Nervous System

Divisions of the Nervous system

- **Central Nervous System – relays messages, processes information, and analyzes information; Consists of brain and spinal cord**
  - **Meninges** – connective tissue around the brain and spinal cord
  - **Cerebrospinal fluid** – Cushions the brain and spinal cord inside meninges
- **Peripheral Nervous System** -- Receives information from the environment and relays commands to organs and glands
- Consists of all the nerves cells outside of the brain and spinal cord
  - **Has two divisions**
  - **Sensory division** – transmits impulses from **sense organs** to **CNS**
  - **Motor division** – transmits impulses from the CNS to muscles or glands (effector organs)
    - **Somatic nervous system** – regulates activities under conscious control - ***Ex. Running, Dancing***
    - **Autonomic Nervous System** – regulates activities that are automatic, or involuntary – ***Ex. Functions of organs***

CNS is very delicate. Damaged nerve cells cannot be replaced because neurons are unable to divide, makes it imperative that this fragile, irreplaceable tissue be well protected.

Motor Division – Two divisions

Somatic Nervous System

Regulates activities under conscious, voluntary control

Movements of skeletal muscles in response to external stimuli

Some somatic nerves are for reflexes so act with or without conscious control

Autonomic Nervous System

Subconscious, automatic control of internal activities – has two subdivisions

Sympathetic and **parasympathetic** divisions

Sympathetic and Parasympathetic divisions – nerves from these divisions stimulate the same organs but can have opposite effects. Sympathetic speeds things up →stimulator; fight or flight response. Parasympathetic – slows things down and responsible for moving things thru digestive system.

Reflex arc – includes a sensory receptor, sensory neuron, motor neuron, and effector. Some reflex arcs include interneurons. In other reflex arcs, a sensory neuron communicates directly with a motor neuron

Somatic nerves and reflexes – a reflex is possible because receptors in skin stimulate sensory neurons, which carry the impulse to your spinal cord. Before the info is relayed to the brain a group of neurons in spinal cord automatically activates the appropriate motor neurons. The motor neurons cause the muscles to react/respond

The Brain

- **<u>Cerebrum</u> – the largest and most prominent region of the brain that is responsible for the voluntary, or conscious activities of the body**
  - **Associated with complex behaviors – learning, memory, and judgment**
- **Divided into <u>right and left hemispheres</u>**
  - **<u>Corpus callosum</u> – tissue that connects hemispheres of brain**
  - **Each half controls opposite side of body**
- **<u>Cerebellum</u> – coordinates movements of the body**
  - **Subconscious coordination of motor activity (movement)**
- **<u>Brain Stem</u> – Controls life-sustaining processes**
  - **breathing, circulation, blood pressure, heart rate and swallowing**
- **<u>Hypothalamus</u> – homeostasis; link between nervous system and endocrine system; region of brain that recognizes hunger**
- **<u>Thalamus</u> – receives messages from all of the sensory receptors throughout the body and then relays the info to the proper region of the cerebrum**

Vertebrate brain evolved from subdivisions: hindbrain, midbrain, forebrain

As humans evolved brain evolved – as the brain evolved it became subdivided. Subdivisions evolved specific functions and specialization

Even though the nervous and endocrine systems have their own realms of authority, they are functionally interconnected. The nervous and endocrine systems are specialized for controlling different types of activities. In general, the nervous system is responsible for coordinating rapid, precise responses. Neural signals in the form of action potentials are rapidly propagated along nerve cell fibers, resulting in the release at the nerve terminal of a neurotransmitter that has to diffuse only a microscopic distance to a target cell. Neurally mediated responses are rapid and brief. The action is quickly brought to a halt as the neurotransmitter is swiftly removed from the target site. This permits either termination of the response, almost immediate repetition of the response, or rapid initiation of an alternate response.

The endocrine system is specialized to control activities that require duration rather than speed, such as regulating organic metabolism and water and electrolyte balance, promoting smooth, sequential growth and development, controlling reproduction, and regulating red blood cell production. The endocrine system responds more slowly to its triggering stimuli than the nervous system does for several reasons. First, the endocrine system must depend on blood flow to convey its hormonal messengers over long distances. Second, hormones mechanisms of action at their target cells is more complex than that of neurotransmitters and thus requires more time before a response occurs. The effect of some hormones cannot be detected until a few hours after they bind with target cell receptors

Spinal Cord

- **Link between brain and rest of body**
- **31 pairs of spinal nerves branch out from spinal cord to connect brain to rest of body**
- **Processes some <u>reflexes</u> and information automatically**
    - **<u>Reflexes</u> – are automatic responses to a stimulus**
    - **Examples – sneezing and blinking**

Reflex behaviors are for survival. Reflexes allow body to respond to danger immediately without spending time thinking about a response

Reflex arc – involves PNS and CNS; automatic, involuntary response to a stimulus. The reaction/reflex occurs before the stimulus is received by the brain to decrease the reaction time. Two-neuron reflex arc – the simplest reflex arc involrs a sensory and a motor neuron. Involves organ or muscle which motore neuron is connected to. A Three-neuron reflex arc involves all three types of neurons. Invovles the muscle or organ which motor neuron is connected to.

