

PATHOLOGY

Sheet no. 11



Writer : Heba shubeir+Nour Soboh

Corrector : Lynn alhamaideh

Doctor : Manar

* The cell is the basic building unit in the body, so any disease process starts at the level of the cell, tissue then the organs.

*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.

Cells interact with each other to adapt and maintain their function and structure ...

*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**

**Cell injury:

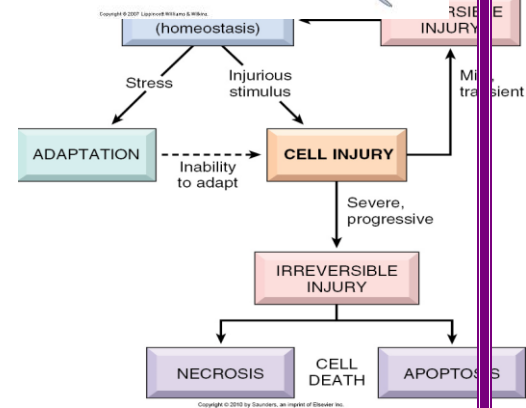
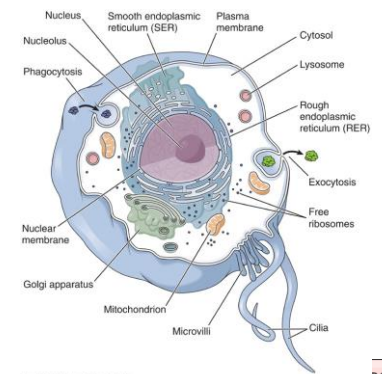
1-**reversible**: If the injurious stimulus was mild, transient, short period of time, after the harmful stimulus released the cell will go back to normal.

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 summer up if the cell is exposed to a stimulus the cell will try to survive firstly by adaptation, secondly by reversible cell injury, finally by irreversible cell injury or what we call it cell death.

**Two forms of Cell death:

1-necrosis 2- apoptosis



ADAPTATIONS

The cell Try to adapt in order to stay alive and keep functioning (سواء تغيرت الوظيفة ام لا)

Physiologic adaptation

Pathologic adaptation.

forms of adaptation (mechanisms)

Caused by any physiological stimulus

Caused by disease

Increase in cell size. (Hypertrophy)

Decrease in cell size. (Atrophy)

Increase in number of cells. (Hyperplasia)

Change into another type of cell. (Metaplasia)

Adaptation to stress can progress to cell injury if the stress is not relieved.

HYPERTROPHY

Increased size & functional capacity

-the size is increased → the functional capacity increased.

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) !! الحجم الي يزيد ما يكون مي

Pathologic vs physiologic

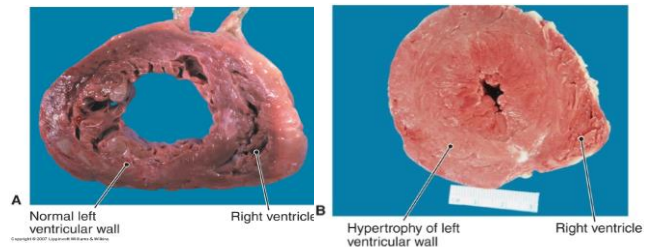
According to the stimulus of hypertrophy

*hormonal stimulation

*Growth factor stimulation

*increased functional demand

لما يكون مطلوب من الخلية تعمل وظيفة أكبر فيالتالي تقوم الخلية بزيادة انتاج البروتينات والعضيات ليزيد حجمها وتشتغل بشكل أقوى



Normal myocyte:
Notice how the chambers are opened.

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 HYPERTROPHY

cardiac muscle hypertrophy due to hypertension and aortic stenosis

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.

****hypertension:** the peripheral vascular resistance in blood vessels is high so the left side of the heart needs to pump against a high vascular resistance so more effort is needed.

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.

****Aortic stenosis:** Aortic valve is closed/narrow then the heart needs stronger contraction to pump blood through this small opening lead to hypertrophy then heart failure.

