Chapter 12

1. The Nervous System
   a. Includes all neural tissue in the body; Neural tissue contains two kinds of cells
      i. Neurons: Cells that send and receive signals
      ii. Neuroglia (glial cells): Cells that support and protect neurons
   b. Organs of the Nervous System
      i. Brain and spinal cord
      ii. Sensory receptors of sense organs (eyes, ears, etc.)
      iii. Nerves connect nervous system with other systems

2. Divisions of the Nervous System
   a. The Central Nervous System (CNS)
      i. Consists of the spinal cord and brain
      ii. Contains neural tissue, connective tissues, and blood vessels
      iii. Functions of the CNS are to process and coordinate:
         1. Sensory data from inside and outside body
         2. Motor commands control activities of peripheral organs (e.g., skeletal muscles)
         3. Higher functions of brain intelligence, memory, learning, emotion
   b. The Peripheral Nervous System (PNS)
      i. Includes all neural tissue outside the CNS
      ii. Functions of the PNS
         1. Deliver sensory information to the CNS
         2. Carry motor commands to peripheral tissues and systems
      iii. Nerves (also called peripheral nerves)
         1. Bundles of axons with connective tissues and blood vessels
         2. Carry sensory information and motor commands in PNS
            a. Cranial nerves — connect to brain
            b. Spinal nerves — attach to spinal cord
      iv. Functional Divisions of the PNS
         1. Afferent division: Carries sensory information From PNS sensory receptors to CNS
            a. Receptors and effectors of afferent division
               i. Receptors
                  1. Detect changes or respond to stimuli
                  2. Neurons and specialized cells
                  3. Complex sensory organs (e.g., eyes, ears)
               ii. Effectors
                  1. Respond to efferent signals
                  2. Cells and organs
         2. Efferent division: Carries motor commands From CNS to PNS muscles and glands
            a. Somatic nervous system (SNS): Controls voluntary and involuntary (reflexes) muscle contraction
            b. Autonomic nervous system (ANS): Controls subconscious actions, contractions of smooth muscle and cardiac muscle, and glandular secretions
               i. Sympathetic division has a stimulating effect
               ii. Parasympathetic division has a relaxing effect

3. The Structure of Neurons
   a. The synapse—Area where a neuron communicates with another cell
      i. Presynaptic cell—Neuron that sends message
      ii. Postsynaptic cell—Cell that receives message
      iii. The synaptic cleft—The small gap that separates the presynaptic membrane and the postsynaptic membrane
      iv. Neurotransmitters—The chemical messengers that are converted to an electrical signal by receptors
Chapter 13

1. Functional Organization of Neurons
   a. Sensory neurons
      i. Deliver information to CNS
   b. Motor neurons
      i. Deliver commands to peripheral effectors
   c. Interneurons
      i. Interpret, plan, and coordinate signals in and out

2. Reflexes
   a. Automatic responses coordinated within spinal cord
   b. Through interconnected sensory neurons, motor neurons, and interneurons
   c. Produce simple and complex reflexes
   d. Most reflexes are polysynaptic, meaning they have more than one synapse, and thus involve more than 2 neurons.
   e. If only 2 neurons are involved, then the reflex is said to be monosynaptic.
   f. If the effect of the reflex occurs on the same side of the body as the signal from the receptor, then the reflex is considered ipsilateral.
   g. If the effect occurs on the opposite side of the body, then the reflex is said to be contralateral.
   h. If you step on a tack with a right foot, you will raise the right foot off the ground (ipsilateral; withdrawal reflex), but you will firmly plant the left foot on the ground (contralateral; crossed extensor reflex) to prevent yourself from falling over.

3. Reflex Arc
   a. The pathway mediating a reflex, has 5 components:
      i. receptor
      ii. the sensory neuron which carries information about the stimulus to the central nervous system
      iii. the integration center with interneurons/association neurons usually the brain or spinal cord.
      iv. a motor neuron which carries information to the effector,
      v. effector, which would be a muscle or a gland.

4. Be able to put the 5 steps of a Neural Reflex in order
   a. Step 1: Arrival of stimulus, activation of receptor
      i. Physical or chemical changes
   b. Step 2: Activation of sensory neuron
      i. Graded depolarization
   c. Step 3: Information processing by postsynaptic cell
      i. Triggered by neurotransmitters
   d. Step 4: Activation of motor neuron
      i. Action potential
   e. Step 5: Response of peripheral effector
      i. Triggered by neurotransmitters

5. Patellar reflex (knee jerk)-assesses the reflex arc involving spinal cord segments L2-L4
6. Achilles reflex (ankle jerk)-Assesses the reflex arc involving spinal cord segments S1 to S2
7. Biceps reflex-Demonstrates the reflex arc involving spinal cord segments C5-C6
8. Plantar reflex (The Babinski Reflex)-This test is performed to assess damage to the corticospinal tract that may be caused by demyelination or damage to the tract itself.
   a. Normal in infants
   b. May indicate CNS damage in adults

