



Pathology

Modified slides no.10

Writer : Lujain Ahmad & Omar Smadi

corrector: Lujain Ahmad & Omar Smadi


Doctor: Manar Hajeer



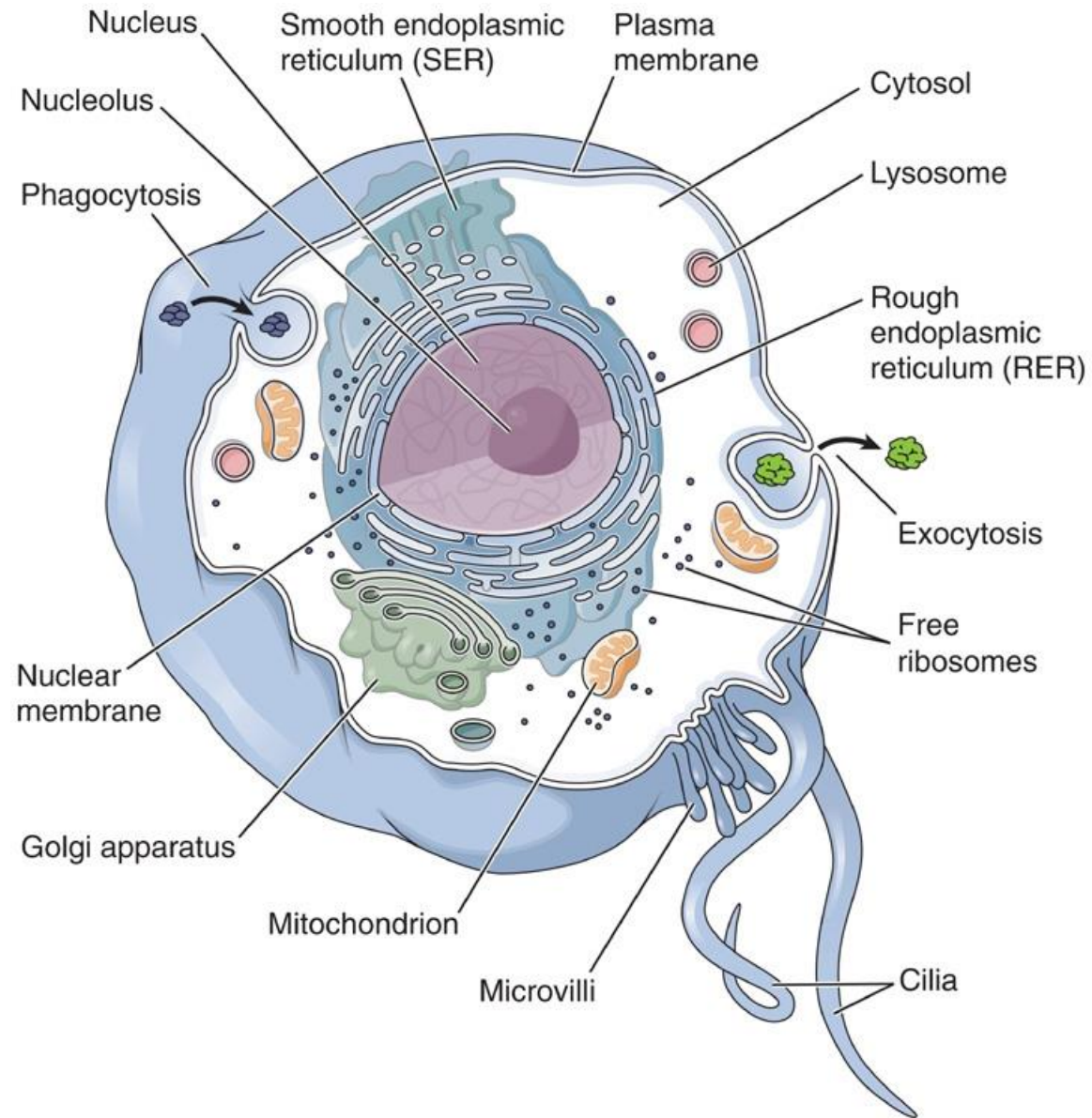
Cellular Adaptations

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

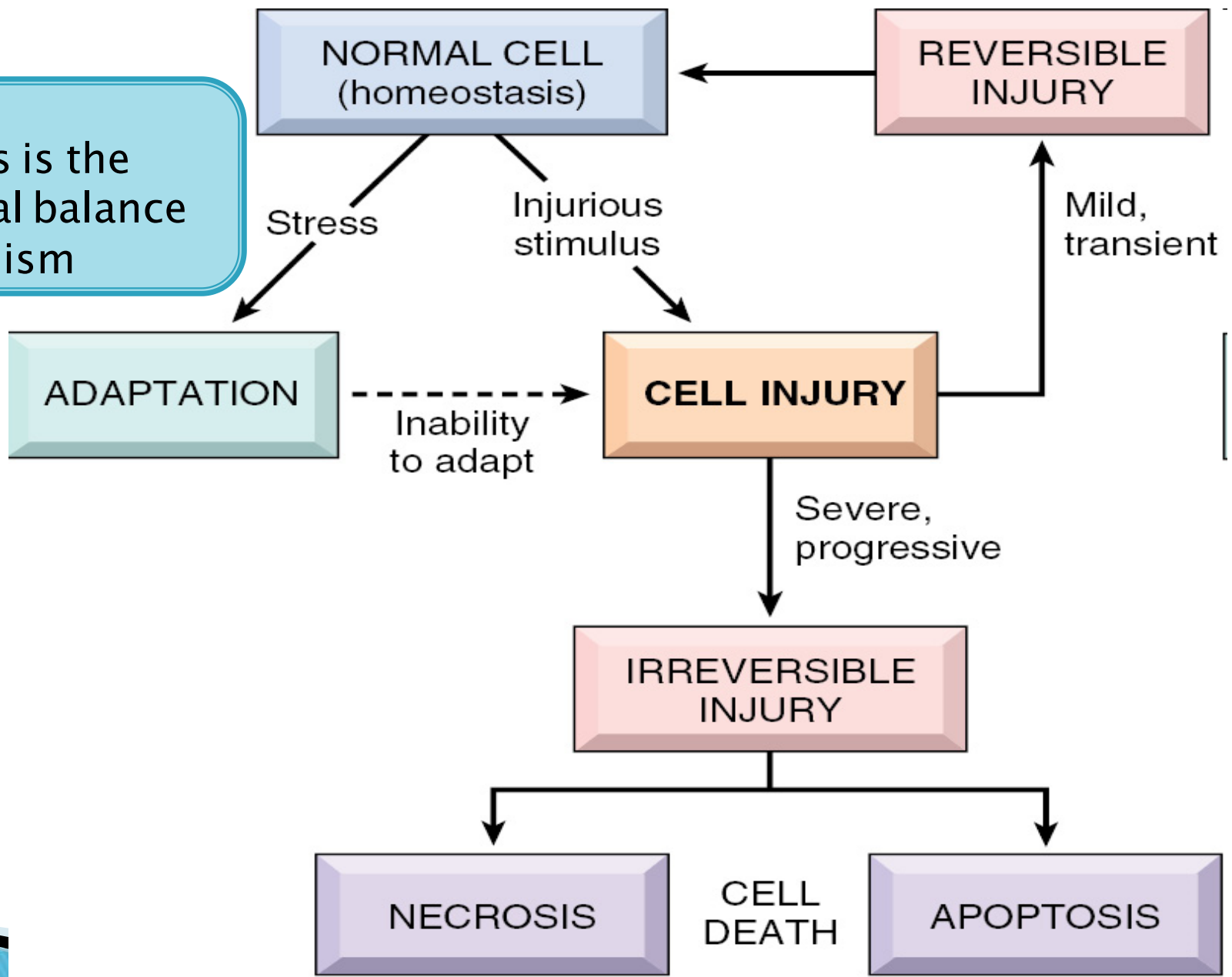
Outlines:

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

□ **NOTE:** The cell is composed of:-plasma membrane: it is a phospholipid bilayer membrane.
-nucleus and nucleolus.
-cytoplasm which has many organelles such as mitochondria ,Golgi apparatus and ER, etc. - ribosomes, lysosomes and structural proteins.



Remember :
homeostasis is the physiological balance in the organism



□ **The complementing this slide:**

***Normal Cell**

If the cell's intracellular components are within the normal range, highly regulated and constant this what we Call homeostasis (balanced life style).

***Stress or injurious stimulus**

if the cell faces stress or is exposed to stimuli it will normally try to adapt with the stress. there are 4 types of adaptation mechanisms (will be discussed soon)

if the cell undergoes Sever injurious stimulus or it is unable to adapt this will lead to cell injury

Adaptations

When the cell faces any stimulus or injury it will try to adapt, but if the injury was severe it will cause cell injury which can be reversible or irreversible.

Physiologic
adaptation

Pathologic
adaptation.

□ **The complementing this slide:**


1-reversible: If the injurious stimulus was mild, transient, short period of time, after the harmful stimulus released the cell will go back to normal.

2-irreversible: if the injurious stimulus was severe, progressive, prolonged, diseased cell, Cell won't go back to normal even when the stressful stimulus is released → cell death (the cell will lose its function)

To sum up: if the cell is exposed to an injurious stimulus, the cell will try to survive firstly by adaptation, if the cell couldn't adapt and the cell was still injured, the cell will die.

