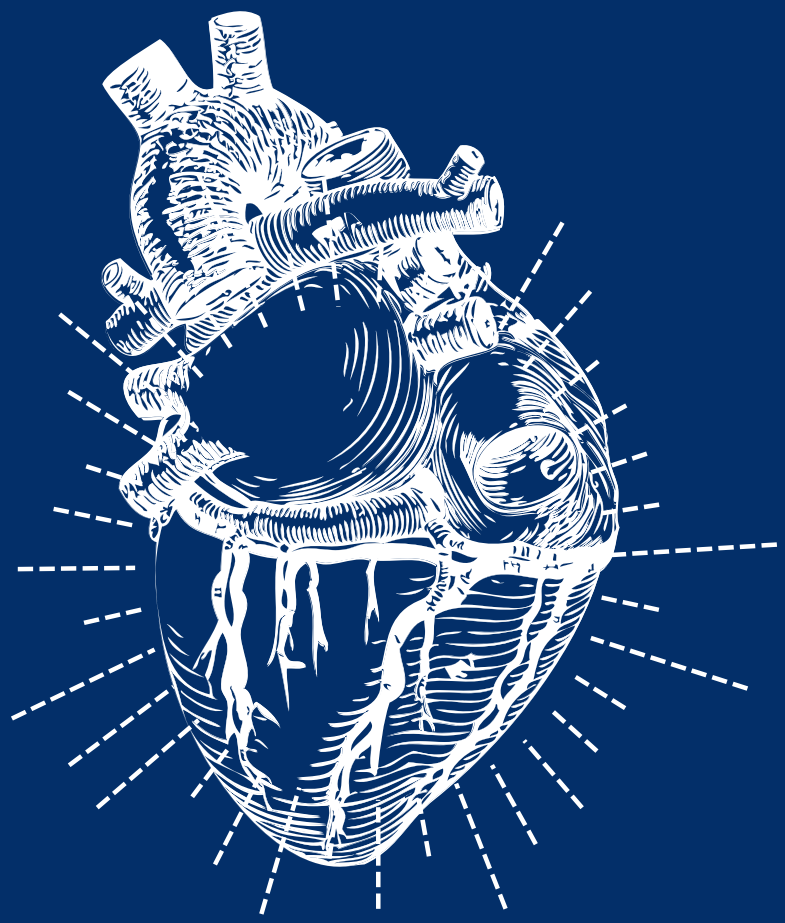
Med-Hub
COURSES

Physiology



Physiology : (body functions) The science that is concerned with the function of the living organism and its parts such as (tissue, cells, organs, systems) and of the physical and chemical processes involved.

- System levels: A **system** consists of related organs with a common function.
- Organ-system level: Digestive system breaks down and absorbs food,it includes organs such as the mouth, small and large intestines, liver, gallbladder, and pancreas.

some systems :

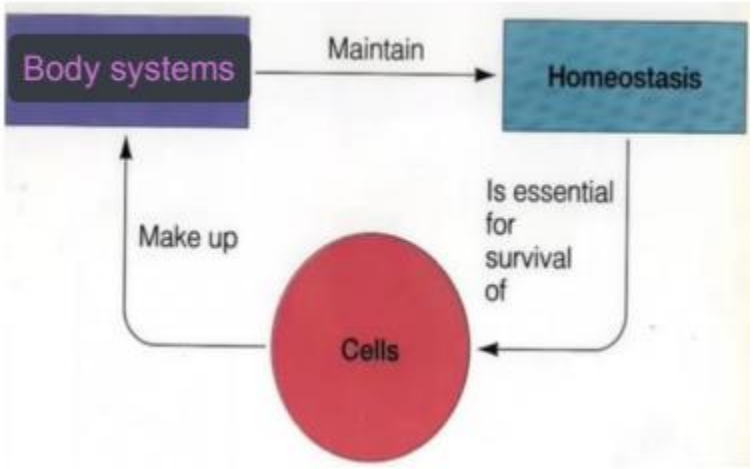
1. **CIRCULATORY SYSTEM**.
2. **RESPIRATORY SYSTEM**
3. **GASTROINTESTINAL SYSTEM**

- Each on of those systems has its **own function** but what conjugate them and Maintain coordination between them to keep the balance?

