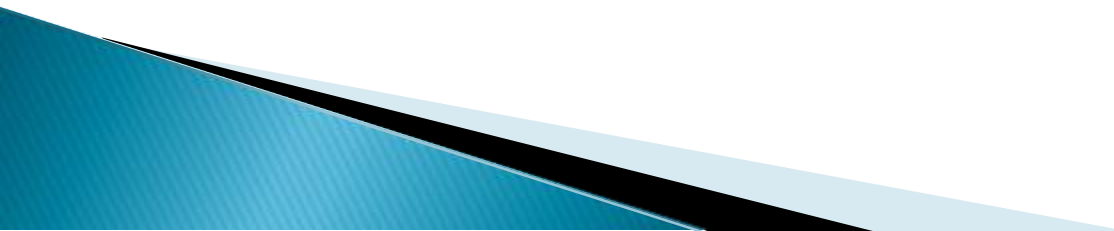
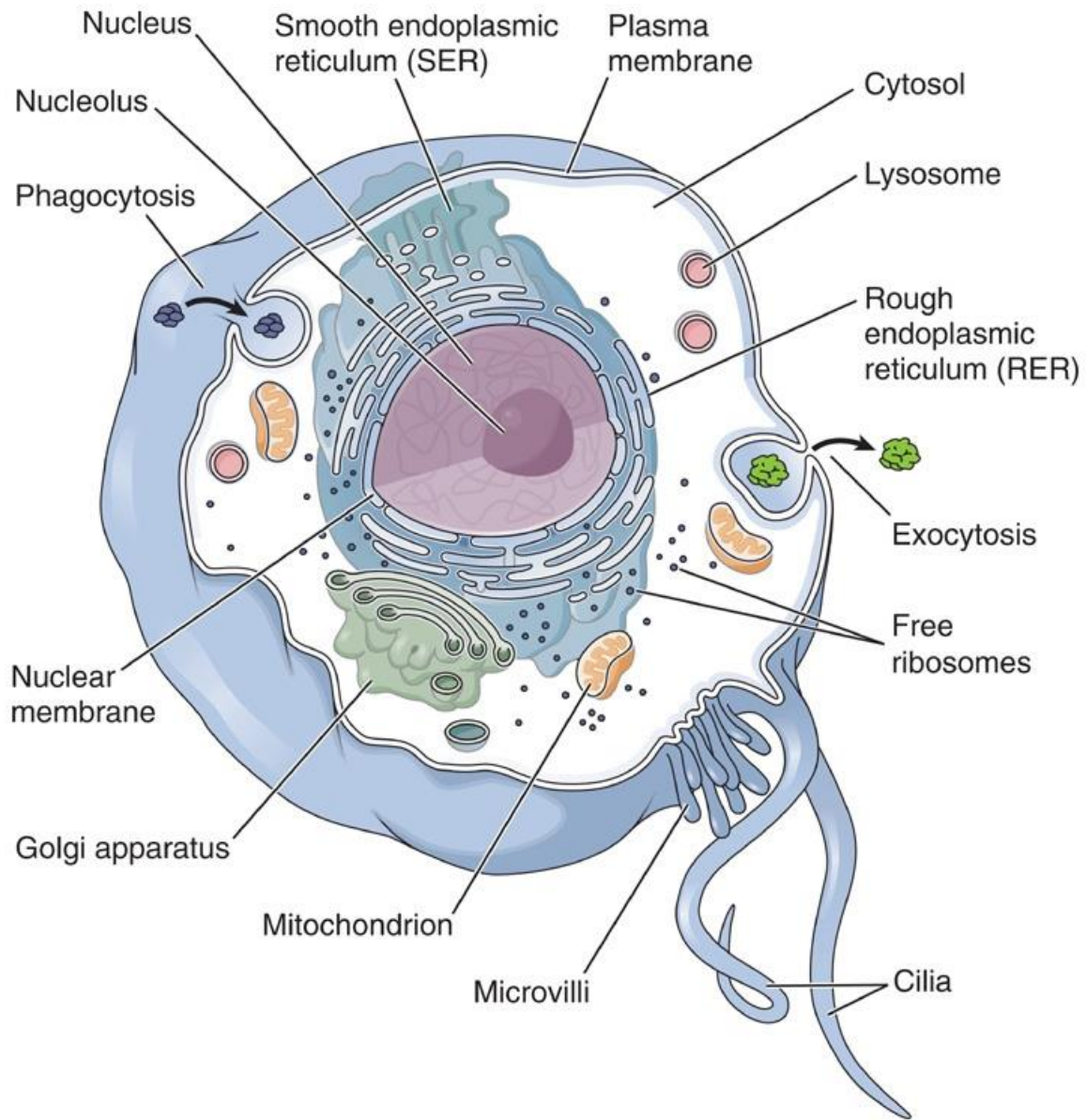


