Grade Level 3-5

The student will be able to:

◊ Use the internet to explore the spinal cord and regenerative medicine
◊ Define specific vocabulary associated with the spinal cord and regenerative medicine
◊ Identify causes of spinal cord injuries
◊ Describe the causes and effects of spinal cord injuries on human health
◊ Discuss and identify new technologies being developed to heal injured spinal cords
◊ Use keyboards and other common input and output devices…efficiently and effectively.
◊ Use technology resources for problem solving, self-directed learning, and extended learning activities
◊ Create a visual representation to demonstrate knowledge of spinal cords

Full educational standards available online at www.sepa.duq.edu/education
**Topic Description**

This Webquest was developed as part of the multimedia educational project “Regenerative Medicine – Partnership for Life.” This project is funded by the National Institutes of Health and the National Center for Resource Research.

This Webquest was developed to help students acquire new knowledge about the spinal cord: how it functions, what happens when it is injured, and new regenerative medicine technologies being developed for the spinal cord.

**Grade Level**

This Webquest is designed for students in third to fifth grade. Instructors at the middle school level, however, can adapt the Webquest for use in their classrooms as well.

**Performance Indicators**

All students should have opportunities to demonstrate the following performances.

Prior to completion of Grade 5 students will:

1. Use keyboards and other common input and output devices (including adaptive devices when necessary) efficiently and effectively. (1)

2. Discuss basic issues related to the responsible use of technology and information and describe personal consequences of inappropriate use. (2)

3. Use general purpose productivity tools and peripherals to support personal productivity, remediate skill deficits, and facilitate learning throughout the curriculum. (3)

4. Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom. (3, 4)

5. Use technology resources for problem solving, self-directed learning, and extended learning activities. (5, 6)

6. Determine when technology is useful and select the appropriate tool(s) and technology resources to address a variety of tasks and problems. (5, 6)
Spinal Cord Webquest

Believe it or not, the spinal cord is made of the same material as the brain. They are both made of neurons and supporting cells called glial cells! Together they make up the Central Nervous System.

The function of the spinal cord is to connect the brain to the rest of the body and take sensations and messages from the body to the brain in the form of electrical and chemical signals. The electrical signals are protected by the insulating coats of glial cells on the nerve cell’s own axons. The nerve cells in the nervous system have many appendages called axons and dendrites to connect the cells. These appendages help connect nerve cells to other cells outside the central nervous system, like muscles and glands, allowing messages to be passed along and travel throughout the body.

The space where the neurons meet is called the synapse. Synapses are very important because they are the point of contact between two neurons, allowing information to be passed between cells. When the electrical signal reaches the synapse, it is changed into a chemical signal. This chemical signal is then passed across a gap to the next cell, where it is transformed into a chemical signal again. A chain reaction continues to occur in the synapses of your body, switching signals from electrical to chemical and back to electrical again. The spinal cord and synapses work together to help you know the floor is cold when you touch it.

When a spinal cord injury occurs, blood supply is cut off. When this happens, some neurons die, and axons swell and shed their protective coating of glial cells. The glial cells can grow back quickly causing a scar to form. This scar interrupts the passing of the messages along axons and between the synapses. Regenerative medicine technologies are being developed to prevent scarring and to promote new nerve growth. As a result, scientists have begun to develop methods for creating healthy environments for young cells (stem cells) to grow as new neurons. Special tubular scaffolds provide a pathway through the scar tissue for new axons to grow. These tubes can be thinner than human hair! This new procedure helps carry stem cells, a scaffold, and neuron cell growth factors directly to the injured area, allowing young cells to grow into neurons and sprout new axons. Communication between synapses can now be re-established!
Resources and Materials

- Computer lab/computer area
- Computers (one for each pair of students)
- Photocopies of the “Dr. Allevable's Spinal Cord Module Webquest” (one copy for each student)
- Pencils

Skills

- Associate
- Create
- Describe
- Draw
- Differentiate
- Explain
- Identify
- Illustrate
- Infer
- Name
- Order
- Predict

Process

Your students will use the Internet to explore the fascinating spinal cord. Students will work in pairs to complete the interdisciplinary Webquest activity during one class period (30-45 minutes). Plan for more time if you feel your students need it. Please advise your students to follow the directions in the Reading Guide and check off each box as a step is completed.

After all the steps on the task list are completed, students can start the evaluation assignment in class. The assignment is to be completed with their partner. Decide how many days your students will have to complete their assignment and set a due date. Pairs will then present their project in front of the class.

Why Use This Webquest?

In the emerging field of tissue engineering, scientists, engineers, and medical experts are devising new ways to replace or support defective or injured body parts. They are also developing and producing new molecules and proteins to support tissue growth. By working with young cells and these new growth-promoting molecules (called growth factors), scientists and doctors can help cells, tissues, and organs heal that could not be healed before.

By using this Webquest, in conjunction with Dr. Allevable's Laboratory Website and the “Dr. Allevable and Regenerobot's Exploration Adventure” workbook, regenerative medicine will come alive in your classroom! This Webquest, in particular, helps integrate technology into your classroom and bring your students new knowledge in a fun, interactive, and engaging manner.

