Neurons

Computational Neuroscience Course homework 04

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a. Neuron Structure and Function Different parts of the brain contain neurons with diverse shapes (morphologies); however, their operational mechanisms are broadly similar. Neurons consist of dendrites (which receive inputs), a soma (the cell body), and an axon (which sends outputs to other neurons).

b. Functions of Neurons Neurons are fundamental in:

1. Transferring information from one point to another within the body.

2. Processing information, though the processing at a single neuron level is relatively simple, often resembling a summation process. (how about differences between different dendrites?)

c. Neural Potentials Neural potentials arise due to the presence of ions inside and around neurons. Key potentials include: Resting potential: Typically ranges from -70 to -90 mV and Action potential: A rapid change in potential that propagates along the axon, characterized by spikes lasting approximately 2 to 3 milliseconds.

d. Ion Channels in Neurons Neurons contain various types of ion channels, such as:

1. Ligand-gated: Activated by specific chemical signals.

2. Mechanically-gated: Activated by changes in the neuron's shape.

3. Always open: Function continuously until reaching the resting potential.

4. Voltage-gated: Open when the potential difference reaches a specific threshold.

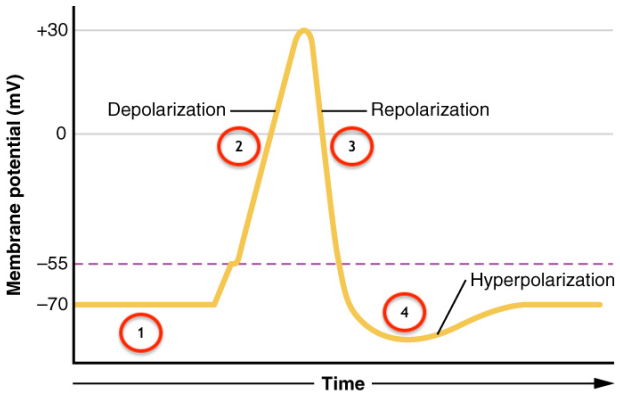

FIG. 1. Cycle of neuron activity

e. Neuron Operation Mechanism The operation of neurons involves several stages:

1. Initially, the neuron is in a resting state.

2. Upon reaching a threshold, voltage-gated channels open, leading to a spike in potential due to the influx of Na+ ions (depolarization).

3. After peaking, Na+ channels close, and K+ channels open, causing repolarization.

4. Finally, always-open channels help return the neuron to its resting potential.

f. Types of Neurons Neurons are classified into:

- **Excitatory Neurons (80%)**: These neurons promote the firing of action potentials in other neurons, primarily through excitatory post-synaptic potentials (EPSPs).
- **Inhibitory Neurons (20%)**: These neurons inhibit action potentials, using inhibitory post-synaptic potentials (IPSPs) to decrease the likelihood of neuron firing.

g. Types of Axons Axons are differentiated by:

- **Myelinated Axons**: Encased in myelin, which speeds up the transmission of electrical signals.
- **Unmyelinated Axons**: Lack a myelin sheath, resulting in slower and continuous signal transmission.

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