Functions of the Nervous System

- Sensory input—gathering information
  - To monitor changes occurring inside and outside the body
  - Changes = stimuli
- Integration
  -
- Motor output
  - A response to _____ stimuli
  - The response activates _____ or _____

Structural Classification of the Nervous System

- Central nervous system (CNS)
  - Brain
  - Spinal cord
- Peripheral nervous system (PNS)
  - Nerves outside the brain and spinal cord
    - Spinal nerves
    - Cranial nerves

Functional Classification of the Peripheral Nervous System

- Sensory (_____) division
  - Nerve fibers that carry information to the central nervous system
- Motor (_____) division
  - Nerve fibers that carry impulses away from the central nervous system
  - Two subdivisions
    - _____ nervous system = voluntary
    - _____ nervous system = involuntary

Nervous Tissue: Support Cells

- Support cells in the CNS are grouped together as "_____"
- Function: to support, insulate, and protect neurons
- _____
  - Abundant, star-shaped cells
  - Brace neurons
  - Form barrier between capillaries and neurons
  - Control the chemical environment of the brain
- Microglia
  - Spiderlike _____
  - Dispose of debris
- Ependymal cells
  - Line cavities of the brain and spinal cord
  - Circulate _____ fluid
- Oligodendrocytes
  - Wrap around nerve fibers in the central nervous system
  - Produce _____ sheaths
- Satellite cells
  - Protect _____ cell bodies

- Schwann cells
  - Form myelin sheath in the _____ nervous system

Nervous Tissue: Neurons

- Neurons = nerve cells
  - Cells specialized to _____ messages
  - Major regions of neurons
    - Cell body—nucleus and metabolic center of the cell
    - Processes—fibers that extend from the cell body
- Cell body
  - _____ substance
    - Specialized rough endoplasmic reticulum
  - _____
    - Intermediate cytoskeleton
    - Maintains cell shape
  - Nucleus
  - Large nucleolus
- Processes outside the cell body
  - _____—conduct impulses toward the cell body
  - _____—conduct impulses away from the cell body
- Axons end in axon terminals
- Axonal terminals contain vesicles with neurotransmitters
- Axonal terminals are separated from the next neuron by a gap
    - _____—gap between adjacent neurons
    - _____—junction between nerves
- Myelin sheath—whitish, fatty material covering axons
- _____ cells—produce myelin sheaths in jelly roll–like fashion
- Nodes of _____—gaps in myelin sheath along the axon

Neuron Cell Body Location

- Most neuron cell bodies are found in the central nervous system
    - _____—cell bodies and unmyelinated fibers
    - _____—clusters of cell bodies within the white matter of the central nervous system
  - _____—collections of cell bodies outside the central nervous system

Functional Classification of Neurons

- Sensory (_____) neurons
  - Carry impulses from the sensory receptors to the CNS
    - Cutaneous sense organs
    - _____—detect stretch or tension
- Motor (_____) neurons

        - Carry impulses from the central nervous system to viscera, muscles, or glands

    - _____ (association neurons)
        - Found in neural pathways in the central nervous system
        - Connect sensory and motor neurons

Structural Classification of Neurons

- _____ neurons—many extensions from the cell body
- _____ neurons—one axon and one dendrite
- _____ neurons—have a short single process leaving the cell body

Functional Properties of Neurons

- _____
    - Ability to respond to stimuli
- _____
    - Ability to transmit an impulse

Nerve Impulses

- _____ neuron
    - The plasma membrane at rest is polarized
    - Fewer positive ions are inside the cell than outside the cell
- _____
    - A stimulus depolarizes the neuron's membrane
    - A depolarized membrane allows sodium (Na+) to flow inside the membrane
- The exchange of _____ initiates an action potential in the neuron
- Action potential
    - If the action potential (_____) starts, it is propagated over the entire axon
    - Impulses travel faster when fibers have a _____ sheath
- _____
    - Potassium ions rush _____ of the neuron after sodium ions rush _____, which repolarizes the membrane
    - The sodium-potassium pump, using ATP, restores the original configuration

Transmission of a Signal at Synapses

- Impulses are able to cross the synapse to another nerve
    - _____ is released from a nerve's axon terminal
    - The dendrite of the next neuron has receptors that are stimulated by the neurotransmitter
    - An action potential is started in the dendrite

The Reflex Arc

- Reflex—rapid, predictable, and _____ response to a stimulus
    - Occurs over pathways called reflex arcs
- Reflex arc—direct route from a sensory neuron, to an interneuron, to an effector

Types of Reflexes and Regulation

- Somatic reflexes
    -

    - Example: When you move your hand away from a hot stove
- Autonomic reflexes
    -
    - Heart and blood pressure regulation
    - Regulation of glands
    - Digestive system regulation
- Patellar, or knee-jerk, reflex is an example of a two-neuron reflex arc

