The **BIG** Idea

- How does my brain work?

AGENDA

Approx. 45 minutes

I. Warm Up: Brain Quiz (5 minutes)

II. Brainstorm (10 minutes)

III. Brain Tour (What's Going on in There?) (15 minutes)

IV. Human Synapses (10 minutes)

V. Wrap Up (5 minutes)

MATERIALS

- ❑ **STUDENT HANDBOOK PAGES:**
  - Student Handbook page 8, Brain Quiz
  - Student Handbook page 9, Structure of a Nerve Cell
- ❑ **FACILITATOR PAGES:**
  - Facilitator Resource 1, Brain Quiz Answer Key
- ❑ Laptop computer and LCD projector
- ❑ Overhead projector
- ❑ Chart paper and markers
- ❑ Cardboard and tape or string (for signs)
- ❑ Stopwatch

OBJECTIVES

During this lesson, the student(s) will:

- Examine their attitudes about intelligence
- Explore the functions of the brain

OVERVIEW

In this unit, students explore the nature of intelligence and learn that it's possible to "grow" their brains. Four lessons explore 1) how the brain works, 2) how practice changes your brain, 3) the "use it or lose it" phenomenon, and 4) the importance of perseverance when work is difficult (and refusing to succumb to stereotypes about why one might not be up to the challenge).

In this lesson, students consider their own attitudes about intelligence, learn about the structure of the brain, and participate in an activity designed to show the function of **neurons, synapses, axons,** and **dendrites** in performance and learning.

PREPARATION

- ❑ List the day's **BIG IDEA** and activities on the board.
- ❑ Write the day's vocabulary and definitions on the board.
- ❑ The following handouts need to be made into overhead transparencies or copied onto chart paper:
  - **Student Handbook page 8, Brain Quiz**
  - **Student Handbook page 9, Structure of a Nerve Cell**
- ❑ Visit the following websites and make sure they're accessible from your classroom. To save class time, you may wish to save a screen shot of the MRI and PET scan images.

MRI:
http://science.nationalgeographic.com/science/photos/brain/#/brain_mri_848_600x450.jpg

PET scan:
http://www.webmd.com/depression/slideshow-depression-overview
(The first slide compares the brain activity of a healthy patient and a depressed patient.)

Brain tour:
http://www.alz.org/braintour/3_main_parts.asp
Click on "Brain Tour" and view slides 1 through 4.

- ❑ If you prefer that your students have the opportunity to individually access the **Brain Tour** (**Activity III**), make arrangements to hold class in the computer lab.

- ❑ For **Activity IV, Human Synapses,** create two signs, one that says "Neuron A" and one that says "Neuron B."

BACKGROUND INFORMATION

Like many educational programs, Roads to Success has struggled with the issue of student motivation. How do you take a kid who's already struggling academically and get him to fix his eyes on the prize – like high school graduation or a challenging career – that's half his lifetime away?

One of the ways is to change his mindset about learning. Dr. Carol Dweck, a professor and researcher at Stanford University, categorizes learners into two groups, those who believe that intelligence is "fixed" (a basic trait that's unchangeable), and those who believe that effort can improve intelligence. (She calls this a "growth" mindset.)

This series of lessons attempts to challenge the idea of fixed intelligence, and owes a debt to the stereotype threat research of Dr. Claude Steele and Dr. Joshua Aronson, and to the malleability of intelligence research of Dr. Carol Dweck and Dr. Lisa Sorich Blackwell. Dr. Aronson consulted on these lessons, and the research of Drs. Steele, Blackwell, and Dweck is reflected throughout.

Decades of research has convinced Dr. Dweck that a fixed-intelligence mindset can be damaging to students at all levels. The "I'm dumb, so why should I try?" assumption is obvious. But students who believe themselves to be smart are also vulnerable. If being smart (or athletic, or artistic) is an unchangeable "given" for students identified as such, it's tempting to quit at the first sign of difficulty. "I'm making mistakes. I'm struggling. I did poorly on this assignment. Maybe I'm not so smart, after all."

