The Nervous System – Important Concepts

The nervous system is an animal's bridge to its external environment. Because animals have the ability to move, their interaction with their environment is especially important. The purpose of the nervous system is communication and thinking.

Accomplished through sense organs, eyes, ears, touch receptors, smell and taste.

Sense organs are connected to the brain via nerve cells, called neurons, which communicate with each other and which also send signals to the muscles and glands. The nervous, muscular, digestive, and endocrine systems work together in this manner.

2 parts:

1. Central Nervous System (CNS) brain and spinal cord &
2. Peripheral Nervous System (PNS) all nerves outside of the CNS.

Neurons – consist of a cell body, containing the nucleus and other organelles and two types of cytoplasmic extensions, called dendrites and axons.

Dendrites are sensory. They receive incoming messages from other cells and carry the electrical signal to the cell body. A neuron can have hundreds of dendrites.

A neuron usually has only one axon. In large mammals it can be up to one meter long. The axon transmits an impulse from the cell body to another cell.

3 types of neurons:

1. sensory receive their initial stimulus from a sense organ, such as eyes or ears, or from another neuron

2. motor stimulates effectors (muscles or glands). A motor neuron can stimulate a digestive gland to release a digestive enzyme or a muscle to contract.

3. interneuron or association neuron in the spinal cord & brain, receives sensory stimuli and transfers it directly to a motor neuron or to the brain for processing.

THE REFLEX ARC

The simplest nerve response, consisting of two or three neurons, is automatic and protective. An example is the knee-jerk reflex.

SUPPORTING CELLS, called glial cells are essential for normal functioning of neurons. One type called Schwann Cells (in the PNS) form the myelin sheath around the axon, speeding the passage of an impulse.

MEMBRANE POTENTIALS

A difference in electrical charge between the cytoplasm (negative) and extracellular fluid (positive charge), is negative: between -50mV and -100mV. (The – sign indicates that the cell's interior is negative relative to the outside of the cell.) This polarized, resting state is maintained at about -70 mV by the sodium-potassium pump which pumps ions leaking across the membrane.

To transmit an impulse, a stimulus must be strong enough to overcome this resting potential. If a stimulus triggers a sodium ion-gated channel to open, sodium flows into the cytoplasm, resulting in a decrease in polarization (depolarization) to about -60 mV.

This signal travels along the dendrite to the cell body from which it continues along the axon. Between the end of the axon and the receptor cell (another neuron or an effector cell) neurotransmitter molecules travel across a very small space called the synapse.

These molecules lodge in receptor molecules in the effector cell, which responds to the stimulus.

THE BRAIN encased entirely within skull, contains about 100 billion neurons & weighs about 3 pounds (1.5 kg).

It controls thoughts, feelings, behavior, perception & memories and allows us to learn.

3 major parts:

CEREBRUM: learning, memory, perception and intellectual functioning; has two halves, left and right hemispheres, which communicate with each other through corpus callosum.

Left side of brain controls right side of body, and right side of brain controls left side of body.

Most sensory and motor processing in cerebral cortex, the multi- folded (for large surface area) outside of cerebrum.

CEREBELLUM, at posterior base of brain, regulates balance, posture and movement

and BRAIN STEM "lower brain" : midbrain, pons and medulla oblongata; leads to spinal cord and connects cerebrum with cerebellum. It also contains the thalamus,a critical site for processing signals and the hypothalamus, just below it, which regulates homeostatic functioning.

SPINAL CORD a dense cable of nervous tissue linking the brain with the peripheral nervous system (PNS). It contains a core of gray matter, the cell bodies of neurons, covered with a sheath of white matter, the axons of neurons.

If the spinal cord is injured, it cannot heal. Each year spinal cord injuries leave almost 15,000 Americans partially or totally paralyzed.

THE PERIPHERAL NERVOUS SYSTEM: 2 parts -

SOMATIC – neurons control voluntary, skeletal muscles, except in reflex arc described above

AUTONOMIC – regulates heart rate and muscles in digestive, urinary, respiratory and reproductive systems. Neurons do not require our conscious control. Can be further divided into

sympathetic – dominates in times of physical or emotional stress; increases blood pressure, heart rate and breathing & directs blood flow toward heart and skeletal muscles

parasympathetic – most active under normal conditions; keeps body active when you are not, eg sleeping

These two systems counterbalance each other.