Central Nervous System (CNS)

- CNS develops from the embryonic neural tube
    - The neural tube becomes the _____ and _____ cord
    - The opening of the neural tube becomes the ventricles
        - _____ chambers within the brain
        - Filled with cerebrospinal fluid

Regions of the Brain

- Cerebral hemispheres (cerebrum)
- _____
- Brain stem
- _____

Regions of the Brain: Cerebrum

- Cerebral _____ (Cerebrum)
    - Paired (left and right) superior parts of the brain
    - Includes more than _____ of the brain mass
    - The surface is made of ridges (_____) and grooves (_____)
- Lobes of the cerebrum
    - _____ (deep grooves) divide the cerebrum into lobes
    - Surface lobes of the cerebrum
        - _____ lobe
        - Parietal lobe
        - Occipital lobe
        - _____ lobe
- Specialized areas of the cerebrum
    - Primary somatic sensory area
        -
        - Located in parietal lobe
    - Primary motor area
        - Sends impulses to skeletal muscles
        -
    - Broca's area

        - Involved in our ability to speak
    - Cerebral areas involved in special senses
        - _____ area (taste)
        - Visual area
        - Auditory area
        - Olfactory area
- Interpretation areas of the cerebrum
    - Speech/language region
        -
    - General interpretation area

Regions of the Brain: Cerebrum

- Layers of the cerebrum
    - _____—outer layer in the cerebral cortex composed mostly of neuron cell bodies
    - _____—fiber tracts deep to the gray matter
        - _____ connects hemispheres
- Basal nuclei—islands of gray matter buried within the white matter

Regions of the Brain: Diencephalon

- Sits on top of the brain stem
- Enclosed by the cerebral hemispheres
- Made of three parts
    - _____
    - Hypothalamus
    - Epithalamus
- Thalamus
    - Surrounds the third ventricle
    - The _____ station for sensory impulses
    - Transfers impulses to the correct part of the cortex for localization and interpretation
- Hypothalamus
    - Under the thalamus
    - Important _____ nervous system center
        - Helps regulate body _____
        - Controls water balance
        - Regulates _____
    - An important part of the _____ system (emotions)
    - The _____ gland is attached to the hypothalamus
- Epithalamus
    - Forms the roof of the third ventricle
    - Houses the _____ body (an endocrine gland)

- Includes the _____ plexus—forms cerebrospinal fluid

Regions of the Brain: Brain Stem

- Attaches to the spinal cord
- Parts of the brain stem
  - _____
  - Pons
  - Medulla oblongata
- Midbrain
  - Mostly composed of tracts of nerve fibers
  - Has two bulging fiber tracts— cerebral _____
  - Has four rounded protrusions— corpora _____
    - Reflex centers for vision and hearing
- Pons
  - The bulging center part of the brain stem
  - Mostly composed of fiber tracts
  - Includes nuclei involved in the control of _____
- Medulla Oblongata
  - The _____ part of the brain stem
  - Merges into the spinal cord
  - Includes important fiber tracts
  - Contains important control centers
    - _____ control
    - Blood pressure regulation
    - _____
    - Swallowing
    - Vomiting
- Reticular Formation
  - Diffuse mass of gray matter along the brain stem
  - Involved in motor control of _____ organs
  - Reticular activating system (RAS) plays a role in _____ cycles and consciousness

Regions of the Brain: Cerebellum

- Two hemispheres with convoluted surfaces
- Provides _____ coordination of body movements

Protection of the Central Nervous System

- _____
- Skull and vertebral column
- _____
- Cerebrospinal fluid (CSF)
- _____ barrier

Meninges

- _____
  - Double-layered external covering
    - _____—attached to inner surface of the skull
    - Meningeal layer—outer covering of the brain
  - Folds inward in several areas
- _____ layer
  - Middle layer
  - Web-like
- _____
  - Internal layer
  - Clings to the surface of the brain

Cerebrospinal Fluid (CSF)

- Similar to blood plasma composition
- Formed by the choroid plexus
-
- Circulated in arachnoid space, ventricles, and central canal of the spinal cord

Hydrocephalus in a Newborn

-
  - CSF accumulates and exerts pressure on the brain if not allowed to drain

Blood-Brain Barrier

- Includes the _____ permeable capillaries of the body
- Excludes many potentially harmful substances
- Useless as a barrier against some substances
  - Fats and fat soluble molecules
  - _____
  - Alcohol
  - Nicotine
  - _____

Traumatic Brain Injuries

- Concussion
  -
  - No permanent brain damage
- _____
  - Nervous tissue destruction occurs
  - Nervous tissue does not regenerate
- _____
  - Swelling from the inflammatory response
  - May compress and kill brain tissue

Cerebrovascular Accident (CVA)

- Commonly called a _____

- The result of a _____ supplying a region of the brain
- Brain tissue supplied with oxygen from that blood source dies
- Loss of some functions or death may result