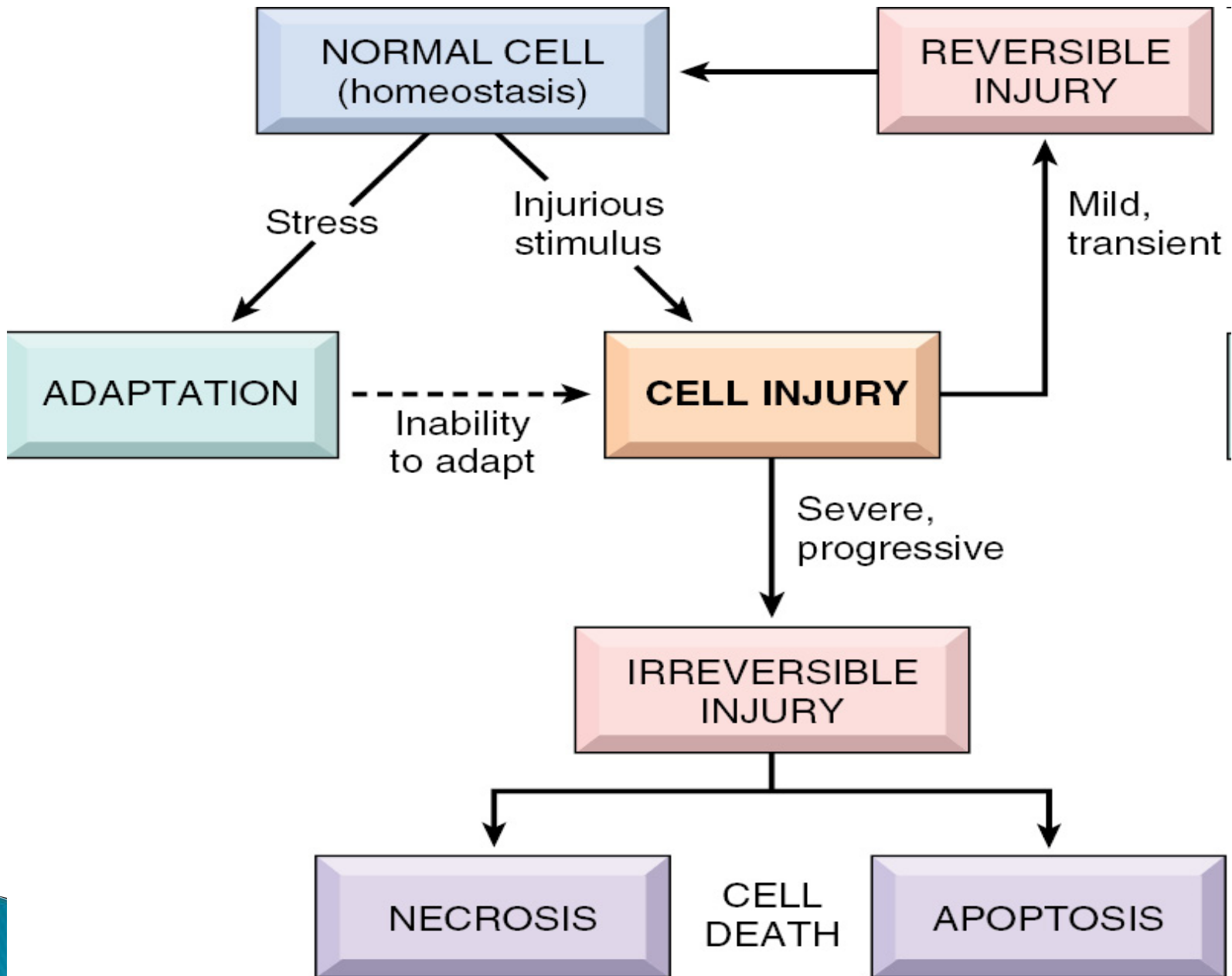
# Cellular Adaptations

cell injury and adaptations  
Manar Hajeer, MD, FRCPath  
University of Jordan , school of medicine

# Outlines:

- ▶ Adaptive mechanisms
  - ▶ Hypertrophy
  - ▶ Hyperplasia
  - ▶ Atrophy
  - ▶ Metaplasia
  - ▶ Causes of cell injury.
- 