The alternative way of thinking, the growth mindset, allows students to take more academic risks, make mistakes, place a premium on learning rather than performance, ask for help when needed, and redouble their efforts when work is challenging.

How can teachers foster the growth mindset in their classrooms? Dr. Dweck recommends the following strategies:*

- Teach students to think of their brain as a muscle that strengthens with use, and have them visualize the brain as forming new connections every time they learn.

- When [you] teach study skills, convey to students that using these methods will help their brains learn better.
- Discourage use of labels ("smart," "dumb," and so on) that convey intelligence as a fixed entity.
- Praise students' efforts, strategies, and progress, not their intelligence. Praising intelligence leads students to fear challenges and makes them feel stupid and discouraged when they have difficulty.
- Give students challenging work. Teach them that challenging activities are fun and that mistakes help them learn.

*SOURCE: "Smart Talking: Tell Students to Feed Their Brains." Milton Chen, http://www.edutopia.org/tell-students-feed-their-brains. Originally published 3/16/2007.

For more information, visit www.brainology.us, "About us."

VOCABULARY

Axon: Part of the nerve cell that sends electrochemical messages.

Dendrite: Part of the nerve cell that receives electrochemical messages.

Neuron: A nerve cell that receives and sends messages from other nerve cells.

Neurotransmitters: Chemicals released by the axon which carries the message across the synapse to the next neuron.

Synapse: The space between neurons.

IMPLEMENTATION OPTIONS

In **Activity IV, Human Synapses,** you may wish to conduct an untimed, slow-motion trial run of the Human Synapses so that everybody understands the rules.

In **Activity III: Brain Tour,** if you anticipate difficultly in securing Internet access in your classroom you may print out the screen grabs and create overhead transparencies to share with students.

ACTIVITY STEPS

I. Warm Up: Brain Quiz (5 minutes)

1. **SAY SOMETHING LIKE:** Over the next four weeks, we will be studying how the brain works. You may be wondering why we're studying this topic in Roads to Success, and that's a great question to ask. Knowing how your brain works can actually improve your learning. Really!

2. Let's start with a quiz to see what you think about learning and the brain.

   [Have students turn to **Student Handbook page 8, Brain Quiz**. Place its transparency on the overhead projector and read the questions aloud, as students mark T or F for each.]

3. **SAY SOMETHING LIKE:** People generally have one of two different ideas about intelligence:
   - You're smart or you're not smart, and that never changes.
     OR
   - It's possible to grow your intelligence.

   Raise your hand if you believe the first one. [Show of hands.] Raise your hand if you believe the second one. [Show of hands.] If you're not sure, you're not alone. This is a question researchers have been asking for years. And some of the answers are surprising!

II. Brainstorm (10 minutes)

1. **SAY SOMETHING LIKE:** In the next few lessons, we'll talk about new scientific discoveries about the brain, and how these affect learning. But first let's talk about what you already know. Let's consider two different questions. [Reveal chart paper on which you've written the following questions.
   - What is the brain and how does it work?
   - What happens inside your brain when you learn something new?]

2. [Use chart paper to record students' answers, beginning with the first question. For items in dispute, add all alternate opinions. Information that students (or you) don't agree on should be followed by a question mark.]

3. [Students may need prompts to answer the second question, such as: How did you

learn to talk? To read? To ride a bicycle? To shoot a basket?]

III. Brain Tour: What's Going on in There? (15 minutes)

1. **SAY SOMETHING LIKE:** Scientists have been curious about the kinds of questions you're asking for a very long time. Understanding how the brain works can help teachers teach and doctors cure illnesses. For most of history, scientists have been very limited in the ways they could answer these questions. They could compare diseased brains with healthy ones after patients died. They could observe how someone with a serious brain injury relearned the things they'd lost – talking, eating, driving a car. Fortunately, technology for seeing inside the brain has improved dramatically in the past 30 years. Scientists can now see inside the brain – no surgery required!

2. Here are two ways of looking inside a human brain. Some brain scans (like an MRI) show the structure of the brain. [Display screen shot of an MRI. (See **Implementation Options** for suggestions.)]

