LESSON 5.1 - AN INTRODUCTION TO THE NERVOUS SYSTEM

Overview:
Students use their five senses to complete a writing exercise, complete a concept map about the nervous system and work through a reading and question package on the components of the nervous system, reflexes and instincts.

Suggested Timeline: 2.5 hours

Materials:
- *Sens*ible Writing (Student Handout)
- What is the Nervous System? (Student Handout – Individual)
- What is the Nervous System? (Student Handout – Group)
- reflex hammer
- QUIZ – An Introduction to the Nervous System (Student Handout)

Method:

INDIVIDUAL FORMAT:
1. Preview this section of the unit with students by going through the nervous system section of their unit organizer or instruct them to do it individually.

2. Provide students 15 minutes to complete '*Sens*ible Writing' (Student Handout).

3. Hand out 'What is the Nervous System?' (Student Handout – Individual) and have students complete the concept map, reading and questions. Students may need some guidance in completing their concept map.

GROUP FORMAT:
1. Preview this section of the unit with students by completing the nervous system section of the unit organizer.

2. Provide students 15 minutes to complete '*Sens*ible Writing' (Student Handout).

3. Hand out 'What is the Nervous System?' (Student Handout – Group). Use the teacher notes to create a concept map with students about the nervous system and explain the components. Note that a sample concept map is provided. Students may also take notes on the key points made in the teacher notes.

4. Ask a volunteer to come to the front of the class and sit on a desk with his/her legs dangling over the edge. Use a reflex hammer to test the knee jerk response OR use the back of your hand and a swift, firm hit under the patella. Have students note the response. Without warning, snap your fingers in front of the student's eyes. Have students note the response. Begin a discussion about reflexes.
   - **Key Q:** Where does the message go in each case? (above head – brain, below head – spinal cord)
   - **Key Q:** Can you control your reflex response?
   - **Key Q:** Why are reflexes important?

5. Have students complete the rest of the reading and questions on reflexes and instincts on their handout.

Assessment and Evaluation:
- Assessment of student's level of understanding of the nervous system via questioning.
- Student grade on quiz

An Introduction to the Nervous System

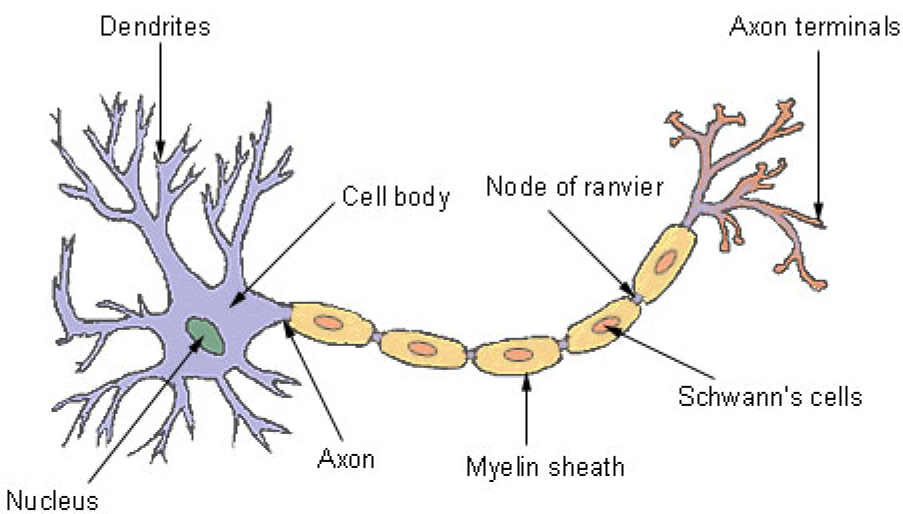
General Information about the Nervous System

The following information may be useful in making (and explaining) a nervous system concept map with students.

The survival of organisms depends on their ability to sense and respond to stimuli in their environment. Sense organs of the body take in information from an organism's surroundings and send them to the brain. The network of cells that make up the nervous system are called nerve cells or **neurons**. There are several hundred billion nerve cells in the human body. The brain itself contains over 100 billion nerve cells. There are actually other cells that surround neurons in the brain called **glial cells**. They greatly outnumber neurons and are thought to support neurons. Scientists are just starting to realize that they may have other functions too, but are not sure of what those functions are.

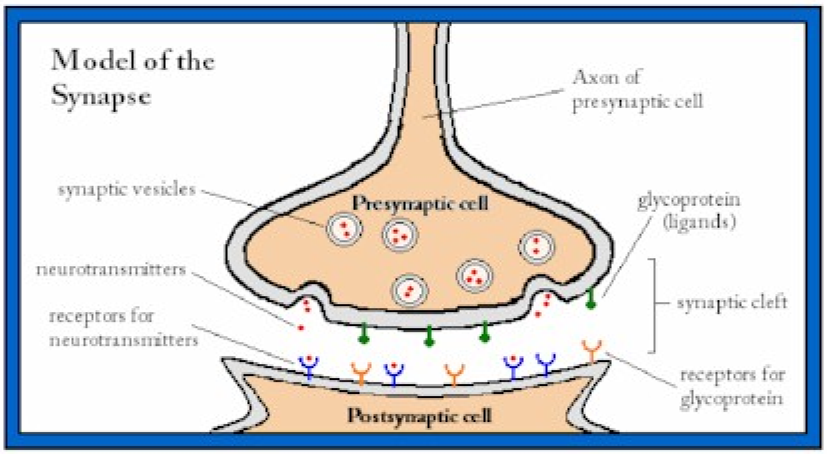
A Spanish cell biologist **Ramón y Cajal** (1852-1934) was the first to show that the neurons make up the nervous system. Each neuron is made up of a **cell body** with a nucleus containing the genetic material. From the cell body extend **dendrites**, acting like antennae to receive signals from other nerve cells. Each neuron has a single **axon** that shoots out from the its cell body and sends the signal to another neuron, muscle or gland. The **myelin sheath** is a fatty covering on the axon that speeds up the rate of transmission of the nervous impulse. The **Nodes of Ranvier** are where depolarization of the membrane actually occurs as the **action potential** or nervous impulse travels along. Axons in your body may measure up to a meter long!!

Structure of a Typical Neuron



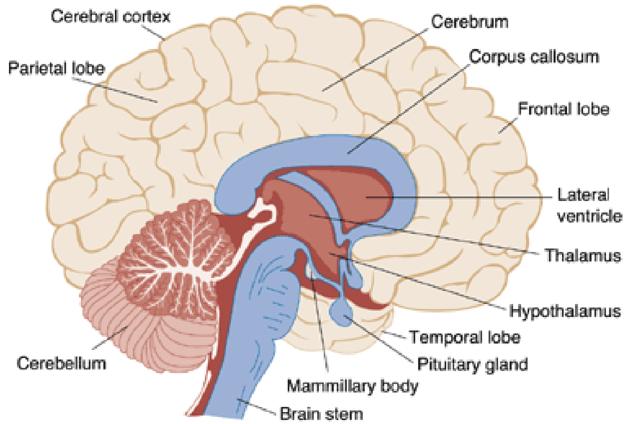
Nerve cells transmit messages via **electrochemical signals**. Ions like sodium, potassium and chloride are important in the changes that occur in the electrical potential of the cell membrane as the impulse moves along the neuron. The difference in concentration of charged ions inside and outside of the nerve cell creates a voltage across the cell membrane. This is kind of like the voltage in a chemical battery!

