Lesson 3.6: The Nervous System

Task	Page(s)	Learning Target
1	2	I can identify structures and explain functions of the nervous system.
2	3	I can plan a model for the nervous system using household materials.
3	4	I can create a concept map that explains how the nervous system receives and responds to information when playing soccer.
4	5-8	I can use text evidence to describe brain plasticity.
5	9	I can design an experiment that tests how _______ affects _________.
6	10	I can develop a clear and detailed procedure that describes how to test the effect of _______ on ______.
7	11	I can collect data by conducting an experiment that tests how _______ affects _________.
8	12	I can present data that illustrates how _______ affects _________.
9	13	I can analyze data in order to draw a conclusion about how _______ affects _________.
10	14-15	I can present and analyze data that explain how time of day affects reaction time.
11	16-17	I can use mechanical and thermal stimuli to test and record data that describes cutaneous sensitivity.

Task 1 Learning Target: I can identify structures and explain functions of the nervous system.

1. **Functions**

A. How does a stimulus compare to an impulse?

B. How does the nervous system maintain homeostasis?

C. *What involuntary and voluntary actions are controlled by the nervous system?*

2. **Structures**

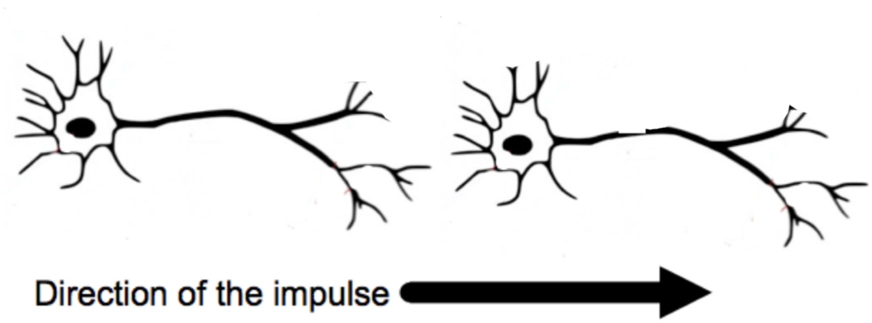
A. neurons:

 a. axons:

 b. dendrites:

 c. neurotransmitters:

 **Draw and label 2 communicating nerve cells



B. Divisions of the Nervous System

 a. PNS:

 b. CNS:

3. **Reflex:** an automatic response that occurs rapidly without conscious control

***How does a reflex differ from a regular response?*

4. **Drugs affect the nervous system**

 A. Depressant:

 B. Stimulant:

Task 2 Learning Target: I can plan a model for the nervous system using household materials.

Material	**How does it represent structure?**	**How does it represent function?**

Task 3 Learning Target: I can create a concept map that explains how the nervous system receives and responds to information when playing soccer.

Ball is kicked towards you acts as a

[ ]

first affects

[ ] → Example [ ]

Electrical [ ]

carried by

[ ]

to the

[ ]

travels up until it reaches the → [ ]

Word Circle

spinal cord
nose
tongue
stimulus
impulse
PNS neurons
eye
skeletal muscles
sense organ
skin
brain
sight
ear

the brain processes the information and determines that the response should be to kick the ball. This response is sent from the brain to the

[ ]

then to the

[ ]

finally to the

[ ]

Challenge: How does the above situation compare to a reflex?

The image to the right shows a reflex reaction.
Describe each step of the reflex in order from first to last.

A Reflex Compares to a Normal Response

1. finger/skin (____________) detects sharp object (stimulus).
2. PNS ____________ carry electrical ____________ to the ____________.
3. ____________ detects pain and will cause a reaction/response.
4. ____________ will process information last.

Task 4 Learning Target: I can use text evidence to describe brain plasticity.

Learning Rewires the Brain

Everyone's brains have the capability to make connections and grow through practice and learning! Musicians, athletes and quiz bowl champions all have one thing in common: training.

Learning to play an instrument or a sport requires time and patience. It is all about steadily mastering new skills. The same is true when it comes to learning information — preparing for that quiz bowl, say, or studying for a big test. As teachers, coaches and parents everywhere like to say: Practice makes perfect.