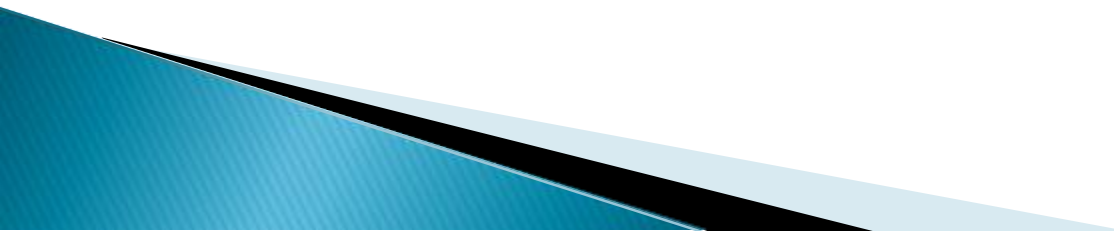


# Adaptations

Physiologic  
adaptation

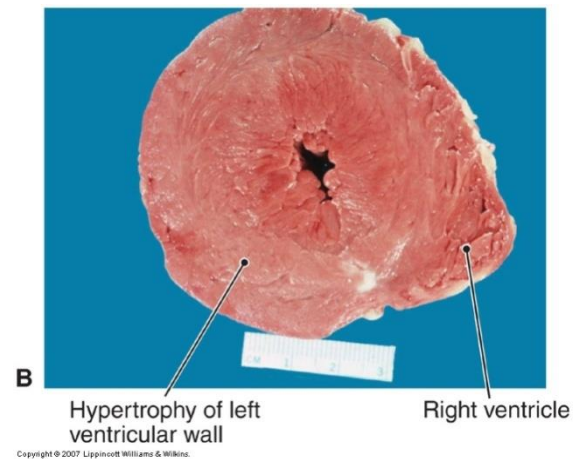
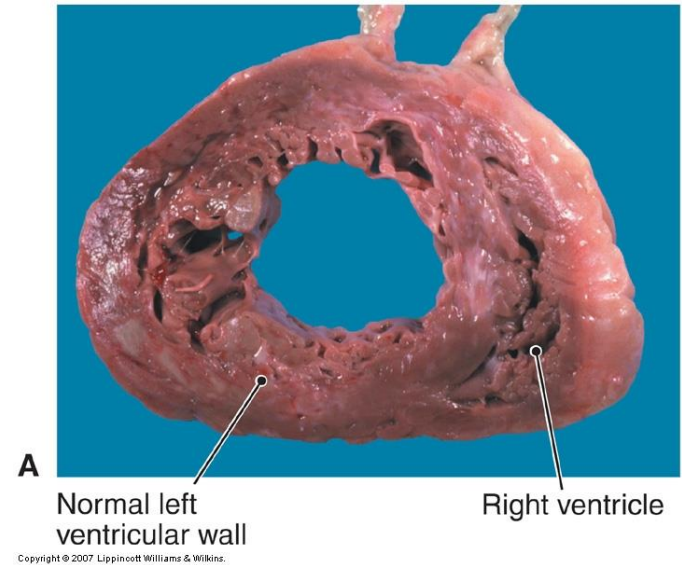
Pathologic  
adaptation.

# Adaptations

- **Many forms:**
  - Increase in cell size.
  - Decrease in cell size.
  - Increase in number of cells.
  - Change into another type of cell
- 
- Adaptation to stress can progress to cell injury if the stress is not relieved.
- 

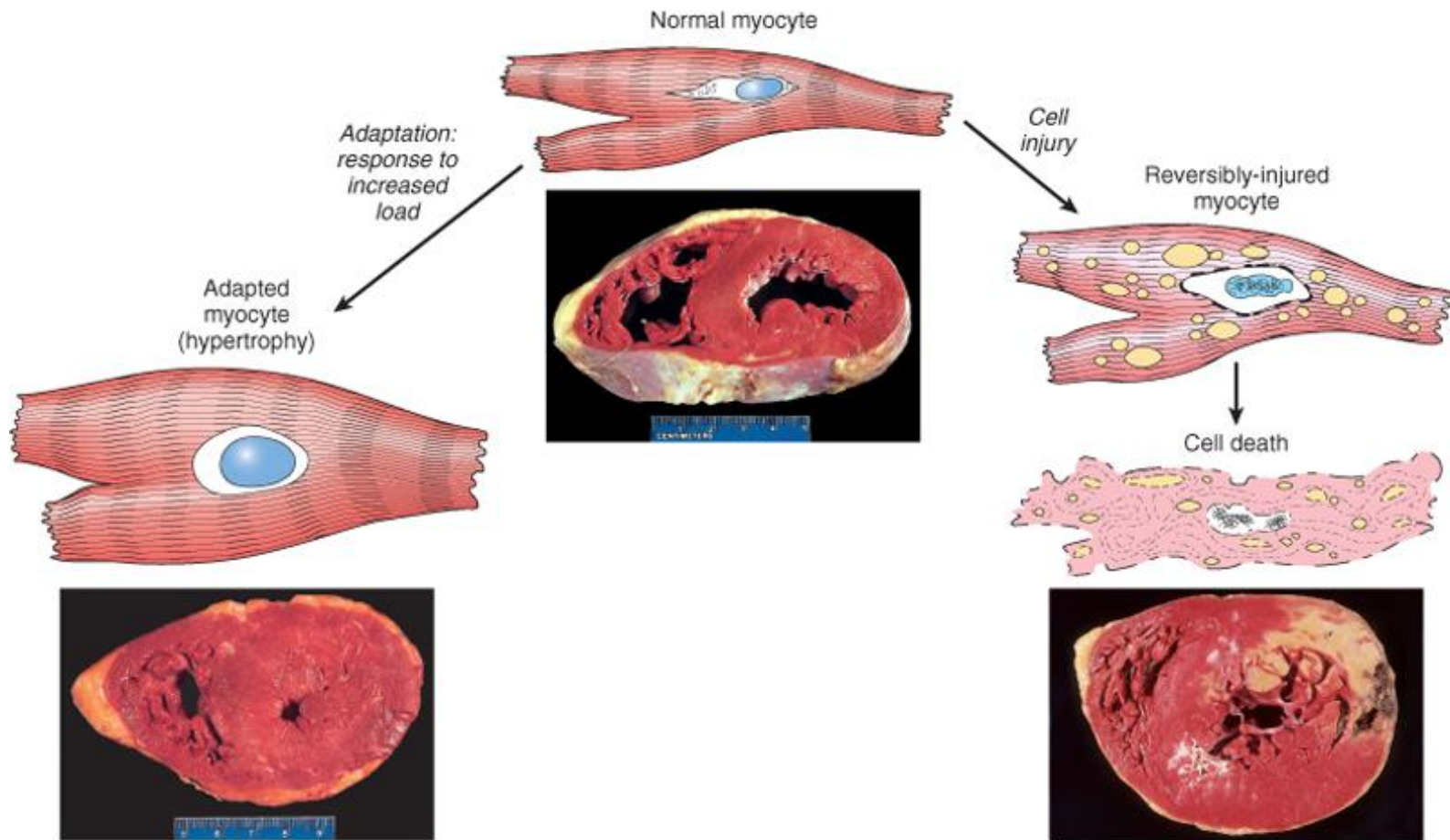
# Hypertrophy

- Increased size & functional capacity
  - Pure or mixed
  - Increased structural proteins and organelles.
  - Pathologic vs physiologic
- 
- Due to
    - hormonal stimulation
    - Growth factor stimulation
    - increased functional demand