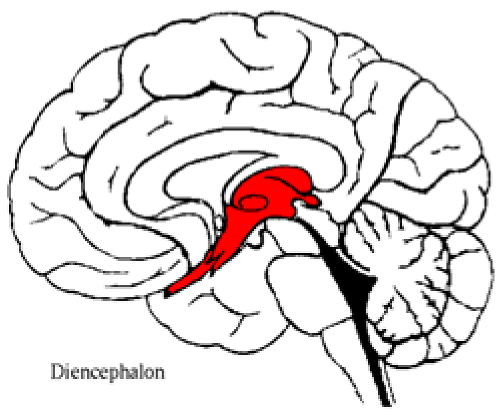
Once the impulse has moved from the dendrites → axon → axon terminals it will pass to another nerve cell, muscle or gland. There is always a *tiny* space, however, between a neuron and the neuron, muscle or gland that it 'communicates' with. This space is called the **synapse**. Information is sent across the synapse from by chemicals called **neurotransmitters**. These chemicals reach the neuron, muscle or gland to send the message. Drugs can numb sensation and paralyze nerves by interfering with the messages sent along the neuron, or by affecting the chemical balance of neurotransmitters at the synapse.



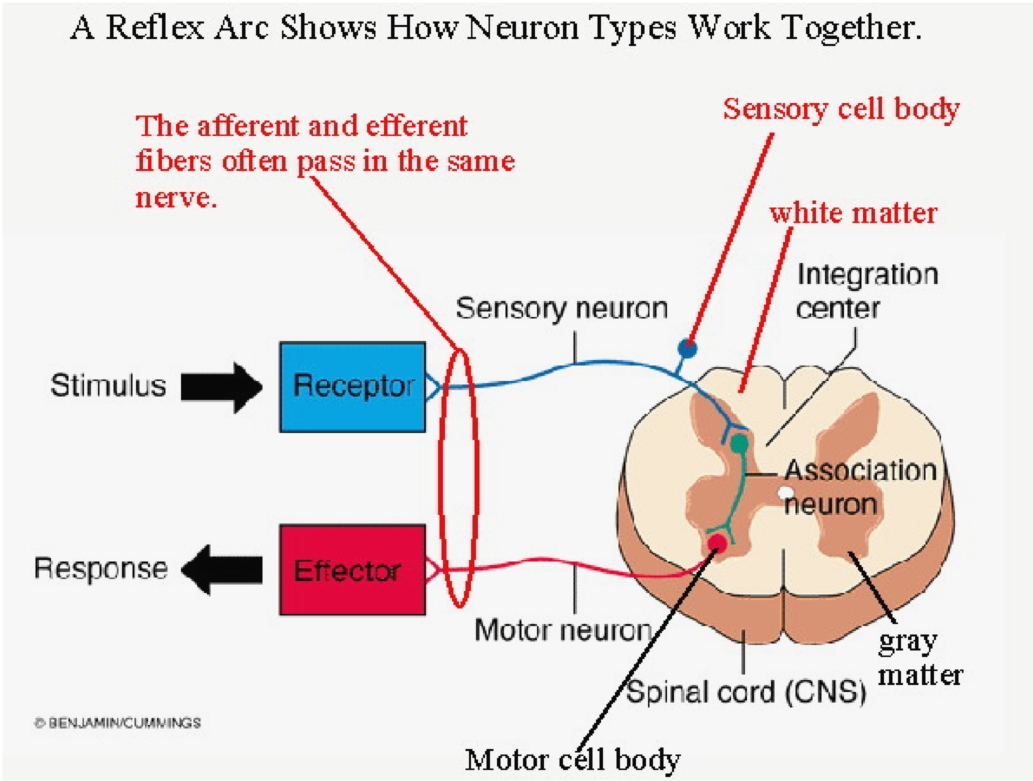
The major divisions of the nervous system are the **central nervous system** and the **peripheral nervous system**. The central nervous system is made up of the brain and spinal cord. The peripheral nervous system is composed of the nerves branching from the brain and spinal cord.

The brain is composed of four major parts: the **cerebrum**, the **diencephalon,** the **cerebellum**, and the **brain stem**. The cerebrum is the top, two-lobed portion of the brain and is the area responsible for thought, memory, the senses and commands for motion. The **diencephalon** is found in the middle of the brain and filters sensory signals before they go to the cerebrum. For example, when you are asleep, the diencephalons 'decides' what sensory information you should wake for and which you can continue to sleep through. The diencephalon is also responsible for controlling the functions of your body so that it stays in a state of equilibrium or **homeostasis** by commanding the **pituitary gland** at the base of the brain to release hormones. The **cerebellum** is found at the back of the brain and controls co-ordination and balance. The **brain stem** is found at the bottom and back of the brain and controls the body's automatic or **autonomic** functions like breathing, heart rate and the contraction of muscles in the digestive system that move food along.





The **spinal cord** relays information between the brain and the rest of the body. It is protected by bony vertebrae. It also controls reflexes below the head, like pulling your hand away when you touch a hot stove.