Recent data have been showing that the brain continues to change over the course of our lives. Cells grow. They form connections with new cells. Scientists have begun unlocking these secrets of how we learn, not only in huge blocks of tissue, but even within individual cells.

The brain is not one big blob of tissue. Just six to seven weeks into the development of a human embryo, the brain starts to form into different parts. Later, these areas will each take on different roles. Consider the prefrontal cortex. It's the region right behind your forehead. That's where you solve problems. Other parts of the cortex (the outer layer of the brain) help process sights and sounds. Deep in the brain, the hippocampus helps store memories. It also helps you figure out where things are located around you.

Scientists can see what part of the brain is active by using modern technology. For example, functional magnetic resonance imaging, (fMRI) uses a strong magnet that detects changes in blood flow. When a scientist asks a volunteer to perform a particular task — such as playing a game or learning something new — the machine reveals where blood flow within the brain is highest. That boost in blood flow highlights which cells are busy working.

Nathan Spreng is a neuroscientist at Cornell University in Ithaca, N.Y. A neuroscientist studies the brain and nervous system. Spreng wanted to know how the brain changes — how it morphs a little bit — as we learn. He teamed up with other researchers. Together, they used an fMRI to probe which regions of the brain turn on when people learn new tasks. Areas that allow people to pay attention became most active as someone began a new task. But those attention areas became less active over time. Meanwhile, areas of the brain linked with daydreaming and mind-wandering became more active as people became more familiar with a task.

"At the beginning, you require a lot of focused attention," Spreng says. Learning to swing a bat requires a great deal of focus when you first try to hit a ball. But the more you practice, Spreng says, the less you have to think about what you're doing. Extensive practice can even allow a person to perform a task while thinking about other things — or about nothing at all. A professional pianist, for example, can play a complex piece of music without thinking about which notes to play next. In fact, stopping to think about the task can actually interfere with a flawless performance. This is what musicians, athletes and others often refer to as being "in the zone."

Spreng's findings involve the whole brain. However, those changes actually reflect what's happening at the level of individual cells. Inside our brains are billions of nerve cells called neurons. When you're using your brain, electrical signals are firing through a pathway called an axon. The signal is received by dendrites, little finger-like structures branching out from the neuron, and delivered to the cell body, where the signal can be sent out again to connect to another neuron.

As we learn something new, cells that send and receive information about the task become more and more efficient. It takes less effort for them to signal the next cell about what's going on. The more you learn, the more pathways between neurons you create. When a pathway is traveled often, it gets stronger. Lots of strong pathways in the brain mean neurons can send more and faster signals to one another — this means you're learning and remembering more and more things! The brain's ability to change is called "plasticity."

These changes in the brain allow for faster, stronger signaling between neurons as the brain gains new skills. But the best way to speed up those signals is to introduce new information to our noggins — slowly.

Many students instead try to memorize lots of information the night before a test. Cramming may get them through the test. But the students won't remember the information for very long, says Hadley Bergstrom. He is a neuroscientist at the National Institutes of Alcohol Abuse and Alcoholism in Rockville, Md.

It's important to spread out learning over many days, his work shows. That means learning a little bit at a time. Doing so allows links between neurons to steadily strengthen.

Even an "aha!" moment — when something suddenly becomes clear — doesn't come out of nowhere. Instead, it is the result of a steady accumulation of information. That's because adding new information opens up memories associated with the task. Once those memory neurons are active, they can form new connections, explains Bergstrom. They also can form stronger connections within an existing network. Over time, your level of understanding increases until you suddenly "get" it.

Bergstrom, as well as many other neuroscientists, stress the importance of sleep in forming the new memories needed to gain knowledge. So the next time you study for a test, start learning new information a few days ahead of time. The night before, give your brain a break and go to bed early. It will allow your brain a chance to cement that new information into its cells. And that should boost your chances of doing well.

Consider this analogy: Pretend that you live in a wooded area, and each day you walk from your house down to a little stream. Over time, you have created a well-worn path through the woods from your house to the stream. Like this path, skills, knowledge, and habits that you often use are well-worn paths in your brain. You can easily do these things because the neuronal pathways are constantly used. But when you learn something new, you have to develop a new path.

