

Nervous systems

Now, don't get nervous...

Overview

- Three functions
 - Sensory input
 - Integration
 - Motor output

Vertebrate neuron

- **Neuron** (nerve cell) = **cell body** + fibers (**dendrites** or **axons**); **Synapse**

The reflex arc

- Note 3 types of neurons

Structural diversity of neurons

Supporting cells (**Glia**)

- Many types
- **Astrocytes**: structural and metabolic support for neurons; also help form tight connections between linings of brain capillaries to form the blood-brain barrier
- **Oligodendrocytes** (CNS) and **Schwann** cells (PNS): form an insulating **myelin sheath** around axons of many neurons

Schwann cells

- Insulation and speed
- Multiple sclerosis causes a deterioration of myelin sheaths; result: loss of coordination due to disrupted nerve signal transmission

What is a nerve signal?

- Changes in voltage across the plasma membrane of nerve cells
- **Membrane potential** is the difference in electrical charge across the membrane due to different concentrations of ions in and out

Squids to the rescue

- Squids and nerve research

Membrane potential

- Maintaining a membrane potential
- Differential permeability

Ion channels

- **Ungated**: open all of the time
- **Gated**: Open/close in response to one kind of stimuli
 - **Chemical-gated**: respond to chemical stimuli (like neurotransmitters)
 - **Voltage-gated**: respond to changes in membrane potential

Graded vs. action potential

- **Graded:** magnitude of membrane potential change depends on strength of stimulus
- **Action:** once the threshold potential is reached, a large response occurs regardless of the strength of the stimulus; “all or nothing”

An action potential dissected

- Different phases—different channels open/closed

Action potential propagation

- Na⁺ pour in—depolarization
- Depolarization continues along axon; repolarization behind (K⁺ go out)

Saltatory conduction

- Action potential jumps from node to node
- Very fast

Synapses

- Nerve impulses traveling from a neuron to the next cell must cross cell junctions called **synapses**
- **Electrical** synapses: direct ion connection between pre- and postsynaptic cells; some in CNS & giant axons; not as common
- **Chemical** synapses: gap, **synaptic cleft**, is present so a chemical signal crosses the gap to transmit the impulse indirectly (elec. to chem. to elec.)

Chemical synapse

- Neurotransmitters to the rescue

Neurotransmitters (1)

- **Acetylcholine:** very common
- Biogenic amines: from AA's
 - **Norepinephrine:** also a ‘stress hormone’
 - **Dopamine:** too little in the brain associated with Parkinson’s disease; too much—schizophrenia
 - **Serotonin:** with dopamine, affects mood, sleep, attention, learning
 - LSD and mescaline act by binding to serotonin and dopamine receptors in the brain

Neurotransmitters (2)

- Amino acids
 - GABA, glycine, glutamate, aspartate
- Neuropeptides
 - **Substance P:** pain perception
 - **Endorphins:** pain relief
 - Morphine and heroin bind to endorphin receptors

Nervous system diversity

- Nerve nets to cephalization and nerve cords

Vertebrate nervous system