# Pathologic

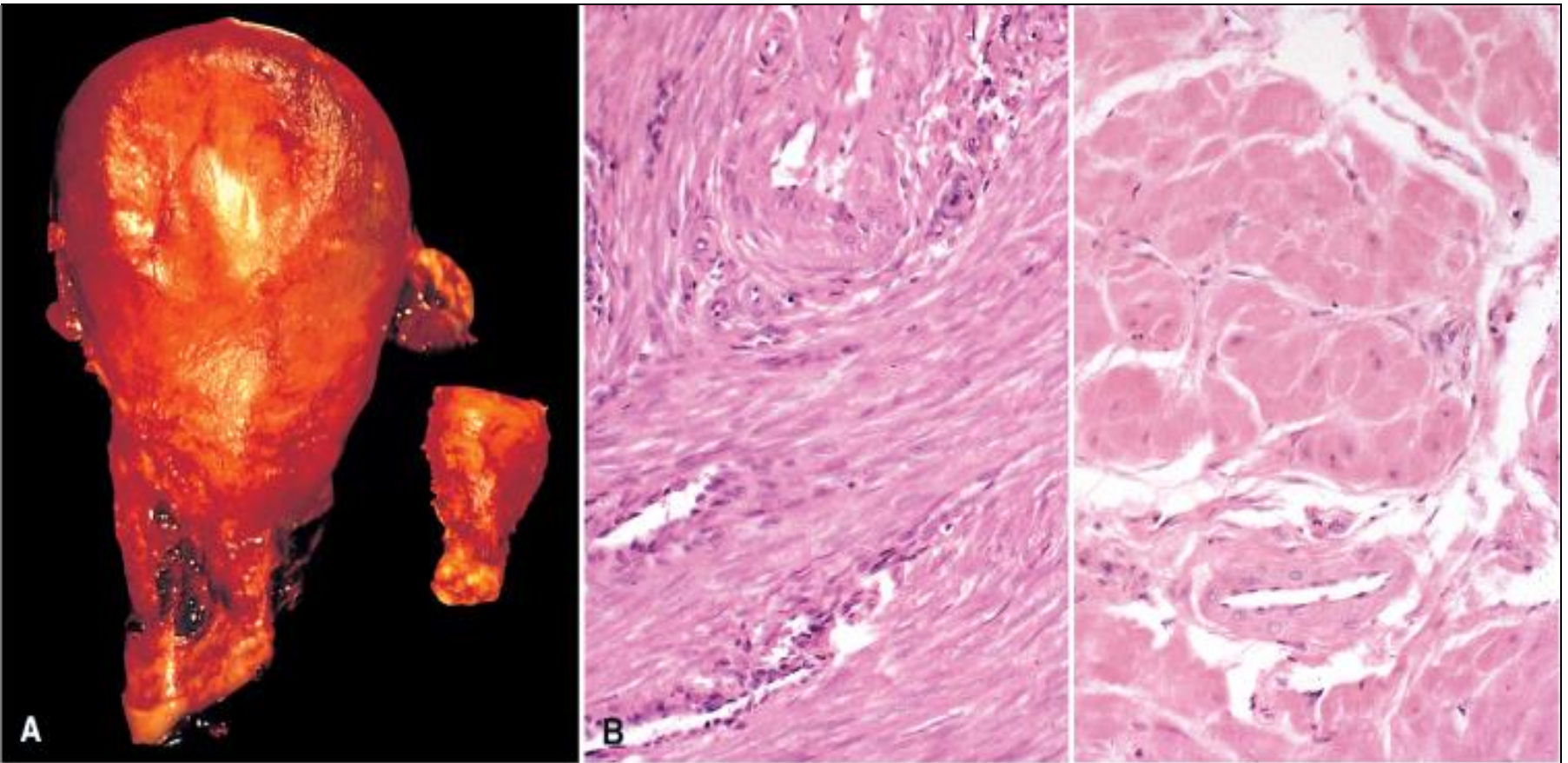
## cardiac muscle in hypertension and aortic stenosis



