Section A: Intro to Nervous System

The Nervous System regulates and coordinates activities within the body. It detects, interprets and responds to changes that occur internally and externally. Sensory receptors gather information and send electrical impulses to the Central Nervous System (CNS – spinal cord and brain). Electrical impulses are processed and generate appropriate reactions by sending electrical impulses via nerves to effector organs such as muscle and glands. The diagram illustrates the divisions of the nervous system.

1. The CNS is composed of the __________________________.
2. What is the function of the brain? __________________________
3. What is the function of the spinal cord? ____________________________
4. The PNS has two divisions – the sensory and motor division.
   a. What is the function of the sensory division? ____________________________
   b. What is the function of the motor division? ____________________________
5. The motor division is composed of the ____________________________
6. What does the somatic nervous system control? ____________________________
7. What does the autonomic nervous system control? ____________________________
8. The autonomic nervous system (ANS) is further divided into two divisions – sympathetic and parasympathetic division. What’s the difference between these two subdivisions? ____________________________

Section B: Divisions & Functions

1. The Nervous System has 3 major functions. Identify the function based on its description.
   a. ____________________________: receives the stimuli and takes information to the CNS.
   b. ____________________________: make decisions/process information.
   c. ____________________________: the act of carrying a response to a gland or muscle.
2. The motor pathway carries information (to / away from) the central nervous system. ____________________________
3. The sensory pathway carries information (to / away from) the central nervous system. ____________________________
4. The (CNS/PNS) is made up of the brain and spinal cord. ____________________________
5. The (CNS/PNS) is made up of the nerves that lead to and from the brain and spinal cord. __________

6. Which sensory division carries information from the skin, skeletal muscles and joints to the CNS? ________________

7. Which sensory division carries information from the visceral organs to the CNS? ________________

8. Which motor division conducts information from the CNS to the skeletal system? ________________

9. The ANS is further divided into the ____________________________. What is another name for this division? ___________________________. This division is commonly referred to as the involuntary division – why would it be called this?

10. The (parasympathetic/sympathetic) division of the nervous system mobilizes the body in emergency situations making someone more alert. It is this portion of the nervous system that causes a person to get the adrenaline rush in times of anxiety, anger, excitement resulting in an increased respiration rate, increased heart rate, increased perspiration, etc… ____________________________

11. The (parasympathetic/sympathetic) division of the nervous system regulates your body’s activities under “normal”/stable conditions i.e. times when your emotional state is normal without any mood swings associated to anger, excitement, etc… ____________________________

12. Identify which division and function of the nervous system. Put a check in the appropriate boxes.

<table>
<thead>
<tr>
<th>Division of the Nervous System</th>
<th>Nervous System Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNS</td>
<td>PNS</td>
</tr>
<tr>
<td>A. Brain</td>
<td>B. Decision Making</td>
</tr>
</tbody>
</table>

**Section C: Neuroglia**

1. What are the functions of neuroglia cells? ____________________________________________________________________________

2. List 2 characteristics of neuroglia cells. ____________________________________________________________________________

**Match the neuroglia cell with the correct function:**
- astrocytes
- microglia
- ependymal
- oligodendrocytes
- schwann cells
- satellite cells

3. ______________________ Cells that produce the myelin in the PNS.
4. ______________________ Cells that produce the myelin in the CNS.
5. ______________________ Phagocytes that dispose of debris such as dead brain cells and bacteria.
6. ______________________ Anchors and braces neurons with cellular projections.
7. ______________________ Cells have cilia that help circulate the cerebrospinal fluid.
8. ______________________ Cells help cushion and protect neurons in the PNS.
9. ______________________ Cells serve as a medium for diffusion between capillaries and neurons.
10. ______________________ Cells line cavities of the brain and spinal cord.
**Section D: Neurons**

1. What is the function(s) of neurons? _____________________________________________________

2. Sam was diagnosed with a brain tumor. Which type of cells would be dividing uncontrollably to form the tumor – neuroglia or neurons? _____________________

Match the parts of a neuron with the correct function.