The answer is : CONTROL SYSTEMS : nervous & endocrine .

Homeostasis: A condition of equilibrium in the **body's internal environment**, where it's maintained at an almost constant level & Homeostasis is dynamic not static; the body has a normal narrow range of values for each variable

Examples of the variables in our body: Blood pressure (BP), Blood Glucose Level (BGL), body temperature, PH of blood, the concentration of [CO_2, O_2, Na^+, K^+, Ca^{2+}].



*The Blood glucose levels range between 70 and 110 mg of glucose/dL of blood.

Homeostatic Imbalances = diseases : Homeostasis is constantly being disrupted by many factors

Feedback System : which we control our balance and restore it if our homeostasis have disrupted

• keeps the internal environment constant.

There are **three Basic components**:

1.**Receptors**: Body structures that monitor changes in a controlled condition , Sends input to the control center, Example: Nerve ending of the skin in response to temperature change.

2.**Control center**: Brain Sets the range of values to be maintained & Evaluates input received from receptors and generates output command.

• Nervous system (nerve impulses) and endocrine system (hormones) •

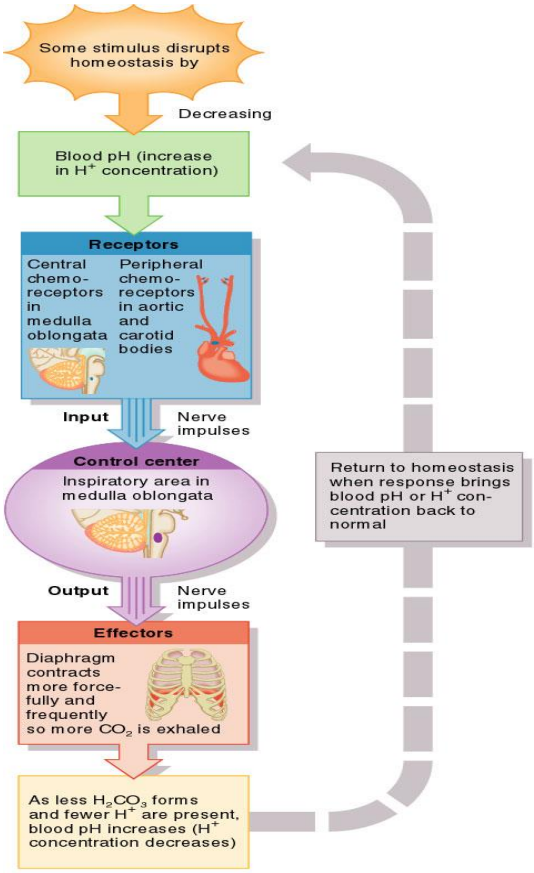
Example: Brain acts as a control center by receiving nerve impulses from skin temperature receptors.

3.**Effectors**: • Receives output from the control center.

• Produces a response or effect that changes the controlled condition. • Found in nearly every organ or tissue.

• Example: Body temperature drops skin receptors sense drop the brain sends impulse to effector (skeletal muscles) muscles contract rapidly causing shivering which generates heat.

The PH as an example OF Negative feedback: PH is inversely related with the concentration of H+



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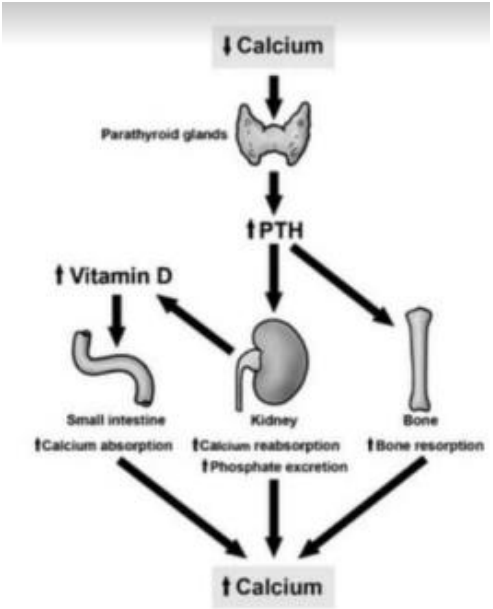
Another example of feedback system is when calcium concentration gets below the normal range, the body will sense that decrease by certain receptors, these receptors will send signals to the brain, and the brain will respond to that signals by stimulating the parathyroid gland to release more parathyroid hormone (PTH), this hormone will

increase the calcium concentration by;

1. Increasing bone resorption (breakdown).

2. Increasing calcium reabsorption by the kidneys

3. Stimulating the kidney to transform the inactive form of vitamin D to the active form, which will increase the absorption of calcium from the intestine.