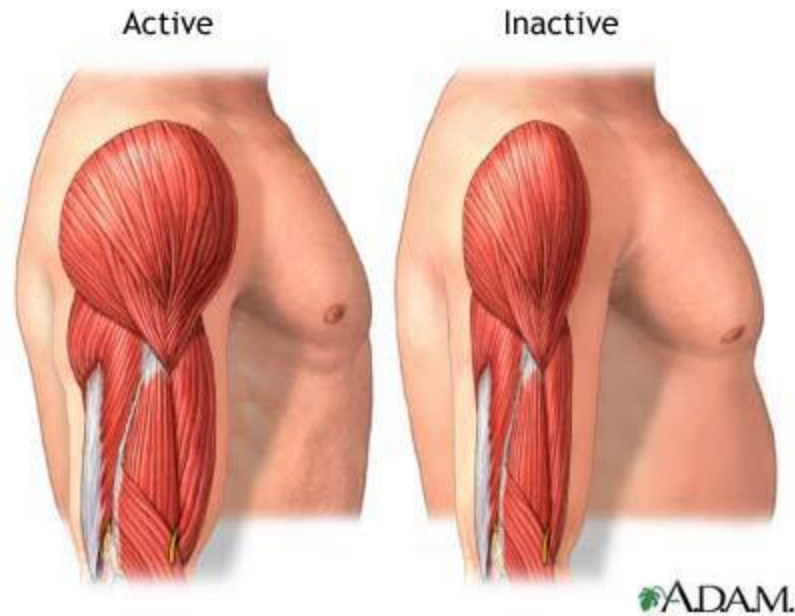


Physiologic

uterine smooth muscle in pregnancy



# Physiologic skeletal muscle in athletes



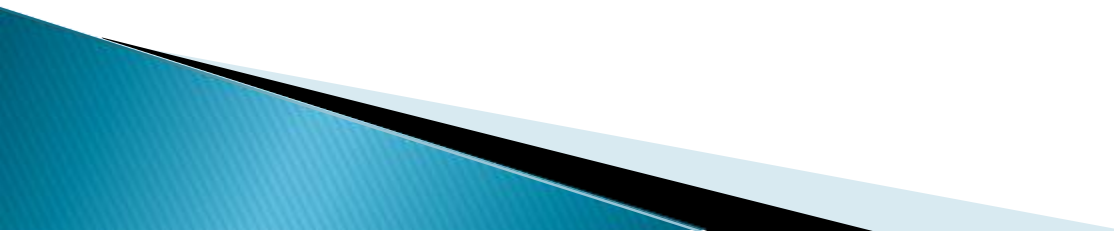
# Hyperplasia

- Increase in number of cells
- Tissues that have proliferative ability
- Pure vs Mixed
- Physiologic vs Pathologic vs cancer
- **Physiologic hyperplasia:**
  - hormonal stimulation
  - Compensatory
- **Pathologic hyperplasia**
  - excessive hormonal stimulation
  - Viral Infections
- ▶ Pathologic hyperplasia constitutes a fertile soil in which cancers may eventually arise. (endometrial)

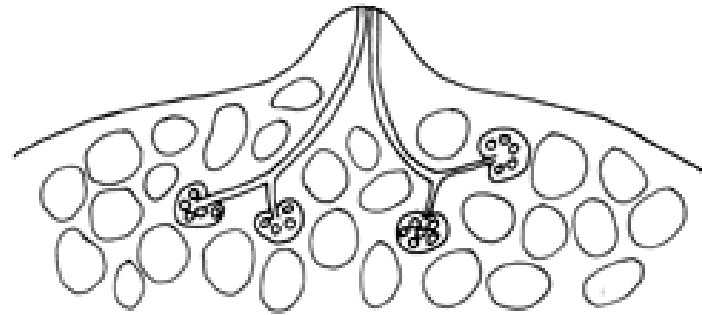
- ▶ **Physiologic**

- ▶ Breast in puberty and pregnancy
- ▶ Liver after partial resection

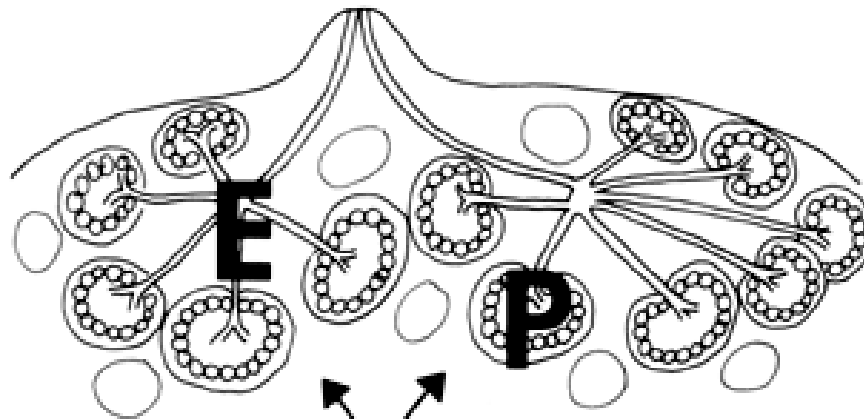
- ▶ **Pathologic**

- ▶ Endometrial hyperplasia, estrogen induced.
  - ▶ Benign prostatic hyperplasia, androgen induced.
  - ▶ Warts (HPV).
- 