Go back to the house in the woods for a moment. Let's say one day you spot a lovely meadow off the path. You decide that you'd like to get to it, but there's no clear way to get there. So you trudge through the brush, moving rocks, ducking limbs, and tripping on obstacles. You get there eventually, but it wasn't easy. It'll take time to wear a new path to the meadow as smooth as the path to the stream. When you learn something new, you're creating a new path in your brain; this is neuroplasticity. Anyone can make a new path, but it's hard work. And, just like a path in the woods, if you don't use the new paths in your brain often, they'll grow over and become difficult to navigate once again. That's why people sometimes say, "Use it or lose it!"

Learning about brain plasticity can help you put aside destructive ideas like people are born stupid, average, or smart, and embrace challenge as an integral and natural part of learning. It's taking on these new challenges outside our comfort zones where the biggest changes in the brain can be seen. To step outside one's comfort zone to start seeing these changes, one needs to first attack the new challenges, mistakes and all, with a growth mindset. When you understand how your brain learns, you can visualize the process happening in your head as you take on new challenges."

https://www.youtube.com/watch?v=88OL8NdkV-s

Questions:

1. The article states that that “the brain is not one big blob of tissue.” According to the article, which of the following statements are true.
    a. The brain is made of two parts, each responsible for different roles.
    b. The brain is made of several parts, each responsible for different roles.
    c. The brain is mostly responsible for solving problems.
    d. The brain is mostly responsible for storing memories so that people can learn from their mistakes.

2. Which statement correctly explains fMRI technology?
    a. Functional magnetic resonance imaging, (fMRI) uses a strong magnet that detects changes in blood flow. More blood flow indicates higher brain activity.
    b. Functional magnetic resonance imaging, (fMRI) uses a strong magnet that detects changes in electrical flow. Less electrical flow indicates higher brain activity.

3. Which of the following best describes the role of a neuroscientist?
    a. A neuroscientist studies the brain and spinal cord.
    b. A neuroscientist studies the heart and spinal cord.
    c. A neuroscientist studies the brain and nervous system.
    d. A neuroscientist studies the brain.

4. What was the purpose of Nathan Spreng’s work?
    a. Spreng wanted to better understand how the brain changes as a person feels pain.
    b. Spreng wanted to better understand which regions of the brain are active when a person learns a new task.
    c. Spreng wanted to prove that the brain is made of neurons.
    d. Spreng wanted to show how different regions of the brain respond to pressure.

5. What did Nathan Spreng learn from his studies using fMRI technology?
    a. Areas of the brain that allow people to pay attention became most active as someone began a new task but those attention areas became less active as the person became more familiar with the task.
    b. When a person is familiar with a task, the task requires more thought.
    c. When a person feels pain, thinking stops brain activity and blood flow in fMRI scans.
    d. All of the options accurately describe Spreng’s conclusions.

6. Why is “plasticity” used to describe the brain?
    a. The brain has the ability to change.
    b. As a person learns new things, neurons make new connections and pathways.
    c. Neurons have the ability to send signals faster.
    d. All of the options describe brain plasticity.

7. How does the analogy about the house in the woods represent brain plasticity?
    a. New pathways can be made.
    b. New pathways often require time and hard work.
    c. If you don't use the new paths, they can grow over and become difficult to navigate once again.
    d. All of the options describe the connection between the analogy about the house in the woods and brain plasticity.

8. Which of the following statements best supports the phrase "Use it or lose it!"
    a. To step outside one's comfort zone to start seeing these changes, one needs to first attack the new challenges.
    b. If you don't use the new paths in your brain often, they'll grow over and become difficult to navigate once again.
    c. Scientists have begun unlocking these secrets of how we learn, not only in huge blocks of tissue, but even within individual cells.
    d. When you understand how your brain learns, you can visualize the process happening in your head as you take on new challenges.