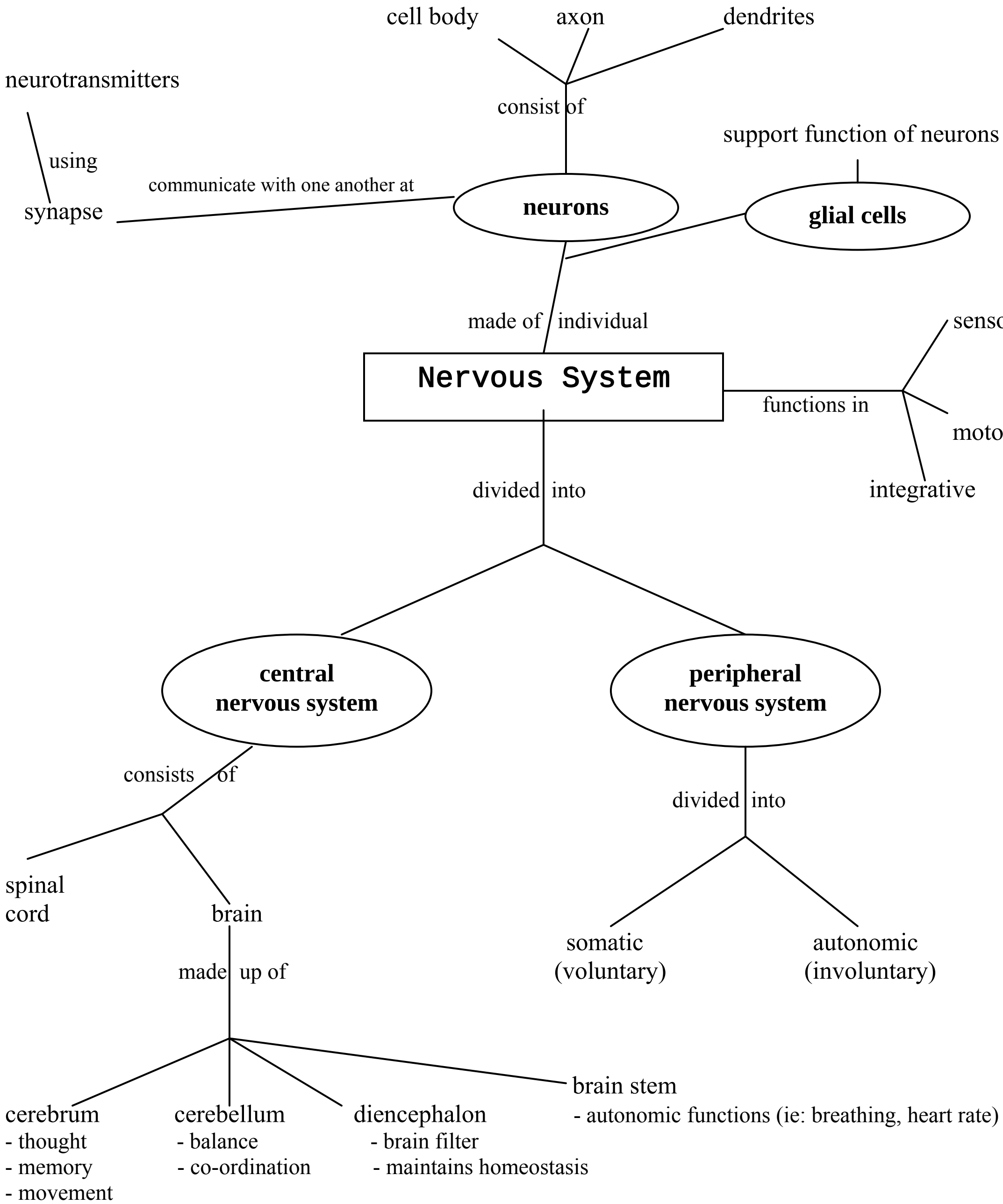


The **peripheral nervous system** is divided into the **somatic** component and the **autonomic** component. The neurons that make up the somatic component are under voluntary control. For example, the neurons associated with muscles in your arm that move when you think about raising your hand would be associated with the somatic component of the peripheral nervous system. The neurons that make up the autonomic component are those associated that work automatically without you having to think about them working. For example, the neurons that extend into your liver and stimulate it to function to detoxify the blood would be part of the autonomic component of the peripheral nervous system.

Adapted from The Nervous System, pp. 113-116 *Human Biology and Health Activities*

TSM Teacher Support Material 5

Sample Concept Map for Nervous System Overview



Student Handout

Name: ________________________ Date: ____________ Period: _____

***Sens*ible Writing**

Part 1 – The five senses are important for taking in information about the environment and writing down that information. Writers often use their senses to compare things. Look at the examples below, then finish each sentence that follows by using a sense comparison. BE CREATIVE!

Examples:
The juicy orange tasted like a burst of sunshine.
The apartment smelled like a pigpen.

1. The spring garden smelled like
   ____.

2. The fresh-baked bread tasted like
   ____.

3. The handsome boy looked like
   ____.

4. The crying baby sounded like
   ____.

5. The cat's fur felt like
   ____.

Student Handout

Part 2 – Think of your favorite place to be. Perhaps it is somewhere out in nature, in your room, or at a tropical destination where you have been. Close your eyes and recall all of the things experienced with your five senses there – What sounds are there? Smells? Tastes? Sights? Are there special textures there that are enjoyable to touch? Write down this information in the map below.

sights

____

____

____

smells

____

____

____

The place:

____

sounds

____

____

____

tastes

____

____

____

textures

____

____

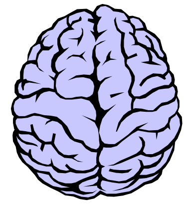
____

Part 3 – On the back of this sheet or on another sheet of paper, write a paragraph about your favorite place to be. Use your map from part 2 to help you. Think of it as a travel brochure to entice others to come to your favorite place. Be sure to include information from all of the five senses!

Student Handout INDIVIDUAL

Name: ________________________ Date: ____________________ Period: _____

What is the Nervous System?



VOCABULARY

neuron –

glial cell –

cell body-

dendrite –

axon –

myelin sheath –

synapse –

neurotransmitter –

central nervous system –

peripheral nervous system –

cerebrum –

cerebellum –

diencephalon –

brain stem –

spinal cord –

autonomic nervous system –

somatic nervous system –

reflex –

instinct -

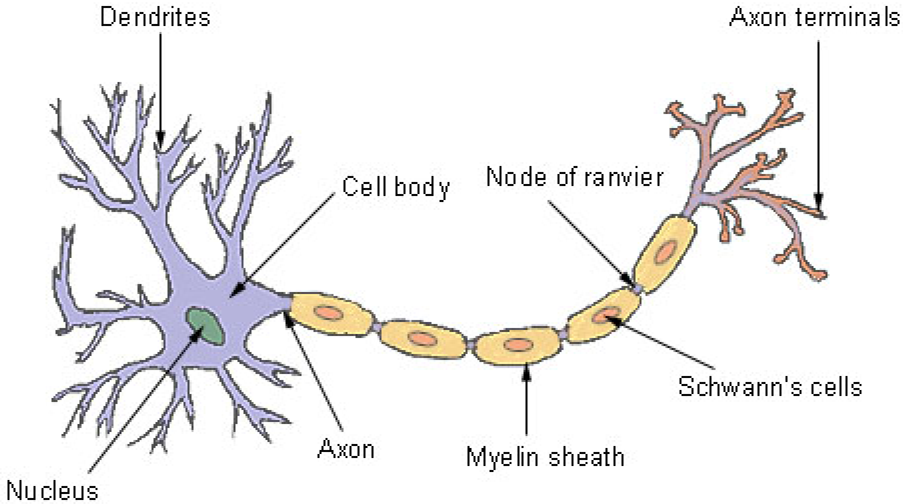
PART 1 - INTRODUCTION TO THE NERVOUS SYSTEM

The survival of organisms depends on their ability to sense and respond to things around them. Sense organs of the body, such as the eyes, take in information from an organism's surroundings and send them to the brain. The cells that make up the nervous system are called nerve cells or **neurons**. There are several hundred billion nerve cells in the human body! The brain itself contains over 100 billion nerve cells. There are actually other cells that surround neurons in the brain called **glial cells**. They greatly outnumber neurons and are thought to support neurons. Scientists are just starting to realize that they may have other functions too, but are not sure of what those functions are.

A Spanish cell biologist **Ramón y Cajal** (1852-1934) was the first to show that the neurons make up the nervous system. Look at the picture of a typical neuron below. Each neuron is made up of a **cell body** with a nucleus containing the genetic material. From the cell body extend **dendrites**, acting like antennae to receive signals from other nerve cells. Each neuron has a single **axon** that shoots out from the its cell body and sends the signal to another neuron, muscle or gland. The **myelin sheath** is a fatty covering on the axon that allows the messages to be sent faster. Axons in your body may measure up to a meter long!!

Student Handout INDIVIDUAL

Structure of a Typical Neuron



Nerve cells transmit messages via **electrochemical signals**. Ions like sodium, potassium and chloride are important in the changes that occur in the cell as the message moves along the neuron. The difference in concentration of charged ions inside and outside of the nerve cell creates a voltage across the cell membrane. This is kind of like the voltage in a chemical battery!