Chapter 14

1. Six Regions of the Brain
   a. Cerebrum: Largest part of brain, Controls higher mental functions
b. Cerebellum: Second largest part of brain, Coordinates repetitive body movements

c. Diencephalon: Links cerebrum with brain stem; consists of the thalamus and the hypothalamus

d. Mesencephalon (midbrain): Processes sight, sound, and associated reflexes, Maintains consciousness

e. Pons: Connects cerebellum to brain stem, Is involved in somatic and visceral motor control

f. Medulla oblongata: Connects brain to spinal cord, Relays information, Regulates autonomic functions, Heart rate, blood pressure, and digestion

2. The Cranial Meninges: Have three layers: Dura mater, Arachnoid mater, Pia mater; Are continuous with spinal meninges; Protect the brain from cranial trauma

3. Brain protection and support:

a. Cerebrospinal Fluid (CSF): Surrounds all exposed surfaces of CNS, Interchanges with interstitial fluid of brain
   i. Functions of CSF
      1. Cushions delicate neural structures
      2. Supports brain
      3. Transports nutrients, chemical messengers, and waste products

b. Blood–Brain Barrier (BBB)
   i. Isolates CNS neural tissue from general circulation
   ii. Formed by network of tight junctions: Between endothelial cells of CNS capillaries
   iii. Lipid-soluble compounds (O₂, CO₂), steroids, and prostaglandins: Diffuse into interstitial fluid of brain and spinal cord
   iv. Astrocytes control blood–brain barrier by: Releasing chemicals that control permeability of endothelium

<table>
<thead>
<tr>
<th>Cranial Nerve</th>
<th>Nerve Type</th>
<th>Major Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>I: Olfactory</td>
<td>sensory</td>
<td>smell</td>
</tr>
<tr>
<td>II: Optic</td>
<td>sensory</td>
<td>vision</td>
</tr>
<tr>
<td>III: Oculomotor</td>
<td>primarily motor</td>
<td>eyeball and eyelid movement; lens shape</td>
</tr>
<tr>
<td>IV: Trochlear</td>
<td>primarily motor</td>
<td>eyeball movement; proprioception (superior oblique muscle)</td>
</tr>
<tr>
<td>V: Trigeminal:</td>
<td>sensory</td>
<td>sensations of touch and pain from facial skin, nose, mouth, teeth, and tongue; proprioception (superior oblique muscle)</td>
</tr>
<tr>
<td>VI: Abducens</td>
<td>primarily motor</td>
<td>eyeball movement; proprioception (lateral rectus muscle)</td>
</tr>
<tr>
<td>VII: Facial</td>
<td>mixed</td>
<td>movement of facial muscles; tear and saliva secretion; sense of taste and proprioception</td>
</tr>
<tr>
<td>VIII: Vestibulocochlear:</td>
<td>sensory</td>
<td>hearing and sense of equilibrium</td>
</tr>
<tr>
<td>IX: Glossopharyngeal</td>
<td>mixed</td>
<td>sensations of taste, touch, and pain from tongue and pharynx; chemoreceptors (that monitor O₂ and CO₂); blood pressure receptors; movement of tongue and swallowing; secretion of saliva</td>
</tr>
<tr>
<td>X: Vagus</td>
<td>mixed</td>
<td>parasympathetic sensation and motor control of smooth muscles associated with heart, lungs, viscera; secretion of digestive enzymes</td>
</tr>
<tr>
<td>XI: Accessory</td>
<td>primarily motor</td>
<td>head movement; swallowing; proprioception</td>
</tr>
<tr>
<td>XII: Hypoglossal</td>
<td>primarily motor</td>
<td>tongue movement, speech, and swallowing; proprioception</td>
</tr>
</tbody>
</table>