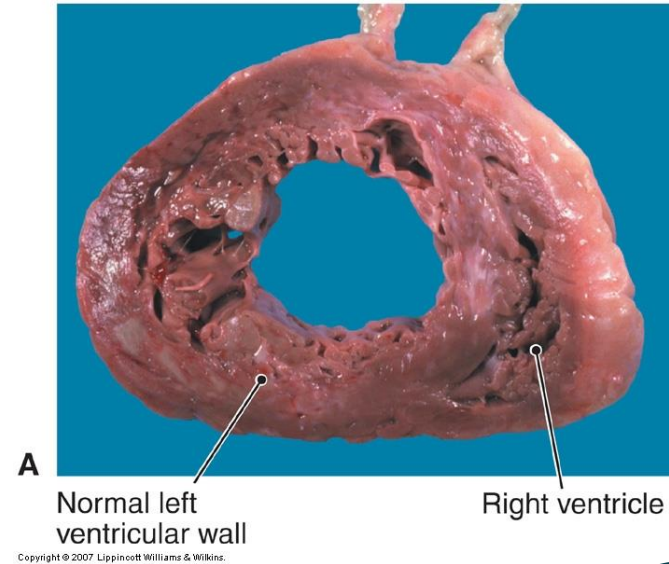
*Two forms of Cell death: 1-necrosis (unprogramed cell death)
2- apoptosis (programed cell death)

Adaptations

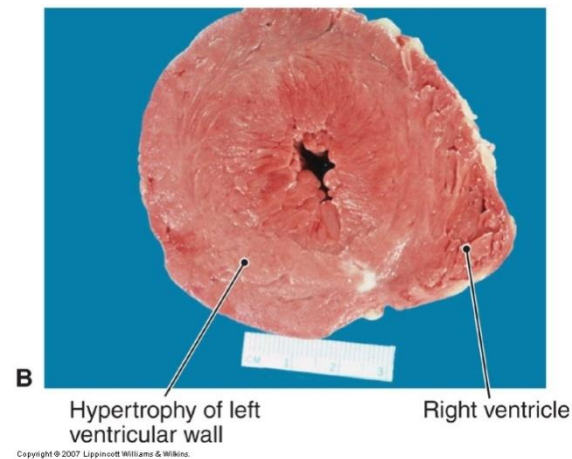
- **Many forms:**
 - Increase in cell size.
 - Decrease in cell size.
 - Increase in number of cells.
 - Change into another type of cell
-
- Adaptation to stress can progress to cell injury if the stress is not relieved.
- 

Hypertrophy

- Increased size & functional capacity
- Pure or mixed
- Increased structural proteins and organelles.
- Pathologic vs physiologic
- **According to the stimulus of hypertrophy**
- **Due to**
 - hormonal stimulation
 - Growth factor stimulation
 - increased functional demand, **like in hypertension in which the heart will need more force to pump blood.**