Alzheimer's Disease

- Progressive _____ brain disease
- Mostly seen in the elderly, but may begin in middle age

- Structural changes in the brain include abnormal _____ deposits and twisted fibers within neurons
- Victims experience memory loss, irritability, confusion, and ultimately, hallucinations and death

Spinal Cord

- Extends from the _____ of the skull to the first or second lumbar vertebra

- _____ pairs of spinal nerves arise from the spinal cord
- Cauda equina is a collection of spinal nerves at the inferior end

Spinal Cord Anatomy

- Internal gray matter is mostly cell bodies
    - _____ (posterior) horns
    - _____ (ventral) horns
    - Gray matter surrounds the central canal
        - Central canal is filled with cerebrospinal fluid
- Exterior white mater—conduction tracts
    - Dorsal, lateral, ventral columns
- Meninges cover the spinal cord
- Spinal nerves leave at the level of each vertebrae
    - _____ root
        - Associated with the dorsal root ganglia—collections of cell bodies outside the central nervous system
    - _____ root
        - Contains axons

Peripheral Nervous System (PNS)

- Nerves and ganglia outside the central nervous system

- Nerve =

- Neuron fibers are bundled by connective tissue

PNS: Structure of a Nerve

- _____ surrounds each fiber

- Groups of fibers are bound into fascicles by _____
- Fascicles are bound together by epineurium

PNS: Classification of Nerves

- Mixed nerves
    - Both sensory and motor fibers

- _____ (afferent) nerves
    - Carry impulses toward the CNS

- _____ (efferent) nerves
  - Carry impulses away from the CNS

PNS: Cranial Nerves

- _____ pairs of nerves that mostly serve the head and neck
- Only the pair of vagus nerves extend to thoracic and abdominal cavities

- Most are _____ nerves, but three are sensory only

- I Olfactory nerve—
- II Optic nerve—sensory for vision
- III Oculomotor nerve—motor fibers to eye muscles
- IV Trochlear—motor fiber to eye muscles

- V Trigeminal nerve—
- VI Abducens nerve—motor fibers to eye muscles
- VII Facial nerve—sensory for taste; motor fibers to the face
- VIII Vestibulocochlear nerve—sensory for balance and hearing

- IX Glossopharyngeal nerve—
- X Vagus nerves—sensory and motor fibers for pharynx, larynx, and viscera
- XI Accessory nerve—motor fibers to neck and upper back
- XII Hypoglossal nerve—motor fibers to tongue

PNS: Spinal Nerves

- There is a pair of spinal nerves at the level of each vertebrae for a total of 31 pairs
- Formed by the combination of the ventral and dorsal roots of the spinal cord

- Named for the

PNS: Anatomy of Spinal Nerves

- Spinal nerves _____ soon after leaving the spinal cord
  - Dorsal rami—serve the skin and muscles of the posterior trunk
  - Ventral rami—form a complex of networks (plexus) for the anterior

PNS: Autonomic Nervous System

- Motor subdivision of the PNS
  - Consists only of motor nerves

- Also known as the _____ nervous system
  - Regulates activities of cardiac and smooth muscles and glands
- Two subdivisions

  - _____ division

  - _____ division

PNS: Differences Between Somatic and Autonomic Nervous Systems

- Nerves
  - _____: one motor neuron
  - Autonomic: preganglionic and postganglionic nerves
- Effector organs
  - Somatic:
  - Autonomic: smooth muscle, cardiac muscle, and glands

- Neurotransmitters
  - Somatic: always use _____
  - Autonomic: use acetylcholine, epinephrine, or norepinephrine

PNS: Anatomy of the Sympathetic Division

- Originates from T_1 through L_2

- Ganglia are at the _____ (near the spinal cord)
- Short pre-ganglionic neuron and long post-ganglionic neuron transmit impulse from CNS to the effector
- Norepinephrine and epinephrine are neurotransmitters to the effector organs

PNS: Anatomy of the Parasympathetic Division

- Originates from the _____ and S_1 through S_4
- Terminal ganglia are at the effector organs
- Always uses acetylcholine as a neurotransmitter

PNS: Autonomic Functioning

- Sympathetic—"_____ or _____"
  - Response to unusual stimulus
  - Takes over to increase activities

  - Remember as the "_____" division
    - Exercise, excitement, emergency, and embarrassment

- Parasympathetic—"_____" activites
  - Conserves energy
  - Maintains daily necessary body functions

  - Remember as the "_____" division
    - digestion, defecation, and dieresis

Development Aspects of the Nervous System

- The nervous system is formed during the _____ month of embryonic development

- Any maternal _____ can have extremely harmful effects

- The _____ is one of the last areas of the brain to develop
- No more neurons are formed after birth, but growth and maturation continues for several years

- The brain reaches maximum _____ as a young adult