# Neurotransmitters

# (norepinephrine and serotonin)

In this lecture we're going to study the **locus coeruleus**. Locus (location), coeruleus (blue)→ it is the blue area seen in the brain by scientists who had dissected the human brain.
This area releases **norepinephrine**; which is a neurotransmitter that is present in ( 00.56 ) and in the brain.

## * Norepinephrine:

We're going to study norepinephrine in the brain only. Norepinephrine is the neurotransmitter needed when you're sitting for an exam, it will give you the sharpness and clear mind, keeps you really focused and concentrated.

Sometimes when we feel confused and our brain is foggy, we go grab a cup of coffee. Coffee is a ( 1:32 ) material like adrenaline, which has epinephrine and norepinephrine, so by getting a cup of coffee we are elevating the norepinephrine in the brain which helps us in focusing. Therefore, caffeine and coffee is good in given amounts, but when the amount is increased more than the usual (about 8-10 cups a day) people start trumoring, tachycardia, nervous and itchy. That's because the brain is altered all the time. However that's needed at difficult times; when you're driving for a long period , sitting for an exam or thinking about something serious in our life, then you need to increase your norepinephrine in your brain.

Norepinephrine also provides a good sleep, and it's one of the mood stabilizing neurotransmitters. When it's high it gives you some sort of feeling good and euphoria.

## * Norepinephrine effect on sleep:

Many questions are asked about the habits of sleep or about the usual hours for sleep,

Sleep is very important to us, to our body, to our brain, to our psych. Sleep has been very well studied; there's a subspecialty of neurology in sleep disorders. It is very important to the body, brain and psych.

In general, deprivation of sleep is very dangerous, it has been used as a torcher in old ancient China. If they captured a spy in their country they would put him in a sitting position, tie him and drip water on his head every 30 seconds, keeping him unable to sleep. After 3 days he will go nervous breakdown and he will beg them and say whatever they want.

Deprivation of sleep can lead to nervous breakdown and death. It kills the human being before deprivation of food and water does; it is very dangerous. So sleep is very important for any person who is interesting in a career of medicine for example or a career which is very difficult that deals with human being.

## * What is sleep ?

sleep is subdivided into two stages.

1) The first stage is called the **slow wave stage**, it's for relaxation of the body. The waves are slow at the beginning with little spikes. If you look at a person who has just slept , sometimes he twitches his hand or his leg and that is the rapid spikes (twitching). Other than that all muscles go to relaxation, respiratory rate goes slower, heart goes slower, metabolism goes slower. This period is for relaxing muscles and body not the psych. This period lasts for 90 minutes (one and a half hours) .

During the 90 minutes of the slow wave stage, people go from stage 1 (low voltage with spikes) to stages 2 and 3 (theta waves) which are not normally to be recorded in alert adults. It's recorded because the brain is now relaxing and relaxing all the muscles.

Then you go to the very deep stage (stage 4) where waves become delta waves (much lesser frequency). During this period you get the deepest sleep, the body and the muscles are very relaxed. Thus, some people at this stage may lose control; in abnormal

conditions, people might start sleep walking or sleep talking because in this deep sleep many areas of the brain are released out of control.

2) After 90 minutes, it's time for your psych to relax. The **rapid eye movement sleep** lasts for 15-30 minutes, the brain here is very active. In some cases people even open their eyes!

It's the dreaming period, the metabolism is high (beta waves),the highest activity of the brain occurs here. It is a non-comfortable time of sleep for the muscles but it's very relaxing to the psych. People always tend to dream about things they wish to achieve. They fulfil the dreams they can't fulfil in real life in their dreams (ex: someone stayed nine years in the university and he failed to sleep then even suddenly he dreamed that he is the first on the university and he is being rewarded). That's why a good sleep gives you a better morning the next day.

Then this cycle will be repeated; another 1.5 hours for the body and then half an hour or 20 minutes for dreaming and then you wake up early in the morning in the dreaming period. We always wake up early in the morning in dreaming period.

One of the disorders of sleep is **sleep paralysis**, which occurs during the dreaming period. For example, if a person is known to be weak physically and he's dreaming that he's Jackie chan and fighting, in order not to act his dream; all the muscles go to paralysis. So during the rapid eye movement sleep, muscles go to paralysis. Sometimes in abnormal conditions that affect lots of medical students, when waking up early in the morning, the muscle paralysis has still not yet recovered, So he opens his eyes, but he feels that he cannot move his body, this is called: sleep paralysis.