Feedback systems could be positive or negative .

Negative if the stimulus and the response are opposite to each other & and it's the normal system

Positive if they are of the same type its incompatible with life .

1. Negative Feedback systems • Reverses a change in a controlled condition.

* Regulation of blood pressure (force exerted by blood as it presses again the walls of the blood vessels)

Glucose level : when blood glucose concentration gets higher than the normal range, the brain sends signals to the islets beta cells in the pancreas to produce more insulin, the insulin by certain mechanisms will decrease the blood glucose back to normal, and if there is a decrease in blood glucose, the signals from the brain will stimulate the pancreas to produce more glucagon which will increase the glucose in the blood.

2. Positive Feedback systems • Strengthen or reinforce a change in one of the body's-controlled condition.

Examples:

A. Normal childbirth: During the process of a delivering a newborn, the uterus starts contracting (also known as labor), the contraction starts as slow and infrequent but will increase and happen more frequently until delivery of baby takes place(pituitary gland to produce a hormone known as oxytocin, this hormone will increase the contraction of the uterus). Once the delivery is finished, everything will return to its normal condition.

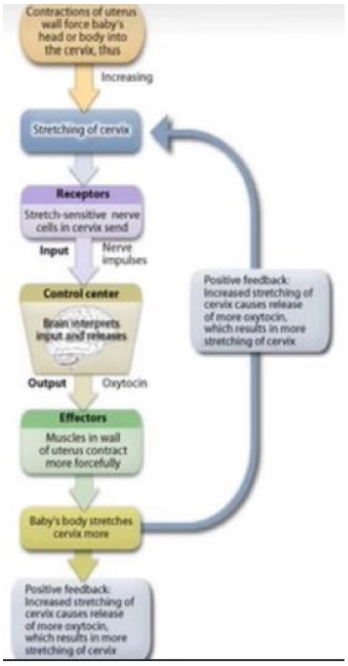
*Notice that the response (increase in contractions) is in the same direction as the stimulus (which is the beginning of the contractions)

B. Blood Loss: In Normal conditions: heart pumps blood to body cells at high blood pressure (to deliver oxygen and nutrients).

In Severe blood loss: Blood pressure drops / and cells receive less oxygen / so they function less efficiently.

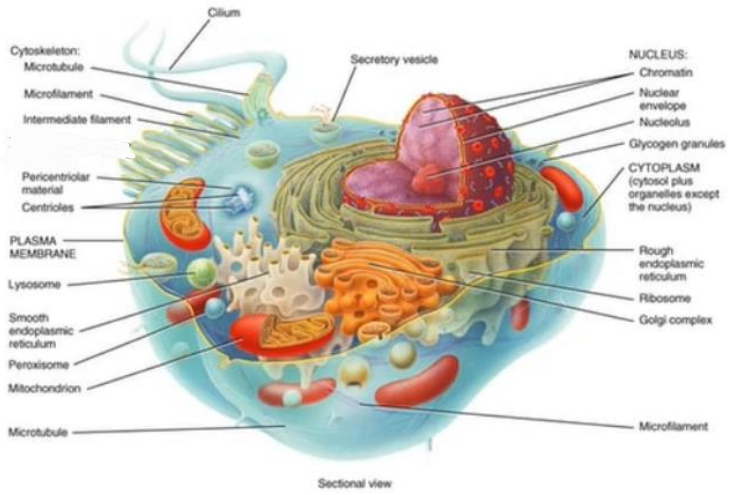
If blood loss continues / heart cells become weaker /BP continues to fall / Heart doesn't pump. (When someone is bleeding, the blood coagulates (stimulus).