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Somatic nerves and reflexes – a reflex is possible because receptors in skin stimulate sensory neurons, which carry the impulse to your spinal cord. Before the info is relayed to the brain a group of neurons in spinal cord automatically activates the appropriate motor neurons. The motor neurons cause the muscles to react/respond

Automatic Nervous System

The autonomic nervous system regulates activities that are automatic, or involuntary. The nerves of the autonomic nervous system control functions of the body that are not under conscious control. The influence exerted on other body systems by the autonomic nervous system is a good example of an interrelationship that is needed between systems for the body's well-being
The autonomic nervous system is further subdivided into two parts – the sympathetic nervous system and the parasympathetic nervous system. Most organs controlled by the autonomic nervous system are under the control of both sympathetic and parasympathetic neurons. The sympathetic and parasympathetic nervous systems have opposite effects on the same organ system. The opposing effects of the two systems help the body maintain homeostasis. For example heart rate is increased by the sympathetic nervous system but decreased by the parasympathetic nervous system. The process of regulating heart rate can be compared to the process of controlling the speed of a car. One system is like the gas pedal and the other is like the brake. Because there are two different sets of neurons, the autonomic nervous system can quickly speed up the activities of major organs in response to a stimulus or slam on the brakes if necessary.

Diseases affecting CNS

- Alzheimers – memory loss
    - **Cause** – deficiency of N.T. Acetycholine
    - Leads to damage of **Hipocampus** region
    - **Hipocampus** – for short term storage of long term memories
    - **Limbic system** – transfers new memories into long term storage

The Five Senses

Sensory Receptors – react to specific stimuli

- **Photoreceptors** – eyes; sensitive to light
    - **Rods** – sensitive to light
    - **Cones** – distinguish color
- **Pain receptors** – throughout the entire body except the brain
    - indicate pain injury or disease
- **Thermoreceptors** – skin, hypothalamus, body core
    - detects variations in temperature
- **Mechanoreceptors** – skin, muscles, inner ear
    - sensitive to touch, pressure, sound and motion
- **Chemoreceptors** – in nose, taste buds
    - sensitive to chemicals

Pain receptors – throughout the body; damaged cells release chemicals that trigger impulses in pain receptors to indicate damage injury or disease

Vision

- **Rods** respond to light and **cones** distinguish color
- **Cornea** -light enters; focuses light
- **Iris** -colored part; adjust size of pupil
- **Pupil** -adjusts to regulate the amount of light that enters the eye
- **Lens** – small muscles attached to the lens change its shape to help focus near or distant objects and focuses light onto retina
- **Retina** -light focuses onto retina
- **Optic nerve** -carries impulse to appropriate regions of brain

Vision – light enters eyes through cornea and helps to focus light then light passes through aqueous humor and at the back of the aqueous humor is the iris which is the colored portion of the eye. In the middle of the iris is the pupil – the small opening. Muscles of the iris adjust the opening of the pupil in response to light. Behind the iris is the lens which is attached to muscles which adjust its shape to focus near or distant objects.
Retina – lens focuses light onto the retina which has a layer of photoreceptors (rods and cones). Photoreceptors convert light energy into nerve impulses that are carried to the cns
Blind spot – The optic nerve enters the eyeball at the back and makes a break in the retina. If an image is projected to the spot where the optic nerve enters the retina the image is not seen because no message is sent to the brain. The spot where the optic nerve enters the eye is called the blind spot.
Cornea -light enters; focuses light
Iris -colored part; adjust size of pupil
Pupil -adjusts to regulate the amount of light that enters the eye
Lens -adjusts eyes focus and focuses light onto retina
Retina -light focuses onto retina; retina contains rods and cones – rods detect light and cones distinguish color
Optic nerve -carries impulse to appropriate regions of brain

Smell and Taste – Smell – detects chemicals – Chemoreception

Sense of Taste – is a chemical sense and is actually "smell". Chemoreceptors in the taste buds are sensitive to chemicals in food
Sense of Smell – is an ability to detect chemicals -- Chemoreceptors in nasal passageway respond to specific chemicals and send impulses to brain through sensory nerves.