9. Which of the following statements would best represent Hadley Bergstrom's advice?
    a. If you wait until last minute to study for an exam, you give your brain a new pathway.
    b. It is better to learn a new task quickly, so you don't forget it.
    c. Learning a new task over several days will allow for stronger pathways.
    d. Getting a good night's sleep before a test is a common misconception.

10. What is meant by "Learning about brain plasticity can help you put aside destructive ideas like people are born stupid, average, or smart, and embrace challenge as an integral and natural part of learning."
    a. Many studies show that some people are born to be stronger in math. Practicing math skills does not work.
    b. Research shows us that the brain is plastic: with focus and practice, the brain can change, it can grow new cells, and we can strengthen neurologic pathways.
    c. Smart people are born with larger neurons and stronger pathways. When a person struggles with a task, the person should skip the task and do something he/she is better able to do.
    d. All of the options are true.

Task 5 Learning Target: I can design an experiment that tests how _______ affects _________.

1. Read and summarize the lab purpose and background:

Purpose: In this lab, you will determine if a person's reaction time varies depending on ________________.

Background: Imagine you are riding a bike down the street. A dog runs right in front of your moving bike. Within a half of a second of seeing the dog, you slam on the brakes of your bike to prevent a collision with the dog. The time that passes from the moment you see the dog to the moment you apply the breaks is called *reaction time*.
Reaction time is the period of time between a stimulus and a response. In the example, the stimulus was seeing the dog; the response was the application of the breaks. The time between stimulus and response is the time required for nerve messages to travel through the body. When the dog appears, receptors in the eyes send nerve impulses to your brain. The brain produces an image of a dog. Your brain interprets this image and plans a course of action in response. Then the brain sends nerve impulses to the muscles of hands telling them to respond by pressing the brakes.

2a. What is your reaction time?
2b. Which unit of measure can be used for reaction time? (minute, second, millisecond, inch, cm, mL)

3. Brainstorm: How can we use a ruler to test reaction time?

4a. Watch the video link below.
https://www.youtube.com/watch?v=3XM-4Qavh5k&t=5s
4b. Answer the following question on your lab sheet: *How is a ruler used to measure reaction time?*

5. Use pencil to complete the Investigation Design Diagram

Independent Variable:				
Levels of IV (How you will change it)				
Number of Trials (Number of times you will test IV)				

Dependent Variable: ____

Constants: ____

6. **Title**: ____
*Hint: **The Effect of** (the IV) **on** (the DV)

7. **Question**: ____
*Hint: **How will** (the IV) **affect** (the DV)?

8. **Hypothesis**:
*Hint: **If** (change of the IV) **then** (change in the DV) **because** (use reasoning from prior knowledge and/or research).

____

____

Task 6 Learning Target: I can develop a clear and detailed procedure that describes how to test the effect of _______ on ______.

1. Answer the following questions in your notebook:
    a. In this lab, what is the stimulus? What is the response?
    b. Is the response voluntary or involuntary? Explain.
    c. Is the response a reflex? Explain.
    d. Critique the Hypothesis- Describe if the following hypothesis is SMRT:
    If males and females are tested for reaction time using a ruler,
    then male and female reaction time will change.

2. List **materials** and quantities

3. Develop a **procedure**: As a team, create and order a MASTER procedure.

Task 7 Learning Target: I can collect data by conducting an experiment that tests how _______ affects _________.

1. Conduct your experiment to test how ____________ affects reaction time.

2. Create **Data Tables** that will organize your data.
   Tables should show individual and larger sample data with:
   - -Title(s)
   - -Units of measure (   )
   - -Numbers (including averages) rounded to the nearest tenth

Task 8 Learning Target: I can present data that illustrates how _______ affects _________.

1. Make a **graph** that shows individual and larger sample averages.

- ○ X axis Label
  - ○ (Units of measure)
  - ○ Constant scale
- ○ Y axis Label
  - ○ (Units of measure)
  - ○ Constant scale
- ○ Points connected with line **or** bar(s)
- ○ Title (includes information from both axes labels)
- ○ Key (or labels) identify all lines or bars

Task 9 Learning Target: I can analyze data in order to draw a conclusion about how _______ affects _________.