The (response) will be an increase in coagulation to prevent blood loss)



Moving to another subject that you already have taken in biology, which is **cell and organelles.**

As the importance of the cell in the body's function, it is important to know the cells' organelles and their function, and that any disturbance in these organelles will lead to a disease.

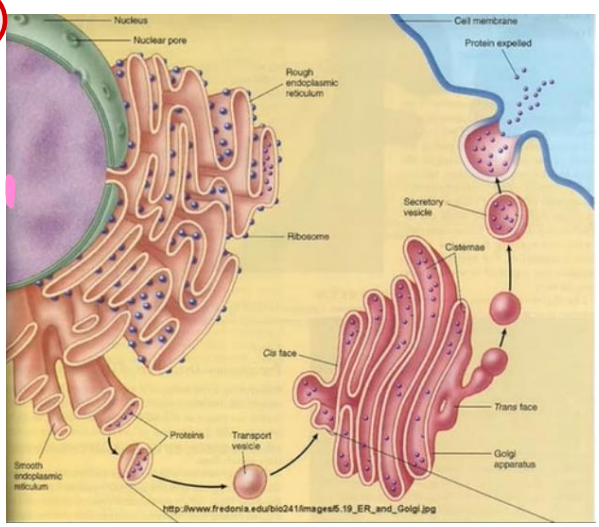


The cell consists of several compartments; for regulation purposes, i.e. lysosomes, endoplasmic reticulum, Golgi apparatus and mitochondria. These organelles contain membranes in their structure which help in separating their **own environment** from the cytoplasm of the cell, this **compartmentalization** helps in controlling the function of the cell, for example; the smooth endoplasmic reticulum contains high concentration of calcium ion in its compartment, which is important in many processes, like **muscle contraction** and **cell signalling**. So by controlling the permeability of the ER membrane, you are controlling the cell function!

Now, we are going to discuss general information that you already know and the doctor cross over them quickly.

These pictures show the endoplasmic reticulum which contains ribosomes, the vesicle formation process (pic 1), and the translation process done by ribosomes (pic 2).

1



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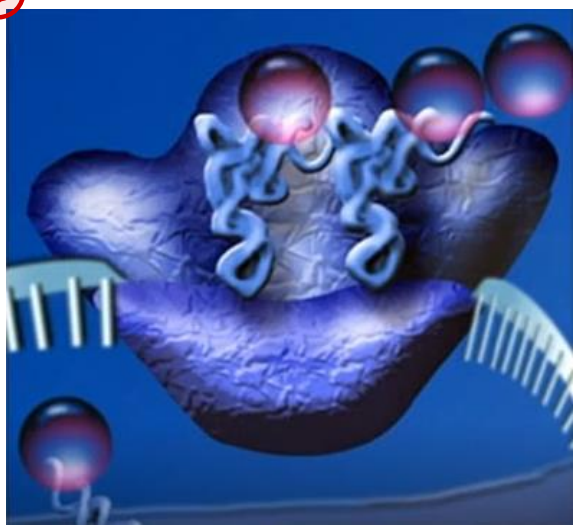
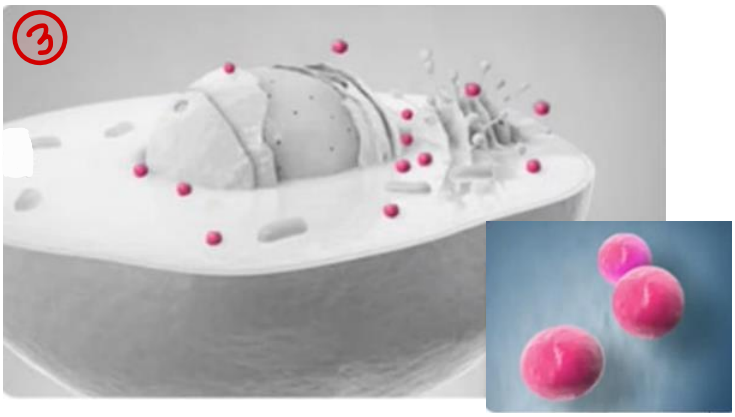


Lysosomes which contain digestive enzymes (pic 3), the mitochondria which is a double membranous structure (the inner and the outer membrane) (pic 4), and it also contains a high concentration of protons (H+) in the intermembrane space due to the electron transport chain.