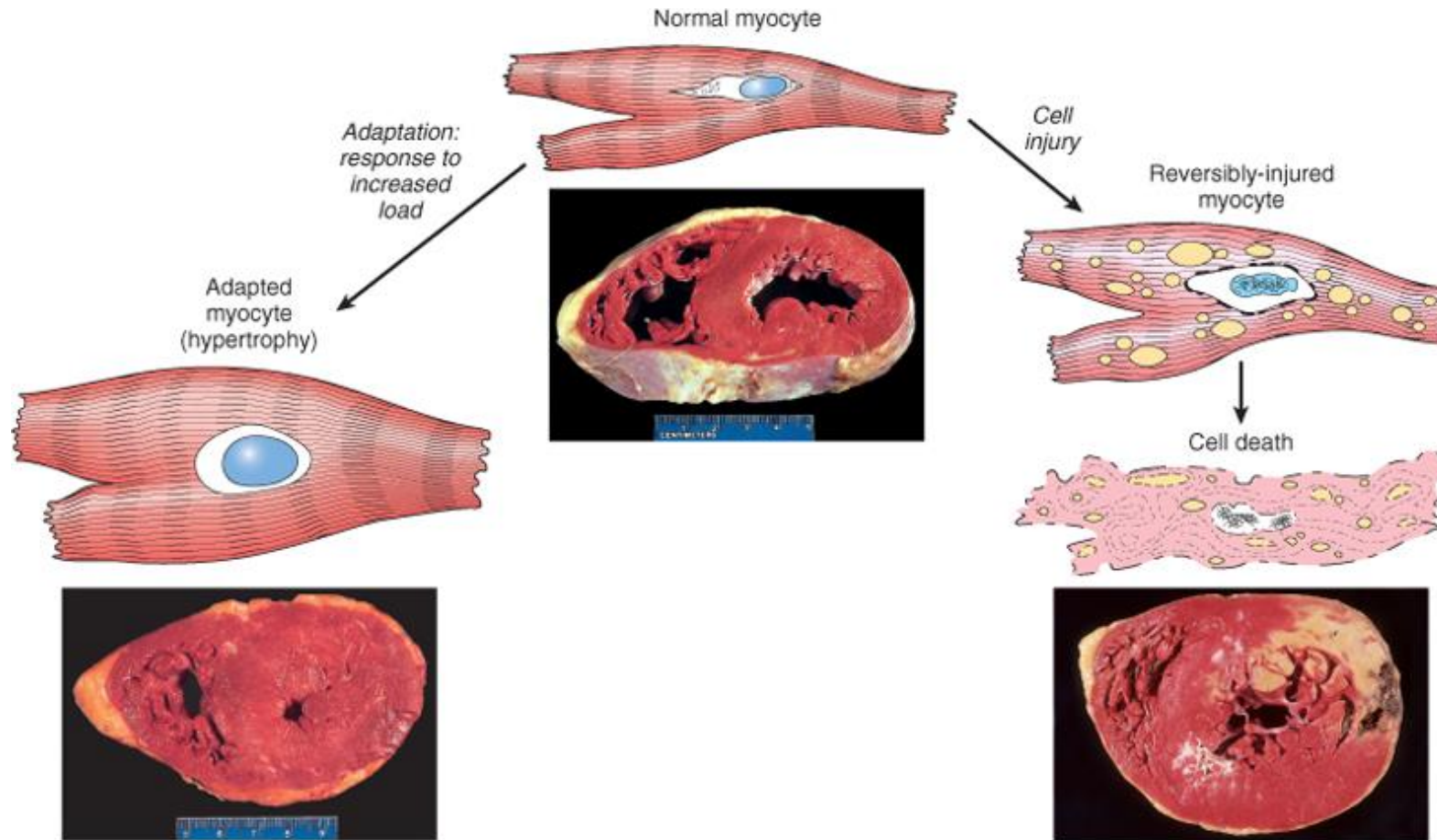


Normal heart:
Notice how the chamber is big.



Look at the thickness of the wall and the narrow of the left ventricles. The muscles is increased in size which we call it hypertrophy.

Pathologic cardiac muscle in hypertension and aortic stenosis



□ NOTE:

Here the stimulus are diseases such as hypertension and aortic stenosis

So it is pathologic

□ The complementing this slide:

- stimulus: functional demand
- pure ,cannot divide

-Hypertrophy of the cardiac muscle is a response to hypertension or Aortic stenosis. This is why the heart is making this adaptation to increase the cardiac output against the increased demand from hypertension and aortic stenosis.

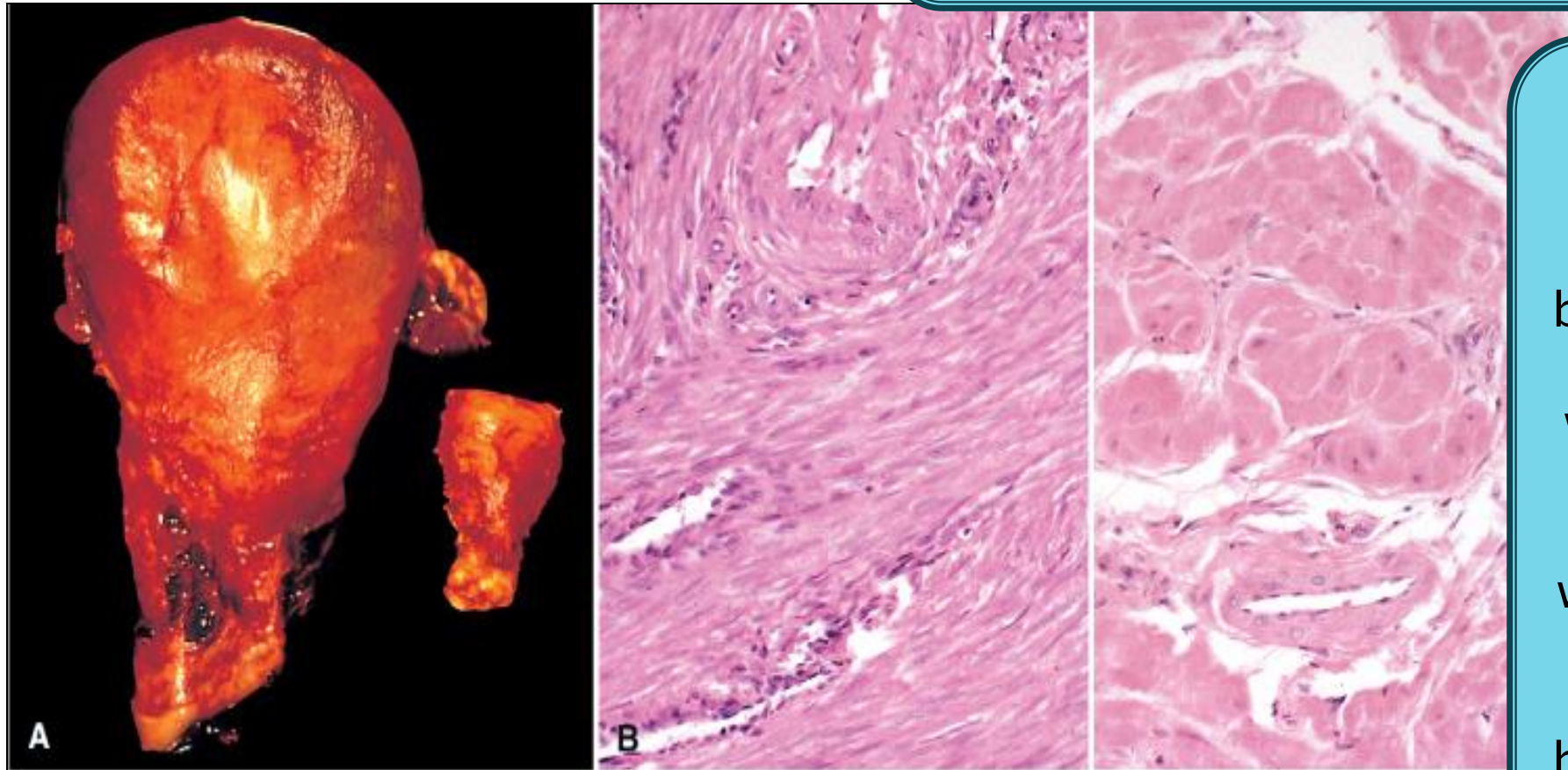
How can the heart adapt with this stress?