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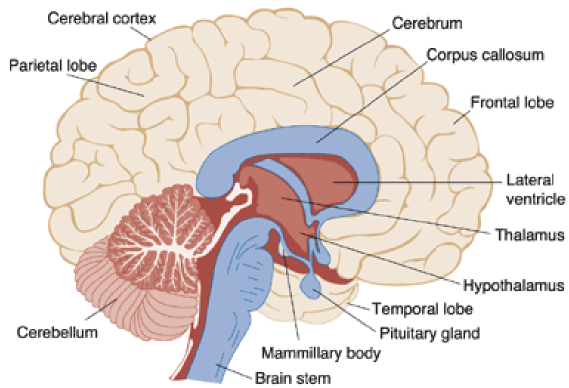

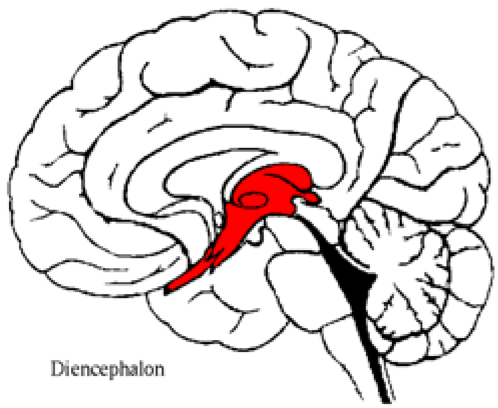

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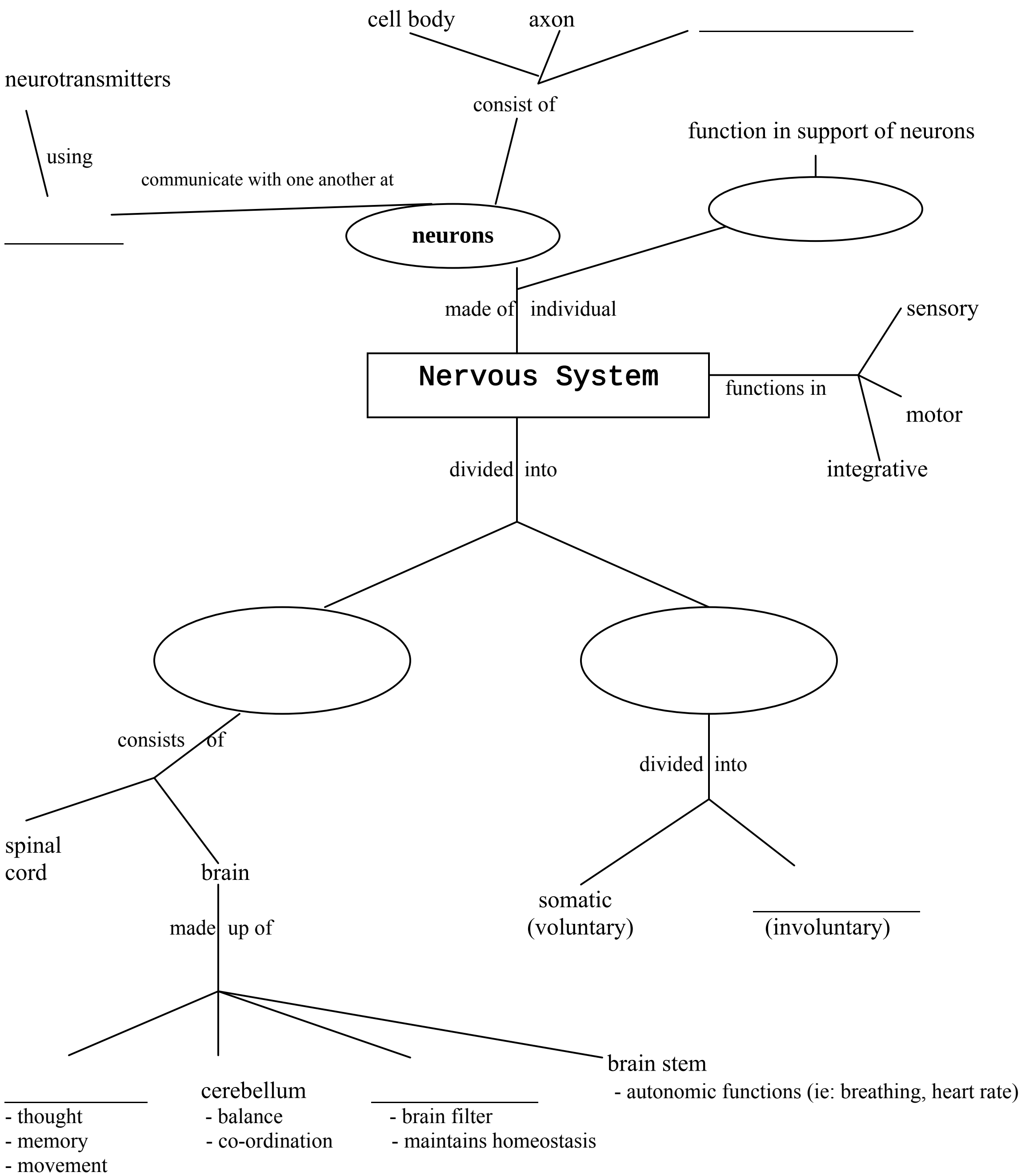
Adapted from The Nervous System, pp. 113-116 *Human Biology and Health Activities*

Student Handout INDIVIDUAL

Use the information above to complete the concept map below. This will help you to pick out the main ideas and form jot notes for yourself.



Student Handout INDIVIDUAL

PART 2 – A CLOSER LOOK AT REFLEXES

From birth, there are things that you have done by yourself, without having to think about them. These include breathing, your heart beating, blinking, searching for food. You were not taught how to do these things. These kinds of responses are called **reflexes**. There are many kinds of reflexes, but they are all alike in the following ways:

a) Reflexes are not learned. They are *inborn*.
b) You do have to think about reflexes for them to happen. They are *automatic* and *involuntary*.
c) A reflex is done the same way every time.

Most of the time, you do not know that a reflex is happening. For example, when you pull your hand away from something hot, you respond without thinking. You know about it only *after* the response has taken place.

Reflexes are important since they protect us and help us to stay alive. Our body organs are controlled mostly by reflexes.

Answer the following questions about reflexes:

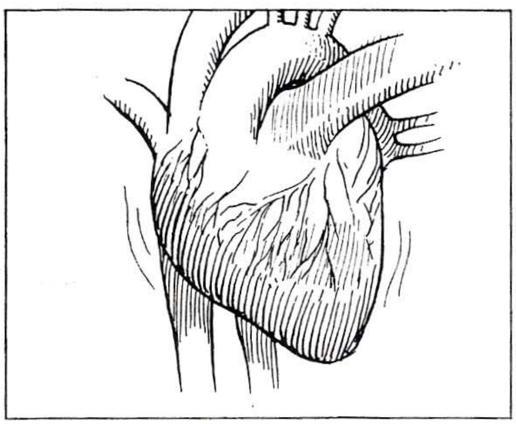


Figure A

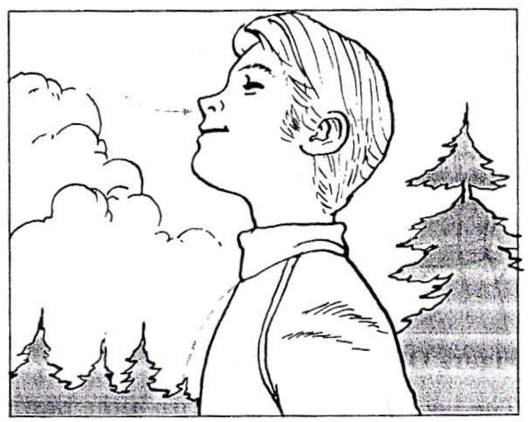


Figure B

Reflexes control the heartbeat.

1. a) What happens to your heartbeat when you are excited?

____

b) What happens to your heartbeat when you are asleep?

____

Reflexes control breathing.