Specific Facts to Know for the Exam

- Nervous system works together with the endocrine system to control and regulate all other systems of the body.
- Nervous system is quickly to respond, but its effects are short lived.
- The sympathetic division tends to prepare the body for action
- Visceral Motor division carries signals to the smooth muscle in the large intestine
- Most metabolic and regulatory functions in a neuron happen at the soma
- Dendrites are the primary site for receiving signals from other neurons
- Oligodendrocytes form myelin in the spinal cord.
- Most of the myelin sheath is composed of lipids
- The myelin sheath is formed by cells
- Conduction speed of a nerve fiber would be the fastest in a large myelinated fiber
- myelinated fibers conduct signals faster than unmyelinated fiber because Diffusion of ions along the axoplasm is faster
• A cholinergic synapse employs acetylcholine as its neurotransmitter.
• γ-aminobutyric acid (GABA binds to ligand-regulated gates, and is the most common inhibitory neurotransmitter in the brain.
• Both cerebrum and cerebellum have gray matter in their surface cortex and deeper nuclei, and white matter deep to the cortex.
• The cerebrum is the largest part of the brain.
• The amygdala, hippocampus and hypothalamus are involved in such feelings as love, anger, fear, pleasure and pain.
• The vision association area resides primary in the occipital lobe.
• The brainstem is made up of diencephalon, the pons, the medulla oblongata and the midbrain.
• The right and left cerebral hemispheres are separated from each other by the longitudinal fissure.
• From superficial to deep, the meninges occur in this order: dura mater, arachnoid, pia mater.
• The blood-brain barrier (BBB) is most permeable to glucose and oxygen.
• The blood brain barrier (BBB) consists of tight junctions between endothelial cells that form the capillary walls.
• The cardiac, vasomotor, and respiratory centers are found in the medulla oblongata.
• Loss of equilibrium and motor coordination would most likely be related with a lesion in the cerebellum.
• Sex drive, body temperature, and food and water intake are regulated by the hypothalamus.
• The vision association area resides primary in the occipital lobe.
• Hippocampus and amygdala are structures found in the limbic system.
• The parasympathetic division stimulates digestion.
• In response to high blood pressure, stretch receptors called baroreceptors in the walls of arteries carrying blood to the head will trigger a reflex that causes the heart to decrease its beats per minute.
• Damage of the oculomotor nerve (CN III) will affect near vision accommodation.
• A ganglion is a swelling along a nerve containing cell bodies of peripheral neurons.
• There are 31 pairs of spinal nerves.
• Cranial Nerves 1, 2 and 8 are the only cranial nerves that are solely sensory in function.
• Cranial Nerve 1 is involved with smell
• Cranial Nerve 2 is involved with vision
• Cranial Nerves 3, 4 and 6 are involved with movement of the eyeball
• Cranial Nerve 5 is involved with the movement of the muscles of mastication
• Cranial nerves 7 and 9 are involved in taste (Cranial Nerve 7 is involved with taste to the anterior 2/3 of the tongue and Cranial nerve 9 is involved with taste to the posterior 1/3 of the tongue).
• Cranial Nerve 8 is involved with hearing
• Cranial nerves 7 and 9 innervate the salivary glands.
• Cranial Nerve 10 innervates most of the viscera in the thoracic and abdominopelvic cavities.
• Cranial Nerve 11 is involved with shrugging shoulder, moving head side to side
• Cranial Nerve 12 innervates the tongue
• The mandibular branch of the trigeminal nerve innervates the muscles of mastication.

Chapter 15 Sensory Pathways and the Somatic Nervous System

• The general senses describe our sensitivity to temperature, touch, pressure, vibration, pain and proprioception. The involve receptors that are relatively simple in structure and distributed throughout the body.
• The special senses include hearing, smell, taste, vision and balance (equilibrium). These sensations are provided by receptors that are structurally more complex than those of the general senses.
• In order for a sensation to become a perception, it must be received by the somatosensory cortex.
• Examples of sensory stimuli include touch, warmth, pain, vibration.
• General sensory receptors are classified by the type of stimulus that excites them:
  o Nociceptors are pain receptors. Endorphins can reduce perception of sensations initiated by, nociceptors.
  o Thermoreceptors are temperature receptors. Thermoreceptors are found within the dermis, are free nerve endings, for "cold" are structurally indistinguishable from those for "warm," are more numerous for cold than for warm temperatures.
  o Mechanoreceptors are sensitive to stimuli that distort their plasma membranes. Mechanoreceptors detect pressure, touch, vibration, muscle length.
  - Mechanoreceptors that respond to changes in blood pressure are called baroreceptors. Baroreceptors are receptors in the aorta that monitor the blood pressure.
• Receptors that monitor the position of joints belong to the category called **proprioceptors**.
• Tactile receptors provide the closely related sensations of touch, pressure, and vibration

Chapter 16 The Autonomic Nervous System and Higher Order Functions

- The **parasympathetic division of the autonomic nervous system (craniosacral division)** is said to function during "rest and digest.” It is especially active during the period of digestion and increases gastric motility.
- The sympathetic **division of the autonomic nervous system (thoracolumbar division)** functions during “fight or flight.” During sympathetic activation, elevated heart rate, elevated blood pressure, sweating, elevated blood glucose, dilation of the pupils, increased blood flow to skeletal muscles. Postganglionic sympathetic axons can release the neurotransmitters acetylcholine, nitric oxide, norepinephrine, Ach at their effector junctions.
- The celiac ganglion innervates the stomach, liver, pancreas, spleen
- Sympathetic and parasympathetic fibers that innervate the heart pass through the cardiac plexus.
- The suprarenal medullae contain **both epinephrine and norepinephrine**. Ganglionic neurons in the suprarenal gland **release epinephrine into blood capillaries**.
- Nicotinic receptors occur on ganglion cells of both the parasympathetic and sympathetic divisions. They open chemically-gated sodium ion channels.
- Muscarinic receptors are normally activated by **acetylcholine**.
- Neurotransmitters influence brain chemistry and behavior
  - The inherited brain disorder **Huntington's disease** is caused by the destruction of basal nuclei that use different neurotransmitters. One neurotransmitter is **acetylcholine** and the other is **GABA**.
  - **Depression** is a mental illness is often improved by drugs that block **serotonin** re-uptake?
- Aging produces various structural and functional changes in the nervous system
  - An age-related decline in mental function characterized by difficulties with spatial orientation, memory, language, and personality is called senile dementia.
  - Changes in the central nervous system that accompany aging include reduction in brain size and weight, decrease in the number of neurons, decreased blood flow to the brain, changes in synaptic organization in the brain.