3



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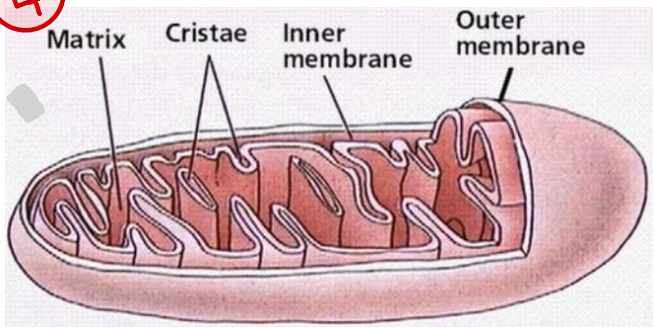
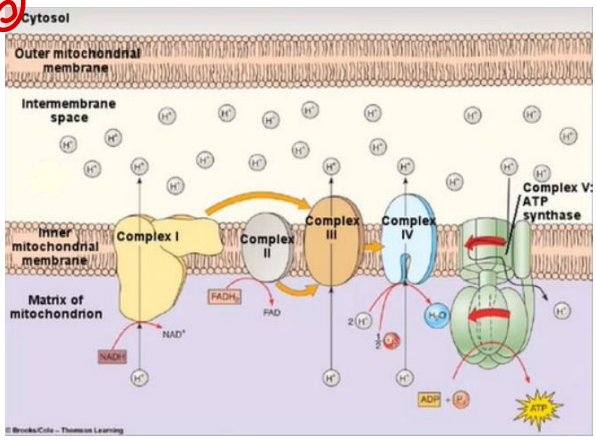


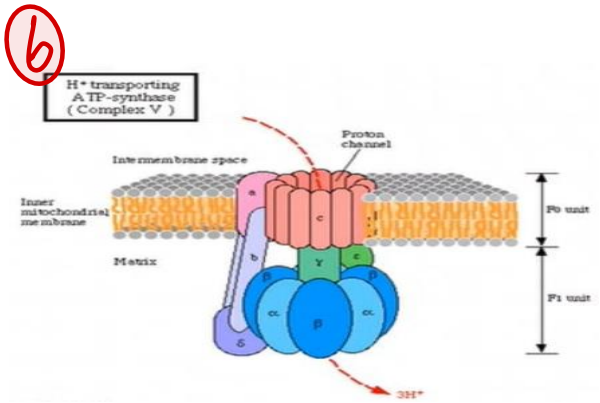
while the electrons are moving from the **higher energy state** to the **lower energy state** throw the complexes in the electron transport chain, the difference in energy are used to pump protons from the mitochondrial matrix to the intermembrane space (pic 5).

5



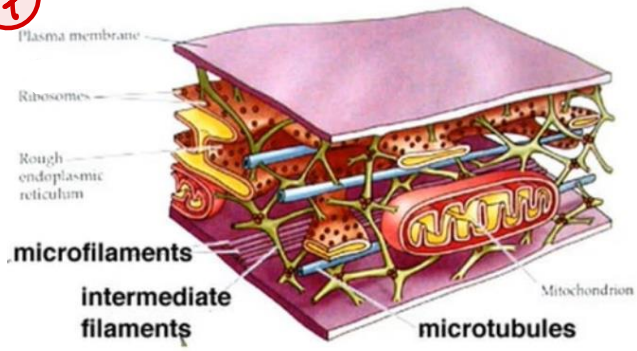
The fifth complex which is known also as "ATP SYNTHASE" uses the H+ difference between the matrix and the intermembrane space to generate energy as ATP in a process called oxidative phosphorylation (pic 6).

6



The cells also contain **cytoskeletal structures** like microfilaments, intermediate filaments and microtubules. These structures are responsible for **determining the shape** of the cell and other functions will be discussed later on, (pic 7+8). Microtubules are responsible for **vesicular transport** in the cell (pic 9), an example for that, in neuron cell, the neurotransmitters are synthesized in the cell body, but their function are in the nerve terminal, so they need to be transported from the cell body to the nerve terminal, this transport of vesicles is done by microtubules (pic 10). Also microtubules helps in cell division by forming what is known as **mitotic spindle** (pic 11).