A. **Conclusion**:

1. What was the purpose of the lab?	
2. What was your hypothesis?	3. Was your hypothesis supported?
4. Evidence: (What observations/data supports or disproves your hypothesis?) *Use **specific numbers** from individual and group data.	5. Scientific Reasoning: (Why do you think this happened based on prior knowledge and /or research?)

B. **Analysis**:

1. How do you know that your data is reliable?

2. Why is it important to control variables? How did you do this?

3. What are some possible sources of error? Explain.

4. How could the data or ideas from this investigation be used in future investigations?
   -If you could redo this experiment, what would you do differently? Explain.
   -What is a similar experiment that you could do? Explain how and why you would do this?

Task 10 Learning Target: I can present and analyze data that explain how time of day affects reaction time.
Background- Reviewing Content:
Imagine you are riding a bike down the street. A dog runs right in front of your moving bike. Within a half of a second of seeing the dog, you slam on the brakes of your bike to prevent a collision with the dog. The time that passes from the moment you see the dog to the moment you apply the breaks is called *reaction time*.

Reaction time is the period of time between a stimulus and a response. In the example, the stimulus was seeing the dog; the response was the application of the breaks. The time between stimulus and response is the time required for nerve messages to travel through the body. When the dog appears, receptors in the eyes send nerve impulses to your brain. The brain produces an image of a dog. Your brain interprets this image and plans a course of action in response. Then the brain sends nerve impulses to the muscles of hands telling them to respond by pressing the brakes.

Reaction time is a measure of how quickly an organism can respond to a particular stimulus that comes from the outside. Reaction time has been widely studied, as its practical implications may be of great consequence, e.g. a slower than normal reaction time while driving a car can have serious results. Many factors have been shown to affect reaction times, including age, gender, physical fitness, fatigue, distraction, alcohol, personality type, and whether the stimulus is auditory, visual or other. There are many ways how the reaction times can be tested.

Title: The effect of time of day on reaction time.

Question: What is the effect of time of day on reaction time?

Hypothesis:

Procedure:
1. A partner holds a meter stick with the zero end about 50 cm above a table.
2. The subject gets ready to catch the meter stick by positioning the top of the thumb and forefinger just at the zero position.
3. The partner drops the meter stick without any warning. Using the thumb and forefinger only (no other part of your hand), the subject catches the meter stick as quickly as possible. Note the distance in centimeters that the meter stick fell. The distance is a measure of reaction time.
4. Five trials were performed at each time of day for 5 students. All morning trials were conducted at 8:00am, all the lunch trials at 11:00am, and all the afternoon trials at 3:00pm.

Complete the following in your notebook:
a. Write a SMRT Hypothesis for the lab.
b. Complete tables 2 and 3. *You may use a calculator and round to the nearest tenth.
c. Analyze data table 1: Identify outliers and explain why those might be considered sources of error.
d. Design a graph
e. Complete Data Analysis
f. Complete a Lab Conclusion
g. Complete a Lab Analysis

Data Table 1: Distance Dropped (cm)				
Student	Trial	8am	11am	3pm
John	1	11	12	7
	2	14	9	10
	3	25	10	5
	4	14	8	8
	5	8	10	10
Cheryl	1	15	10	11
	2	12	9	10
	3	12	12	6
	4	10	13	9
	5	10	7	7
Linda	1	14	14	17
	2	18	12	14
	3	18	11	16
	4	19	12	12
	5	23	16	15
Dan	1	18	20	15
	2	14	20	20
	3	19	16	15
	4	10	14	14
	5	15	16	8
Anna	1	30	33	18
	2	37	30	20
	3	38	18	11
	4	36	12	9
	5	21	20	16

Data Table 2			
	Average Distance Dropped (cm)		
Student Name	**8am**	**11am**	**3pm**
John	14.4	9.8	8
Cheryl			
Linda			
Dan			
Anna			

Data Table 3			
	8am	**11am**	**3pm**
Average Distance Dropped (cm)			