By increasing the size of the myocyte/cardiac muscle cells so it will contract in a stronger way to have more cardiac output. After a while patient will have a heart failure due to cardiac muscle fatigue. Heart failure causes pulmonary edema and decrease the cardiac output for the body.

Physiologic

uterine smooth muscle in pregnancy

- stimulus: hormonal estrogenic stimulation
- mixed(hypertrophy+ hyperplasia(cell proliferation, will be discussed soon))
- can divide

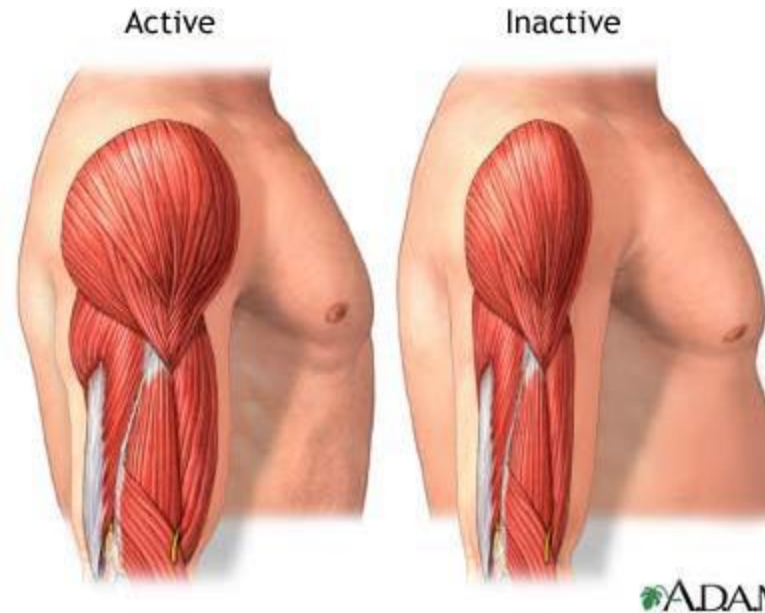


After pregnancy (Estrogene is back to normal) so the uterus will go back to normal size, the new cells will die and the large cells will shrink to go back to normal.

Physiologic skeletal muscle in athletes

□ NOTE:

- stimulus: functional demand
- pure hypertrophy
- cannot divide



□ NOTE:

The functional demand on skeletal muscle will lead to enlarge on size and to make hypertrophy

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)

□ **NOTE:**

– Can be Pure vs Mixed.
With or without hypertrophy
occurrence

□ **The complementing this slide:**

Pure or mixed

- Pure: in cells that cannot divide, so they cannot undergo hyperplasia .they only undergo hypertrophy
e.g.: skeletal muscle, cardiac muscle
- Mixed: cells that can divide, so they can undergo hyperplasia and hypertrophy at the same time for the same stimulus.
e.g.: smooth muscles of uterus.


Increased structural proteins and organelles

The cell size increases by increasing the number of proteins and organelles (mechanism of hypertrophy) .

- ▶ **Physiologic**

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

- ▶ **Pathologic**

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

□ **The complementing this slide:**

Compensatory hyperplasia of the liver after partial resection.

Sometimes a part of the liver is removed in cases of trauma and hepatic tumor.

The remaining cells of the liver will produce some growth factors that will stimulate the proliferation of hepatocytes to retain the normal pre resection size of the liver. This is a peculiar ability of the liver cells to restore the normal size of the liver.