# Physiologic breast in pregnancy and lactation

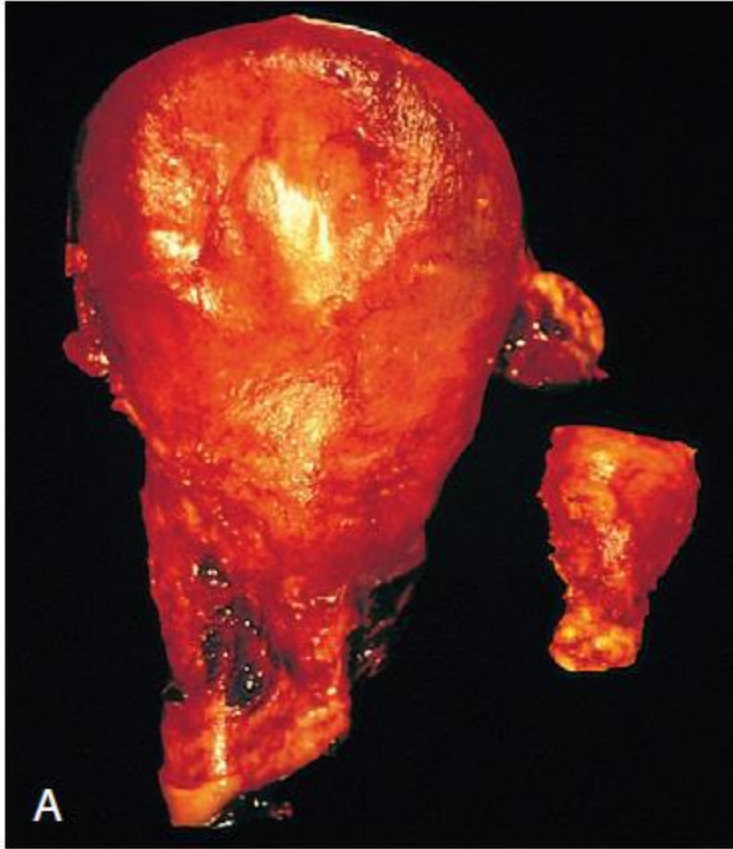


**PREGNANT**



**Prolactin**

# Pathologic endometrial hyperplasia, estrogen induced

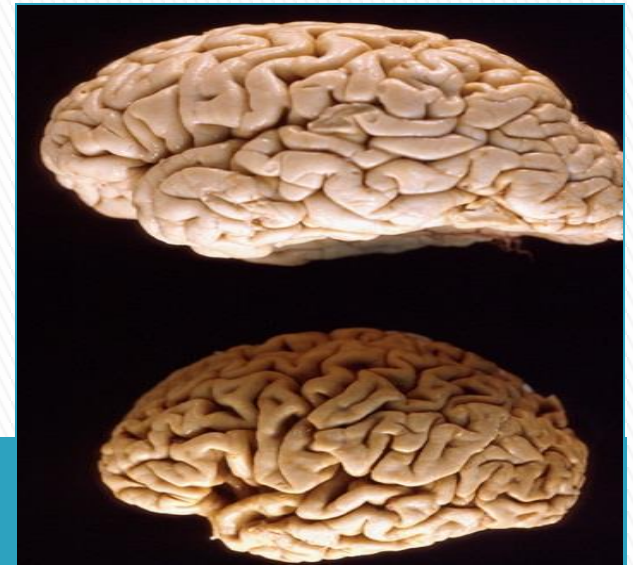
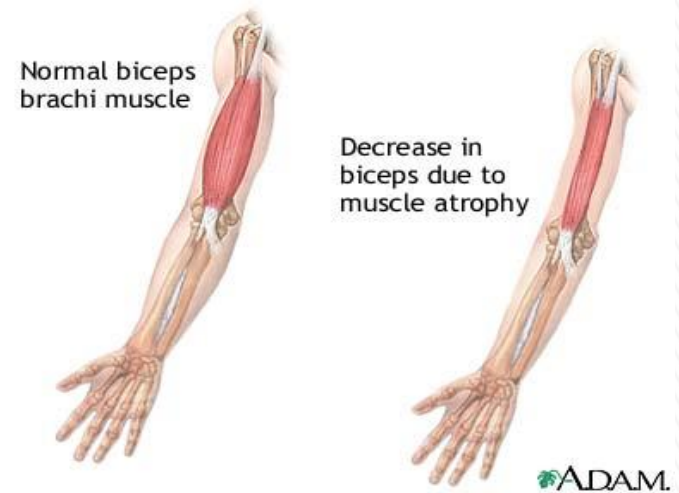


# Atrophy

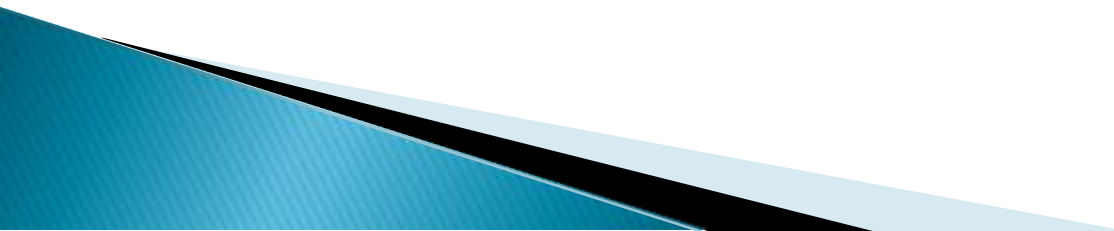
- Decreased cell size & function
- Mechanism: ↓ Protein synth
  - ↑ Degradation
  - ↑ Autophagy
- Atrophic cells can still function

# Causes:

- ▶ Decreased workload (immobilization of a limb after fracture)
- ▶ Loss of innervations
- ▶ Diminished blood supply,
- ▶ Inadequate nutrition
- ▶ Loss of endocrine stimulation
- ▶ Aging (senile atrophy)

