.g. tuberculosis, diabetes, thyrotoxicosis.
 3. Malignant cachexia: in malignant tumors.

ABNORMAL CELL GROWTH

- **Atrophy:**

Pathological atrophy:




ABNORMAL CELL GROWTH

- **Atrophy:**

- Pathological atrophy:*

- Localized:

- **Definition:**  size and weight of a diseased organ.

- **Types:**

1. Ischemic atrophy
2. Pressure atrophy
3. Disuse atrophy
4. Neuropathic atrophy
5. Hormonal atrophy
6. Idiopathic atrophy

ABNORMAL CELL GROWTH

● Atrophy:

Pathological atrophy:

■ Localized:

1. Ischemic atrophy:

- Pathogenesis: ↓ blood supply and hypoxia → gradual apoptosis of the ischemic cells
- Examples:
 - Atherosclerosis of coronary arteries → ischemic atrophy of the heart and replacement by fibrous tissue
 - Atherosclerosis of renal artery → ischemic atrophy of kidney and fibrosis.

ABNORMAL CELL GROWTH

- **Atrophy:**

- Pathological atrophy:*

- Localized:

- 2. Pressure atrophy:**

- Pathogenesis: Pressure on organ tissue ↓ blood supply and hypoxia → gradual organ ischemia

- Examples:

- Aortic aneurysm → atrophy of sternum and vertebrae but not the inter-vertebral discs (they are avascular).

- 3. Disuse atrophy:**

- Pathogenesis: Prolonged unused organ → atrophy of its cells

- Examples:

- Prolonged limb immobilization → Atrophy of the affected muscles, ligaments and even bone.

ABNORMAL CELL GROWTH

● Atrophy:

Pathological atrophy:

▪ Localized:

4. Neuropathic atrophy:

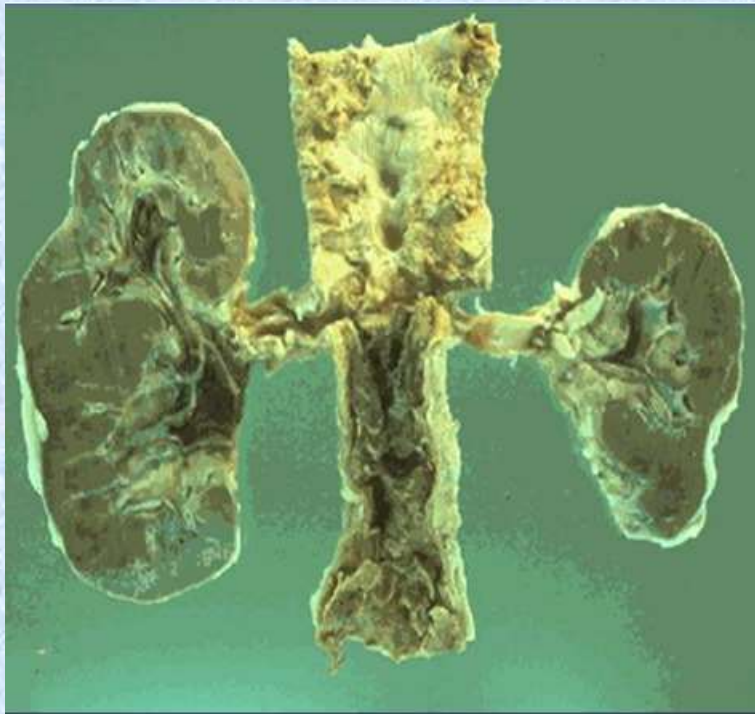
- Pathogenesis: Prolonged unused organ → atrophy of its cells.
- Examples: Hemiplegia, paraplegia and poliomyelitis →
Atrophy of affected muscles, ligaments and bone.

