THE NEURAL GARAGE COMPANY

NEUROSCIENCE - DALE PURVES

Andrew Leacock

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***Abstract* – Neuroscience chapters 3-7 Notes**

I. IONIC CURRENTS

The increase in permeability to Na^+ triggers action potentials. The mechanism that is responsible to Na^+ permeability is sensitive to the membrane potential. The ionic current that flows during an increase in membrane conductance is given by:

$$I_{ion} = g_{ion}(V_m - E_{ion})$$

I_{ion} = ionic current
$\boldsymbol{g}_{ion}$ = membrane conductance
V_m = membrane potential
E_{ion} = equilibrium potential for the ion flowing through the conductance

Na^+ reach its conductance(permeability) more rapidly than K^+. The Myelin sheath is a wrapping around neurons that increase the speed in which ions flow. Without the mylein axon conduction velocities range from 0.5 to 10 m/s. With the Mylein the velocity is up to 150 m/s. Action potentials jump from node to node. There are gaps in the mylein sheath for the ion pumps and channels, the gaps are called nodes of Ranvier.

II. ION CHANNELS

Currents flowing throw single channels are called **microscopic currents** and **macroscopic currents** flow through a large number of channels in a large region of the membrane. A small current of 1 pA can have thousands of ions flow through it every millisecond. Neuronal membranes have at least two types of ion channels, one selectively permeable to Na^+, and one to K^+. Both of these channels are **voltage-gated**, meaning the open based upon the membrane potential.

III. OTHER ION CHANNELS

Ion channels have 3 large groups:

voltage-gated
extracellular ligand-gated
inter-cellular ligand-gated

There are 4 voltage gated channels that have been discovered (Na^+, K^+, Ca^{2a}, Cl^-).

Na^+ - for the initiation and propagation of action potentials
Ca^{2a} - can also do what the Na^+ can do in some neurons but they also play an essential part during the release of neurotransmitters at synapses.
K^+ - are the largest of the voltage-gated channels. Some set the resting membrane potential, some change the frequency of the action potential train or alter the duration of individual action potentials.

Extracellular ligand-gated channels are usually insensitive to changes in membrane potentials but activated by binding extracellular ligands such as neurotransmitters. These are essential for synaptic transmission. Intracellular ligands-gated channels enables the transmembrane transfer of an ion by a channel that opens when a specific intracellular ligand has been bound by the channel complex or one of its constituent parts.

IV. ELECTRICAL SYNAPSES

Two communicating neurons are close together and are linked by the gap junction. Together the two cells have channels between them. These channels are much larger than voltage-gated channels. Ions as well as large molecules are travel along the gap junction channels. The synapses allow for ionic currents to flow passively through the channels. Electrical transmission can flow in either direction. A purpose of the electrical synapse is to synchronize electrical activity among populations of neurons.

V. CHEMICAL SIGNALS

The communicating neurons are further apart than in the electrical synapse and are called synaptic clefts. The presynaptic terminate contains synaptic vessels than hold neurotransmitters.

VI. SYNAPTIC VESICLES

There are about 100,000 molecules of neurotransmitters per vesicles. Synaptic vesicles are recycled within the cell.

VII. NEUROTRANSMITTERS

There are two categories of neurotransmitters, small molecule neurotransmitters and neuropeptides. There are well over 100 neurotransmitters. Small neuropeptides mediate rapid reactions and neuropeptides modulate slower brain functions. Neurotransmitters only travel from the presynaptic cell to the post synaptic cell. Some substances can act like neurotransmitters in one area of the brain and act like a hormone in other areas of the brain. Neurotransmitters with 3 to 36 amino acids are considered to be neuropeptides anything less is a small molecule neurotransmitter. Neurons can synthesize,package, release, and degrade neurotransmitters.

VIII. NEUROTRANSMITTER RECEPTORS

Neurotransmitter receptors give rise to electrical signals when they become filled with neurotransmitters from the presynaptic cell. When the receptors are filled the open ionic channels. There are two major types of receptors ligand-gated ion channels and Metabotropic receptors. The ligand-gated channels are for fast responses. The Metabotropic are for slower longer responses. Metabotropic responses activate G-proteins that alter properties of the ion channel.