SENSORY RECEPTORS

TOUCH –

1. mechanoreceptors respond to physical stimuli, such as pressure and tension

THE EARS convert the pressure of sound waves into electrical signals that are interpreted by the brain. Sound waves enter the outer ear and cause eardrum to vibrate. Three small bones attached to each eardrum transfer vibrations to cochlea, fluid-filled chamber containing hair cells, which generate nerve impulses in auditory nerve. Auditory nerve communicates these signals through thalamus and then to the temporal lobe of the cerebral cortex at the side of the head.

The ear also helps you keep your balance. Semicircular canals, fluid-filled chambers in inner ear contain hair cells, that respond to changes in the position of your head with respect to gravity. Signals generated by these cells send messages to the brain that enable it to determine orientation and position of the head.

2. pain receptors respond to anything that can cause tissue damage. Very important, because pain informs you that something is wrong in your body

3. thermoreceptors: in skin and hypothalamus detect changes in temperature

4. photoreceptors: ("photo" light in Greek) in eyes

Light enters eye through pupil and lens focuses images on the retina, in back of eye. The retina contains cones, that detect colors and rods, that detect shapes. These communicate with the brain through the optic nerve, converting light to electrical signals. The thalamus of the brain relays visual information to the occipital lobe in rear of the cerebral cortex.

5. chemoreceptors: tongue and nose

<u>tongue</u> contains 2000 – 5000 taste buds. Each taste bud contains 50-100 taste cells, chemoreceptors detecting at least four basic chemical substances: sweet, sour, bitter and salty.

<u>Nose</u> contains olfactory receptors in the roof of the nasal passage. These are stimulated by various chemicals and are interpreted by your brain. These influence taste.
The study of
HOW DRUGS AFFECT THE NERVOUS SYSTEM
is called neuropharmacology

Generally How they Work:
Cocaine is a highly addictive stiulant found in the leaves of the coca plant, Erythoxylon coca.

Stimulant – a drug that increases the activity of the central nervous system.

Neurotransmitter molecules are released from a presynaptic neuron and bind to receptor proteins on a postsynaptic cell.

Some neurotransmitter molecules are reabsorbed by presynaptic neurons after they have been released into the synaptic cleft. **Cocaine interferes with a presynaptic neuron's ability to reabsorb, or <u>reuptake</u> neurotransmitter molecules.**

Cocaine affects dopamine neurons in the limbic system, which plays an important role in the sensation of pleasure.

Addiction occurs because more cocaine must be taken to maintain adequate stimulation of the postsynaptic cell.

DEPRESSANTS
Barbituates (sedatives), tranquilizers and alcohol

Cause decreased activity of the central nervous system.
RISKS – drowsiness, decreased reaction time which can interfere with operating machinery; depression, brain or nerve damage, coma and respiratory failure if taken in excessive amounts.

STIMULANTS
Nicotine (in tobacco) highly addictive stimulant; cocaine, crack, amphetamines,

Cause increased activity of the central nervous system
RISKS – aggressive behavior, paranoia, cardiac arrest, high blood pressure, brain damage

INHALANTS
Nitrous oxide, ether,paint thinner, cleaning fluid, aerosols

Cause disorientation, confusion, memory loss
RISKS – brain damage, kidney and liver damage, respiratory failure

HALLUCINOGENS
LSD, PCP, MDMA (ecstasy), peyote (mescaline), psilocybe mushroom

Cause sensory distortion, anxiety, hallucinations, numbness
RISKS – depression, paranoia, aggressive behavior

THC
marijuana, hashish

Cause short-term memory loss, impaired judgment
RISKS – lung damage, loss of motivation

NARCOTICS
heroin, morphine, codeine, opium

Cause feeling of well-being, sedation, impaired sensory perception, impaired reflexes
RISKS – coma, respiratory failure