5. Endocrine atrophy:

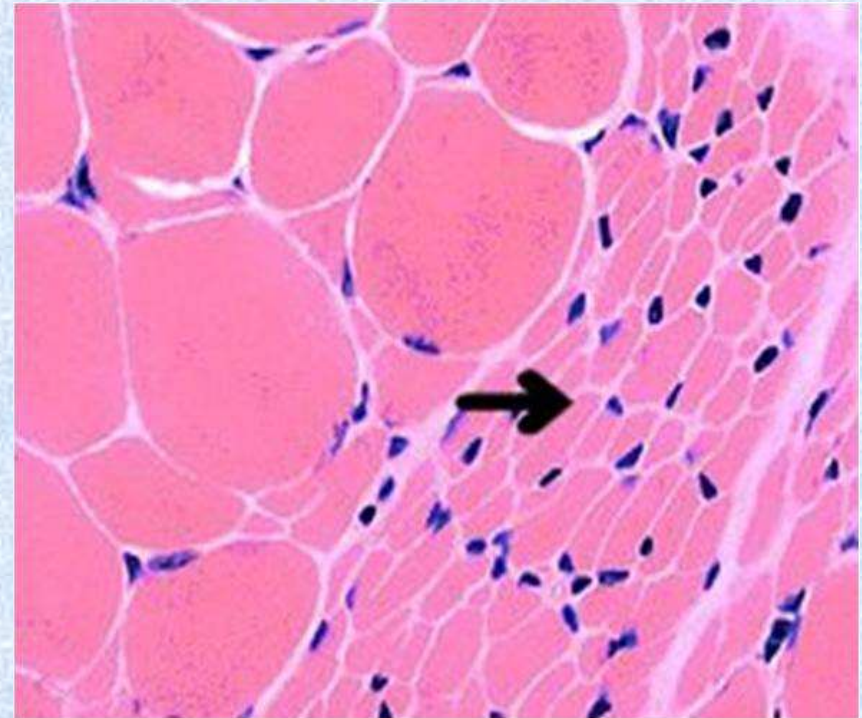
- Pathogenesis: depletion of a hormone → atrophy of this hormone dependent organ.
- Example: removal of ovaries → atrophy of breast and uterus.

ABNORMAL CELL GROWTH

- **Atrophy:**



Atrophic kidney



Muscle atrophy

ABNORMAL CELL GROWTH

HYPERPLASIA

ABNORMAL CELL GROWTH

● **Hyperplasia:**

- **Definition:** Increased size of an organ or tissue due to increase in the NUMBER of its cell constituent.
- **Features:**
 - Occurs as a result of a specific stimulus.
 - It continues as the stimulus persists
 - Stops when the stimulus is removed.
 - Reversible cell proliferation
 - Has a useful purpose
 - Hyperplasia may be focal or diffuse

ABNORMAL CELL GROWTH

- **Hyperplasia:**

- ***Examples:***

- A. **Physiological**: e.g.

- Increased size of the breast after puberty, during pregnancy and lactation due to excess estrogen and progesterone
- Increased in size of the gonads (ovary and testis) after puberty due to hormonal change.

ABNORMAL CELL GROWTH

● Hyperplasia:

B. Pathological: e.g.

1. Compensatory hyperplasia: e.g.

- Hyperplasia of bone marrow after hemorrhage or excessive haemolysis.
- Hyperplasia of one kidney after surgical removal of other kidney.

2. Hormonal hyperplasia: e.g.

- Endometrial and breast hyperplasia as a result of exposure to excess estrogenic stimulation.
- Prostate hyperplasia in response to excess androgen
- Thyroid epithelial hyperplasia in response to excess TSH leading to thyrotoxicosis.

