Chapter 28 Notes – Nervous Systems

28.1: Nervous systems receive sensory input, interpret it, and send out appropriate commands.

- **Nervous systems** are the most intricately organized data processing systems on Earth.
- The nervous system is made up of the central nervous system (CNS), which consists of the brain and spinal cord and the peripheral nervous system (PNS), the nerves.
- The nervous system fulfills three interconnected functions, sensory input, (sending of signals from receptors to integration centers) integration, (interpretation of the sensory signals) and motor output (conduction of signals from integration centers to effector cells).

28.2: Neurons are the functional units of the nervous system.

- Neurons consist of a cell body from where dendrites and axons originate.
- Gilia are outnumbering neurons that are essential to the normal functioning of the nervous system.
- Synaptic Clefts and synaptic terminals are located at the terminus of each neuron.

### Nerve Signals & Their Transmission

28.3: A neuron maintains a membrane potential across its membrane

- The neuron’s resting potential is slightly negative, and the interstitial fluid surrounding the cell is positive.
- The sodium potassium pump selectively controls the movement of sodium and potassium across the membrane.

28.4 The nerve signal begins as a change in the membrane potential when a stimulus is present.

- A stimulus opens some $Na^+$ channels, which trigger action potential from threshold. (-50 mV) When $Na^+$ channels are open, $K^+$ channels are closed and the interior of the cell becomes more positive. The $K^+$ channels then open and $K^+$ rushes out of the axon. As the channels close relatively slowly, a brief undershot occurs in the membrane potential.

28.5: Action potential moves itself across the neuron’s axon segments, generating an impulse.

- The frequency of each action potential leads to changes in the intensity of the stimuli.

28.6: The synaptic cleft is where communication occurs between the sending neuron and the receiving neuron through vesicles fusing with the plasma membrane.

- The synapse prevents the action potential from jumping between neurons.
- Through ion channels (facilitated diffusion), neurotransmitters are entered into the receiving neuron.
28.7: The many **synapses** located on the dendrites allow for complex information processing to be possible.

- A **receiving neuron**'s membrane may receive signals - both **excitatory** and **inhibitory** – from many different **presynaptic neurons**.

28.8: Many **molecules** function as **neurotransmitters**.

- **Acetylcholine** is in the brain and present between motor neurons and muscle cells.
- **Biogenic amines**, derived from amino acids, effect the CNS. **Epinephrine**, **norepinephrine**, **serotonin**, and **dopamine** are biogenic amines (and also serve as hormones).

28.9: **Medicines** act at **chemical synapses**, **altering** the effects of **neurotransmitters**.

- **Antidepressant medication** affects the action of **serotonin** (responsible for sleep, mood, attention, and learning).
- **Schizophrenia** may occur when tetrahydrocannabinol (THC) binds to brain receptors normally used in anandamide.

The Animal Nervous System

28.10: The **layout** of the nervous system corresponds with **body symmetry**.

- **Nerve nets**, a diffuse, web like system of neurons, are present in hydra. Although the nerve net has no central or peripheral divisions, the nerve net can still control the contractions of the digestive cavity.
- **Brains** are located in a **cephalized** region of an organism. This causes **centralization**.
- **Nerve chords** control an animal’s movements.

28.11: The nervous system in vertebrates contains a **brain**, **spinal chord**, **cranial nerves**, **spinal nerves** and **ganglia**.

28.12: The **peripheral nervous system** is in a **functional hierarchy**, split between the **somatic** and **autonomic nervous systems**.

- The **somatic nervous system** carries signals to and from **skeletal muscles**.
- The **autonomic nervous system regulates** the **internal environment**, controlling **sympathetic division**, **parasympathetic division**, and **enteric division**.

28.13: The **sympathetic** and **parasympathetic** neurons oppose each other, regulating the internal environment.

- **Parasympathetic division** primes the body for activities that gain and **conserve** energy for the body.
- **Sympathetic division** prepares the body for intense, **energy consuming** activities.
- Sympathetic division allows for a **flight or fight response**.

The Human Brain

28.14: **Brains** in vertebrates develop from bulges of the **neural tube**, the **forebrain**, **midbrain**, and **hindbrain**.

- The **forebrain** divides into the **cerebrum** and the **diencephalon**.
The midbrain becomes part of the brainstem. The hindbrain divides into the Pons, medulla oblongata (part of brainstem) and cerebellum. The cerebrum is the most sophisticated center of nervous activity.

28.15: The human brain is made up of the brainstem, cerebellum, thalamus, basal ganglia, and the cerebral hemispheres.

- The brainstem is made up of the Pons and medulla. The brainstem controls many involuntary actions, such as breathing.
- The Cerebellum coordinates body movement; playing a role in learning and the memorization of immune responses.
- The cell bodies that relay information to the cerebral cortex are located in the thalamus. The information is sorted in the thalamus as well.
- The Basal ganglia, located under the corpus callosum contains neurons important in motor coordination.
- The cerebral hemispheres are responsible for the opposite sides of the body from which they are located.

28.16: The cerebral cortex contains a plethora of specialized regions.

- The cerebral cortex is divided into a frontal lobe, parietal lobe, occipital lobe, and temporal lobe.
- Laterization is a phenomenon where the cortex becomes specialized.

28.17: Injuries and brain operations provide a greater insight into the overall function of the brain.

- Phineas Gage had two pierced frontal lobes in his brain. People with these injuries often exhibit irrational decision-making.

28.18: Sleep and arousal are regulated by different parts of the brain.

- The lower the rate of mental activity, the more regular the brain waves are on an EEG (Electroencephalogram)
- A sleep cycle alternates between two types of deep sleep – short wave sleep / delta waves and REM sleep.
- Dreams occur during REM sleep.

28.19: The limbic system is involved in emotions, memory, and learning.

- The hippocampus is involved in both the formations of memory and their recall.

28.20: The nervous system has many neurological disorders, produced by changes in brain physiology.

- Schizophrenia is a severe mental disturbance where patients loose their ability to distinguish reality.
- Depression and bipolar disorder have a genetic component, yet are environmentally driven. SSRIs are now used to combat depression.
- Alzheimer’s disease is a form of dementia. In Alzheimer’s disease, certain sections of brain tissue either shrink or die.
- Parkinson’s disease is a motor disorder where movements are slowed. Parkinson’s, a progressive neurological disease, sadly has no cure. Current treatments for Parkinson’s include drugs such as L-dopa, and surgery.