2. Which gas stimulates this reflex? (Hint: You breathe it out.)

____

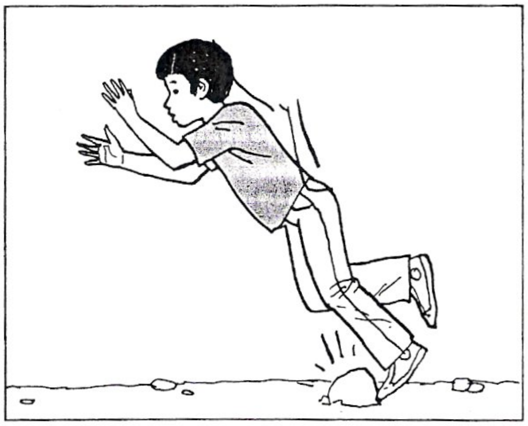


Figure C

Figure D

Reflexes protect you from injury.

E.g., When you trip, your hands automatically move to cover your face.

E.g., When dust gets into your eyes, you tear and your eyelids flutter automatically.

3. Look at Figure C. What part of your body do you seem to protect first during this reflex?

    ____

4. How does the reflex shown in Figure D protect you?

    ____

How Do Reflexes Happen?

Examine the event that is shown in the two pictures below.

Figure O

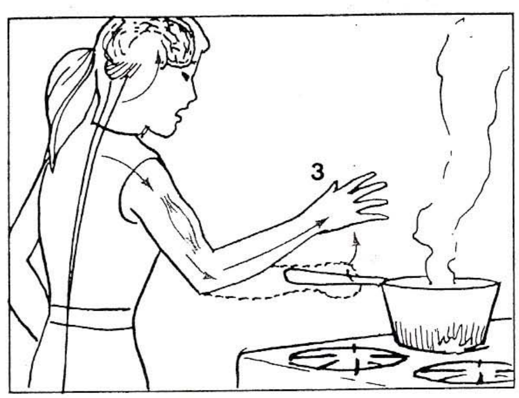


Figure P

Here the heat stimulus moves from the pan to the hand.

An instant later, the message reaches the brain which records pain in the hand.

Student Handout INDIVIDUAL

The **stimulus** is touching a hot object. The **response** is pulling the hand away. In order for the response to occur, the following sequence of steps must happen:

1. Nerves send the message of 'heat' to the spinal cord and the spinal cord 'decides' what to do.
2. The nerves carry the message of what to do away from the spinal cord. The message is sent to the muscles of the hand.
3. The message tells the muscles to 'let go' of the hot object.

The following questions correspond to the numbers that are seen in figures O and P (e.g., Question #1 is asking about step 1, as labeled in figure O). Answer each by choosing the correct phrase for the blank.

1. a) At this point, the brain ___________________________ know what is happening.
   does OR does not

   b) The girl ______________________ feel pain.
   does OR does not

2. The girl ___________________ had a chance to say 'ouch.'
   has OR has not

3. a) The brain now _____________________ know what is happening.
   does OR does not

   b) The girl now _____________________ feel pain.
   does OR does not

   c) Was the feeling of pain needed for the response to take place? ____________________

Choose the correct term for each statement and write it in the space provided.

1. Reflexes are ________________________.
   learned OR inborn
2. You _________________ control reflexes.
   can OR cannot
3. Reflexes ____________________ planned.
   are OR are not
4. Reflexes ____________________ happen by themselves.
   do OR do not
5. You ________________ know that most reflexes are happening.
   do OR do not

6. Reflex responses are carried out by __________________.
   nerves OR muscles

7. Most reflexes are very ____________________.
   slow OR fast

8. A reflex always happens ______________________________.
   the same way OR in different ways

9. Reading _________________ a reflex.
   is OR is not

10. Blinking when something enters your eye _____________________ a reflex.
    is OR is not

PART 3 – A LOOK AT INSTINCTS

Like a reflex, an **instinct** is inborn and is automatic. It also happens the same way every time. However, an instinct is a lot more complex than a reflex.

There are many examples of instincts that can be considered. Animals other than humans depend on instincts a lot. For example, it is instinct that drives a bird to build a nest. It can build a nest even if it has never seen a next being built. Building a nest is complicated, as it requires choosing a nesting place, selecting nest materials and constructing the nest.

An instinct can be described a s a series or reflex responses. One response leads to the next. It one 'link' in the chain of reflex responses is not there, the instinct will not be completed or will be completed incorrectly.

Answer these questions about instincts.

1. Instincts are ______________________.
   learned OR inborn

2. Both reflexes and instincts are _______________________.
   thought out OR automatic

3. Instincts are ___________________ complicated than reflexes.
   more OR less

4. An instinct is a series of inborn ________________________.
   stimuli OR responses

5. For an instinct action to happen, all of the steps that lead to the action must be ___________.

Adapted from What is a Reflex?, pp. 164-168 *Science Workshop Series - Biology*

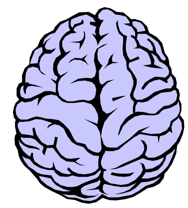
Unit: Biology G – Nervous System

Name: ________________________ Date: ____________________ Period: _____

What is the Nervous System?

VOCABULARY

neuron –



glial cell –

cell body-

dendrite –

axon –

myelin sheath –

synapse –

neurotransmitter –

central nervous system –

peripheral nervous system –

cerebrum –

cerebellum –

diencephalon –

brain stem –

spinal cord –

autonomic nervous system –

somatic nervous system –

reflex –

instinct -

PART 1 – An Introduction to the Nervous System
Draw your concept map in the space below.

Student Handout GROUP

PART 2 – A CLOSER LOOK AT REFLEXES

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1) Reflexes are not learned. They are *inborn*.

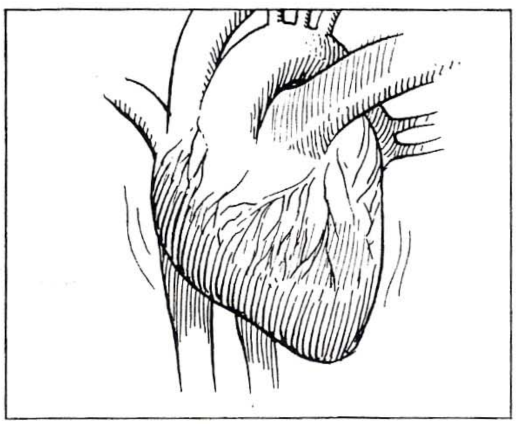
2) You do have to think about reflexes for them to happen. They are *automatic* and *involuntary*.

3) A reflex is done the same way every time.

Most of the time, you do not know that a reflex is happening. For example, when you pull your hand away from something hot, you respond without thinking. You know about it only *after* the response has taken place.

Reflexes are important since they protect us and help us to stay alive. Our body organs are controlled mostly by reflexes.

Answer the following questions about reflexes:



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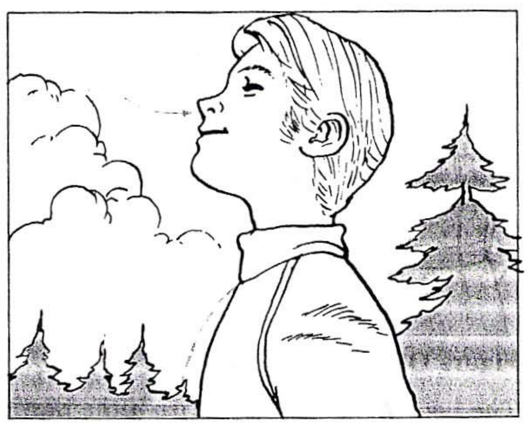

Figure B

Reflexes control breathing.

