**Pathology**

**Lec #1**

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\* Pathology is the study of diseases,

And it covers the causes , presentation ,and methods of diagnosis of diseases .

pathology is divided into general pathology and systematic pathology

systematic pathology related to specific systems and it talks about all the diseases that affect this system but we will take in this course general pathology which affect all the organs in general way

First of all; we will talk about the cells , any disease starts with abnormality in the cell , actually all the diseases is related to malfunction of the cells ,

normality presented by normal cell that should be normal in shape , size and function

as we come to the cell we see that there are many factors that cause damage and then a disease .

**causes of cell damage (injury)**

***1)the most common cause is hypoxia***

as we know that oxygen is essential to the cell to perform its function including protein synthesis and ATP production

once the oxygen concentration decreases, the availability of energy will decrease and this will initiate a disease process,

this decrease in oxygen can be related to many factors;

first , obstruction of blood vessels , because oxygen is carried by blood.

Heart contraction is important to push the blood that carry oxygen , that's why heart failure is one of the causes of hypoxia.

hemoglobin also should be normal in its shape and its affinity to oxygen , any problem in hemoglobin cause hypoxia.

the lung is the site of oxygen so if the lung is infected this will cause hypoxia and affect other tissues.

***2)the second cause of cell injury is the Physical agents***

it is usually causes a direct damage to the cell for example : high temp damage the cell as well as low temp causes frostbite and damage the cell, physiological agent also include direct trauma which cause bruise or fracture

also radiation causes damage to the cell, actually simple exposure of radiation to the lung can cause large damage ;but this is not the normal case because cells can repair themselves.

electric shock ; because it changes the charges of the cells and affect the permeability ,for example in muscles and heart cells.

***3)chemicals & drugs***

even the chemicals that is needed for the body to perform its normal action ,if it was in high concentration it will cause cell injury

that's why increase level of sugar or salt causes damage to the cells.

oxygen itself although it's very important molecule to the body;

increasing its concentration can cause damage specialty for premature infant , if they exposed to high concentration of oxygen some cells will damage ,like retinal cells and this will cause blindness to the infant.

insecticides are toxic chemicals to the body ,the most common one is ethanol that causes lots of diseases.

carbon monoxide comes from incomplete combustion of carbon

and this can be inhaled by people especially when fire set on

inhalation of carbon monoxide lead to death because CO can replace the attachment site of oxygen on hemoglobin, so it leads to hypoxia and death in addition to that it can cause damage to the lung.

***4)other causes of cell injury is infectious agent*** such as bacteria & viruses

***5)immunologic reaction*** can be produced by some of infectious agent like bacteria ,viruses and other microorganism.

immunologic reaction sometime can be initiated without obvious agent in this case it's called Autoimmune diseases,

it's a disease because reaction happens and antibody produced without having any infectious agent , these antibodies can target antigen inside the cell or on the cell membrane , causing antigen - antibody complex and make a damage in the cell

***6)genetic derangement***

any genetic derangement or abnormality in the cell's gene considered as a disease , actually nowadays the global trend of the diseases is related to gene abnormality , and the genetic background of all diseases is known.

simply like sickle cell anemia which happens by a replacement one amino acid by another one ,in hemoglobin .

this is same as gene derangement that occur by replacing one nucleic acid by another so disease will occur!

this can be inherited or acquired , this mean that the person can be born with this disease or acquire it during life , however either it is acquired or inherited the disease will be the same

***7)nutritional deficiency*** : \*deficiency of iron for example cause a very common type of anemia which is known as " iron deficiency anemia"

\*deficiency of iodine cause goiter and abnormality in the thyroid gland.

in addition to these deficiency in vitamin and amino acid cause different diseases.

***8)aging :***

aging by itself without having any disease is associated with decrease in the efficiency of the cell, the synthetic part will decrease and the damaging part will increase,

usually in adulthood there is equilibrium between both parts

with age , protein synthesis decrease as well as the efficiency of the cell,

thats why muscle mass's and bone mass's decrease when the person get old.

however cell growth reach the beak during adulthood.

Cells once exposed to these damages factors , they try to adapt to avoid damage and death.

this adaptation is different from one cell to another , and it is developed in certain cells so they can adapt more than other cells , and then the damage will be less.

In general adaptation is either physiologic or pathologic

in diseases , the adaptation is not normal (pathologic)

however , physiological adaptation is useful for the body and usually happens under the effects of hormones , like the adaptation that happens during pregnancy , size of uterus increase to adapt with the increasing size of fetus , so this is good adaptation (physiologic), after delivery everything back to normal because the hormones that causes this adaptation , start to drop.

Same during lactation the breast increase its cells number which secrete milk , after weaning those cells back to normal.

p.s : any thing that is not useful and doesn't serve good things to the body is considered as a disease.

\*How the cells in general response to stressful condition??

by receiving some signals , those signals affect the structure of the cell particularly at molecular level, then the cells start to change to overcome this condition.

so any message to the cell should be sent through a factor that bind to the receptor on the cell surface , sometimes those receptor found inside the cell.

once the receptor receive the signal this will initiate changes on the inner side of the cell membrane such as synthesis of proteins or change the structure or increased sensitivity to something.

this changes mean that the signal transmitted from outside to inside the cell , and it continue through the cytoplasm until it reachs the nucleus

so the nucleus might start to function more to give us certain molecule in larger amount for example ,more protein synthesis or less , according to the received signal.

also some cells can switch their function to produce new molecule, all these can occur to the cells in order to adapt.