<table>
<thead>
<tr>
<th>nodes of ranvier</th>
<th>axon terminals</th>
<th>axon hillock</th>
</tr>
</thead>
<tbody>
<tr>
<td>axon</td>
<td>dendrites</td>
<td>synapse</td>
</tr>
<tr>
<td>myelin</td>
<td>soma</td>
<td>synaptic cleft</td>
</tr>
</tbody>
</table>

3. ___________ Contains the nucleus and is the metabolic center of cell

4. ___________ Slender fibers that conduct impulses toward the soma

5. ___________ Junction of two neurons

6. ___________ Space between the axon terminal of one neuron & the dendrites of another

7. ___________ Long fiber that extends from soma and conducts impulses away from soma

8. ___________ End branches that contain neurotransmitter storage vesicles

9. ___________ Gaps found between the myelin sheaths

10. ___________ Fatty material that protects fibers and speeds up impulse transmission

11. ___________ Part of the soma that connects to the axon

➢ Did you know? Synapses change as we learn from our experiences. The brain forms new synapses when we are learning and removes unneeded synapses. Our brain is constantly adapting to reflect our lives. [http://www.healthybrainforlife.com/](http://www.healthybrainforlife.com/)

12. Label the neuron.

   A. ______________________

   B. ______________________

   C. ______________________

   D. ______________________

   E. ______________________

13. Explain how an impulse is transmitted through a neuron starting at the sensory receptors.

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

**Section E: Types of Neurons**

Neurons are divided into afferent, efferent, and interneuron. In sensory (afferent) neurons, the dendrites contain sensory receptors and change information from external sources, such as light waves or sound vibrations, into electrical impulses. In motor neurons, the axons send electrical impulses to stimulate effector organs (muscles and glands). Interneurons connect afferent and efferent neurons allowing them to communicate. Interneurons are located entirely within the CNS.
Sensory neurons conduct impulses from the sense organs to the spinal cord where interneurons form ascending tracts that transmit sensory impulse to the brain for integration. Impulses are transmitted from the brain by interneurons that form descending tracts in the spinal cord. Motor neurons conduct impulses from the spinal cord to effector organs.

1. What are the 3 types of neurons? _______________________________
2. What is the function of the afferent neurons? ______________________________________________
3. What is the function of interneurons? ______________________________________________
4. What is the function of efferent neurons? _________________________________________________
5. Which neurons have sensory receptors? __________________________
6. Where are the sensory receptors located on a neuron? _________________________________
7. Which neurons cause movement or action in an organ? ________________________________
8. What are ganglia? ___________________________________________________________________
9. Which neuron has ganglia in the PNS? _______________________

Section F: Neuron Physiology
1. Nervous tissue possesses two distinctive properties – irritability and conductivity. Define these terms.
   a. Irritability - _______________________________________________________________________
   b. Conductivity - _____________________________________________________________________
2. Using the diagram, compare the conduction rate in an unmyelinated fiber and a myelinated fiber. Which fiber conducts an impulse faster? Explain your answer. ______________________________________
3. An inactive neuron is polarized. What is meant by polarized?

4. What causes depolarization?

5. What causes repolarization?

6. What is the function of Ca+?

7. What happens to create an action potential?

8. What is the function of the Na+/K+ pump?

**Section G: Neurotransmitters**

Neurotransmitters are chemicals which carry the impulse from one neuron to the next neuron. These chemicals allow the transmission of signals across the synapse. Some neurotransmitters are excitatory or inhibitory. Here are a few examples of common neurotransmitters.

- **Acetylcholine** – stimulates muscle contractions and causes glands to secrete hormones.
- **GABA** (gamma-aminobutyric acid) – an inhibitory neurotransmitter; causes cells to be less excitable.
- **Serotonin** – an inhibitory neurotransmitter involved in mood and emotion. It brings about a sense of emotional well-being and helps to regulate sleep. (Low levels lead to depression.)
- **Dopamine** – controls mood and motivation. Drives our internal feelings of reward and pleasure. It has an important role in learning. (Drugs such as cocaine and alcohol increase the levels of dopamine. Schizophrenia is associated with increased levels of dopamine.)
- **Norepinephrine** – is released to stimulate our sympathetic nervous system and put our body into ‘high alert’. (Exercise increases the release of norepinephrine and stress decreases it.)
- **Glutamate** – an excitatory neurotransmitter which plays a role in memory. (Excessive amounts of glutamate due to brain damage will kill neurons. ALS results from excessive glutamate production.)
- **Endorphins** – an inhibitory neurotransmitter involved in pain reduction and pleasure.