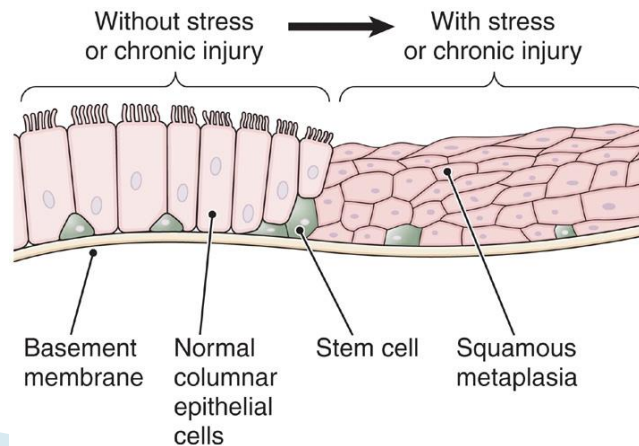




- ▶ **Physiologic**
  - ▶ Loss of hormone stimulation in menopause (endometrial atrophy)
  
  - ▶ **Pathologic**
  - ▶ Denervation injury.
  - ▶ Chronic ischemia.
- 

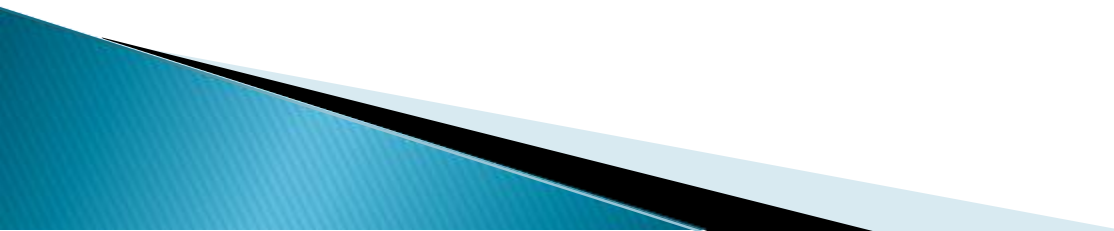
# Metaplasia

- Change from one cell type to another
- Reprogramming of stem cells NOT differentiated cells
- Persistent change increases risk of cancer
- New cell type copes better with stress but function less.
- Reversible
- Causes: Smoking , Vitamin A deficiency, GERD.
- Vitamin A is needed for normal epithelial differentiation, deficiency leads to squamous metaplasia of the bronchi)

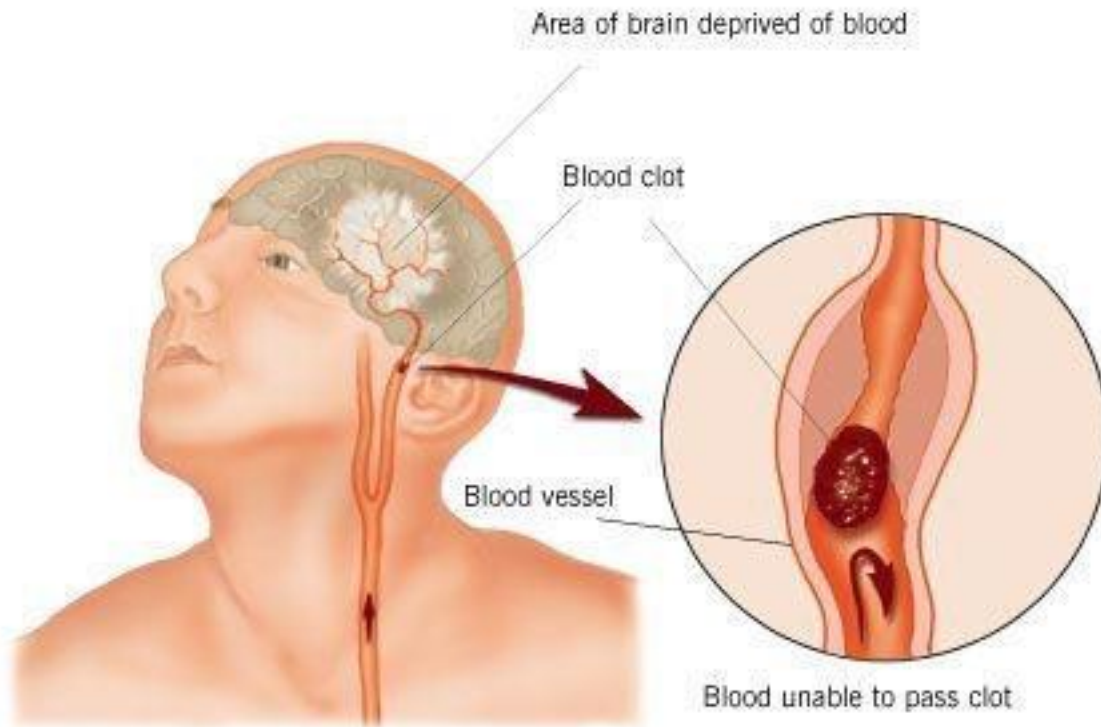


# Cell injury and death

# CAUSES OF CELL INJURY

- Oxygen Deprivation (Hypoxia Vs ischemia)
  - Chemical Agents
  - Infectious Agents
  - Immunologic Reactions
  - Genetic Factors
  - Nutritional Imbalances
  - Physical Agents
  - Aging
- 