Sometimes it's associated with sleep hallucinations (the person feels that he's dreaming but he's not in a dream هلوسات and he cannot move).. this's not dangerous and there's no need to worry about it. The normal mechanism is that the muscle paralysis is gone before opening your eyes, but sometimes some abnormality causes the paralysis to stay after opening the eyes.

Norepinephrine is responsible for the period of rapid eye movement, in psychological deprivation it makes you feel better, gives you a better dreaming period, gives you happy events and when you wake up in the morning you'll find yourself in a good mood.

So usually when the norepinephrine is high in the brain, people get beautiful dreams and wake up early in the morning fulfilled not only physically but also psychologically.

(A student asked about the night mares if they're caused by disorders in norepinephrine

Doctor's answer: It is not specifically related because sometimes even with high norepinephrine you get nightmares; it depends on the way you already started your sleeping period, in that case you might have been very stressed. So in general when norepinephrine is high you wake up in the morning psychologically satisfied, you feel good and you're in a good mood. But it's not necessary to have happy dreams always.)

We talked about the Physiology of the norepinephrine, let's talk now aboyt the Pathology:

## * What happens when norepinephrine goes very low?

It will cause depression. One of the major neurotransmitters when they go very low in the brain, they lead to depression. There's a decease called the bipolar decease (manic depressive illness). There are around 2.5 million schizophrenic in the USA, however there're 8 million manic depressive illness patients. What does that mean?

We are human beings; we are not robots, so our mood swings. We have good days and bad days.

When you are happy → the chemistry in your brain is high,

but when you're having a bad day → the norepinephrine goes low and many other neurotransmitters.

So this swing between good days and bad days is very usual because we are not robots. But when a patient comes to you and he mentions that for few weeks he was in a good mood, telling jokes and laughing out loudly. Then he might start doing inappropriate social behaviours, as a result he reaches mania الجنون (over activity); for example taking off his clothes and walk down the street naked, or start hitting on people. This shows an abnormal swing, it might take him few months or few weeks and then he goes down, he becomes quite, unhappy a little bit depressed, severely depressed and then he will try to commit suicide. So this swing of mood is abnormal, in fact very large numbers of people suffer from manic depressive illness. In our countries -unfortunately- the number

of patients is under estimated; however in the developed countries the number is higher than schizophrenic and depressed people. It's thought that the 11th chromosome is involved in this decease, so it runs in families. Usually affects females; because the limbic system is larger and more liable for psychiatric illnesses.

During mania we have to decrease the activity of the brain as well as the norepinephrine, and during depression and committing suicide we have to elevate the mood and give patients more norepinephrine. It's very difficult to treat those patients because they swing from mania to depression, but there're many patients around us suffering from this swing. Many of the famous people are manic depressive; usually artists and beloved movie stars.

3 neurotransmitters alter your mood: dopamine, norepinephrine and serotonin.

## * Serotonin:

It's released from the raphe nuclei (a group of nuclei; raphe means the midline in Latin) so it's a midline nuclei that release serotonin. Serotonin also alters your mood and gives you this feeling of satisfaction, it doesn't give you euphoria, but it gives you the quiet and comfortable feeling. It affects the sleep; the slow wave sleep (stage 1,2,3 and 4) that is relaxing to the body. When serotonin goes low; then you are deprived from sleep and you are suffering insomnia قلة النوم . It's either difficulty in falling asleep (rolling in bed instead of falling asleep) or interrupted sleep (so that you wake up early in the morning and you are feeling very tired مكسر ).

The norepinephrine affects the dreaming period (rapid eye movement sleep), otherwise, the serotonin affects the non-rapid eye movement (slow wave sleep) and its deprivation will lead to insomnia.

Rapid eye movement derived its name from the rolling movement of the eye as the beta waves that occur at that period if you watch someone sleeping, after the first one and a half hour of sleep (after the slow wave stage) he will start blinking his eyes, some people even open their eyes partially or completely, but they are fully unawake. This is the dreaming period, this case is restless as you can notice that the respiration is high and the muscles aren't resting, it rests the psych. This period can be diagnosed by the EEG because of the rolling movement of the eye.

Dopamine, norepinephrine and serotonin all of them when they are increased they give you a good mood. So what type of medication can really release them and can cause this good mood? what do we call those drugs? The narcotics.

