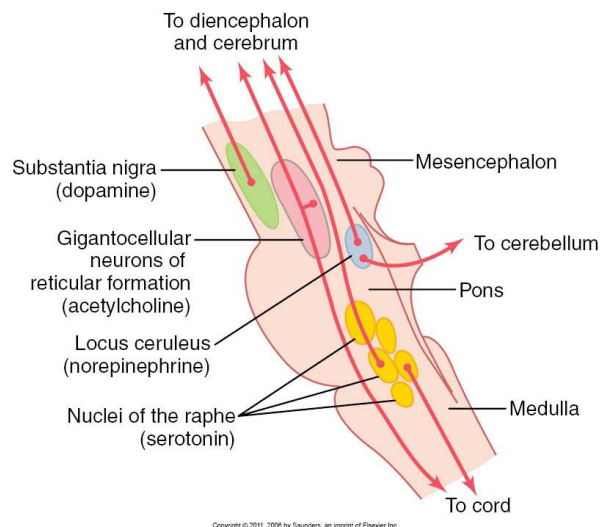


## بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Salam everyone , I made my best to make this sheet clear enough to be easily understood Inshallah ☺ let the party begin :P

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In the previous lecture we talked about Substantia nigra majorly releasing dopamine, locus coeruleus majorly releasing norepinephrine in the brain and we talked about the nuclei of the raphe or we call it raphe nuclei and it releases majorly serotonin and the last one which is Very important and highly active in the brain, we call it the gigantocellular, giganto from giant means large cells, it is situated within an area within the brain stem we call it the reticular formation, when you hear reticulum or reticular formation what does that mean? In Latin it means network or mesh , so here the reticular formation is like a network (شبكة) where there are large cells we call them gigantocellular or giant cells, all of them release acetylcholine, we know that the acetylcholine as a neurotransmitter in the neuromuscular junctions, today we will talk about acetylcholine in the brain and at the end you will realize that it is also very important in your transmitter in the autonomic nervous system .



### Acetylcholine in the brain :

#### ❖ what are the major functions of acetylcholine in the brain ?

previously the acetylcholine was recognized in the brain as the major excitatory in the transmitter however nowadays they have substituted to be the second major excitatory, they say that glutamate or glutamic acid (which really 80% of our neurons in the brain

release them, is the first excitatory, but still acetylcholine is considered one of the major excitatory neurotransmitter in the central nervous system specially in the brain .

❖ What is the function of acetylcholine and the physiology of acetylcholine ? their is Three very important functions :

1. Intelligence : acetylcholine is all released from the area responsible for your IQ (your intelligence)
2. Memory: to remember things and to remember things that you have memorized previously to retrieve them the moment when you need them.
3. The conscious level : keeps you awake and alert .

Now let us forget about conscious level for a while, if we can correlate memory and intelligence when the acetylcholine in neurons in the brain are destroyed this will cause **Dementia**, 70% - 80% of dementia cases are caused by the Alzheimer's disease, the dementia patients start having a disturbance or difficulty remembering the recent information, he doesn't remember two hours ago what he took for breakfast, he doesn't remember yesterday who has visited him. While he remembers the very far or old memories like if you ask him when you were 20 years old what was the first job you took, he will remember it. So the Alzheimer's first starts with forgetting about the recent information, also the cognitive functions of the brain goes down, means that the intelligence start to be lost, therefor you see those patients who suffers from dementia or Alzheimer's they usually have a bad decisions like for example if they are doctors they start diagnosing incorrectly or improperly (their diagnoses wrong), if he is a business man he will start to make bad contracts .

So Alzheimer's disease is recognized by the decrease in memory and decrease in the intellectual functions.

Our emotional brain, our limbic system is the basis of al psychiatric illnesses and many of the neurological disorders

**The hippocampus** : the word hippocampus means the sea horse because its shape like the sea horse, It is the hippocampal area in the brain, because it is in the limbic system, it is responsible for the selection of information to be stored as a form of memory.

Every single minute in our lives actually we are facing thousands of information come to our brain, are we going to store all of them? Definitely no, actually we store only 1% of information received by the brain which will be recognized by the brain as very important, like for example at this moment you are seeing so many things (of course you are reading this sheet :P), you are hearing so many things and at least your cloths touching 3/4 of your

body, all of these are information beside information that come from viscera to the brain, so the brain cannot store all this, he has first to diagnose which of them is important, the part of the brain which select this is the hippocampus.

