1. Write brief definitions of the following concepts: (1 pt ea)
   a. reflex loop
   b. action potential
   c. neuromuscular junction
   d. Hox gene
   e. Node of Ranvier

2. Using the list below, fill in the term that most closely matches these definitions: (1 pt ea.)
   a. post-synaptic structure
   b. nervous system from this germ layer
   c. segmented region of neural tube
   d. signal from sensory neuron
   e. larger and more complex head nervous system

   Terms: dendritic spine, synaptic vesicle, hindbrain, induction, action potential, acetylcholine esterase, specification, endoderm, ectoderm, spinal cord, afferent signal, efferent signal, cephalization

3. List three differences in structure or function between axon and dendrite. (3 pts)
   a.
   b.
   c.

4. List the three different types of glia in the CNS, and the one type in the PNS. For each, briefly describe one function. (4 pts)

<table>
<thead>
<tr>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNS a</td>
<td></td>
</tr>
<tr>
<td>CNS b</td>
<td></td>
</tr>
<tr>
<td>CNS c</td>
<td></td>
</tr>
<tr>
<td>PNS a</td>
<td></td>
</tr>
</tbody>
</table>
5. As we learned in class, the Spemann organizer is a small group of cells that induces ectoderm to form the nervous system. For each of the following categories, briefly describe one specific experiment and result that we learned in lecture. (These experiments can be on the tissue, cell, protein, or genetic level). (6 pts)

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>“show it”</td>
</tr>
<tr>
<td>Loss of function</td>
<td>“block it”</td>
</tr>
<tr>
<td>Gain of function</td>
<td>“move it”</td>
</tr>
</tbody>
</table>

6. The neuron is a polarized type of cell, with tightly regulated flows of material to and from the cell body. Using the cartoon neuron below, circle the arrow that is pointing in the correct direction. (4 pts)

![Diagram of neuron]

- a. Direction of kinesin movement:
  - → ←
- b. Direction of dynein movement:
  - ← →
- c. Direction of retrograde transport:
  - ←
- d. Direction of anterograde transport
  - →

7. Briefly describe three ways to identify a synapse that uses acetylcholine as a neurotransmitter. (6 pts)

   a.

   b.

   c.
8. Below is a cartoon of a transverse section showing the dorsal-ventral organization of the spinal cord in a vertebrate embryo. A. Label all of the structures in the cartoon below. (3 pts)

B. From the lecture on dorsal-ventral patterning of the neural tube, briefly describe (or draw and label a picture of) one experimental result that reveals the mechanisms that set up dorsal-ventral patterning. (4 pts)
Option #1: Experimental Problem (10 pts): [Choose either Option #1 or #2]

Recall the discovery of the organizer, the phenomenon of neural induction, and the strategy used to discover the Noggin gene. Suppose that a search of the sequence databases leads to the identification of another gene with a similar sequence to Noggin. The similarity in sequence suggests that this new gene (let's call it Noggin-2), might have a similar function in neural induction.

A. Using what you know about neural induction, propose a hypothesis about the potential expression pattern and function of noggin-2.

B. Describe a correlation experiment to test your hypothesis (correlation in time or space: “show it”).

   a. Describe a result that is consistent with your hypothesis.
   b. Describe a result that is inconsistent with your hypothesis.

C. Describe a loss-of-function experiment to test your hypothesis (“block it” to show necessity).

   a. Describe a result that is consistent with your hypothesis.
   b. Describe a result that is inconsistent with your hypothesis.

D. Describe a gain-of-function experiment to test your hypothesis (“move it” to show sufficiency).

   a. Describe a result that is consistent with your hypothesis.
   b. Describe a result that is inconsistent with your hypothesis.
Option #2: Experimental Problem (10 pts): [Choose either Option #1 or #2]

As we learned about dorsal-ventral patterning in the neural tube, the Sonic hedgehog (Shh) signaling protein is a critical ventralizing signal. A few other genes with similar sequence to Shh have also been identified in vertebrate embryos. One of these genes is called Tiggy-winkle hedgehog (Twhh, I’m not kidding!).

A. Using what you know about the experimental evidence for Shh function, propose a hypothesis about the possible expression pattern and function of Twhh.

B. Describe a correlation experiment to test your hypothesis (correlation: “show it”).

   a. Describe a result that is consistent with your hypothesis.

   b. Describe a result that is inconsistent with your hypothesis.

C. Describe a loss-of-function experiment to test your hypothesis (“block it” to show necessity).

   a. Describe a result that is consistent with your hypothesis.

   b. Describe a result that is inconsistent with your hypothesis.

D. Describe a gain-of-function experiment to test your hypothesis (“move it” to show sufficiency).

   a. Describe a result that is consistent with your hypothesis.

   b. Describe a result that is inconsistent with your hypothesis.