The Nervous System: communication

A. Neurons = masses of nerve cells that transmit information

1. Cell Body - contains the nucleus and two extensions

2. Dendrites – shorter, more numerous, receive information

3. Axons – single, long “fiber” which conducts impulse away from the cell body, sends information
Central Nervous System (CNS): brain and spinal cord.

Peripheral Nervous System (PNS): nerves of the body

-- Includes 31 pairs of spinal nerves
-- And 12 pairs of cranial nerves
Basic Divisions of the Nervous System

Figure 12.2
THREE BASIC FUNCTIONS OF THE NERVOUS SYSTEM

- Sensory - gathers info
- Integrative - information is brought together
- Motor - responds to signals, homeostasis
Motor Functions

Somatic Nervous System - skeletal (voluntary)

Autonomic Nervous System - smooth muscles, glands (involuntary)
Neurons = nerve cells

1. Dendrites - receive information

2. Axons - conducts impulses
Neuroglial Cells (p 208)

- support cells for the neurons
1. Microglial Cells: digest debris or bacteria

Microglial cells respond to immunological alarms
2. Oligodendrocytes:

makes the myelin sheath that provides insulation around the axons
3. Astrocytes: connect blood vessels to neurons
4. Ependymal Cells: forms a membrane
5. Schwann cells: form the insulating myelin sheath around the neurons
MYELIN SHEATHS
- these serve as insulation around the axon

Schwann cells supply the myelin for peripheral neurons.

Oligodendrocytes myelinate the axons of the central nervous system.

Practice with neuroglia coloring!
Supporting Cells - NEUROGLIA

Neuroglial Cells of the CNS

- Astrocyte
- Oligodendrocyte
- Microglia
- Ependymal cells
Supporting Cells- NEUROGLIA

Neuroglial Cells

- Nuerons
- Axon
- Oligodendrocyte
- Microglial cell
- Astrocyte
- Ependymal cell
- Capillary
- Fluid-filled cavity of the brain or spinal cord
Neurons

**Dendrites** (receptive regions)
**Cell body** (biosynthetic center and receptive region)

- Nucleus
- Nucleolus
- Nissl bodies
- Axon hillock
- Axon (impulse generating and conducting region)

- Neurilemma (sheath of Schwann)
- Schwann cell (one internode)
- Terminal branches (telodendria)

**Axonal terminals** (secretory component)

**Impulse direction**

**Node of Ranvier**

**Dendritic spine**

**Neuron cell body**
9.4 Neurons

Axon - long section, transmits impulses

Dendrite - small extensions from the cell body; receive information

Neurofibrils - fibers within the axon
- Chromatophilic substance (rough ER) - transport system
- Myelin - insulation surrounding axons
- Nodes of Ranvier - gaps in the insulation
White vs Grey Matter

Myelinated (white matter) – myelinated axons
Unmyelinated (grey matter) - unmyelinated
Classification of Neurons

Functional:
Sensory, Motor, Interneurons

Structural:
(A) Bipolar
(B) Unipolar
(C) Multipolar
Interesting Facts about the Neuron

- Longevity – can live and function for a lifetime
- Do not divide – fetal neurons lose their ability to undergo mitosis; neural stem cells are an exception
- High metabolic rate – require abundant oxygen and glucose

The nerve fibers of newborns are unmyelinated - this causes their responses to stimuli to be coarse and sometimes involve the whole body. Try surprising a baby!
9.5 Cell Membrane Potential

Resting Potential / Threshold Potential / Action Potential

Nerve Impulse = weak electric current.
1. Neuron membrane maintains resting potential
2. Threshold stimulus is received
3. Sodium channels open
4. Sodium ions diffuse inward, depolarizing the membrane
5. Potassium channels open
6. Potassium ions diffuse outward, repolarizing the membrane
7. The resulting action potential causes a local bioelectric current that stimulates adjacent portions of the membrane.
8. Wave of action potentials travel the length of the axon as a nerve impulse

* What does the word “adjacent” mean?
Ions in the cell and outside the cell create a positive and negative side, which produces an electric current.
9.6 Nerve Impulse

Speed of an impulse is proportionate to the DIAMETER of the AXON.