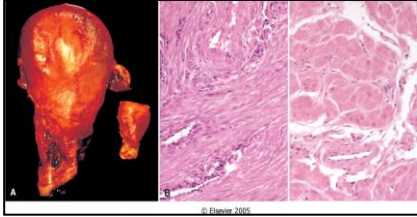
Adaptation يشبه المطاط في البدايه يكون مرن ثم يصل إلى مرحلة فينقطع

All hypertrophy is reversible, but hypertension is a chronic disease and when atherosclerosis happen then it is hard to return the vessels to normal but we can lower the blood pressure and if the patient adheres with the treatment the progression maybe slow and the cells may go back to normal but actually in this case the heart will enlarge in size until reaching heart failure

PHYSIOLOGIC HYPERTROPHY

1-uterine smooth muscle in pregnancy

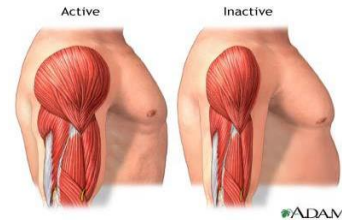
- stimulus: hormonal **estrogenic stimulation**
- mixed(hypertrophy+ hyperplasia)
- can divide



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.

2-skeletal muscle in athletes

- stimulus: functional demand
- pure hypertrophy
- cannot divide



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

HYPERPLASIA

Increase in number of cells

Which means that the cells have proliferative ability to divide with a correspondent increase in the size of the organ

-Tissues that have proliferative

Ability like liver, squamous epithelium of skin, lining epithelium of the GI tract all of them can undergo hyperplasia.

***IMPORTANT NOTE: CARDIC MUSCLE, Skeletal MUSCLES AND NEURONS CAN'T UNDERGO HYPERPLASIA BECAUSE THEY AREN'T ABLE TO DIVIDE BUT ONLY CAN UNDERGO HYPERTROPHY.**

- Can be Pure vs Mixed.

With or without hypertrophy occurrence

- Can be Physiologic vs Pathologic vs cancer.

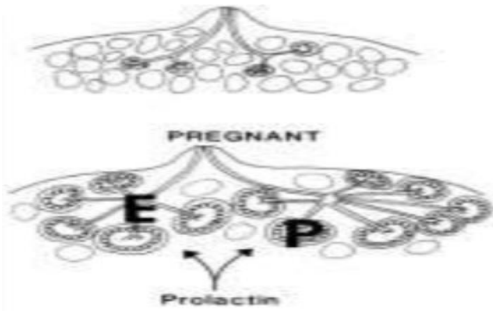
Physiologic hyperplasia: hormonal stimulation , Compensatory

Pathologic hyperplasia: excessive hormonal stimulation , Viral Infections
pathologic hyperplasia constitutes a fertile soil in which cancers arise

PHYSIOLOGIC

1-Breast in puberty and pregnancy (during the preparation for lactation).

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



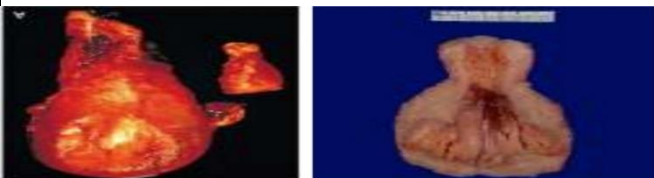
2. Compensatory hyperplasia of the liver after partial resection.

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.

PATHOLOGIC

1.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.



2.Benign prostatic hyperplasia Androgen induced:

In males, the prostate glands undergo hyperplasia. Caused by hyper androgenic stimulation enlargement of the prostate gland.

3. Warts(Hpv)

(ثوالبيل)Caused by a virus called Human papilloma virus (HPV)

ATROPHY

Decreased cell size & function .

Mechanism: ↓ Protein synth

↑ Degradation

↑ **Autophagy**: sometimes the cell undergo Autophagy which means that the cell start to eat itself by using its proteins and organelles as a source of energy in period of starvation or lack of nutrition.

Atrophy is opposite to Hypertrophy.

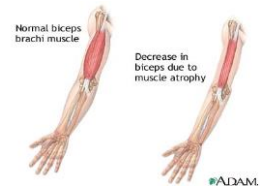
Atrophic cells can still function

The atrophic cells still alive & can still function but with less capacity.

CAUSES:

-Decreased workload (immobilization of a limb after fracture)

When you put a splint after you remove the splint you will notice that your hand get smaller than the other.