3. Some (like a PET scan) show brain function. The part of the brain that a patient is using shows up in color. [Display screen shot of a PET scan.] Some kinds of brain scans do both. These pictures allow scientists to figure out how different parts of the brain are used.

4. Let's look at another website, and see what they've discovered.
   [Log on to http://www.alz.org/brain.]

5. This is the Alzheimer's Association website. Slides 1 through 4 show us what's going on in a healthy person's brain.

   [Read through the descriptions of each slide, making sure to roll the mouse over the highlighted words so students can see what part of the brain is being discussed. Items worth noting during this tour:
   - Slide 1, bullet point 3: Explain what's meant by "automatic function," things you don't have to think about doing.
   - Slide 3, bullet point 2: Scientists think that this area, the prefrontal cortex, continues to develop through your early twenties, which is why young people often need adult help in thinking through long-term plans.
   - Slide 3, bullet point 4: Voluntary movement is one you control, like kicking a soccer ball or picking up the TV remote. (This is different than "automatic function," like your breathing or your heart beat.)

6. [Direct students' attention to **Student Handbook page 9, Structure of a Nerve Cell,** and place its transparency on the overhead projector. As you talk, have students fill in the sentences with the brain vocabulary at the bottom of the page.]

   SAY SOMETHING LIKE: Let's take a look at a picture of a nerve cell. Your brain is made up of these types of cells.

   Another name for a nerve cell is a neuron. You have about 100 billion of these cells in your brain. (They're obviously very tiny.) Their job is to carry electrochemical messages from one part of the body to another. Neurons don't travel; messages jump from one neuron to the next.

   Neurons don't touch each other. So how does your brain pass a message from one neuron to the next, say, from the part of your brain that smells a fire to the part that tells you what to do next – toast marshmallows? Call the fire department?

   Each neuron has a part that sends the message along. This part is called the **axon** – it's the pitcher in the baseball game. Each neuron has parts that receive the message – these are called **dendrites**. The dendrites are the baseball catchers. The axon sends the message via chemicals released into the brain, called **neurotransmitters**. These chemicals cross the short gap to the dendrites of the next neuron. This gap is called a **synapse**.

   You have many of the same neurons throughout your life. What changes are the connections between the neurons.

   Practicing a task over and over, and trying things that are a little harder each time, produces more dendrites. It's like having a whole team of catchers, each ready to "catch" the message so it can be sent on – quickly. That's what's going on inside. What it looks like outside is a person who's on top of his game.

IV. Human Synapses (10 minutes)

1. **SAY SOMETHING LIKE:** We're going to create a human model to illustrate the way messages are passed in the brain. We'll start with two people, and add more until we have a whole chain.

   [Ask two student volunteers to come to the front of the class and stand side by side. Introduce them as **neurons,** and place signs around their necks identifying them as

Neuron A and Neuron B. Have Neuron A raise his hand (the one nearest Neuron B). Identify this hand as his **axon**. Place a koosh ball or other small object into Neuron A's hand (axon) and ask him to pass it to the Neuron B. Ask the class for the scientific name of the hand into which the object was placed (**dendrite**). Ask the students if the axon (Neuron A's hand) and the dendrite (Neuron B's hand) can touch (No). Explain that the neurons must find a way to pass the object without touching. The space between Neuron A and Neuron B is the **synapse**.

Have students practice this move a few times, making sure the hand-off is always from Neuron A to Neuron B, so that it's clear that messages pass from axons to dendrites. You may wish to have students illustrate the hand-off in slow motion, with students chanting as the object is passed – Axon! Synapse! Dendrite!]

2. When the action has been established, ask for two more students to come to the front of the room so that the four students form a chain. Practice sending the object from one end of the chain to the other, always in the same direction established with the first pair of students. Add more students if needed to get the point across.]

3. **SAY SOMETHING LIKE:** Let's see if we can make a giant chain of neurons using all the members of the class. Please do not get up out of your chairs until I give the signal.

   Once you're in your positions, we'll see how long it takes for the object to make it around the room. If you drop it, you may pick it up. If you touch each other, you have to start again at the beginning.