ABNORMAL CELL GROWTH

- **Hyperplasia:**

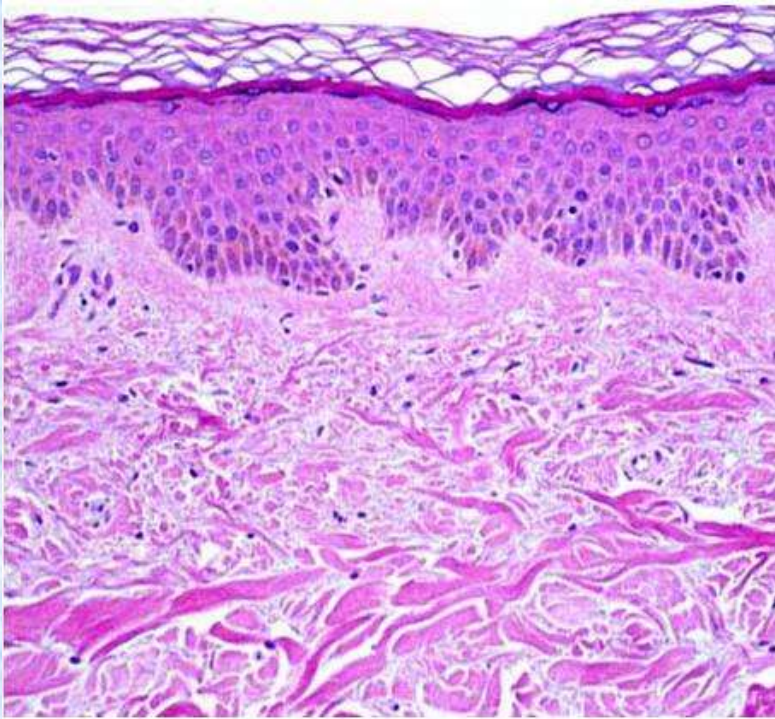
- B. Pathological:** e.g.

- 3. *Irritative hyperplasia e.g.***

- Hyperplasia of lymphoid tissue during chronic infection and toxemia which is due to antigenic stimulation.

ABNORMAL CELL GROWTH

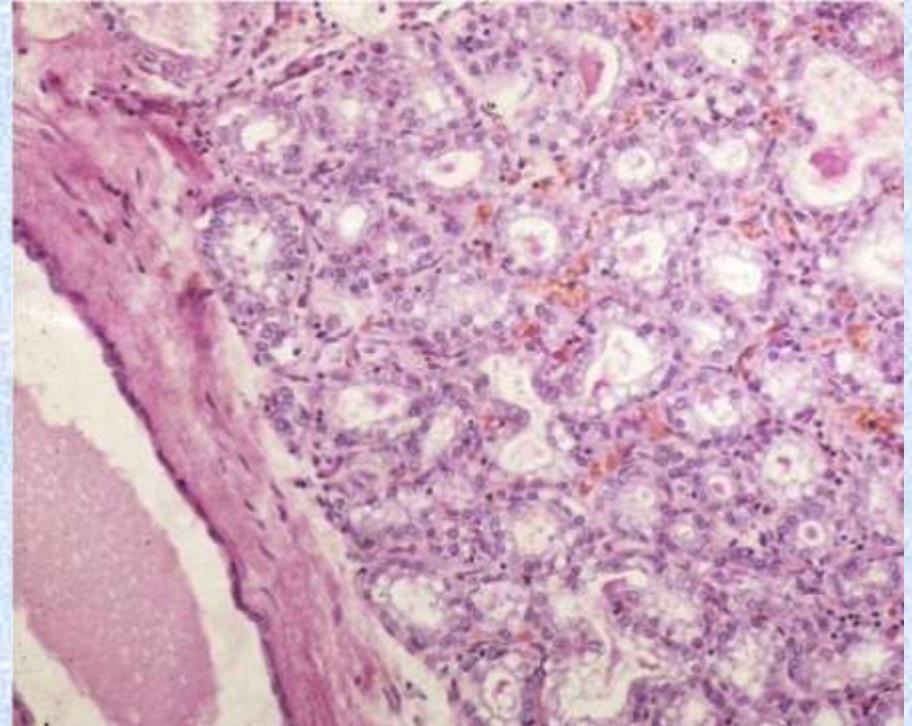
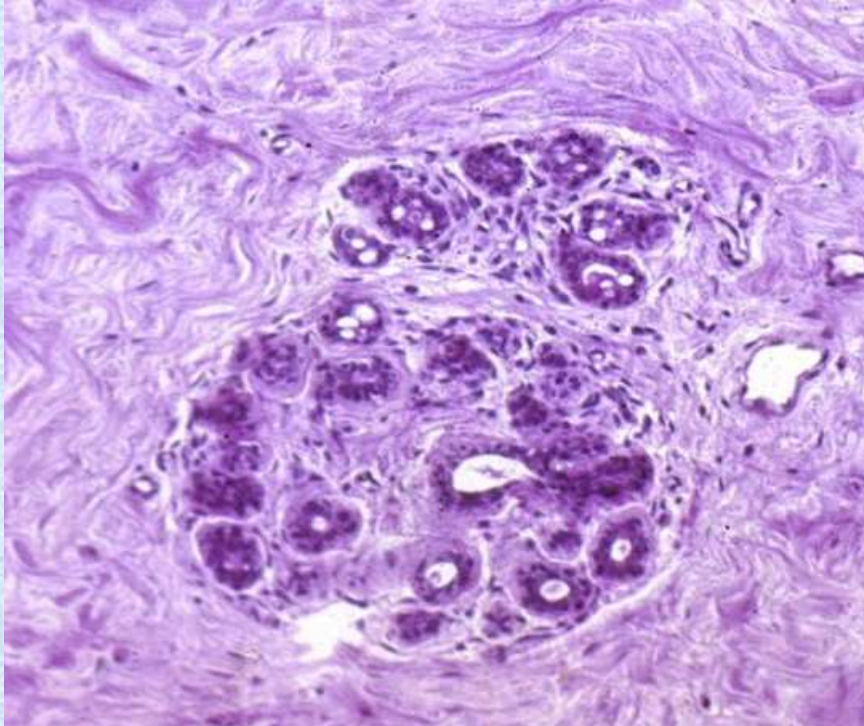
- **Hyperplasia:**