2. Which gas stimulates this reflex? (Hint: You breathe it out.)

____

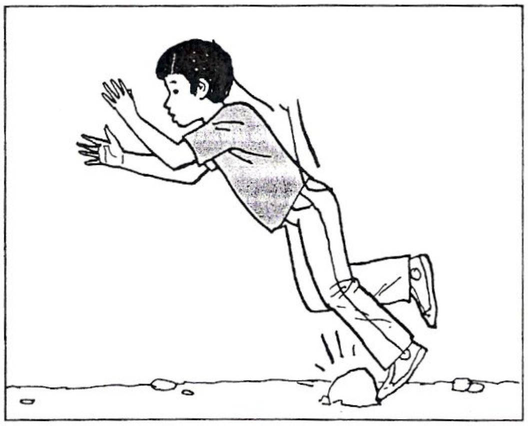

Figure C

Figure D

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3. Look at Figure C. What part of your body do you seem to protect first during this reflex?

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E.g., When dust gets into your eyes, you tear and your eyelids flutter automatically.

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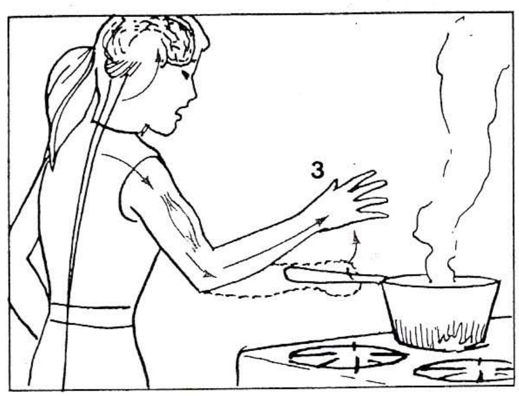

Figure P

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Student Handout GROUP

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4. An instinct is a series of inborn _______________________.
stimuli OR responses

5. For an instinct action to happen, all of the steps that lead to the action must be ___________.

Adapted from What is a Reflex?, pp. 164-168 *Science Workshop Series – Biology*

Student Handout

___
12

Name: ______________________ Date: ______________ Period: _____

QUIZ – An Introduction to the Nervous System

PART 1 – Multiple Choice – Circle the correct answer. **5 marks**

1. The building blocks of the nervous system are nerve cells called _____________.
   a) synapses
   b) myelin
   c) glial cells
   d) neurons

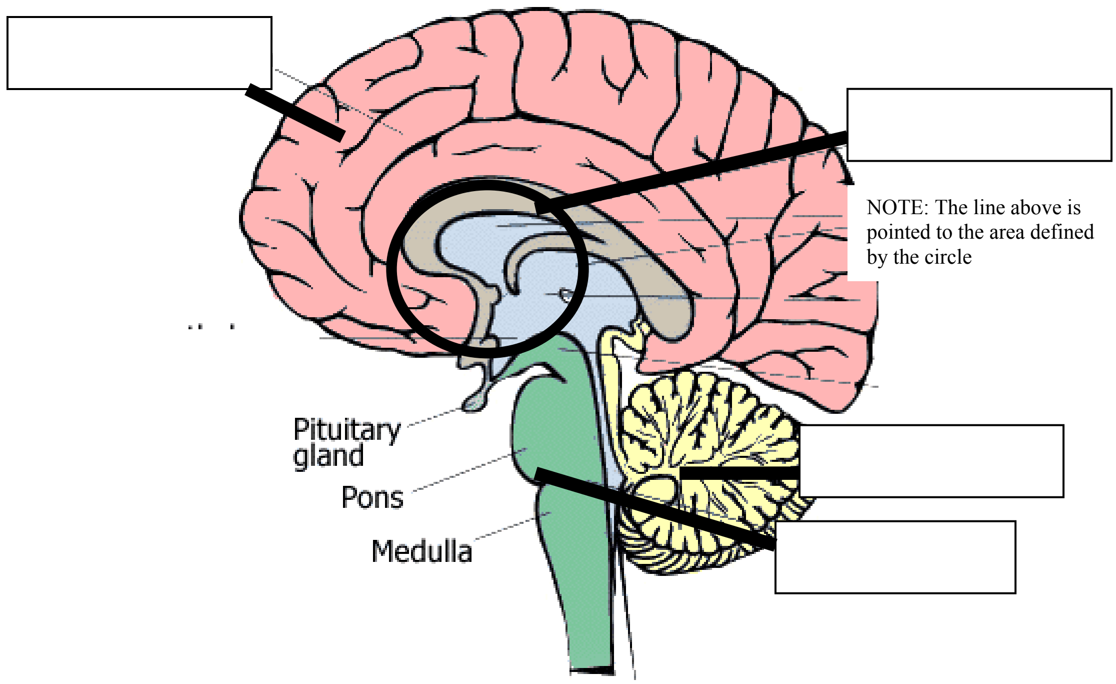
2. Nerve cells communicate *chemically* with one another by ______________.
   a) neurotransmitters
   b) electricity
   c) glial cells
   d) the hypothalamus

3. Which of the following is NOT a function of the cerebellum?
   a) balance
   b) memory
   c) co-ordination

4. What is the portion of the peripheral nervous system called that involves nerves that you cannot control?
   a) somatic nervous system
   b) sporadic nervous system
   c) autonomic nervous system
   d) central nervous system

5. The two-lobed, large portion of the brain that is responsible for functions like thinking and memory is the ______________.
   a) diencephalon
   b) brain stem
   c) cerebellum
   d) cerebrum

PART 2 – Diagram – Label the diagram by filling in the boxes with one of the words in the word pool below. **4 marks**



PART 3 – Short Answer – Answer the question in the space provided. **3 marks**

1. A friend of yours throws a piece of paper at your face and your eyes automatically blink.

   a) Is this an example of an instinct or a reflex? **1 mark** ______________________

   b) Explain the difference between a reflex and an instinct. **2 marks**

LESSON 5.2 - INVESTIGATING YOUR SENSES

Overview:
Students complete hands-on laboratory activities that allow them to explore each of their senses by investigating stimuli that affect each sense.

Suggested Timeline: 2 hours

Materials:
- *Sensing* Your Surroundings – A Laboratory Investigation (Student Handout)
- Playing with Perception – An Investigation of Vision (Student Handout)
- a few gummy candies
- Per lab group (for '*Sensing* Your Surroundings' lab)
  - cotton-tipped swabs
  - compass with two points OR compass with one point + sharp pencil
  - ruler
  - container of hot water
  - container of ice water
  - container of room-temperature water
  - lemon juice
  - quinine water
  - 5% fructose solution
  - 10% sodium chloride (salt solution)
  - small cubes of potato, onion and apple
  - 5% sucrose solution (sugar solution)
  - blindfold
  - paper towels
- Per lab group (for 'Playing with Perception' lab)
  - cellophane or tissue paper (red and green)
  - 2 flashlights
  - felt-tip markers (red, yellow and green)
  - ruler
  - rubber bands

Method:

INDIVIDUAL FORMAT:
1. Have students complete '*Sensing* Your Surroundings – A Laboratory Investigation' (Student Handout) and 'Playing With Perception – An Investigation of Vision' (Student Handout) and hand in questions when completed. *Note*: If there is only one Science 21 student, he/she will need a helper for parts of the activities