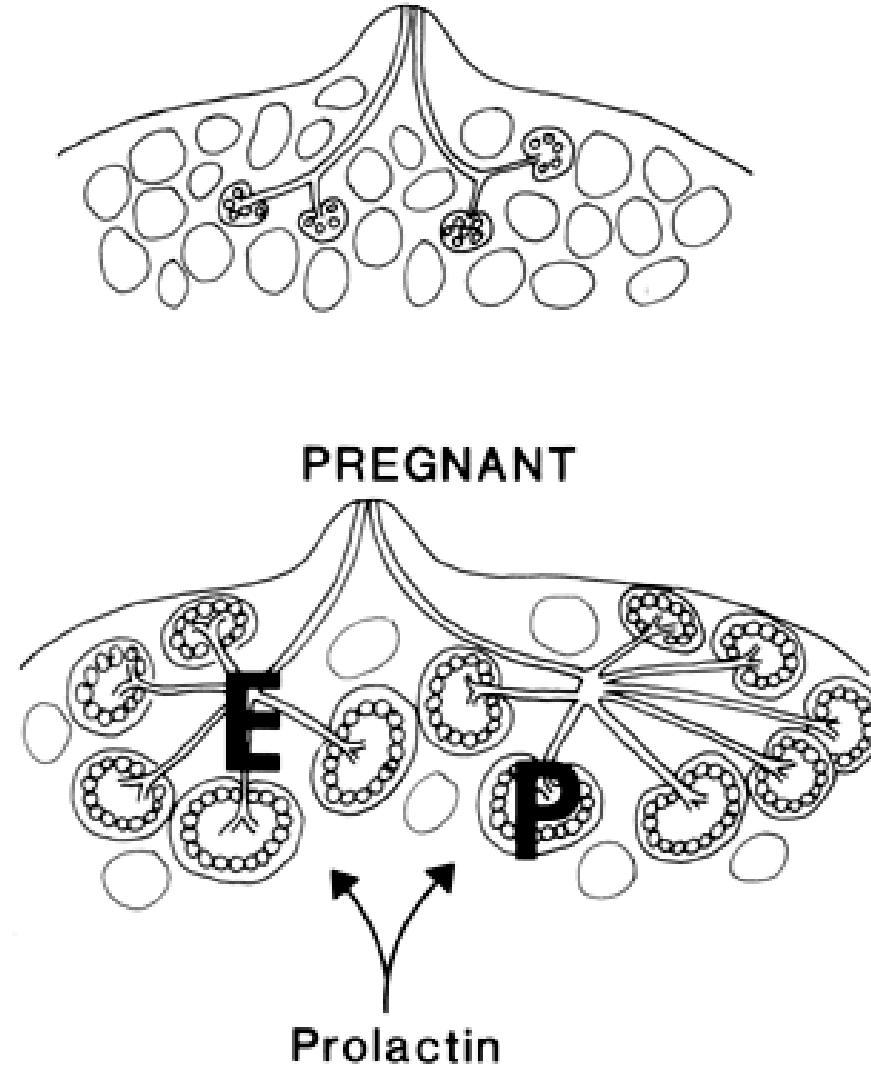
Pathological benign prostatic hyperplasia Androgen induced:

In males, the prostate glands undergo hyperplasia.

Caused by hyper androgenic stimulation enlargement of the prostate gland.

An example of pathological hyperplasia are Warts(Hpv)(ثوالبيل)
Warts are caused by a virus called Human papilloma virus (HPV)

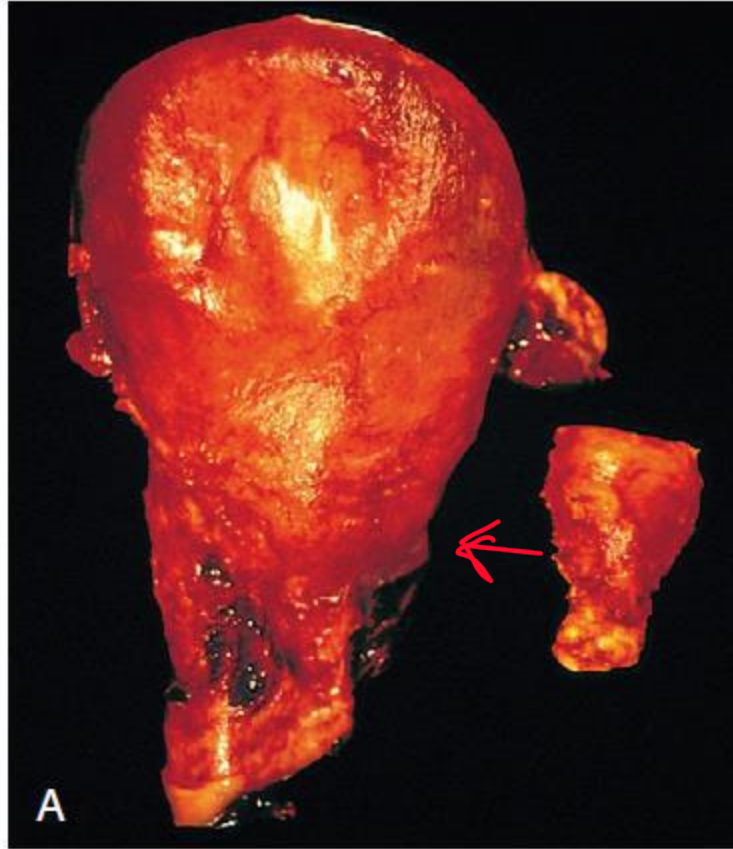
Physiologic breast in pregnancy and lactation



□ NOTE:

No. of mammary glands increased as result of hyperplasia. this case is physiologic so after the pregnancy and lactation are gone everything back to normal

Pathologic endometrial hyperplasia, estrogen induced



□ **The complementing this slide:**

hyperplasia, estrogen induced :

endometrial hyperplasia is driven by continuous estrogenic stimulation. Continuous estrogenic stimulation in these females can lead to endometrial hyperplasia.

If this endometrial hyperplasia persists or not treated, it can transform at some point into the endometrial carcinoma. It can also happen even in premenopausal women.