7



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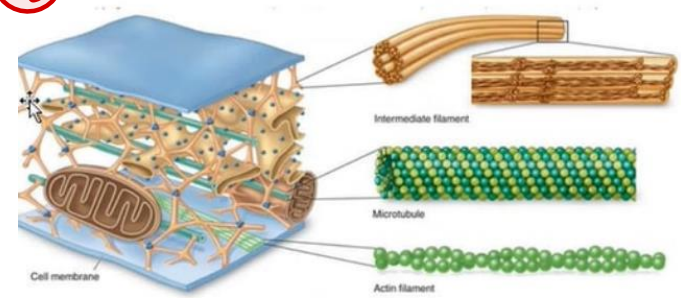

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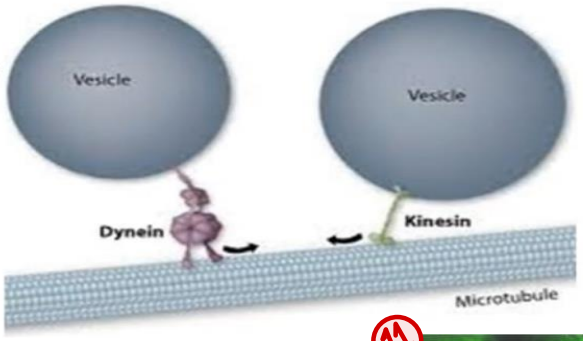

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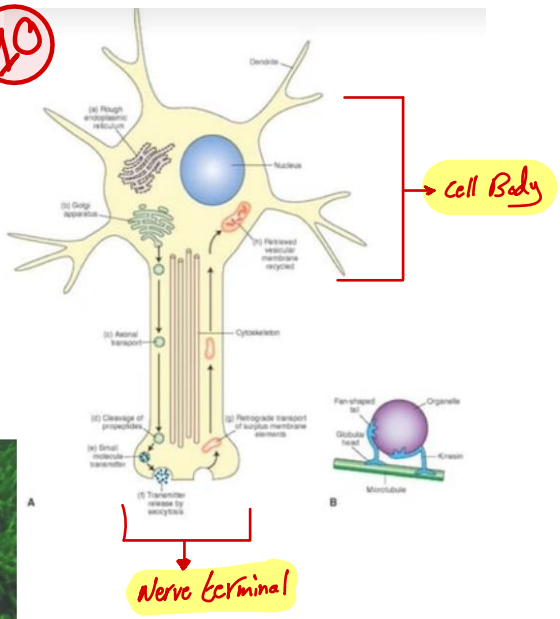

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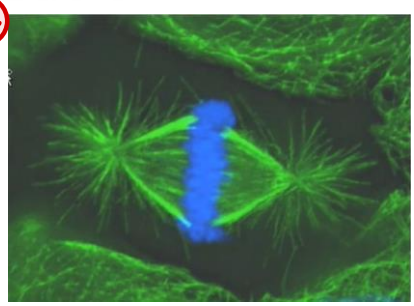
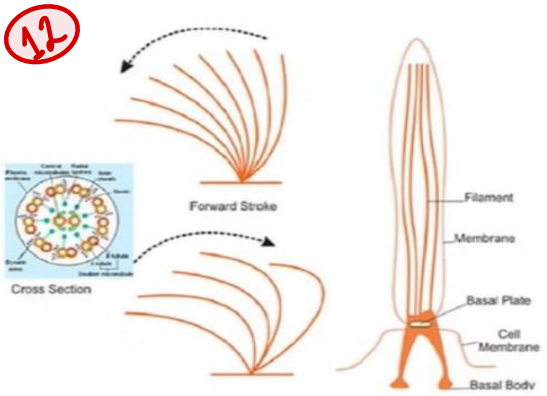


Cells also have small filaments projecting from their surface called ***cilia*** that are responsible for **moving the mucus** as seen in epithelial cells (pic 12). Cilia consists of microtubules, the movement of these microtubules leads to the movement of cilia (pic 13).