-Loss of innervations:

If you cut a nerve after trauma or injury this will lead to loss stimulation so the muscle will undergo atrophy

-Diminished blood supply:

either by injury in a blood vessels or people with atherosclerosis for lower limb or people who have diabetes or chronic ischemia all of these cases make atrophy for muscles and loss of hair of the lower limb for these patients.

-Inadequate nutrition:

You aren't supplying the body with what it needs so the size of the cell will shrink.



-Loss of endocrine stimulation: It can be physiologic (patients after menopause have normally decreased levels of estrogen in the blood, so they will develop endometrial atrophy) or pathologic.

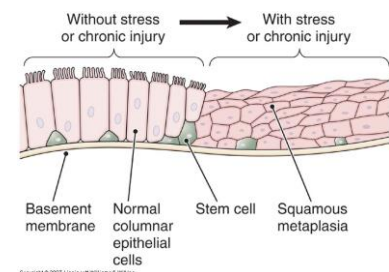
-Aging (senile atrophy) : like brain it can undergo some atrophy either with aging or certain disease like alzheimer or chronic ischemia or previous history of stroke.

PHYSIOLOGIC	PATHOLOGIC
Loss of hormone stimulation in menopause (endometrial atrophy)	Denervation injury. Chronic ischemia.

METAPLASIA

Change from one cell type to another. Cell is still alive and functioning but the function will change because the type of the cell is changed .

Reprogramming of stem cells NOT differentiated cells : (highly Reprogrammed process comes at the level of stem cells NOT the cell itself change, the stem cells instead of giving us a certain type of cells they give another type of cells).



Persistent change increases risk of cancer

New cell type copes better with stress but function less.

Reversible

Due to Loss of function risk of infection increases and that increase the risk of cancer which lead to metaplasia then dysplasia then carcinoma.

Causes: Smoking , Vitamin A deficiency, GERD.

1- Smoking: Example: the epithelium that covers the bronchi is called ciliated pseudostratified respiratory epithelium which is generated from stem cells >>when this epithelium faces stress like smoking immediately will transform the stem cells into squamous epithelium. This epithelial tissue can withstand to these stresses more, but its function in purifying the air is reduced due to its inability to produce mucus and the disappearance of the cilia. When smoking continues, the risk of developing cancer increases, and therefore smokers are more vulnerable to lung cancer.

2-Vitamin A deficiency:

Vitamin A is needed for normal epithelial differentiation, deficiency leads to squamous metaplasia of the bronchi.

3-GERD: (Gastroesophageal reflux disease) -->in these patients, the normal lining of the esophagus is squamous epithelium, but when the patient has

continuous reflux of gastric acidic content to the lower part of the esophagus, the squamous epithelium will change into glandular epithelium that can withstand to acidity, but its protection to the esophagus is less. The patient might have esophageal carcinoma if metaplasia persisted.

→ All examples above are epithelial metaplasia but sometimes it can be mesenchymal metaplasia like bone metaplasia.

Most of the time metaplasia is due to pathological causes. (the doctor didn't mention physiological causes).

CELL INJURY AND DEATH

CAUSES OF CELL INJURY

Oxygen Deprivation (Hypoxia Vs ischemia)

Chemical Agents

Infectious Agents

Immunologic Reactions

Genetic Factors

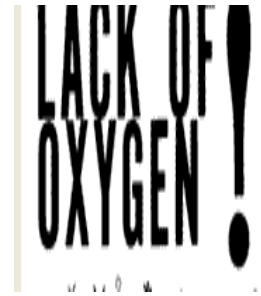
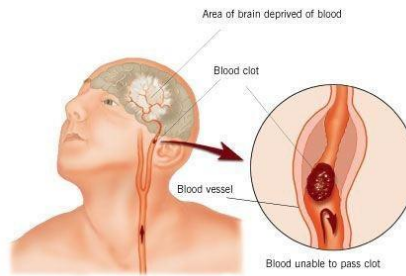
Nutritional Imbalances

Physical Agents

Aging

Oxygen Deprivation

there is a difference between hypoxia and ischemia, hypoxia means decrease in oxygen supply, while ischemia means decrease in blood supply which can lead to hypoxia.



ischemia mostly is the result of occlusion of an artery by a thrombus or a blood clot, if it happened in the cerebral vessels, it could lead to O₂ deprivation in the brain, or in the heart and causes myocardial infraction.