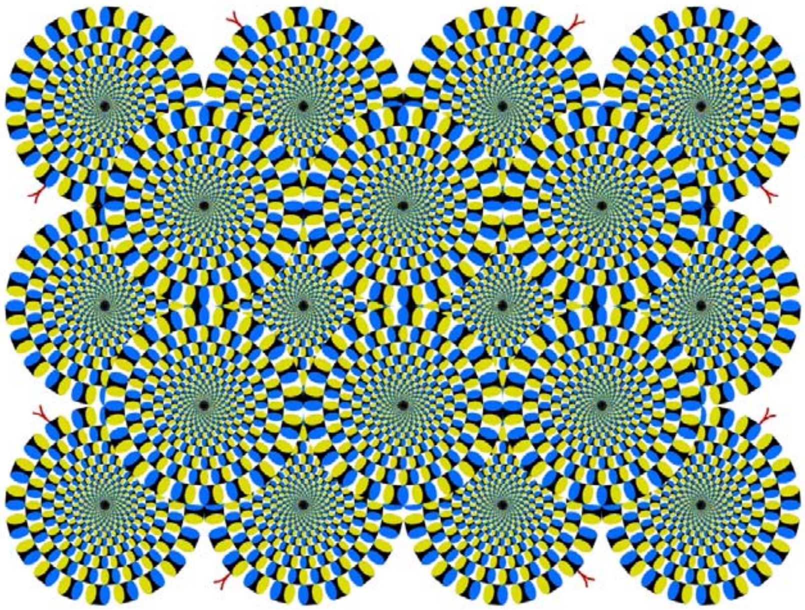
GROUP FORMAT:

1. Call two students up to the front who like gummy candies. Tell them that their knowledge of gummy candies will be tested. Blindfold both students and instruct one of the students to plug his/her nose. Tell students that their task is to shout out the name of the candy as fast as they can after tasting it. It is likely that the student plugging his/her nose will NOT win.
   Key Q: What affects our perception of food? (Partly taste, but mostly sense of smell).
2. Show students the optical illusion, as found on 'Investigating Your Senses' (Teacher Support Material). Use this to stimulate some discussion of vision and the brain. Excite students with the opportunity to investigate their senses further in two lab activities.
3. In groups, have students complete '*Sensing* Your Surroundings – A Laboratory Investigation' (Student Handout) and 'Playing With Perception – An Investigation of Vision' (Student Handout) and hand in questions when completed.

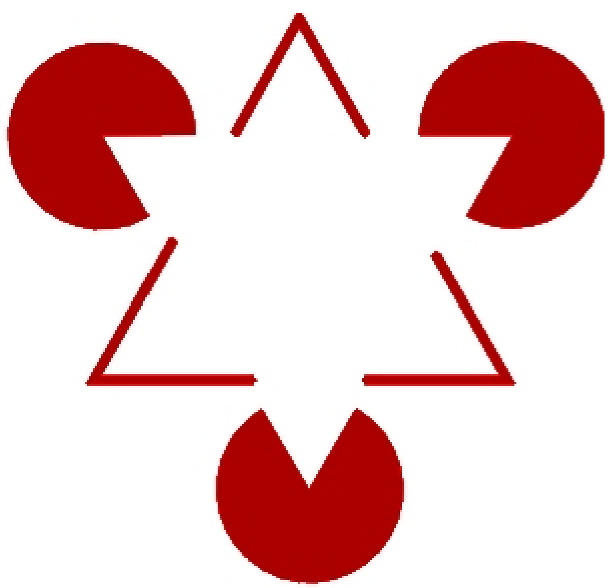
Evaluation:
Student grade on labs

INVESTIGATING YOUR SENSES

Optical illusions to introduce 'Playing with Perception – An Investigation of Vision'



No, it's not actually moving!



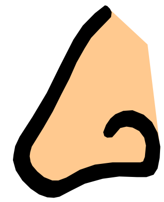
Do you see a pattern? Your brain fills in the spaces and you perceive two triangles!

24

Name: ______________ Partners: __________________ Date: ____________ Period: ____

***Sensing* Your Surroundings**

A Laboratory Investigation



Purpose:
To learn about how we perceive temperature, touch, smell and taste.

Materials:

Touch:
- compass with two points or with one point and a sharp pencil
- ruler

Taste:
- lemon juice
- 5% fructose solution
- 5% sucrose solution
- quinine water
- 10% sodium chloride
- cotton-tipped swabs

Temperature perception:
- container of hot water
- container of ice water
- container of room temperature water

Smell:
- small cubes of potato, onion and apple
- blindfold
- paper towels

Background Information:
Neurons, or nerve cells, carry information from the sense organs to the brain. Some of the receptors – those for pressure, pain, position and touch – are scattered throughout the muscle, skin or endothelium (lining of the organs). Other receptors – for smell, sight, hearing and taste – are concentrated in specialized organs. This lab will involve an investigation of touch, temperature perception, smell and taste.

Procedure:

PART A – Touch

The sense of touch is essential in perceiving stimuli in one's environment. Humans use their hands for many activities. Follow these steps to investigate the sense of touch:

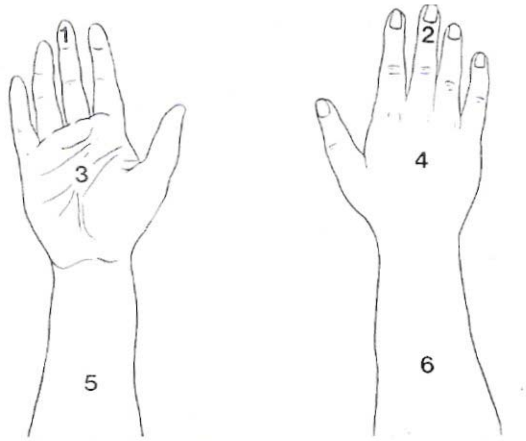
1. Work with a partner. Begin by setting up a compass so that the two tips (or the one tip and the pencil on the other end) are as close together as possible.
2. Have one person look away and hold out his/her hand with the palm facing up.
3. *Gently* touch the compass tips to your partner's middle fingertip. If your partner feels only one point, spread the compass tips apart approximately 2 mm and touch the fingertip again. Repeat this until your partner feels two points. This is called the **two-point threshold**. Record this distance, in mm, in row one of the chart below.

Location	*Two-point Threshold (in mm)*
fingertip (1)	
back of finger (2)	
palm (3)	
back of hand (4)	
inside of forearm (5)	
back of forearm (6)	

0.5 mark per row x 6 rows = 3 marks

4. Repeat steps 2-3 for the back of the middle finger, the palm, the back of the hand, the inside of the forearm and the back of the forearm. Use the diagram below as a guide and record all two-point thresholds in the chart above.

Student Handout



Determine the two-point threshold in the order numbered.

5. Reverse roles and have the other partner record his/her two-point thresholds.

PART B – Perceiving Temperature

Getting information about the temperature of things is our environment is important for protecting ourselves and for finding an area in which our bodies work best. This part of the investigation will involve testing your perceptions of hot and cold water.

1. Immerse one hand in the container of ice water and the other in the container of hot water. Keep your hands there for one minute.
2. Dip both hands at once in the container of room-temperature water.
   a) Does the room temperature water feel hot or cold? Why do you think that this is so? **2 marks**

   ____

   ____

PART C – Smell

Humans have a sense of smell that is less sensitive than other mammals. The olfactory, or smell centre of the brain is smaller in humans. However, we still respond unconsciously to many different odors. Our sense of smell also contributes to the flavor of many foods. With a partner, complete the following steps to investigate your sense of smell.