Please.....Comment???

ABNORMAL CELL GROWTH

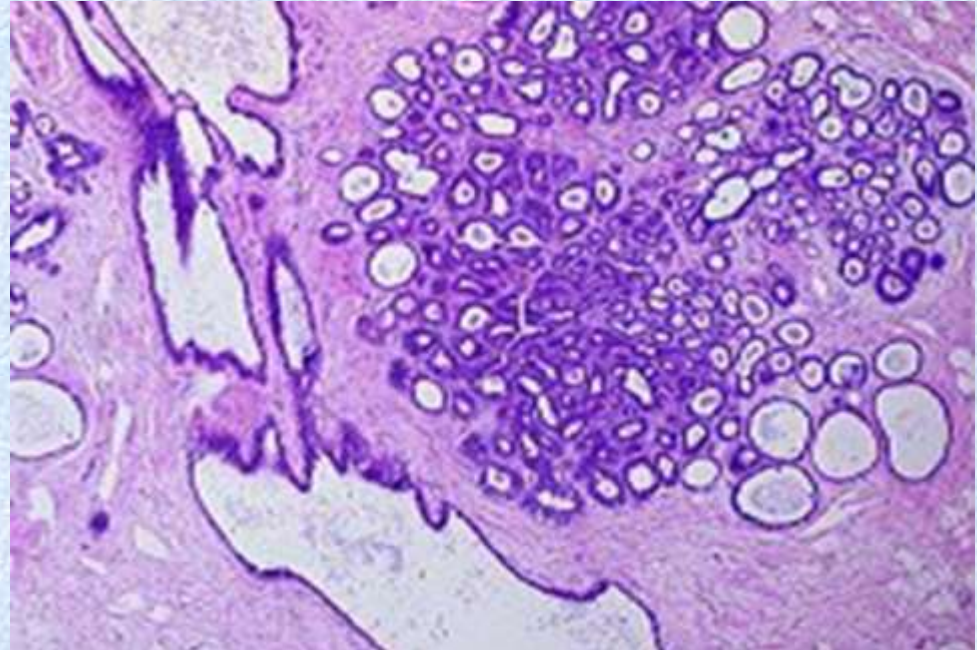
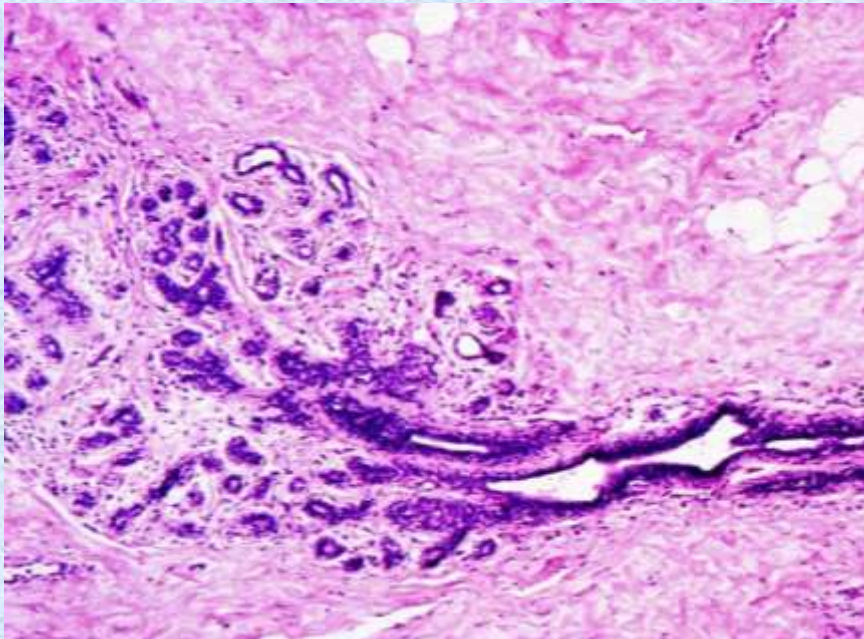
- **Hyperplasia:**



