Neurotransmitters, Endocrine System, Synapses

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Neurotransmitters

➢ They are the chemicals which allow the transmission of signals from one neuron to the next across synapses.
➢ The neurotransmitters are manufactured in the cell body and travel down the axon to be stored in vesicles associated with the synaptic knobs.
➢ When a vesicle reaches the cell membrane of the synaptic knob, it fuses with the cell membrane and releases its neurotransmitter into the synaptic region.
➢ Major neurotransmitters include, acetylcholine, serotonin, dopamine, norepinephrine, epinephrine, GABA, and glutamate.
Acetylcholine

➢ The first neurotransmitter to be discovered in 1921 by a German biologist named Otto Loewi
➢ It is responsible for most of the muscle movement throughout the body.
➢ In the central nervous system, acetylcholine acts as part of a neurotransmitter system and plays a role in attention and arousal.
➢ In the peripheral nervous system, this neurotransmitter is a major part of the autonomic nervous system and works to activate muscles.
➢ It is also found in sensory neurons and in the autonomic nervous system, and has a part in scheduling REM (dream) sleep.
Sero tonin

➢ An inhibitory neurotransmitter.
➢ Found to control emotion and mood.
➢ A lack of serotonin has been shown to lead to depression, problems with anger control, obsessive-compulsive disorder, and suicide.
Dopamine

➢ An inhibitory neurotransmitter.
➢ Associated with reward and pleasure mechanisms in the brain.
➢ Also helps regulate movement and emotional responses, and it enables us not only to see rewards, but to take action to move toward them.
➢ A lack of dopamine in the motor areas of the brain leads to Parkinson’s disease which is a disorder of the brain that leads to shaking and difficulty with walking, movement, and coordination.
➢ An excessive amount of dopamine leads to schizophrenia.
### Norepinephrine
- Found mainly in the sympathetic nervous system.
- It is strongly associated with bringing our nervous systems into “high alert.”
- Used pharmaceutically to increase our heart rate and blood pressure.
- Released by our adrenal glands into the bloodstream, along with epinephrine.
- It is also important for forming memories.

### Epinephrine
- Hormone essential to metabolism.
- Regulates attention, mental focus, arousal, and cognition.
- Also inhibits insulin excretion and raises the amounts of fatty acids in the blood.
- Made from norepinephrine and is released from the adrenal glands.
- Low levels have been can result in fatigue, lack of focus, and difficulty losing weight.
- High levels have been linked to sleep problems, anxiety and ADHD.
GABA
➢ Major inhibitory neurotransmitter in the central nervous system. Acts like a brake to the excitatory neurotransmitters that lead to anxiety.
➢ It helps the neurons recover after transmission, reduces anxiety and stress.
➢ Regulates norepinephrine, adrenaline, dopamine, and serotonin, it is a significant mood modulator.
➢ People with too little GABA tend to suffer from anxiety disorders, and drugs like Valium work by enhancing the effects of GABA.
➢ If GABA is lacking in certain parts of the brain, epilepsy results.

Glutamate
➢ Major excitatory neurotransmitter
➢ It is required for learning and memory.
➢ Low levels can lead to tiredness and poor brain activity.
➢ Increased levels of glutamate can cause death to the neurons (nerve cells) in the brain.
➢ Dysfunction in glutamate levels are involved in many neurodegenerative diseases such as Alzheimer’s disease, Parkinson’s, Huntington’s, and Tourette’s.
➢ High levels also contribute to Depression, OCD, and Autism
Synapses

❖ The synapse is a small area between the dendrites and the axon terminal where synaptic transmission occurs.
❖ This is where nerve impulses transit between neurons.
Synapses

- Nerve impulses travel through the synapse through the process of synaptic transmission.
- This can be broken down into 4 steps
- This process is how all information gets from our brain to the rest of the body.

1. Neurotransmitters are synthesized and stored in vesicles waiting for action potential.
2. The neurotransmitter is expelled from the axon terminal into the synaptic cleft.
3. The neurotransmitter reaches the receptor of the dendrite and is recognized so it may pass on the signal.
4. The neurotransmitter is deactivated so that the receptor becomes free to collect new signals.
Synaptic Disorders

❖ Dysfunction in the synapses can be caused by an obstruction or improper set up of the transceiver and receiver.
❖ The synaptic structures can be blocked or moved out of place by a genetic defect, causing dysfunction.
❖ The dendrite receptor can also not process the signal of a neurotransmitter, causing the signal to not pass on.
❖ Dysfunctional synapses are main culprits of anxiety disorders, depression, dementia and addiction.
Endocrine System

❖ A collection of glands that produce hormones responsible for regulating the body's growth, metabolism, and sexual development and function
❖ Hormones are released into the bloodstream and distributed throughout the body's tissues and organs
❖ Hormone levels that are too high or too low can indicate a problem with the endocrine system
➢ A common disease of the endocrine system is diabetes. This is due to the body's inability to produce a sufficient amount of insulin.
➢ Hypothyroidism occurs when the thyroid gland does not produce enough hormone to meet the body's needs. This can cause many of the body's functions to slow or shut down completely.
## Endocrine System vs. Nervous System

<table>
<thead>
<tr>
<th>Endocrine System</th>
<th>Nervous System</th>
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<tbody>
<tr>
<td>★ No structural connection with each other; wireless system</td>
<td>★ Specific structural arrangement b/w targeted cells and neurons; wired system</td>
</tr>
<tr>
<td>★ Carries signals through hormones</td>
<td>★ Carries signals through neurotransmitters</td>
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<tr>
<td>★ Hormones are released and carried in blood to long distances</td>
<td>★ Neurotransmitter diffused and released through short distances</td>
</tr>
<tr>
<td>★ Slow and long lasting response (ex. body growth)</td>
<td>★ Response is rapid and brief; can happen within seconds (ex. reflex)</td>
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<tr>
<td>★ Target cells that are more widespread</td>
<td>★ Target cells in specific locations</td>
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Glands & Functions

- **Adrenal glands** secrete hormones that influence the body's metabolism, blood chemicals, and body characteristics; influence the part of the nervous system that is involved in the response and defense against stress.

- **Hypothalamus** controls involuntary body functions, the hormonal system, and many body functions such as regulating sleep and stimulating appetite.
Glands & Functions

- **Ovaries and testicles** - influence female and male characteristics
- **Pancreas** - secrete insulin
- **Parathyroid glands** - hormones maintain calcium level in blood
- **Pineal body** - source of melatonin, a hormone derived from tryptophan that regulates sleep cycle
- **Thymus glands** - plays a role in immune system
- **Thyroid Glands** - produces hormones that stimulate body heat production and bone growth
Glands & Functions

- **Pituitary gland**—referred to as “master gland” because it produces different hormones that affect other endocrine glands; divided into 3 sections
  - **Anterior:** involved in development of the body, sexual maturation and reproduction. Hormones produced by the anterior lobe regulate growth and stimulate the adrenal and thyroid glands as well as the ovaries and testes.
  - **Intermediate:** releases a hormone which stimulates the melanocytes, cells which control pigmentation through the production of melanin
  - **Posterior:** produces antidiuretic hormone, which reclaims water from the kidneys and conserves it in the bloodstream to prevent dehydration
Sources

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