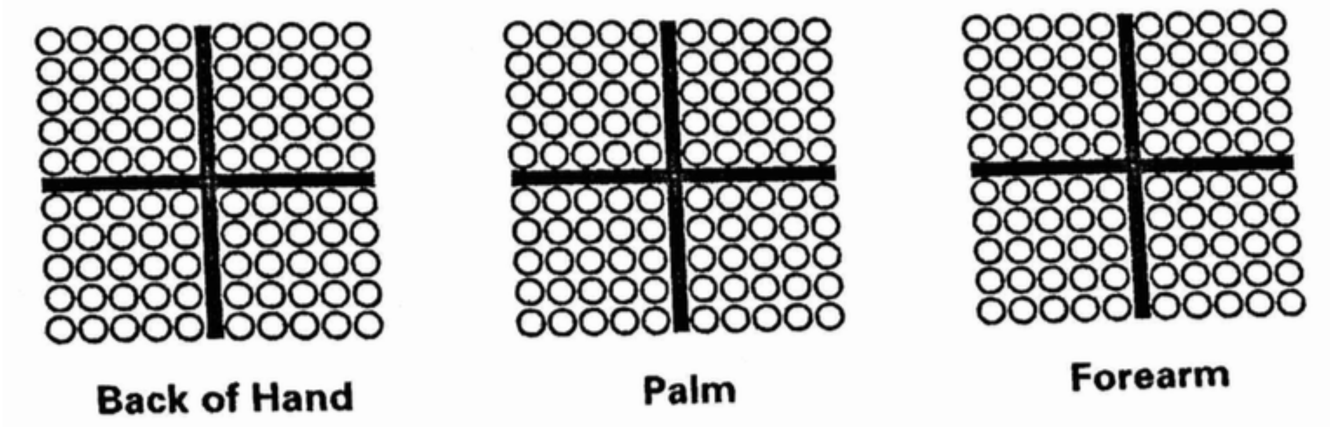
Task 11 Learning Target: I can use mechanical and thermal stimuli to test and record data that describes cutaneous sensitivity.
Background: The skin is the largest sensory organ of the body. The skin has many receptor sites for cutaneous sensations and is sensitive to many different kinds of stimuli, including touch, pressure, temperature, and pain. The ability to perceive these sensations is determined by specific sensory receptors and their pathways to the brain. The distribution of receptors varies at different locations on the body surface. Areas of the body such as the fingertips and the palm of the hand contain a higher receptor density and can therefore sense stimuli more accurately.

Activity A: Stimulus Sensitivity Testing- test and document stimulus sensitivity using a medical monofilament, studying which body parts are more sensitive to single-point pressure than others.
1. The test subject sits with eyes closed and with the stamped hand palm downward and motionless on the desk. The experimenter begins with the grid labeled "Back of Hand."
2. The experimenter begins in one quadrant of the dot grid and **gently** touches each dot with the medical monofilament. Hold the monofilament by the paper handle and touch it lightly to an ink dot on the test subject's skin. The test subject reports whether or not he or she feels a stimulus.
3. Repeat this activity, touching the other dots on the grid, reporting the sensation, and recording the response on the Data Sheet. Continue until all of the dots (or the required number of dots) have been tested. Record the data provided by the test subject by coloring/shading in the corresponding dot on the Data Sheet each time a stimulus is felt by the test subject. Remember that, in order to analyze and interpret data correctly, it must be organized, complete, and recorded accurately.
4. Repeat this procedure for the palm and forearm locations and record the results.

Activity B: Two-Point Discrimination- test and document stimulus sensitivity using a medical two-point discriminator, studying which body parts are more sensitive to two-point pressure than others.
1. The test subject sits with eyes closed and one hand palm downward and motionless on the desk. The experimenter begins by testing the back of the hand.
2. Start with the two points on the two-point discriminator touching each other. In increments of 1-2 mm, gradually increase the distance between the two points. Test the subject's skin after each adjustment. Each time the two points are touched to the skin, ask the test subject whether he or she feels only one point or two distinct points.
3. Repeat this procedure until the test subject reports feeling two distinct contact points. The measurement at which two distinct points are felt is called the "two-point threshold." This value is obtained by reading the number found between the two arrows in the middle of the sliding scale on the two-point discriminator. Record the test subject's two-point threshold in the "Trial 1" column on the data table.
4. Repeat steps 2 and 3, obtaining a two-point threshold measurement for the remaining areas of the test subject's body. Record each of these results in the "Trial 1" column of the data table.
5. Conduct two additional trials for each of these locations, following the procedure above. Record the results in the "Trial 2" and "Trial 3" columns of the data table.
6. Using data from the three trials, determine the test subject's average two-point threshold value at each location. Add this data to your table in an appropriate section. You will need to add an additional column or row.