Breast.....Comment???

ABNORMAL CELL GROWTH

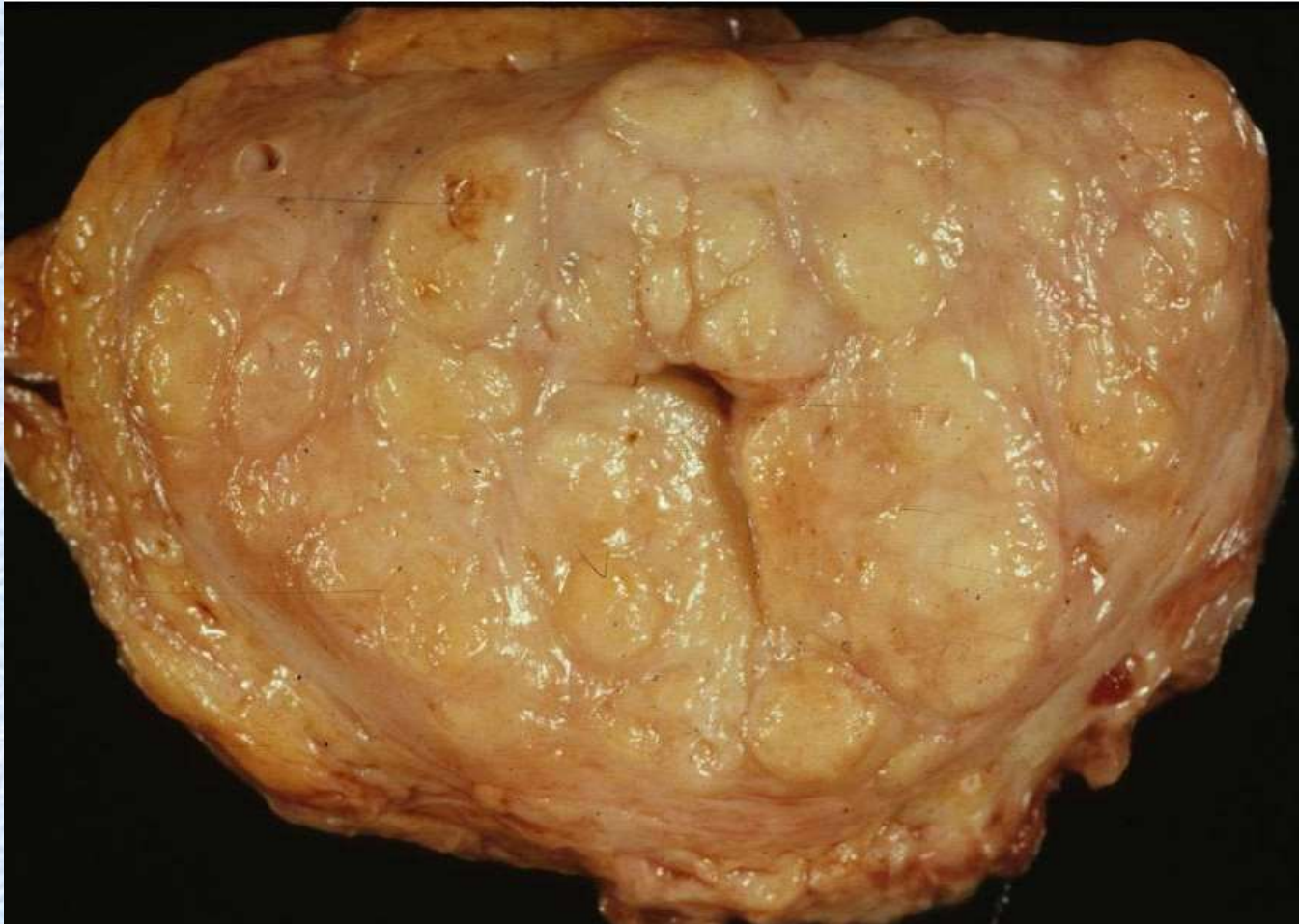
- **Hyperplasia:**



**Breast.....
Comment???**

ABNORMAL CELL GROWTH

- **Hyperplasia:**



Prostate.....Comment???

ABNORMAL CELL GROWTH

Hypertrophy

ABNORMAL CELL GROWTH

- **Hypertrophy:**


Definition:

- Increase in size of an organ or tissue due to increase in the **SIZE** of its cell constituent.

ABNORMAL CELL GROWTH

● Hypertrophy:

Features

- The stimulus is always a mechanical.
- Occurs in permanent cells which cannot divide to compensate excessive functional demand.