Because the hippocampus is part of your emotional brain, you only store things that you like or you hate, that's why my first advice to you if you forced to come to the medical school make a good selection in your specialty, follow your passion 😊, whenever you do things you love you will be excellent in it !! because the memory stored will be very easy.

If you search your brain now and you look about things that you have you can remember so easily it either for information or for events that have happened in your life that they are very happy, for example the day you received your Tawjihi results and you remember the person who told, what day what minute, what you have done etc...

So always you remember thing that are very happy events and very happy moments in your life you remember them with all the details, also unfortunately the sad events, losing a person, losing a battle, losing a house etc...

Some students older than us asked the doctor that they have a lot of information in their brain, they neither love nor hate like geography information, biochemistry information, math, not physiology of course -\_- . why do we have to store these information in our brain, this is actually indirect love, you realized that without memorizing these information you cannot reach your destination, so you have to keep them in your brain, actually this is indirect love, like you remember a lot of things that you studied in primary school or in high school not because they are happy or sad events, because you realized by your intellectual level that these are the only way you can reach your destination.

- **So keep in mind that hippocampal area it is majorly responsible for the selection of memory and it is very important and it is the first part that is destroyed in Alzheimer's patient, we diagnose Alzheimer's patient when we look to the MRI of the patient and find this area in his MRI is small or shrunk or destroyed, so he fails to select information and he fails to store them.**

If you are looking for conscious level, the reticular formation with in the brain stem as we have said like a mesh, it wakes you in the morning when you feel rested body wise and psychology wise these are majorly cells that release acetylcholine, when this area is destroyed the patient goes to coma, he cannot wake up his brain or his cerebral cortex .

Because the conscious level is very important we have excitatory and we have inhibitory area, the excitatory area that excite the whole brain it releases acetylcholine and we need acetylcholine to wake up in the morning, we need it to keep us awake.

So if you were asked about acetylcholine in the brain, you have physiology while for the time being memory intelligence conscious level, and abnormalities of acetylcholine when it is destroyed, then the patient will suffer from **dementia** and majorly **Alzheimer's disease**.

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## Autonomic nervous system

The Nervous system is divided into 2 parts , one part is under our control and the other part is working subconsciously, this means that you have no control over it, so we have the **somatic nervous system** and we have the **autonomic nervous system**, autonomic means (تلقائي أو ذاتي) it is not under your control, the autonomic nervous system actually regulating the internal organs of your body, like how the stomach secretes or digests food, or the heartbeat, the rate of heart beating or the contractility on the blood vessel wall.

The Dr. showed a cross section of spinal cord (slide 2) it contains a somatic pathway (أعصاب الجسدية) soma means body, that actually controls the skeletal muscles (muscles that move your skeleton), so upon any stimulation from skin like feeling hot, feeling cold. for example you feel hot, you take off your jacket or whatever, so the sensation comes and enters from what we call it the dorsal horn, (dorsal means posterior) and then it goes through the gray matter makes connection to the motor fiber and the motor fiber will leave through the anterior or the ventral horn and then will go to the muscles (taking off your jacket or putting on it means a muscle activity) so this nerve will order the muscle to contract or to relax. This is under your full control we call it the **somatic pathway** .

on the other side of the spinal cord we have the **autonomic pathway** this usually controls the smooth muscles, the cardiac muscles and the glands also it has very little control on the skeletal muscles, usually it regulates the blood vessels and regulates the internal organs " didn't exactly recognize the word " .

If we have any sensation that has been felt from blood vessel or from a gut from viscera means from the intestine, upon entering through the dorsal horn, it will make a synapse at an area which we call it the intermediate.