Things to Consider Before Implementing this Webquest in the Classroom

- Pair students into effective cooperative partner groups (see below)
- Reserve time/class period in the computer lab
- Review proper computer lab etiquette with students
- Copy Spinal Cord Webquest Reading Guides for students
- Implement necessary academic adaptations (see below for suggestions)
**Academic Adaptations**

- Students should work in pairs in the computer lab to create an evaluative product. The partners can be previously chosen by the teacher to ensure that all levels of learners are able to complete this task (i.e. a lower-level learner may be paired with a higher-level learner). This pairing style helps students work collectively and practice cooperative and social skills. Additionally, students can practice delegation of roles and division of tasks to complete and create the assignment.
- Students will present their finished evaluative products to the entire class with a partner. As partners, students scaffold each other’s learning and create more advanced products/ideas than if they work on an individual basis.
- If a student has a visual learning impairment, feel free to create learning guides using larger print or Braille. Additionally, consider using a mouse with a magnifying feature to aid them in reading smaller texts on a website.
- This activity should not create problems for students with auditory impairments, as the Dr. Allevable Lab Website does not contain sound effects that would impede comprehension.

**Website**

For this Webquest, your students will be using the following website:

*Dr. Allevable’s Unbelievable Laboratory*

www.sepa.duq.edu/thelab

**Other Resources**

The following resources provide additional information and activities:

* Nervous Tissue: The Brain and the Spinal Cord. The counterpart website to *Dr. Allevable’s Unbelievable Laboratory* for teachers and older students.
  http://www.sites.duq.edu/sepa/regmed/nervous

* Neuroscience for Kids - Website with Engaging Extension Activities*
  http://faculty.washington.edu/chudler/spinal.html

* Neuroscience Coloring Pages - Print, Color, and Label the Nervous System* 
  http://faculty.washington.edu/chudler/colorbook.html

* Neuroscience Education Resources Virtual Encycloportal (NERVE)* 
  http://www.ndgo.net/sfn/nerve
Instructions and Answer Guide

Part 1: (Please check off when complete)

- Go to the following website: http://www.sepa.duq.edu
- Click “Visit the Lab!”
- Give the lab a chance to load
- Click on “Spinal Cord Module”
- Read the Introduction page that pops up and complete the following questions:

1. Write T or F to mark the following statements true or false. If it is false, change the statement so it is true.
   - T The spinal cord is soft like jelly.
   - F The spinal cord is as big around as your pinkie.
     The spinal cord is as big around as your thumb.
   - T The spinal cord is made of cells called neurons.
   - F Only the brain is a part of the central nervous system.
     The brain and the spinal cord make up the central nervous system.
   - F Messages from your brain are carried through your nerves.
     Messages from the brain are carried through the spinal cord.

Part 2:

- Click the black NORMAL FUNCTION tab at the bottom of the Spinal Cord Module screen
- Read this section and answer the following questions:

1. What is the function of the axons on the neuron cells?
   The axon acts as an insulating coat for the electric charge that goes through it.

2. What are the longest cells in the human body? What is the total length of all these cells in the body?
   Neurons are the longest cells in the human body. There are 62,000 miles of neurons in the body.
Part 3:

- Click the black SYNAPSES tab at the bottom of the Spinal Cord Module screen
- Read this section, click to watch "How Synapses Work," and answer the following questions:

1. **Why is it important for neuron cells to have many appendages?**
   
   *It is important for neuron cells to have many appendages to connect them to other neurons and pass messages along.*

2. **Arrange the following sentences by writing the correct number on the line (1-7) to explain how synapses work.**

   5️⃣ The chemical message is released from neuron #1.
   
   3️⃣ The electrical signal moves along the cell's axon until it reaches its endpoint, a synapse.
   
   2️⃣ The neuron creates an electrical signal to represent that information.
   
   6️⃣ The chemical message spreads across the gap between cells to neuron #2.
   
   1️⃣ A neuron receives an important piece of information.
   
   9️⃣ When enough synapses are active, the signal threshold is reached and the electrical signal passes along the cell's axon to its end.
   
   7️⃣ The chemical message binds to special receptor proteins on neuron #2.
   
   8️⃣ Receptor proteins on neuron #2 are activated and cause the cell to begin creating an electrical signal again.
   
   4️⃣ The electrical signal is then changed into a chemical message at the synapse.
Part 4:

◊ Click the black **INJURY** tab at the bottom of the Spinal Cord Module screen
◊ Read this section, click to watch how spinal cord injuries are like knocked-down phone lines, and answer the following questions:

1. Mark the following sentences in each set with a “C” if it is a cause or an “E” if it is an effect.

<table>
<thead>
<tr>
<th>C</th>
<th>The axons swell.</th>
<th>E</th>
<th>Axons shed their protective coating.</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>Blood supply is cut off from the spinal cord.</td>
<td>C</td>
<td>The spinal cord swells.</td>
</tr>
<tr>
<td>E</td>
<td>The message is interrupted between synapses.</td>
<td>C</td>
<td>A scar forms.</td>
</tr>
<tr>
<td>C</td>
<td>Neurons die and break open.</td>
<td>E</td>
<td>Damaged cells leak and cause swelling.</td>
</tr>
</tbody>
</table>

2. Complete the following analogy:

*A fallen telephone pole is like a(n) ______ injured ______ neuron cell.*

*Why is this analogy true? (Answer should contain the following elements, in some variation.*)

*When a telephone pole falls, the electricity or pulse cannot get through. When a neuron cell is injured, messages cannot pass through the synapses to be carried to and from the brain.*