## * Addiction:

In an experiment that has been done on a monkey (closest creatures to humans when we're investigating the brain). Monkeys usually explore things around them, if we put one monkey in a cage he will keep jumping from one place to another. The experiment starts by putting prier ahead atronichaly implanted electrodes أقطاب كهربائية in his brain and they're connected to a handle, so while he's playing around he will discover the handle, he'll start playing with it. The experiment is designed so that if he pulls the handle downward, an electrical signal will go to his brain. So if it happens to go to the nucleus accumbens or to the ventral tegmental area or to the part of emotional brain where it gives him pleasure, this monkey will continue holding this handle forever and he keeps pushing the handle downward, he forgets to sleep, he forgets to eat or drink, he even forgets about his mates and then he dies from happiness.

This gives a hint, that whenever you are stimulating the pleasure area in the brain it's just like the addict. The addict doesn't care about his family, his work. He only cares about the second dose that will make him high.

Later on the scientists removed the electrodes from the pleasure area and they put it in another area in the emotional brain which gives the punishment; the feeling of guilt الضمير الحي . When the monkey discovers the handle, he puts it down, so the electrical activity will stimulate the feeling of guilt causing an unpleasant feeling. The monkey will never come back to the handle no matter how small the cage he's locked in was, because he doesn't want to get that unpleasant feeling.

So we can exclude from this experiment that our brain works by reward and punishment نظرية الثواب والعقاب. You do good things, you feel good about yourself and you're happy . You do bad things, you start blaming yourself. They discovered that in many animals and also in human beings, 35% of our emotional brain is reward centers (gives you pleasure and happiness) 5% gives you guilt and punishment and 60% are indifferent (for other functions). So you have a large area that you can stimulate it.

## * Causes of addiction: (things people are addicted to)

Cigarettes, caffeine, cocaine, heroin, morphine, alcohol (40-60% of perfumes is alcohol), new technology, gambling, pornography (sex movies), internet, video games, pain killers (tramadol; 70% of the Egyptian population is addicted to it) and cough syrup (contains codeine)

Addiction is a genetic predisposition, if you have an addict parent, then you are highly advised never to try the addictive material because you have the genes of addiction so you will become an addict as well.

## * Types of alcohols:

1- ethanol : alcoholic beverages, which is socially accepted in the American and European societies and not much accepted in our conservative environment.

2- methanol : the wood alcohol, like spirits (used in hospitals). Drinking these products results in blindness. Patients who have lost their sight due to drinking wood alcohol can be treated immediately by giving him whiskey (100% pure ethanol), because whiskey inhibits the metabolism of methanol in the liver and prevents blindness, so it's considered here as a life-saving drug.

Addiction is due to the reward centers, majorly when the nucleus accumbens and the ventral tegmental area are stimulated.

## * Criteria for addiction:

If you want to know whether you are addicted to facebook or not, you put the laptop and you pass by it for 24 hours without looking or checking or contacting any person. If you can survive, then you are not an addict.

## * Diagnosis of addiction:

1- Exposure and feeling of well-being (a friend or someone offers trying it for free)

2- Exposure seeking behaviour, you start paying money to get your drug after you like it.

3- Tolerance, the body and brain need higher doses to get the norepinephrine, serotonin and the dopamine high (increasing dose: every time the dose increases).

4- Getting sick (in the case of absence of the drug due to poverty): nosia, vomiting, headache, pain, axe, this might elevate causing epilepsy.

5- Dependence, the addict neglects his family, future. He cannot live without the material he's addicted to.

It's a triad between the three neurotransmitters (dopamine, norepinephrine and serotonin) that causes us feeling good, happy, content and accepting ourselves we don't want people who are overactive, young people are mostly who suffers from that, they keep up blaming themselves. Having them stable is done by the good habits of diet and quality of life.

Norepinephrine and dopamine give you alertness, make you active. While serotonin puts you in the quite mood. There are certain kinds of food that can elevate norepinephrine and dopamine (red meat and high protein diet; burgers, steaks), and other kinds of food can elevate the levels of serotonin (pasta, pizza, rice, carbohydrates and vegetables). That's why balance between your diet can make you feel good, content and happy.

Banana, chocolate and spices elevate the mood and can lead you to an addictive behaviour ;specially the spicy food.

* Keep it in your mind:

Sheep is sheep and lion is lion;

The sheep eats vegetables→ high serotonin → he's always quite

The lion always eats meat → high norepinephrine and dopamine → he's aggressive