12



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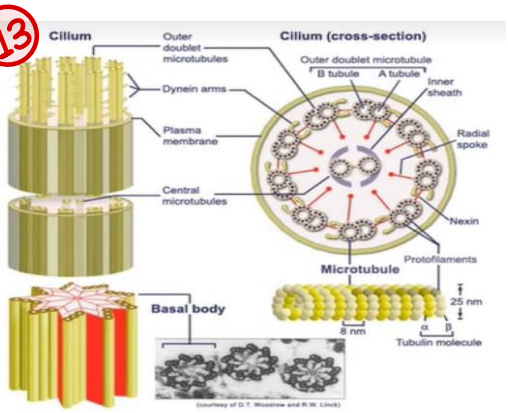
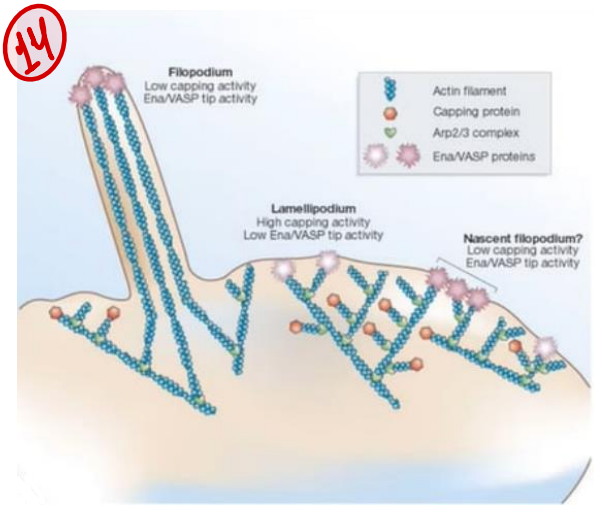


Actin filaments help in cell movement by forming pseudopods (أقدام كاذبة), these pseudopods will attach to a sight near the cell by p**olymerizing** actin filaments, and when it reaches it, it will detach from that sight by **depolymerizing** actin filaments and that will make the cell move (pic 14). Also, actin filaments help in muscle contraction as they are part of the muscle cell (the thin filaments),(pic 15).

14



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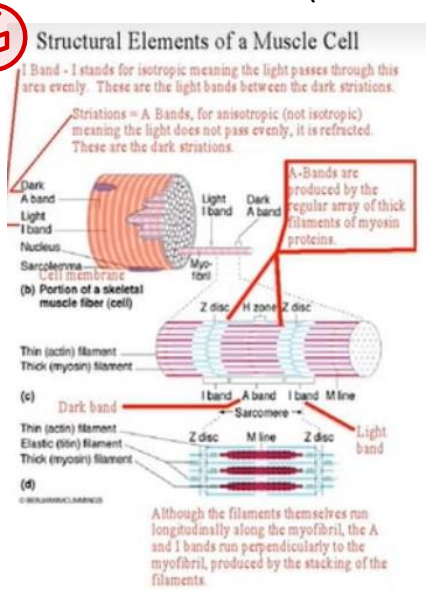
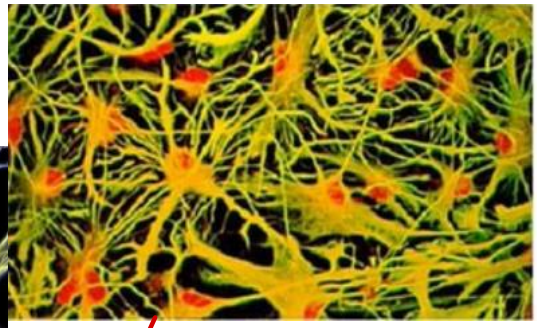
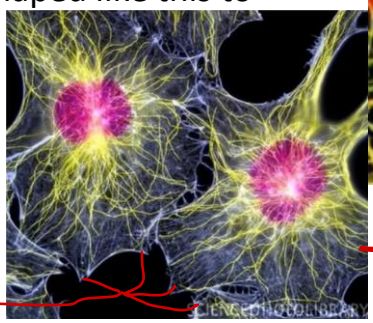


So, these cytoskeletal structures are **important in cell shape**, and the **shape is important for cell structure** as in the neuron cells, the dendrites are shaped like this to *increase the surface area* of the cell so they can collect as much as possible **trophic factors** (these factors are allow neurons to develop) (pic 16).