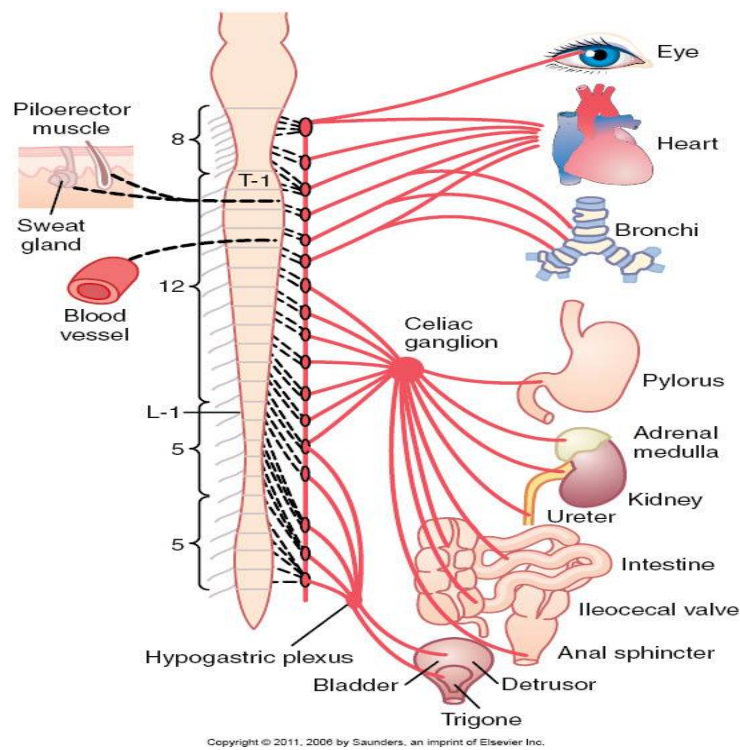
- **We have the dorsal horn, and we have the ventral horn, and we have what we call it the intermediate.**

the intermediate usually makes a synapse at the lateral or intermediolateral horn and then it goes out by the ventral root however it will not go directly it have to bypass through something we call it the ganglia, the ganglia is an aggregation of neurons outside the brain and the spinal cord, we have a paravertebral and we have prevertebral ganglia.

The motor regulation in somatic pathway is one neuron starts from the ventral horn goes directly to the muscle while in the autonomic nervous system we have two neurons one we call it preganglionic and the other called postganglionic.

The preganglionic starts from the intermediolateral horn, goes to the ganglia, then there is a synapse, and there is a postganglionic that goes to the viscera.

### The autonomic nervous system regulation :



as you can see in the figure it starts from the upper part of the body to the lower part of it, getting red innervation and blue innervation, you can tell that the parasympathetic usually either arises from the cranium as the cranial nerves or from the sacral region because the other regions " the lumbar and thoracic " have no origins from it for any nerves .

The parasympathetic arises from the brain and the sacral region, the sympathetic arises from T1 to L2, yet both of them innervated majority of the viscera that we have from the head down to the lower parts of your body, it doesn't matter from where they arise they both innervate all the structures in the body, actually they complete each other (this is very very important ).

❖ **What is the difference between the activity of sympathetic and parasympathetic?**

Whenever you need to fight or flight means you are in danger then you are going to activate your sympathetic nervous system, whenever you need to run from a danger or you fight for things that you believe in, or you want to convince people or when you are emotionally involved in a conversation then you are sympathetically stimulated, when you are preparing to sit for exam, these are things that you need sympathetic control.

In contrast, the parasympathetic it is rest and digest, so whenever you are quiet, meditating, peaceful after a meal or you are sitting on a beach or whatever, then you are really stimulating the parasympathetic.

The red color (**in the figure that she explained**) is actually the balance between sympathetic and parasympathetic, majority of the day we are in a balance we are neither fighting or flighting nor we are very lazy and resting and digesting all the time, we are in a balance between them and this what makes you living normally.

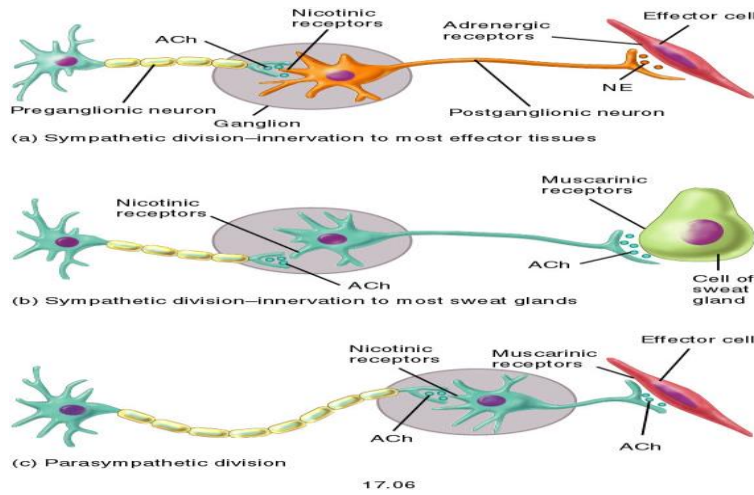
Young people like our age and people younger than us (the teenagers); the sympathetic tone is very high much higher than the elderly people, that's why they are easily getting involved in a fight, easily can get upset.