Activity C: Temperature Sensation- study cutaneous sensitivity to hot and cold stimuli.
1. Place the aluminum temperature probe in cold water for a few minutes and allow it to cool. When the probe has cooled, remove it from the cold water and wipe it dry with a paper towel.
2. The test subject sits with eyes closed and with the stamped hand palm downward and motionless on the desk. The experimenter begins with the grid labeled "Back of Hand."
3. The experimenter begins in one quadrant of the dot grid and gently touches 10 dots with the temperature probe. The probe should remain on each dot for about two seconds. The test subject reports whether or not he or she feels a cool stimulus.
4. Repeat this activity, touching the 10 other dots on another quadrant of the grid, reporting the sensation, and recording the response on the Data Sheet. Follow the same procedure until the remaining quadrants have been tested.
5. Repeat this procedure for the palm and forearm locations and record the results. Remember that in order to analyze and interpret data correctly, it must be organized, complete, and recorded accurately.
6. Repeat steps 1 through 5, this time using a warm temperature probe to map warmth receptors. Give the sensor time to warm up and then follow the same protocol, mapping warmth receptors for the back of the hand, the palm, and the forearm.

Activity A: Stimulus Sensitivity Testing Test Subject: ___________________________________

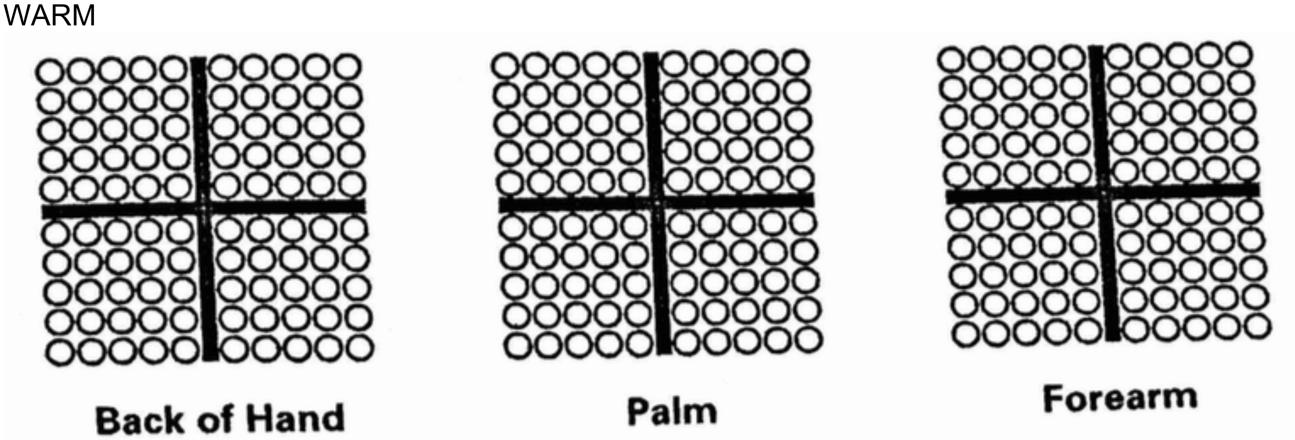


Activity B: Two-Point Discrimination Test Subject: ___________________________________

Location	Trial 1 Two-Point Threshold (mm)	Trial 2 Two-Point Threshold (mm)	Trial 3 Two-Point Threshold (mm)
Back of Hand			
Palm			
Forearm			
Fingertip			
Back of Neck			
Lower Leg (Calf)			

Activity C: Temperature Sensation Test Subject: ___________________________________

WARM



COOL