Atrophy

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

□ NOTE:

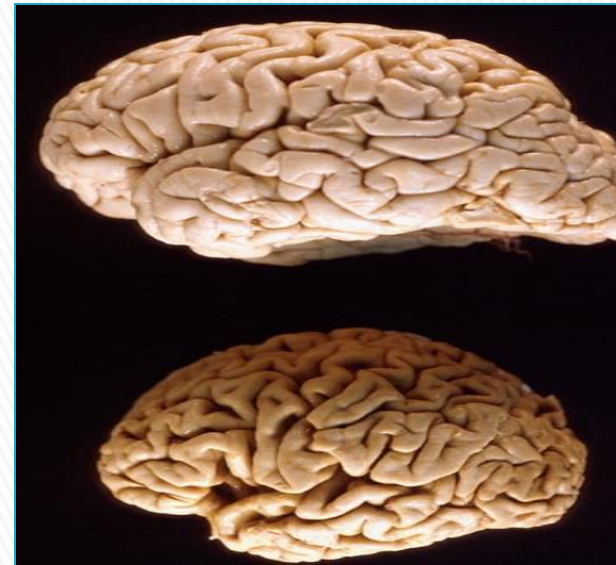
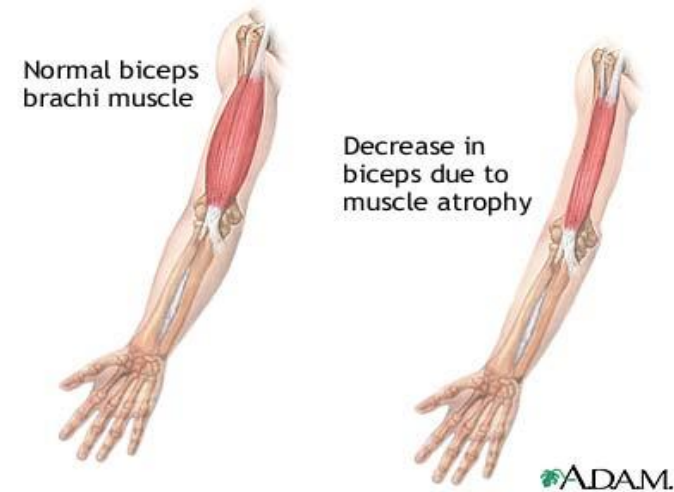
Atrophy is the total opposite of hypertrophy but with some additional mechanisms.

□ NOTE:

– Although cells are still functioning, they are weaker and function less.

Causes:

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



□ **Loss of innervation :**

- Could be caused by the damage of the nerve innervating the atrophied tissue, like physical trauma, or diabetic neuropathy.

□ **Diminished blood supply :**

Also because diabetic patients have high risk of arteriosclerosis, they may have diminished blood supply leading to atrophy. So atrophy in some tissues could be a sign of diabetes.

□ **Loss of endocrine stimulation :**

Just like the increase in estrogen stimulation caused hyperplasia in the uterine myometrium, loss of estrogen stimulation lead to atrophy in the myometrium.

□ **Aging :**

Aging could lead to increased risk of ischemic disease (Diminished blood supply) causing atrophy.

- ▶ **Physiologic**

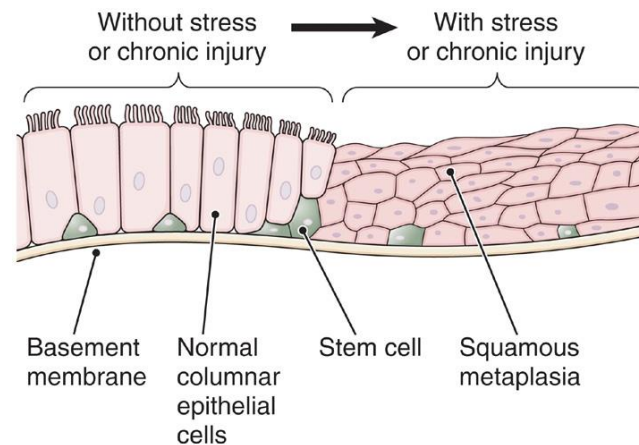
- ▶ Loss of hormone stimulation in menopause (endometrial atrophy)

- ▶ **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)



□ **The complementing this slide:**

Metaplasia is the change from one cell type to another, along with the change of its function, but note each cell changes its own cell type, but the newly generated tissue is from a new type and function.


For example : smoking causes the epithelial tissue of the bronchus to change from ciliated psudostratified to non-ciliated simple squamous which may be more protective from harmful smoking gases but in return caused the loss of the cilia that used to push dust and mucus out of the bronchus.

Another example is GERD (Gastroesophageal reflux disease) in which the stomach acids move up to the lower part of the esophagus leading to metaplasia changing the cells to a more tolerant type for acids, in the expense of losing its function.

