UNIVERSITY OF JORDAN
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INTRODUCTION TO NEUROPHYSIOLOGY
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Textbook of Medical Physiology
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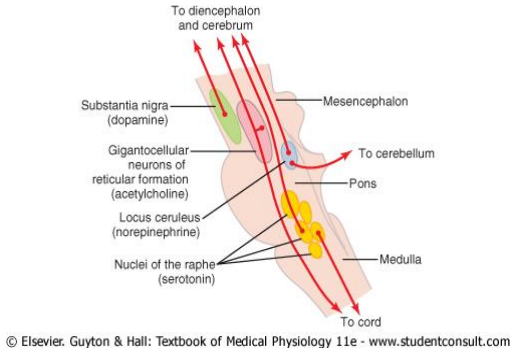
NEUROHORMONAL CONTROL OF BRAIN:

They often persist for minutes or even hours & provide long periods of control. In human four systems were described:



1. The SUBSTANTIA NIGRA & the DOPAMINE SYSTEM:

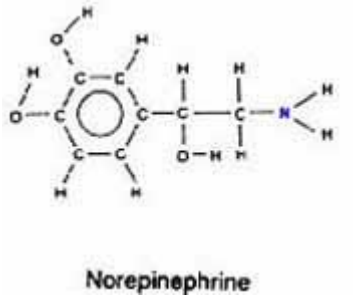
Dopamine (DA) is the neurotransmitter that plays a part in controlling movement, thought processes, emotions, and the pleasure centers of the brain. When a person physically works out or accomplishes a difficult task, the brain releases excess dopamine into certain areas of the brain. Any release of dopamine induces a sense of euphoria and wellbeing.

Destruction of the dopaminergic neurons in the substantia nigra is the basic cause of Parkinson's disease. Studies with Positron Emission Tomography (PET) indicate steady loss of dopamine receptors in the basal ganglia with age.

PET scanning of Schizophrenic patients indicate elevated level of D_2 receptors & chromosomal study in these patients indicate abnormality in chromosome 5 which may well be involved in dopaminergic system.

Amphetamines which stimulate secretion of dopamine & norepinephrine produces a psychosis resemble schizophrenia when administered in large doses. Phenothiazines tranquillizers are effective in the relief of the symptoms of schizophrenia through their ability to block D_2 dopamine receptors.

1. **The LOCUS CERULEUS & the NOREPINEPHRINE SYSTEM:**



Norepinephrine

Norepinephrine (NE) is a neurotransmitter that plays a part in controlling alertness, attention, and memory. So if you are reading this lecture, and are having trouble concentrating, it could be because your brain is currently not producing enough norepinephrine. Going to get some coffee would help you to raise these levels, allowing concentration to return.
NE generally excites the brain to increase its activity, & may be inhibitory in a very few brain areas. This system play important role in causing dreaming (REM sleep).
Drugs that increase extracellular norepinephrine level elevates mood, while drugs that decrease it cause depression. In manic-depressive illness there is a genetic abnormality close to or in the gene on chromosome 11 that codes for Tyrosine hydroxylase, the rate limiting enzyme in catecholamine biosynthesis leading to mood swing in those patients.

Sleep

Slow wave sleep:

Deep, restful type of sleep, experienced usually during the first hour of sleep after being kept awake for many hours. It composes 75 % of total sleep period, interrupted by REM sleep. It lasts for 90 minutes to recur after a period of 5 - 30 minutes of REM sleep. It is associated with a decrease in blood pressure, respiratory rate & basal metabolic rate. Dreams do occur & even nightmares however they cannot be remembered i.e. consolidation of the dreams in memory do not occur.