   [Designate one student to act as timekeeper, and designate others to move any furniture that's in the way. Remind students that there is to be no yelling or running, and that neurons never, ever touch each other. Ask small groups of students to quietly push in their chairs and take their places around the room – either in a large circle or a chain from one end to the other.

   When everyone is ready, the timekeeper says "go" and starts the stopwatch. Keep your eye on the proceedings to make sure everyone is following the rules.

   Have the timekeeper record the first time on the board, and ask students if they think they can improve their time on the second try. Continue for a third or fourth try if desired.

   Have students return to their seats.]

4. **SAY SOMETHING LIKE:** How did you feel during the first time trial? (Answers might include nervous, frustrated, eager for a challenge.)

   In what ways did your classmates make you feel better, or worse, about your performance?

   What did you do to get faster on later tries? [If students didn't get faster, ask how they could improve their time.]

   How did you feel when your times improved?

   What do you think the purpose of this activity was? (to show how nerve cells operate, but also to illustrate that everything we learn is hard before it's easy.) How could you use this information in your everyday life? [Allow students to respond.]

V. Wrap Up (5 minutes)

1. Place a transparency of **Student Handbook page 8, Brain Quiz,** on the overhead projector. Cover the transparency with a piece of paper so that you reveal one question at a time.

   At the bottom of the page, ask the class whether Theory A or Theory B seems most likely, based on what they've learned so far.

2. **SAY SOMETHING LIKE:** Next week, we'll examine some of the research that scientists have used to test the theory that you can grow your intelligence. Here's a hint: the title of the lesson is "You Can Grow Your Intelligence."

Brain Quiz

How does your brain work? In the next four lessons, you'll discover how humans learn. Take this True-False quiz to discover your opinions about this subject. Put a T beside each statement you think is true. Put an F beside each statement you think is false.

__T__ Your brain can grow and change throughout your life.

__F__ The best students are born smart.

__T__ People develop skills by practicing them over and over again.

__T__ Your brain changes when you practice a new skill.

__F__ If you don't succeed at a new task, you might as well give up.

__F__ Natural talent is the key to being a good athlete.

__T__ You can get smarter by working hard and practicing.

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Big Ideas about Intelligence:

- **Theory A**: Either you're smart or you're not smart, and that never changes.
- **Theory B**: It's possible to grow your intelligence.

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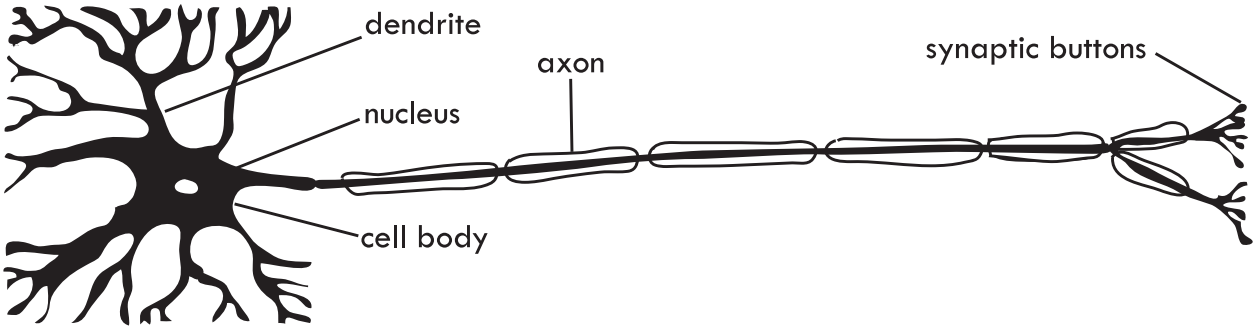
STRUCTURE OF A NERVE CELL



Another name for a nerve cell is a(n)

The part of the cell that sends messages to other cells is called a(n)

The part of the cell that receives messages from other cells is called a(n) .

Axons and dendrites don't touch each other. The axon sends chemicals across the tiny gap between it and the dendrite. These chemicals are called .

The gap between neurons is called a(n) .

NERVE CELL VOCABULARY

synapse

neurotransmitters

neuron

dendrite

axon