- Hypertrophy should be distinguished from hyperplasia, in which there is  in cell number.
- Hypertrophy and hyperplasia occur frequently together, e.g. enlargement of uterus during pregnancy.
- Pure hypertrophy without accompanying hyperplasia occurs only in **athletic muscles**.

ABNORMAL CELL GROWTH

- **Hypertrophy:**

Types:

A. Physiological hypertrophy: e.g.

- Uterus in pregnancy.

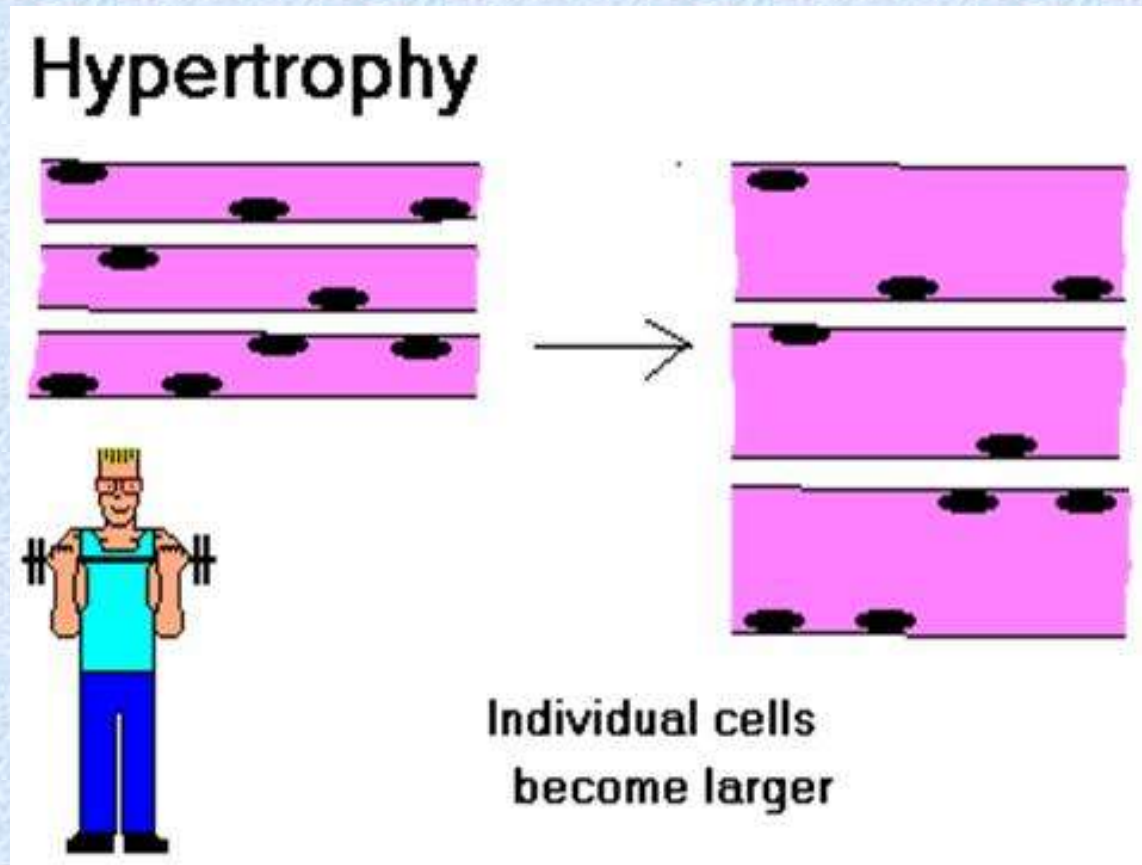
- Skeletal muscle: in muscles of the athlete due to the mechanical work overload.