Greater diameter = faster speed

**Myelinated Axons conduct faster than unmyelinated ones**
A: Neuron (Presynaptic)
B: Neuron (Postsynaptic)

1. Mitochondria
2. Synaptic vesicle Autoreceptor
3. Receptor
4. Synaptic Cleft
5. Receptor
6. Calcium Channel’
7. Vesicle releases neurotransmitter
8. Re-uptake
The Synapse

Synapse - junction between two communicating neurons

Nerve pathway - nerve impulse travels from neuron to neuron

Dendrite → cell body → along axon -> synapse (gap) → dendrite
The Synapse

To complete the signal, a NEUROTRANSMITTER is released at the gap to signal the next neuron.

Receptors on the dendrite receive the chemical message
Neurotransmitters

**Excitatory** - increase membrane permeability, increases chance for threshold to be achieved

**Inhibitory** - decrease membrane permeability, decrease chance for threshold to be achieved
Types of Neurotransmitters

- **Acetylcholine** - stimulates muscle contraction
- **Monoamines** - Norepinephrine & Dopamine (sense of feeling good, low levels = depression)
- **Serotonin** (sleepiness) and mood
Endorphins = reduction of pain produced during exercise, excitement, pain, love and they resemble the opiates in their abilities to produce a feeling of well-being.

The name “endorphin” comes from endo- and -orphin; intended to mean "a morphine-like substance originating from within the body."
Drugs that Affect Synapses and Neurotransmitters

Curare - poison made from frog skin and causes paralysis by blocking Ach receptors at the neuromuscular junction.
Strychnine poisoning can be fatal to humans and animals and can occur by inhalation, swallowing or absorption through eyes or mouth.

Strychnine is a neurotoxin which acts as an antagonist of acetylcholine receptors. It primarily affects the motor nerves in the spinal cord which control muscle contraction. An impulse is triggered at one end of a nerve by the binding of neurotransmitters to the receptors.

Read about Strychnine Poisoning
Drugs that Affect Synapses and Neurotransmitters
In the normal communication process, dopamine is released by a neuron into the synapse, where it can bind to dopamine receptors on neighboring neurons. Normally, dopamine is then recycled back into the transmitting neuron by a specialized protein called the dopamine transporter. If cocaine is present, it attaches to the dopamine transporter and blocks the normal recycling process, resulting in a buildup of dopamine in the synapse, which contributes to the pleasurable effects of cocaine.
Dangers of Ecstasy (MDMA)

The neurotransmitter serotonin is vital in regulating many of our basic functions. Serotonin is, among other things, the feel good neurotransmitter and helps to regulate body temp.

Our brain cells are constantly trying to bring some amount of serotonin back into the cells and out of the synapse using serotonin reuptake transporters.

Ecstasy essentially takes these upkeep transporters and reverses their roles. This causes a massive flood of serotonin from the brain cells into the synapse.

The most common cause of Ecstasy-related death is overheating (hyperthermia). MDMA interferes with the body's ability to regulate its own body temperature and to see other warning signs allowing the body to overheat without discomfort especially when dancing for hours in hot clubs.
LSD; lysergic acid diethylamide

Actions/Effects: LSD alters the action of the neurotransmitters serotonin, norepinephrine, and dopamine, triggering extreme changes in brain function. Physical effects include increased body temperature, heart rate, and blood pressure. Psychological effects include perceptual and thought distortions, hallucinations, delusions, and rapid mood swings.

Cocaine blocks reuptake of dopamine
Antidepressants

- Zoloft is part of a class of drugs called selective serotonin reuptake inhibitors, or SSRIs for short. SSRIs act on a specific chemical within the brain known as serotonin. This is one of several chemicals used to send messages from one nerve cell to another.
9.8 Impulse Processing

Neuronal pool - groups of neurons that make hundreds of synaptic connections and work together to perform a common function.

These "pools" help us remember sequential tasks, like tying a shoe or riding a bike.
9.9 Types of Nerves

Sensory Nerves - conduct impulses into the brain or spinal cord

Motor Nerves - carry impulses to muscles of glands

Mixed Nerves - contain both sensory and motor nerves
Neurons Classified by Function: Sensory vs. Motor Neurons
9.10 Nerve Pathways

- Reflex arc = simple path, only includes a few neurons
- Reflex Behavior = automatic, subconscious responses
- Knee-jerk reflex = maintains uprightedness
- Withdrawal reflex = avoidance of painful stimuli