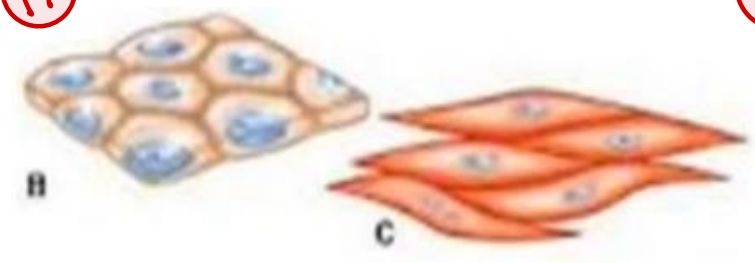


16

Dentrites

So, the shape is really important for the cell function and that is also seen in muscle cells which are elongated cells, this **elongation** of the cells makes the contraction process **more efficient** (pic 17,C), another example is red blood cells, as they need to circulate in the body for long distance and be loaded with oxygen in a short period of time, so if they are spherical in shape, they won't be able to diffuse to a long distance and can't be loaded with oxygen sufficiently, so the most compatible shape for RBC is Biconcaved disk (Pic 18).

17



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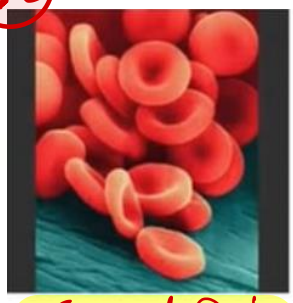
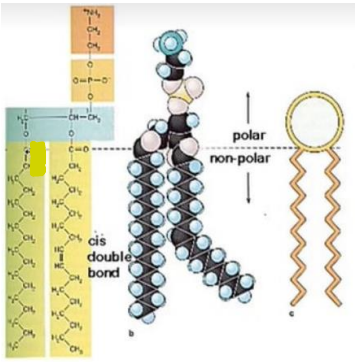


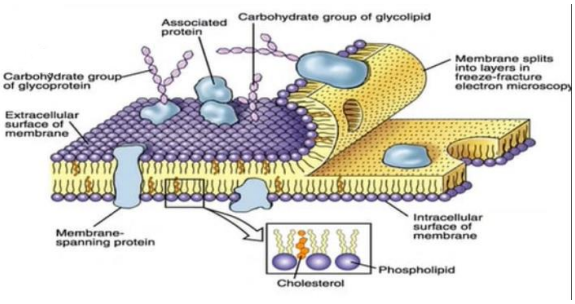
Concaved Disk

Spherical

The **main topics** of the coming lectures will be about lipid function of plasma membranes and the function of receptors embedded in it.

The plasma membrane consists of phospholipid bilayer, with mostly unsaturated phospholipids that maintain the fluidity of the plasma membrane at 37 degrees.





This table will be discussed in the upcoming lectures, take a look!

Membrane Structure	Function
Phospholipid Bilayer	• The phospholipids are arranged in a bilayer, with their polar, hydrophilic phosphate heads facing outwards, and their non-polar, hydrophobic fatty acid tails facing each other in the middle of the bilayer. • This hydrophobic layer acts as a barrier to all but the smallest molecules (oxygen & Carbon Dioxide), effectively isolating the two sides of the membrane. • Phospholipids can exchange position in the horizontal plane but not the vertical.
Integral Proteins	• Usually span from one side of the phospholipid bilayer to the other. • Proteins that span the membrane are usually involved in transporting substances across the membrane (more detail below)
Peripheral Proteins	• These proteins sit on one of the surfaces (peripheral proteins). They can slide around the membrane very quickly and collide with each other, but can never flip from one side to the other. • Proteins on the inside surface of plasma membrane are often involved in maintaining the cell's shape, or in cell motility. • They may also be enzymes, catalysing reactions in the cytoplasm.
Glycoproteins	• Usually involved in cell recognition which is part of the immune system. They can also acts as receptors in cell signaling such as with hormones.
Cholesterol	• Binds together lipid in the plasma membrane reducing its fluidity as conferring structural stability

THE END