ABNORMAL CELL GROWTH

- **Hypertrophy:**

Types:

A. Physiological hypertrophy: e.g.



ABNORMAL CELL GROWTH

- **Hypertrophy:**

Types:

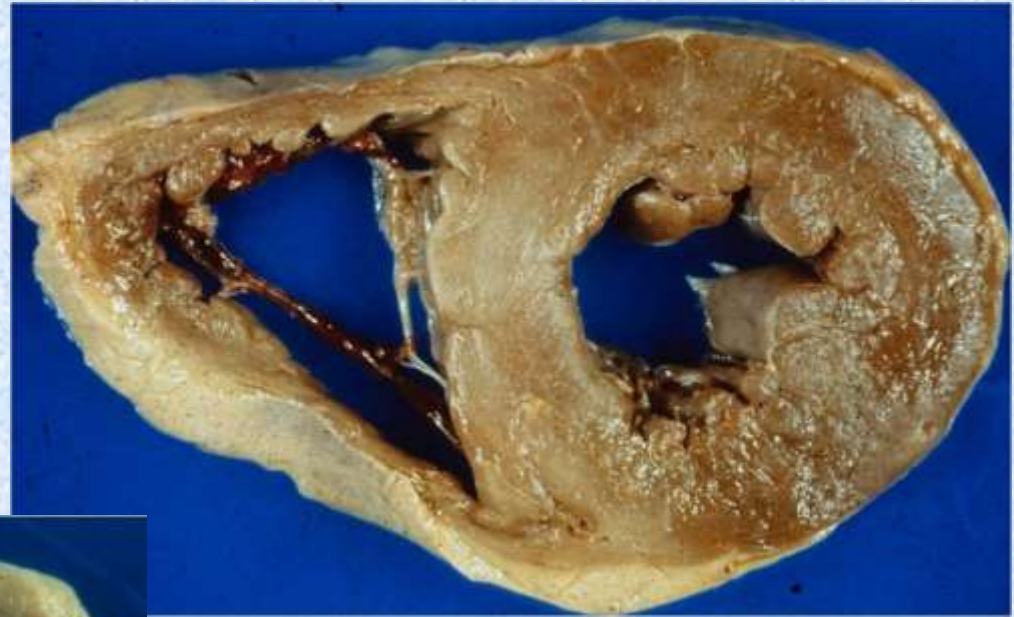
B. Pathological hypertrophy: e.g.

□ ***Adaptive hypertrophy:***

- Heart: hypertrophy of the left ventricle in hypertension and in aortic stenosis
- Stomach: as in congenital pyloric stenosis or healed peptic ulcer or stenosis by a tumour.
- Urinary bladder: Hypertrophy of urinary bladder due to urethral stricture by enlarged prostate