Visit [http://webspace.ship.edu/cgboer/genpsyneurotransmitters.html](http://webspace.ship.edu/cgboer/genpsyneurotransmitters.html)

**Section H: Reaction Time Lab**

Reaction time is a measure of how quickly you can respond to a given stimulus. It is more complex than a reflex. It requires information to be sent to the brain to be interpreted and back to cause an action.

**SIGHT:**
1. Have your partner hold the card at the top.
2. Place your thumb and forefinger just below either side of the bottom of the card.
3. Watch the card. When your partner drops it, catch it as fast as you can. Record the reaction time.

**SOUND:**
1. Follow the same procedure as above, but close your eyes. Your partner will say “go” when he/she drops the card. Catch the card as fast as you can.

**TOUCH:**
1. Follow the same procedure as above, but close your eyes. Your partner will tap your shoulder as he/she drops the card. Catch the card as fast as you can.

**Conclusions:**
- ✓ Describe the path of a stimulus from sensory receptor to motor neuron.
Section I: CNS - Cerebrum
1. Label the 4 parts of the brain.
   a. _______________________
   b. _______________________
   c. _______________________
   d. _______________________

2. What are the elevated ridges of tissue on the cerebrum called? ______________________________
3. The ridges are separated by shallow grooves called ________________________.
4. What are the deeper grooves called? _________________________
5. What is the bundle of myelinated fibers that allow the left and right cerebral hemisphere to communicate? _______________________________

Speech, memory, logical and emotional response, consciousness, interpretation of sensation and voluntary movement are all functions of the cerebrum. Identify which lobe controls the following activities:
6. Primary motor area that allows us to consciously move our skeletal muscles. ______________________
7. Somatic sensory area - recognize pain, temperature or touch from the skin. ______________________
8. Primary visual area. _________________________
9. Primary auditory and olfactory areas. ______________________
10. Ability to speak – Broca’s area. ______________________
11. Higher intellectual reasoning. ______________________

12. Cerebral Cortex
   a. What is the outermost cerebral cortex consists of? ________________________________
   b. What is the function of the cerebral cortex? ________________________________
   c. Describe what the fibers in this area. ________________________________

13. Cerebral Medulla
   a. What is the innermost cerebral medulla consists of? ______________________________
   b. What is the function of the cerebral medulla? ______________________________
   c. Describe the fibers in this area. ______________________________

14. What is the function of basal nuclei? ________________________________________________

Section J: Broca’s & Wernicke’s Area
In 1861, Paul Broca, a French neurosurgeon, examined the brain of a recently deceased patient who had had an unusual disorder. Though he had been able to understand spoken language and did not have any motor impairments of the mouth or tongue that might have affected his ability to speak, he could neither speak a complete sentence. When Broca autopsied the brain, he found a sizable lesion in the left inferior frontal cortex.

Ten years later, Carl Wernicke, a German neurologist, discovered an area involved in understanding language, in the posterior portion of the left temporal lobe. People who had a lesion at this location could speak, but their speech was often incoherent and made no sense. Neuroscientists now agree that running around the lateral sulcus in the left hemisphere of the brain, there is a sort of neural loop that is involved both in understanding and in producing spoken language.

1. What’s the function of the Broca’s area? _____________________________________________
2. What’s the function of the Wernicke’s area? _________________________________________
3. In which hemisphere do you find these areas? _______________________________________
4. Do the lobes work independently of each other? Explain your answer. ______________________

_________________________________________
Section K: Stroop Effect Lab (adapted from http://faculty.washington.edu/chudler/words.html)

Psychologist John Stroop studied the processing of words and how these thought processes affected other mental tasks. He found that the brain must override an automatic response when it receives conflicting information or inference. This is called the Stroop Effect.

Procedure:
1. Use the cards that have the words in their own color.
2. Have a partner time and record how long it takes for you to say the color of the word. Give your response as quickly as possible. Record your data. Repeat this step.
3. Use the cards that have the words in different colors.
4. Have a partner time and record how long it takes for you to say the color of the word. Give your response as quickly as possible. Record your data. Repeat this step.