# Oxygen Deprivation



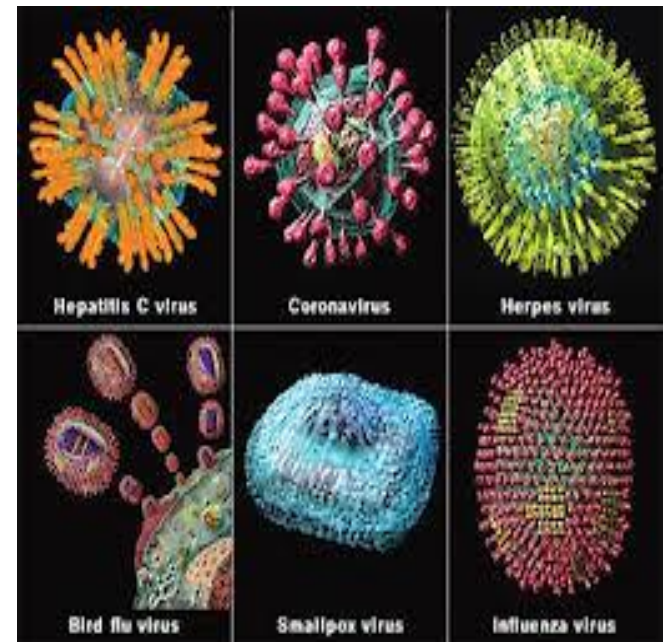
**LACK OF  
OXYGEN!**



# Chemical Agents



# Infectious Agents



# Immunologic Reactions

autoimmune, allergic, microbes

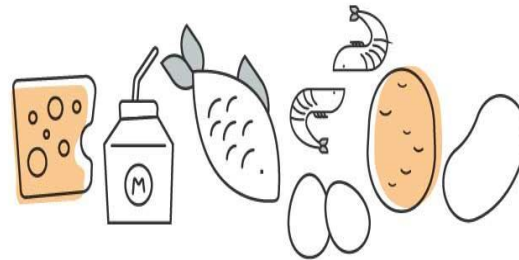




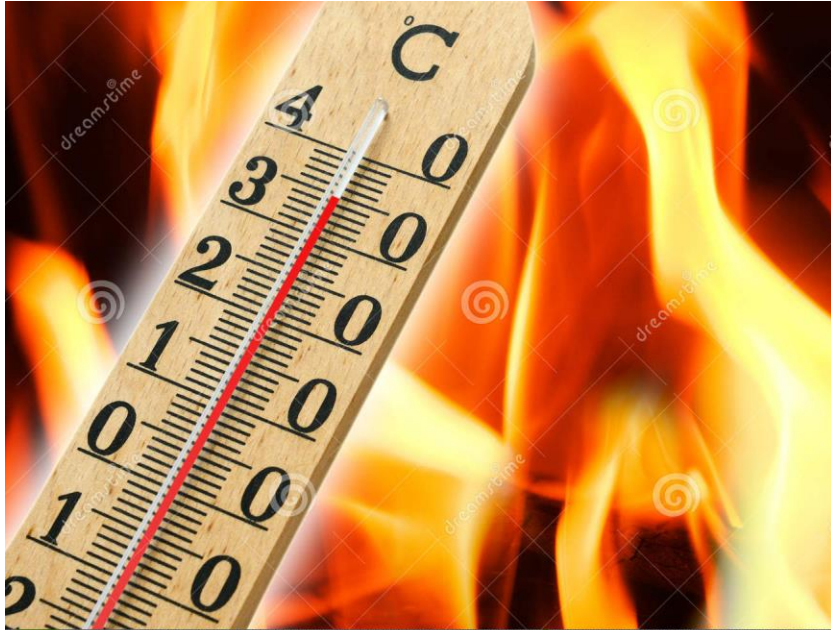
# Genetic Factors



# Nutritional Imbalances



# Physical Agents



Download from  
**Dreamstime.com**  
This watermarked comp image is for previewing purpose only.

36179058  
Andreadonetti | Dreamstime.com

▶ A 43 yearold male presents with mild burning substernal pain following meals for the past 3 years. Upper GI endoscopy is performed and biopsies are taken of an erythematous area of the lower esophageal mucosa 3 cm above the gastroesophageal junction. There is no mass lesion, no ulceration, and no hemorrhage noted. The biopsies show the presence of columnar epithelium with goblet cells. Which of the following mucosal alterations is most likely represented by these findings?

- ▶
- ▶ A Dysplasia
- ▶ B Hyperplasia
- ▶ C Carcinoma
- ▶ D Ischemia
- ▶ E Metaplasia



▶ A 22 year old recently wed female has missed her last two menstrual cycles . Her OB/GYN confirms her pregnancy. If we were to have a look at her uterus we would find which of the following adaptive cellular responses?

▶

- ▶ A Hyperplasia
- ▶ B Dysplasia
- ▶ C Atrophy
- ▶ D Hypertrophy
- ▶ E More than one of the above

▶ A 56 year old female heavy smoker presents with chronic cough, but recently has noted increased sputum production. After a thorough history & physical examination bronchoscopy with biopsy is performed. The biopsy reveals bronchial epithelium with squamous metaplasia. Which of the following statements is applicable to these findings?

▶

- ▶ A Physiologic process of aging
- ▶ B Irreversible, even if she stops smoking
- ▶ C Metastases to the lung
- ▶ D Risk for infection
- ▶ E Thromboembolism with infarction

▶