you can convince young people so easy to get engaged in a fight while it is much more difficult if they are 50s or 40s to convince them in getting engaged in a fight, because of two things :-

1. **Immature brain** : our brain is not yet mature, decision making is not proper, at the age of 25 the decision making area becomes fully mature.
2. **The sympathetic tone is very high**: you are always preparing for a fight or to flight, always fight or flight of the sympathetic tone keeps the majority of you trembling, heart usually racing, and this is because of the high sympathetic tone.

Now the sympathetic preganglionic fibers upon reaching to the paravertebral ganglia (paravertebral means around the vertebral column on either side) they really rotate in the white ramus and make a synapse and then they go to the organ, if they don't make a

synapse at the paravertebral then they will go to the prevertebral which is the cilia or the hypogastric, then they make a synapse and they come to the organ.



Usually if I want to move a skeletal muscle I have only one motor nerve starts from the spinal cord and goes to the muscle, but if I want to change the activity of the heart, if I want to change the activity of the intestine, the sympathetic division they go to the paravertebral sympathetic ganglia which is on either side of the vertebral column, they make a synapse and then they go to the heart. So we have what we call it a preganglionic and a postganglionic.

If it does not make a synapse as a paravertebral, it will bypass it goes to the cilia or we call it the hypogastric nuclei that are in the abdomen, they will make a synapse and then will go, there are just few fibers that will go unsynapsed to the adrenal medulla and the will release from it norepinephrine and epinephrine directly.

- **So keep in mind that if you want to move a skeletal muscle you need single motor nerve fibers, if you want to really affect the heart, the intestine or the liver or any internal organs you need two neurons; preganglionic and post ganglionic.**

The sympathetic division (fight or flight) starts from T1 and goes down until L2 all of these are involved, so you can say that thoracic 1 (T1) is responsible for the head, T2 for the neck, and then you go downward, it is really in a very beautiful organization.

The heart because originally (embryonically) arises from the level of the neck, it usually gets its innervation from T2, it is actually in the chest so it supposed to be innervated from T3 to T6, but the heart is innervated from T2 because embryonically was high up so it takes from T2.

Then if you go down you can see that the sympathetic innervates all the internal organs.

As we said the sympathetic is responsible for fight and flight, so when you are fighting what do you need from your body?

1. pupils are going to dilate because we need to see clearly (sympathetic effect)
  2. Heart rate and contractility will become more powerful, because all my muscles need energy, need oxygen.
  3. For breathing, expanding the lungs and inhaling as much as you can.
- So **not** always the sympathetic excitatory and the parasympathetic inhibitory ,when you are fighting all flighting the sympathetic will inhibit all the GI digestion and secretion, you don't need to digest your food you don't need to filtrate urine from the kidney, so the sympathetic inhibits areas and excites other areas.
  - Keep in mind that the sympathetic nervous system is the major controller of circulation, so when you are in a fight or flight mechanism, when you are afraid and when you are expecting a danger you need first your heart and blood pressure, so first of all sympathetic will be stimulated causing increase in the heart rate maybe it will reach 100 or 120, and the contractility the power of the heart beat becomes much more and the blood will be ejected to the parts of the body that you need, for example it is going to be directed toward blood vessels of the skeletal muscle so you can run away, therefore sympathetic dilate the blood vessels of the skeletal muscle, but it contract the blood vessels of the kidney and of the GI tract because you don't need them.
  - ❖ When we come to the regulation of sympathetic, how do you think our brain senses the blood pressure? For example if we want to exercise and increase the Blood pressure, how the brain knows that the blood pressure must be increased?