Why?
The words themselves have a strong influence over your ability to say the color. The interference between the different information causes a problem. There are two theories that may explain the Stroop effect:

- Speed of Processing Theory: the interference occurs because words are read faster than colors are named.
- Selective Attention Theory: the interference occurs because naming colors requires more attention than reading words.

<table>
<thead>
<tr>
<th>Words in their own color</th>
<th>Time (sec)</th>
<th>Correct (c) or Incorrect (i)</th>
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Total incorrect responses:

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<thead>
<tr>
<th>Words in a different color</th>
<th>Time (sec)</th>
<th>Correct (c) or Incorrect (i)</th>
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Total incorrect responses:

Section L: CNS – Diencephalon, Cerebellum & Brainstem

Diencephalon -- Identify the parts of the diencephalon based on description.
1. Maintains homeostasis. Control centers for regulating hunger, sleep, thirst, body temperature, water balance and blood pressure. Control pituitary gland. ______________________
2. Central relay station for sensory impulses traveling from everywhere else to the cerebrum. Receives all sensory impulses except smell and sends them to correct region of the cerebral cortex to be interpreted. ______________________
3. Contains the pineal gland which secretes the hormone melatonin – which regulates daily rhythms. ______________________
4. System of pathways connects frontal lobes, temporal lobes, thalamus and hypothalamus – involved in emotions and memory. ______________________
5. Responsible for feelings of anger, fear, sorry, pleasure, affection and sexual interest. ______________________
6. Parts of the limbic system involved in learning and memory – links emotion to stored memories. ______________________

Cerebellum & Brainstem – Identify the parts of the brainstem and cerebellum based on description.
7. Part of Brainstem: Centers for regulating heartbeat, breathing and blood pressure. Reflex centers for vomiting, coughing, sneezing and swallowing. Ascending and descending tracts between higher brain centers and spinal cord. ______________________
8. Part of Brainstem: Relay station for tracts that run between cerebrum, spinal cord and cerebellum. Reflex centers for visual, auditory and tactile responses. ______________________
9. Coordinates muscles – integrates impulses from higher centers to produce smooth and graceful motion. Maintains normal muscle tone and posture. ______________________
10. Part of Brainstem: Contains tracts between cerebellum and rest of CNS. Coordinates with medulla to regulate breathing. Reflex centers for head movements in response to visual and auditory stimuli. ______________________
11. System of loosely clustered neurons extending through brainstem -- functions to maintains cortex in alert conscious state. ______________________
Section M: PNS – Spinal Cord
1. The spinal cord provides a two way conduction pathway to and from the brain. What is the other function? ____________________________
2. Which neurons are found in the dorsal root? ____________________________
3. Which neurons are found in the ventral root? ____________________________
4. What happens to the body if the dorsal root is damaged? ____________________________
5. What happens to the body if the ventral root is damaged? ____________________________
6. What happens to the body if the spinal nerve is damaged? ____________________________

Section N: Protection of CNS
1. The meninges are a connective tissue membranes composed of three layers. Identify the layer.
   a. Tough double-layered membrane is attached to the skull and forms the outermost covering of the brain and spinal cord. Forms channels called dural sinuses that collect and return venous blood to circulation. ____________________________
   b. The middle layer has threadlike extension spanning the space to attach it the innermost membrane. The space is filled with CSF. ____________________________
   c. The innermost layer clings tightly to the surface of the brain and spinal cord following every fold. ____________________________
2. What is the cerebrospinal fluid and what are the components of ‘this fluid’? ____________________________
3. What forms the cerebrospinal fluid? ____________________________
4. What is the function of the CSF? ____________________________
5. CSF circulates through ventricles, into the central canal of spinal cord, into the subarachnoid spaces and returns to veins of the brain where it drains into the dural sinuses and returns to the blood. If the production and drainage is blocked, what happens? ____________________________
6. What is the blood-brain barrier? ____________________________

Section O: PNS - Nerves
1. What is a nerve? ____________________________
2. Explain the relationship between the endoneurium, perineurium, fascicle and epineurium. ____________________________
3. What are reflexes? ____________________________