Hearing

- Ears detect **sound** and **positional changes** associated with movement
- **Auditory canal** - receives sound waves
- **Tympanum (ear drum) -** vibrates in response to sound waves and transmits vibrations to **tiny bones** inside inner ear

- **Hammer, anvil, and *stirrup*** - transmit vibrations to the **oval window** to creates pressure waves in the fluid filled cochlea
- **Cochlea** – pressure waves inside pushes tiny hairs in response to movements which produce nerve impulses that are sent to the brain through the ***cochlear nerve***

Hearing and Balance – ear has two sensory functions. One of these functions is hearing. The other function is detecting positional changes associated with movement.
Mechanoreceptors for hearing – sound is pressure waves – vibrations in the air. Vibrations cause the tympanum or the ear drum to vibrate. Vibrations are picked up by three tiny bones called the hammer, anvil, and stirrup. The stirrup transmits the vibrations to the oval window and these vibrates created pressure waves in the fluid-filled cochlea of the inner ear. Pressure waves in cochlea push the tiny hair cells in the cochlea back and forth in response theses movements and they produce nerve impulses that are sent to the brain through the cochlear nerve.
Semicircular canals – monitor the position of your body, especially your head, in relation to gravity. Semicircular canals and the sacs are filled with fluid and lined with hair cells. As the head changes position, the dluid in the canals also changes position. This causes the hair on the hair cells to bend. This action sends impulses to the brain that enable it to determine body motion and position.
Sound waves detected by the tympanum which sends pressures waves to the cochlea
Triggers nerve impulses sent to brain through cochlear nerve

Influences/Effects on the CNS

- Block synthesis, release or uptake of Neurotransmitters
- **Stimulants** Caffeine, nicotine, amphetamine, cocaine
  - Lowers threshold of stimulus required to trigger nerve impulse
  - Mimic N.T.'s and stimulates sensory neurons
  - Increase heart rate, blood pressure, and respiration
- **Depressants** – Alcohol, barbiturates (a sedative-hypnotic such as Phenobarbital – a medication often used to treat seizures), tranquilizers
  - Plasma membrane of neurons become altered so can't transmit nerve impulse and won't trigger neurosecretion
  - Slows heart rate, respiration, blood pressure
- **Opiates** – Codeine, morphine
  - Mimic natural chemicals in the brain known called neuromodulators such as **Endorphins**
  - neuromodulators reduce pain naturally by inhibiting chemoreception of N.T.'s

SPECIFIC EXAMPLES

- Cocaine – a powerful stimulant
  - Triggers a massive release of the neurotransmitter dopamine
    - Usually released when a basic need is met (hunger/thirst) – you feel better
    - Larger amounts produce intense feelings of satisfaction and euphoria.
      - When drug wears off, not enough dopamine is left in body so intense feelings of sadness and depression
      - One exposure can possibly be addictive – it is a psychological addiction, not a physical addiction
  - Stimulates heart rate, blood pressure – possibly even enough to cause a heart attack with just one use
    - Common causes of death of those who use cocaine are cardiac arrest (heart stops) or seizures followed by respiratory arrest (breathing stops)
- Marijuana – both a stimulant AND a depressant
  - Acts on receptors in the brain that influence pleasure, memory, thinking, concentration, sensory and time perception, and coordinated movement (slower reactions, etc)
  - It does tend to increase the heart rate for a time which can lead to heart damage or even heart attacks
  - Can influence normal brain development and function including a significant decline in IQ, especially when use begins at a younger age
  - Addiction rates are lower than with some other drugs but the body does experience physical withdrawal symptoms including irritability, sleeplessness, decreased appetite, anxiety, and drug craving
  - Causes more damage to the lungs than tobacco – damage to lung cells, susceptibility to lung infections, cough, mucus production
- Alcohol – a depressant
  - Slows the rate at which the central nervous system functions
  - Alcohol abuse and alcoholism are different!
    - Alcohol Abuse does not have physical withdrawal symptoms
    - Alcoholism does have physical withdrawal symptoms
  - Causes heart and nerve damage, damage to liver cells (cirrhosis), can cause seizures
    - Consumption by pregnant women can least to Fetal Alcohol Syndrome
      - Physical deformities, delayed growth, mental impairment, poor motor coordination
  - Binge drinking can lead to other risky behaviors
  - Affects men and women somewhat differently; size of individual also a factor
  - BAC level in text is CHANGED
    - Now 0.08 in all states (for over 21)
    - 0.00-0.02 for under 21 – California is 0.01
    - Most states have enhanced penalties if higher numbers (vary from .15-.20)