ABNORMAL CELL GROWTH

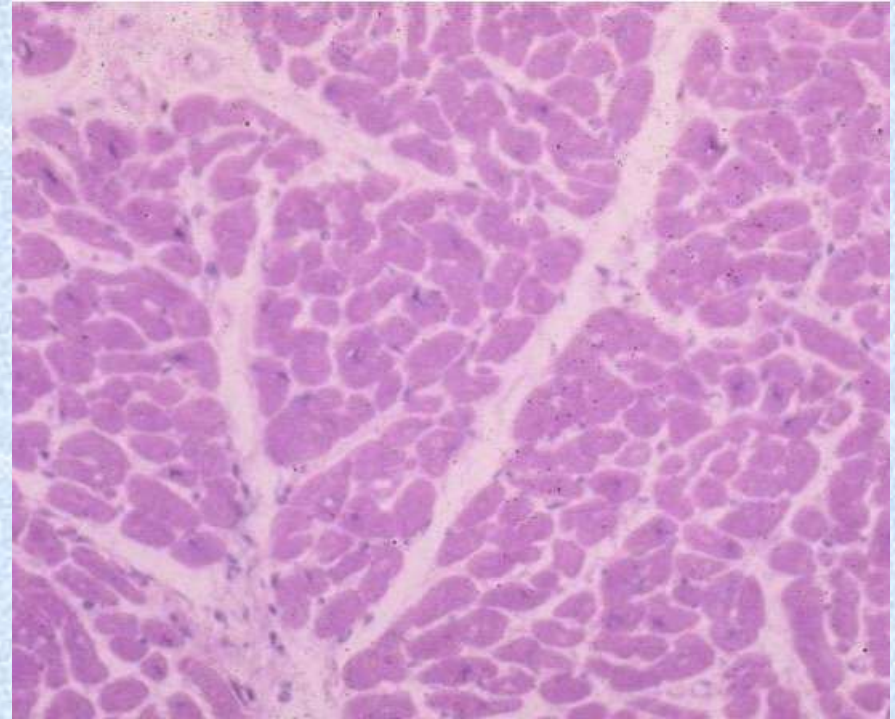
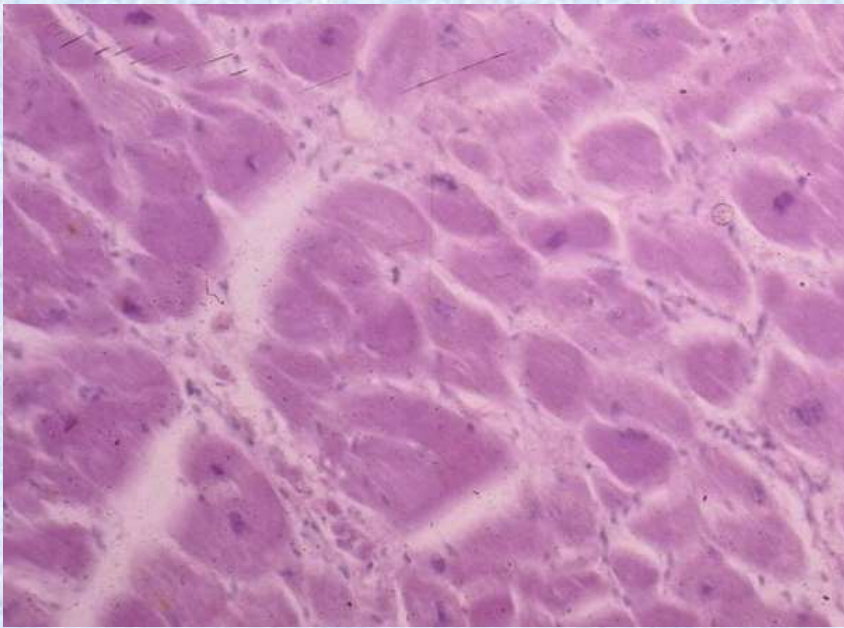
- **Hypertrophy:**



**Myocardium.....
.....Comment???**

ABNORMAL CELL GROWTH

- **Hypertrophy:**



**Myocardium.....
.....Comment???**

ABNORMAL CELL GROWTH

- **Hypertrophy:**

Types:

B. Pathological hypertrophy: e.g.

- **Compensatory hypertrophy**: in paired organs when one is pathologically destroyed or surgically removed; nephrectomy of one kidney leads to hypertrophy and enlarged size of the other kidney.

ABNORMAL CELL GROWTH

- **Hypertrophy:**

Which is more serious??

ATROPHY

HYPERPLASIA

HYERTROPHY

GOOD LUCK

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