The main mechanism of ischemia in causing cell injury is the lack of blood supply which leads to lack of oxygen supply (oxygen is needed by all cells in their metabolism and their energy production).

- All cells needs O₂ to work ,so hypoxia leads to cell injury.

Hypoxia has other reasons than ischemia such as pulmonary hypertension, emphysema, and obstructive pulmonary diseases. (Doctor said don't worry about the other causes).

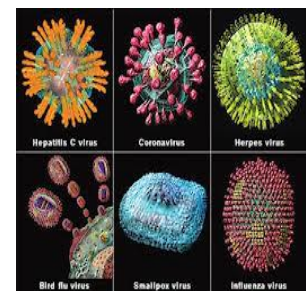
Chemical Agents

Like sugar, drugs, Pesticides and insecticides.



Infectious Agents

Such as viruses ,bacteria ,protozoa ,parasites and worms



Immunologic Reactions autoimmune, allergic, microbes

Allergic conditions such as:
rhinitis, conjunctivitis and
eczema.



Genetic Factors

Starting from
chromosomal
abnormalities such as:
Down syndrome,
ending with single gene
defects that lead to
abnormal enzymatic activity. It
also could lead to some diseases such as certain types of anemia.



Nutritional Imbalances

Whether from under nutrition or
malnutrition, by not getting enough
certain types of food.

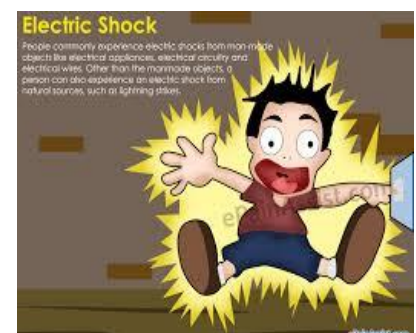
Or from excess nutrition by getting
excess food, which leads to obesity
and it is associated with diseases.



Physical Agents

Such as : Trauma, extremes of temperature and Electric shock

GOOD LUCK



V2

التعديل كآآتي :-

صه تحت موضوع HYPERPLASIA سطر ٧
الخطأ

*IMPORTANT NOTE: CARDIC MUSCLE , SMOOTH MUSCLE AND NEURONS
CAN'T UNDERGO HYPERPLASIA BECAUSE THEY AREN'T ABLE TO DIVIDE
BUT ONLY CAN UNDERGO HYPERTROPHY.

الصواب

*IMPORTANT NOTE: CARDIC MUSCLE , SKELETAL MUSCLE AND NEURONS
CAN'T UNDERGO HYPERPLASIA BECAUSE THEY AREN'T ABLE TO DIVIDE
BUT ONLY CAN UNDERGO HYPERTROPHY.

V3

صواب :صفحة 6 في جدولين كل واحد اله عنوان الاول

Physiologic

و الثاني

Pathologic

خطأ :مع الطباعة التنيين انحطوا فوق الثاني كنعوان اله و هاد غلط.
فرفعنا عنوان الاول وحطيناه فوقه

V4

Pathologic hyperplasia: excessive hormonal stimulation , Viral Infections

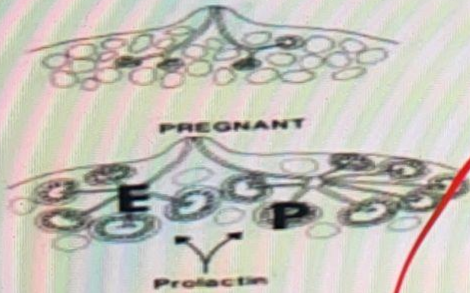
PHYSIOLOGIC

PHYSIOLOGIC

Pathologic hyperplasia constitutes a fertile soil in which cancers may

1-Breast in puberty and pregnancy (during the preparation for lactation).

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



2. 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.

eventually arise. (Endometrial)

PATHOLOGIC

Endometrial

1. hyperplasia, estrogen induced :

endometrial hyperplasia is driven by continuous estrogenic stimulation.

2. Benign prostatic hyperplasia

Androgen induced:

In males, the

3. Warts (Hpv)

(ثوالبيل) Caused by a virus called Human