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1 The Brain and Behavior

1.1 The Brain Has Distinct Functional Regions

The Central Nervous System Has Seven Main Parts

- ▷ **Spinal cord:** most caudal part of the central nervous system. It is subdivided into cervical, thoracic, lumbar, and sacral regions.
- ▷ **Brain stem:** consists of the medulla oblongata, pons, and midrain. Relays input from the spinal cord and back, and controls input to and from the head.
- ▷ **Medulla oblongata:** rostral to spinal cord and includes several centers responsible for vital autonomic functions.
- ▷ **Pons:** rostral to medulla and conveys information about movement.
- ▷ **Cerebellum:** lies behind pons, modulates force and range of movement, and involved in learning motor skills.
- ▷ **Diencephalon:** lies rostral to midrain and contains two structures, thalamus (processes information reaching cerebral cortex) and hypthalamus (regulates autonomic, endocrine, and visceral functions).
- ▷ **Cerebrum:** comprises two cerebral hemispheres, each consisting of wrinkled outer layer (the cerebral cortex), and three deep lying structures (basal ganglia, the hippocampus, and the amygdaloid nuclei).
- ▷ **Cerebral cortex:** divided into four distinct lobes— frontal, parietal, occipital, and temporal. The frontal lobe is largely concerned with short-term memory and planning, as well as movement; the parietal lobe with somatic sensation, forming a body image, and relating it to extrapersonal space; the occipital lobe with vision; and the temporal lobe with hearing—combined with deeper structures—with learning, memory, and emotion.

2 Nerve Cells, Neural Circuitry, and Behavior

2.1 The Nervous System Has Two Classes of Cells

- ▷ There are two main classes of cells in the nervous system: nerve cells, or neurons, and glial cells, or glia.
- ▷ A neuron has four defined regions:
 - **Cell body**: or *soma*, is the metabolic center of the cell, containing normal cell organelles.
 - **Dendrites**: branch out in tree-like fashion and are main apparatus for receiving signals.
 - **Axon**: extends some distance from a cell and carries signals to other neurons.
 - **Presynaptic terminals**: specialized enlarged regions of its axon's branches and is responsible for transfer of signals.
- ▷ **Principle of dynamic polarization**: electrical signals only flow in one direction in neurons.
- ▷ **Connectional specificity**: nerve cells do not connect randomly with one another in these formation of networks.
- ▷ Neurons are classified into three groups:
 - **Unipolar**: simplest due to single primary process, which gives rise to many branches. One branch as axon and others as receiving structures. These cells predominate invertebrates; they occur in the autonomic nervous system in vertebrates.
 - **Bipolar**: oval soma that gives rise to two processes: a dendritic structure that receives signals and an axon that carries information towards the central nervous system. Many sensory cells are bipolar, and pain receptors are pseudo-unipolar.
 - **Multipolar**: predominate nervous system of vertebrates and vary greatly in shape; typically containing a single neuron and many dendritic points emerging from various points around the cell body.

- ▷ Glial cells support nerve cells and greatly outnumber neurons.
- ▷ Glial cells surround the cell bodies, axons, and neurons and can be divided into two major classes:
 - **Microglia**: immune system cells that become phagocytes during injury, infection, or degenerative diseases.
 - There are three main types of **macroglia**: oligodendrocytes, Schwann cells, and astrocytes. About 80% of all brain cells are macrogalia.

3 Genes and Behavior

This chapter has been intentionally left blank, see genetic notes for more information.

4 The Cells of the Nervous System

This chapter was intentionally left blank, see cell biology notes for more information.

5 Ion Channels

5.1 Rapid Signaling in the Nervous System Depends on Ion Channels

- ▷ Up to 100 million ions can pass through a single channel each second, comaprable to the turnover rate of the fastest enzymes, catalase and carbonic anhydrase.
- ▷ Each channel allows only one or a few types on ions to pass.
- ▷ Many open and close, however, some remain open resulting in significant contribution to resting potential.
- ▷ Ions pumps maintained gradients and are 100 to 100,000 times slower than channels.
- ▷ Questions for this chapter:
 - Why do nerve cells have channels?
 - How can channels conduct ions at such high rates adn still be selective?
 - How are channels gated?
 - How are properties of theses channels modified by various intrinsic and extrinsic conditions?

5.2 Ion Channels are Proteins That Span the Cell Membrane

- ▷ Cells have channels in order the transport ions across lipid bilayer easily and eliminate the need to be stripped of waters of hydration.
- ▷ The smaller the ion, the greater attraction to water, and the lower its mobility. This partially explains selection, but does how does the inverse selection, that selecting of lower mobility, occur?
- ▷ Some ions bind to proteins that can transport them, but this is far to slow for some cases.

- ▷ An extension of pore theory says that channels have narrow regions that act as molecular sieves, where the ion sheds most of its water and only is let through by a binding to a specifically charged selectivity filter.

5.3 Ion Channels in ALL Cells Share Several Characteristics

- ▷ The opening and closing of a channel involve conformational changes.
- ▷ *Gating*: the transition of a channel between these stable functional states.
- ▷ Three major gating mechanisms:
 - Ligand: binding of chemical ligands known as agonists at either cellular site; transmitters on the extracellular; others that activate signaling cascades; and more.
 - Voltage-gated: changes in electrochemical changes as often as temperature sensors.
 - Mechanical stretch or physical changes in the membrane.

6 Electrical Properties of the Neuron

This chapter was intentionally left blank. No alternative notes, but may need to review chemistry and physics if this chapter is needed.