REM sleep:

Called also paradoxical sleep or desynchronized sleep.
It occurs periodically, not so restful type of sleep. It occupies 25 % of sleep time of young adults, lasts for 5 - 30 minutes for every 90 minutes of slow wave sleep. It is associated with active dreaming that can be remembered after wakefulness, associated with decrease in all muscle tone through spinal inhibition except the rapid eye movements & sometimes irregular muscle movements do occur. Heart rate & respiratory rate are irregular. It is difficult to arouse the person by sensory stimuli in REM sleep however people usually awaken in the morning during an episode of REM. In REM sleep the brain is highly active (Beta waves) & the brain metabolism is increased up to 20 % however the brain activity is not channeled to let the person be fully aware of his surroundings or to be awake.

3. THE RAPHI NUCLEI & THE SEROTONIN SYSTEM:

Serotonin plays an important role in many behaviors including sleep, appetite, memory, sexual behavior, and mood. The chemical structure of serotonin closely resembles that of many hallucinogens. A hallucinogen like LSD can bind onto serotonin receptors, mimicking

the actual neurotransmitter, resulting in unnatural stimulation in different areas of the brain. The actual serotonin neurotransmitter is structurally different than the other synaptic messengers of the brain.
When a person has a deficiency in brain serotonin levels, they are more likely to exhibit violent behavior, anxiety, depression, impulsiveness, and could have a propensity towards drug and alcohol abuse. When a person has higher levels of serotonin in the brain, they are less aggressive, mellow, and happier.
The raphe nucleus sends fibers to diencephalon & cerebrum to play an inhibitory role to help in causing normal sleep (Slow wave sleep) & selective depletion of serotonin in brain lead to Insomnia (inability to sleep). Serotonin may play a role in inhibiting transmission of pain in the Spinal cord.
The antidepressant drug, Prozac increases serotonin activity. Its main action is to increase serotonin transmission in the brain by inhibiting the reuptake of the neurotransmitter.

When a person does a drug like meth (Methamphetamine), that person's neurotransmitter levels can be affected. Dopamine, norepinephrine, and serotonin are all affected by meth and can suffer long-lasting damage even after just one trial with this dangerous drug. It has been reported that people are more alert when their brains are producing the neurotransmitters dopamine and norepinephrine, while serotonin production in the brain has been associated with a more calming, anxiety-reducing effect (and even drowsiness in some people). A stable brain serotonin level is associated with a positive mood state. It appears that women have a greater sensitivity than men to changes in this brain chemical. Mood swings during the menstrual cycle and menopause are thought to be caused by hormonal changes that influence the production of serotonin.
How does diet play a role? The foods that increase the production of serotonin in the brain are high in carbohydrates. Many kinds of foods carbohydrates, such as candy, cereal, and pasta, can produce a temporary increase in brain serotonin—and a subsequent calming or anxiety-reducing effect. This explains why people may feel drowsy in the afternoon after eating a large meal of pasta, since a rise in serotonin in the brain can also lead to drowsiness. Carbohydrates affect brain serotonin because they increase the amount of tryptophan in the brain. Tryptophan is the amino-acid precursor of serotonin. The two other important brain chemicals that appear to be influenced by foods, dopamine and norepinephrine, produce a feeling of alertness, an increased ability to concentrate, and faster reaction times. There are two possible mechanisms for how this happens: (1) serotonin production is blocked by the consumption of protein-rich foods, resulting in increased alertness or concentration, or (2) levels of dopamine and norepinephrine are increased by the consumption of protein-rich foods.

4. THE GIGANTOCELLULAR NEURONS OF THE RETICULAR EXCITATORY AREA & THE ACETYLCHOLINE SYSTEM:

Send excitatory fibers to the higher centers which lead to awake & excited mind. It also sends excitatory fibers to SC through the Reticulo-spinal tract. Acetylcholine is distributed throughout the CNS with high concentration in cerebral cortex, thalamus, & various nuclei in the basal forebrain. Cholinergic neurons projecting to hippocampus are involved in memory, while projections from nucleus basalis of Meynert, amygdala & the entire neocortex are involved in motivation, perception & cognition. In Alzhiemer's disease there is extensive cell loss of these projections leading to Dementia. In basal ganglia acetylcholine is excitatory & dopamine is inhibitory, therefore loss of the dopamine alters the cholinergic-dopaminergic balance.