Cell injury and death

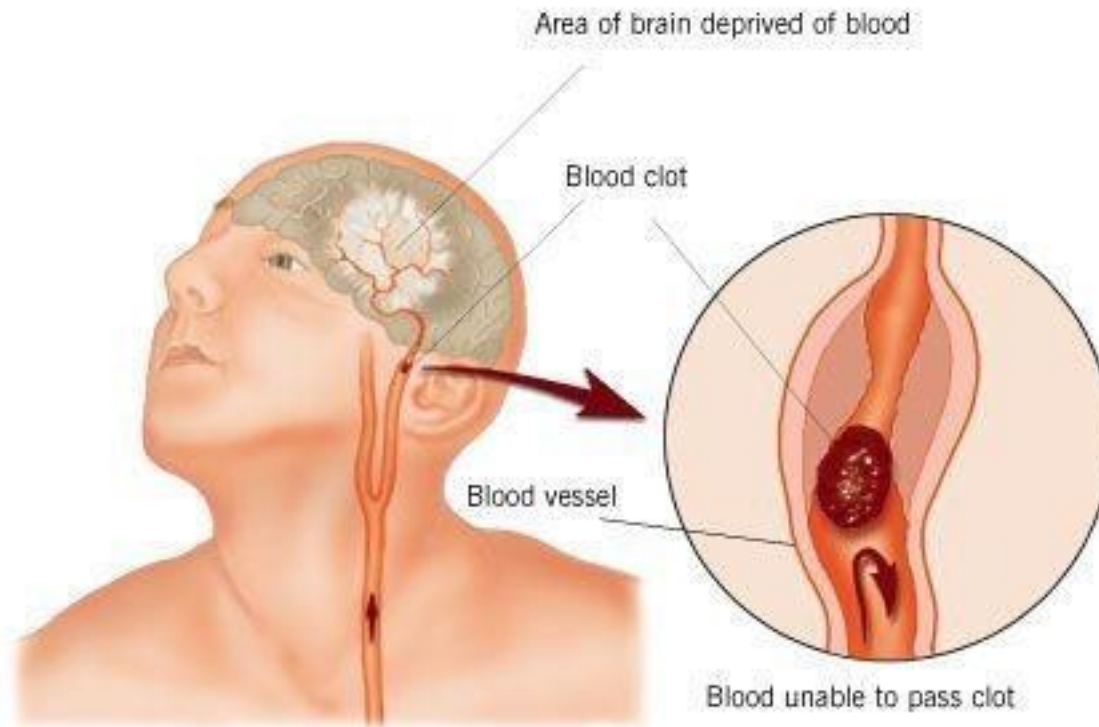


CAUSES OF CELL INJURY

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

Oxygen Deprivation

❑ Oxygen deprivation (lack of oxygen supply):
Causes are : ischemia, asthma, living in high altitude where oxygen is poor, anemia, etc.



**LACK OF
OXYGEN!**

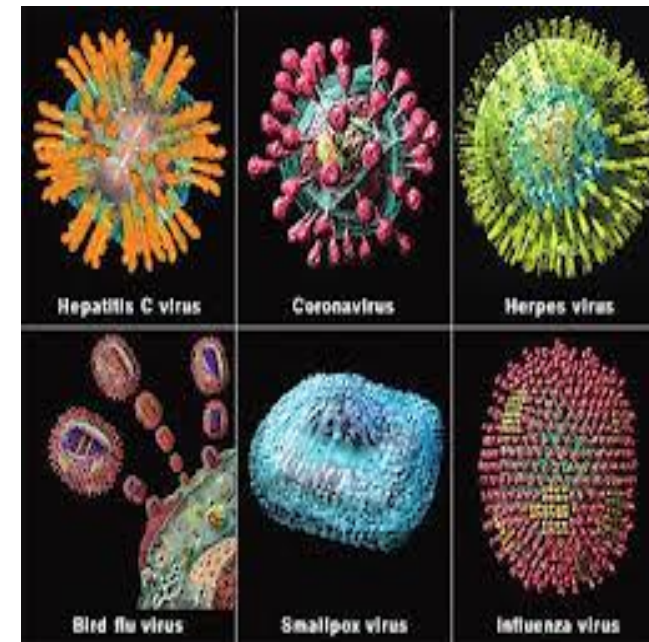
Chemical Agents

Like pesticides for example.



Infectious Agents

Like viruses and bacteria.



Immunologic Reactions

autoimmune, allergic, microbes

Immune cells could cause damage to its surroundings, either in normal immunologic reactions or in autoimmune diseases.



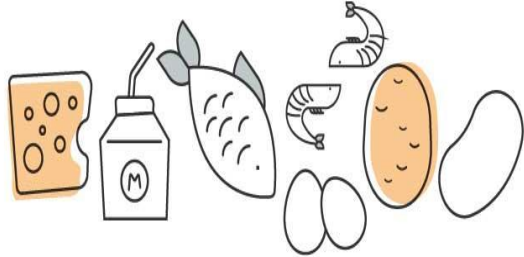
Genetic Factors

From chromosomal abnormalities and even simple genetic mutations



Nutritional Imbalances

Either over nutrition or under nutrition



Physical Agents

All types of physical trauma :
burns, fractures, etc.



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

36179058
Andreadonetti | Dreamstime.com



اللهم كن لغزاة عوناً
اللهم إنا لا نملك إلا الدعاء لهم
فيارب لا ترد لنا دعاء ولا تخيب لنا رجاء
اللهم أنصر ضعفهم فإن ليس لهم سواك