The Only way by which the brain knows that the blood pressure is low or high is by SIGNALS that come from the major blood vessels:

1- From the arch of aorta from what is called the **baroreceptors** - word "baro" means pressure, so it senses pressure -.

2- At the bifurcation of the carotid, we have the internal carotid that goes to the brain and supplies it, and we have the external carotid that supplies the skull the neck and the



face area. At the bifurcation, we have the carotid sinus which means the baroreceptors here are the signals that goes.

The receptors that are at the aorta are conducted by the 10<sup>th</sup> cranial nerve “the VEGUS nerve “ . And the carotid receptors are conducted by the 9<sup>th</sup> cranial nerve “the glossopharangeal nerve “. They will go to the brain stem and as we mentioned the function of the brain stem is the regulation of heart and blood pressure and this is the cardiovascular control.

So when your blood pressure rises up to a dangerous level they will be stimulated and once the brain takes the signal he'll try to open the blood vessels so vasodilatation and decrease the heart rate by parasympathetic and the blood pressure goes down, but when you are preparing for exercise” to fight of flight“ the opposite will happen the parasympathetic will be completely inhibited and the blood pressure will be rising.

One more time there are changes that takes place in our body in our internal organs that we can't see, and there is no other way for the brain to understand the changes other than receiving signals from the periphery, for example your blood pressure changes when you walk increases when you set decreases and when you sleep decreases even more when you fight it increases to a higher level when you fight. so the brain needs to adjust that, brain usually receive information from receptors present on major vessels, on the aorta and the carotid bifurcation through the 9<sup>th</sup> and the 10<sup>th</sup> cranial nerves, they will go to the brain stem area and they will tell the brain whether the blood pressure is high or low so that the brain will adjust it.

If the brain needs to increase the blood pressure, he will cause vasoconstriction and increase heart rate, if you need to decrease the blood pressure he will cause vasodilation and decrease the heart rate, the first one is sympathetic and the second one is parasympathetic.

There is something called the **carotid sinus syndrome** , for example a young male during his graduation or engagement party he is under stress , usually males wear tuxedos and a neck tie ( girls have no problem because the usually wear dresses , so they have nothing pressing on their neck ) so the carotid sinus syndrome is for males , some of the males are very sensitive on the neck area , so this is a warning specially for you guys specially when you are laughing or fighting with your younger brother do NOT chock them from the neck because it is a very dangerous area ,here we have the two carotid if you press on them in some people that are very sensitive “ what we call it : the carotid sinus syndrome “ the receptors will get a wrong information that the blood pressure is rising from the external pressure , but actually it is not so when these information goes to the brain will

understand that blood pressure is dangerously increasing so it will call immediately the parasympathetic and cause vasodilatation, decrease in heart rate and fainting, so when you see a handsome young man wearing a neck tie and he suddenly faints, just open the first button and remove the neck tie he will get better, this is what we call it carotid sinus syndrome, it's kind of external pressure that simulates high blood pressure. This needs to be treated, and this is a warning to you, especially for the guys, even sometimes they put to the old people pacemaker in the heart to treat this condition, when too much fainting trifier on the brain.

- Keep in mind that the **carotid sinus syndrome** is actually a simulation to increase in the blood pressure and the response of the brain to decrease it, which is false because it is coming from the outside.

The most important two organs in our body are the brain and the heart, the first effect that happens on the parareceptors is affecting the brain and the heart, if you can take care of these two major organs in any person, then any other organ comes next, therefore the parareceptors are placed on the major vessels, because if there is a brain death or a heart myocardial function the patient almost dying.

الاشتغال بالعلم من أفضل الطاعات وأجل القربات ومذاكرة العلم تسييح والبحث عنه جهاد وتعلمه وتعليمه ودراسته توجب رضا رب العباد.

أسأل الله عز وجل أن ينفعني وإياكم بعلمه، وأن يهديني وإياكم لما يحبه ويرضاه، وأن يجعل منا أمة متعلمة مستتيرة بنور العلم والإيمان.

لا تنسوا أخوكم موسى صبح من دعواتكم ، وإذا كنت قد قصرت في شيء فأنا لست إلا انسان يخطئ ويصيب

لكم مني كل الحب والتقدير زملائي وأصدقائي في دفعتي العظيمة .. دفعة 2013

والى اللقاء في شيت آخر ☺