**we have 4 types of adaptation**

***first : Atrophy***

it's mean the decrease in the size of the cell, and it is important because cells can avoid death by decreasing its function because cells of smaller size need less oxygen and less nutrition.

so if the cells exposed to low level of oxygen for any reason such as narrowing in the vessels ,the only escape to avoid the damage is by decreasing its size so this will be reflected on the whole tissue size.

for example when the blood flow decrease to a muscle it will become smaller.

this can occur in different situation and to different organs , such as the kidney if the renal artery was obstructed for any reason ,its size will decreases.

so atrophy will occur mainly when there is a decrease in the oxygen supplied

also atrophy may caused by decreasing the workload , as the muscle is not subjected to exercise it will get smaller.

muscles doesnt depend only on oxygen and blood , it also depends on innervation so the muscle that is deprived from innervation due to injury for example, will get smaller

"it will not contract , so someone who has paraplegia for example his muscles will be very thin"

nutrition is very important also , because synthesis of some protein depend on the amino acids that are provided by diet so if this amino acid are not exist the synthesis of protein will become less and atrophy will happen.

some cells depend on the hormones for stimulation and for their size

ex: breast one of the endocrine gland that depend on hormones that is secreted from pituitary gland.

so if something affect the pituitary , and those hormone weren't secreted , the breast will become atrophic.

also aging is one of the causes for atrophy because by aging the protein synthesis will decrease, and the the damaging will overcome the synthesis .

we mentioned before that atrophy means that the cell will get smaller , and this means that the structural component of the cell will be lost , these structural component include cytoplasmic protein and the cell membrane.

sometimes loss of cells or decrease of its size is associated with what known as Autophagy ,this mean that the cell start to digest its own component , so the cell will get smaller.

Autophagy is related to 2 systems in the cells

First : lysosome , which are granules that are full of different type of enzymes , when it releases its enzyme they will start to digest.

Second : ubiquitin , simply they enhanced protein degradation through certain small proteins , once those proteins attached to a target, the lysis operation will start .

\*check the picture in the slides it compares between atrophic brain (B) and normal brain (A)

brain atrophic is usually caused by chronic hypoxia

\*\*how we can know that this brain is atrophic??

\*we can notice that the fold or the gyri look thinner and the spaces look larger.

the other picture shows us atrophic testicle caused usually by vascular derangement.

**The second type of cellular adaptation is : hypertrophy**

hypertrophy means increasing in the size of the cell , it can occur alone or it can occur with other types of adaptation.

when cells increase in size they need more structural protein and that's why more protein should be synthesized.

again hypertrophy could be physiologic or pathologic

physiologic hypertrophy : like enlargement of the uterus smooth muscle during pregnancy.

also athletes increase the size of their muscles by working out.

when hypertrophy is part of disease process it is considered pathologic

for example the enlargement of the heart for patient with hypertension

because in hypertension , the walls of blood vessels increase the resistance of blood , so the heart will pump harder in order to give the normal results

and in order to function more we need larger cells that's why hypertrophy happens

\*enlargement of muscles size happens on the expense of lumen , this mean that the champers become smaller and the thickness of the wall become larger , this mean that the blood supply of the muscles should increase ( nutrition and oxygen supply).

if the blood supply wasn't enough it will start to die that's why heart infraction happens.

the same thing happens for who has valve problems, like valve stenosis or calcified valve , in these cases the valve will not open fully so this is associated with increasing the heart contraction.

\*\*\*refer to the slides to see uterus normal size and how much it enlarges during pregnancy.

we can see that the muscle fibers was compact in normal condition , however during pregnancy the fibers become more blunt , because of the increasing in the structural protein.

**third type of adaptation is hyperplasia :**

it means increase in the number of cells but NOT THE SIZE, but this will be reflected to the tissue size.

hyperplasia does not occur every where , and the cells must have some characteristic to have hyperplasia.

\*\*\* cells are classified into 3 types according to the capacity of the cell to divide

1)very high capacity to divide it's called " Dividing cells "

in these cells hyperplasia occur easily , once they damage this have the ability to compensate and produce new cells, like bone marrow cells which are responsible for production of new blood cells

also GI mucosal cells divide quickly , because these cells are lost constantly so they must be easily replaced.

another example is epithelial cells that lines cavities like skin , GI tract , urinary tract and air way

2) cells with no capacity to divide , called permanent cells

so if the damage occur to these cells it will be permanent because they can't be replaced

the most famous example is nerve cells, and cardiac muscles

the only way to replace these type of cells , is by other type such as fibrous tissue , which is totally different from the original cells ( heart cells )

3) the third type of cells , which have little capacity to divide and it is in between both types, sometimes under stressful condition they can divide like cartilage , smooth muscle , endothelial cells and fibrous tissue.

hyperplasia might be pathological or physiological ; such as hormones stimulation during pregnancy and lactation , increase the size and numbers of cells, and after that they back to normal

liver has special capability of hyperplasia , if we remove part of the liver , normal cells of the liver can be stimulated and compensate for the loss and this is called compensatory hyperplasia , that's why patient who donate some parts of liver tissue will not suffer from anything because the cells can replace the loss. Also endothelial tissue undergoes hormonal stimulation .