1. Have one partner put on the blindfold and pinch his/her nostrils shut.
2. Have the other partner put a small cube of potato, onion or apple in the blindfolded partner's mouth.
3. The blindfolded group member should then chew the cube, spit it into a piece of paper towel and identify the food *with the blindfold still on*. The results should be recorded by the seeing partner in the chart below. He/she should not tell the blindfolded partner if his/her identification was correct or not.
4. Repeat steps 2-3 for the other two foods.
5. Keeping the blindfold on, have the partner repeat steps 2-4, but now without the nostrils pinched shut. The order of the foods given should be changed.
6. Switch roles and complete the above steps for the other partner.

7. Dispose of all of the paper towels containing chewed food.
8. Answer the questions that follow.

Nostrils Shut

Food Given	*Identification*

Nostrils Open

Food Given	*Identification*

1.5 marks per chart x 2 charts = 3 marks

a) In the first test (with your nostrils closed), could you tell which food was which? Provide a possible explanation for your answer. **2 marks**

____

____

b) In the second test (with your nostrils open), could you tell which food was which? Provide a possible explanation for your answer. **2 marks**

____

____

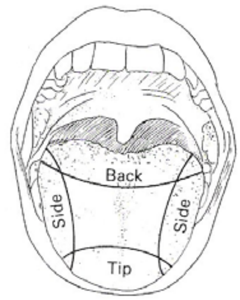
PART D – Taste

Have you ever drank orange juice after brushing your teeth? Did you wince at the taste? The reason for this experience is that most toothpastes contain detergents like sodium lauryl sulfate. These can interfere with your ability to taste the sugar in orange juice. What you then taste is orange juice without the sugar which makes it seem sour or bitter.

There are four widely recognized categories of taste perception: sour, salty, sweet and bitter. Most scientists now also recognize a fifth category called umami. This is the taste of compounds such as glutamate that are found in fermented and aged foods like strong cheeses, fish sauce and soy sauce. It is also found in the artificial flavor enhancer called monosodium glutamate.

The chemoreceptors for taste are called **taste buds**. Although you may have learned that certain tastes can only be detected by certain parts of the tongue, this idea is highly debated.

In this activity, you will test to see if you can detect any differences in taste in different areas of the tongue as mapped below.



Sour taste – Foods taste sour because you detect hydrogen ions in them. Acids have a higher concentration of hydrogen ions, therefore causing acidic foods to taste sour.

Dip a clean cotton swab in the lemon juice. Touch the four regions of your tongue, as shown in the diagram above.

Was there one area where you perceived the sour taste the most? If so, where? **1 mark**

____

Salty taste – Foods taste salty because you detect sodium ions in them. Table salt is sodium chloride.

Rinse your mouth with plain water. Dip a clean cotton swab into the sodium chloride solution and touch the four areas of your tongue.

Was there one area where you perceived the salty taste the most? If so, where? **1 mark**

____

Sweet taste – Foods taste sweet due to the detection of molecules larger than the ions detected in sour and salty tastes. Different kinds of molecules cause you to perceive sweetness. The ability to taste different kinds of sugars and other molecules that taste sweet differs from one person to the next.

Rinse your mouth with plain water. Dip a clean cotton swab into the sucrose solution and touch the four areas of your tongue.

Was there one area where you perceived the sweet taste the most? If so, where? **1 mark**

____

Rinse your mouth with plain water. Dip a clean cotton swab into the fructose solution and touch the four areas of your tongue.

How does the sweetness of the fructose compare to the sweetness of the sucrose? **1 mark**

____

Bitter taste – Foods taste bitter as a result of tasting several different kinds of large molecules. Some people are sensitive to certain bitter-tasting molecules, whereas others cannot taste them at all! Certain large molecules that stimulate the sweet-detecting taste buds can also stimulate the bitter-detecting taste buds. This may explain why some people find that artificial sweeteners have a bitter taste.

Rinse your mouth with plain water. Dip a clean cotton swab into the quinine water and touch the four areas of your tongue.

Was there one area where you perceived the bitter taste the most? If so, where? **1 mark**

____

Analysis Questions:

1. How would a keen sense of taste help an animal to survive? **2 marks**

   ____

   ____

2. What did your reaction to the room temperature water tell you about temperature sensation? **2 marks**

   ____

   ____

3. When you eat vanilla ice cream, what senses are involved? **1 mark**

____

4. When you were investigating your sense of touch, you filled in a chart about your two-point thresholds. Review these results. What do your results tell you about the amount of touch receptors in different parts of the body? **1 mark**

   ____

   ____

5. It is a commonly-held belief that a blind person's senses other than sight become better developed because they cannot see. It seems more likely, however, that a blind person just relies more on the other senses. Many things in the world are modified for blind people. For example, in an elevator, Braille labels are sometimes added to the buttons.

   Suppose that you wanted to design a kitchen for a blind person. What modifications could be made for the blind person in each of the following situations?

a) To use the controls on a stove: ____

____

b) To identify spices and extracts: ____

____

c) To put out a fire: ____

____

d) To take a telephone message: ____

____

4 marks

Adapted from Touch, Temperature, Smell and Taste, pp. 193-200 *Addison-Wesley Biology – A Systems Approach*

Student Handout

18

Name: __________________ Partner(s): ________________________ Date: _____________
Period: ____

Playing With Perception

An Investigation of Vision

Purpose:
To learn about how human vision works by investigating several types of perception.

Materials:
- cellophane or tissue paper (red and green)
- 2 flashlights per team
- felt-tip markers (red, yellow and green)
- rubber bands
- ruler

Background Information:
- Much information about the world around us comes from our sense of vision. The organ of human vision is the eye. The eye contains **rods** and **cones**. These special cells make up the **retina** – a layer at the back of the eye onto which light from our surroundings is focused to form an image. Rods are sensitive to dim light and cones are used in bright light and to sense colour.
- Since we have two eyes that both face forward, we see our world in three dimensions. This enables us to perceive depth and judge distance.
- Whatever our eyes see is sent to the brain to be processed. Certain shapes like faces are remembered by the brain and we compare them with memories of other faces that we have seen.

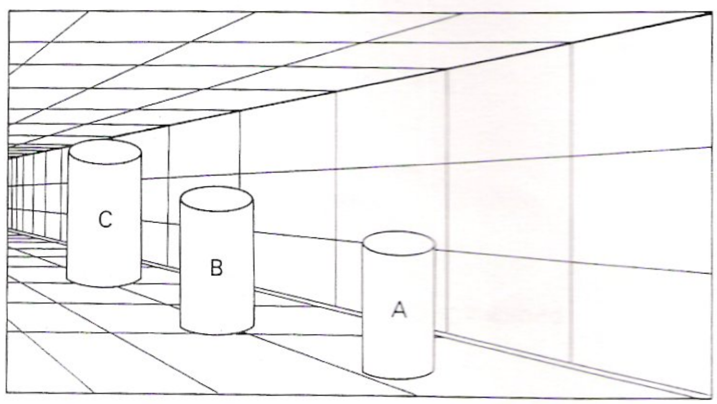
Student Handout

Procedure:

A. Perspective

Some of our ability to perceive distance and size is inborn. We also use information from the surroundings to help us to judge distance and size.

1. Look at the following picture. Without using a ruler, which cylinder appears to be the largest? ______________________________ **1 mark**



2. Measure the cylinders using your ruler. Were you mistaken? ________
   Why might people mistake the sizes of the cylinders? **2 marks**

____

____

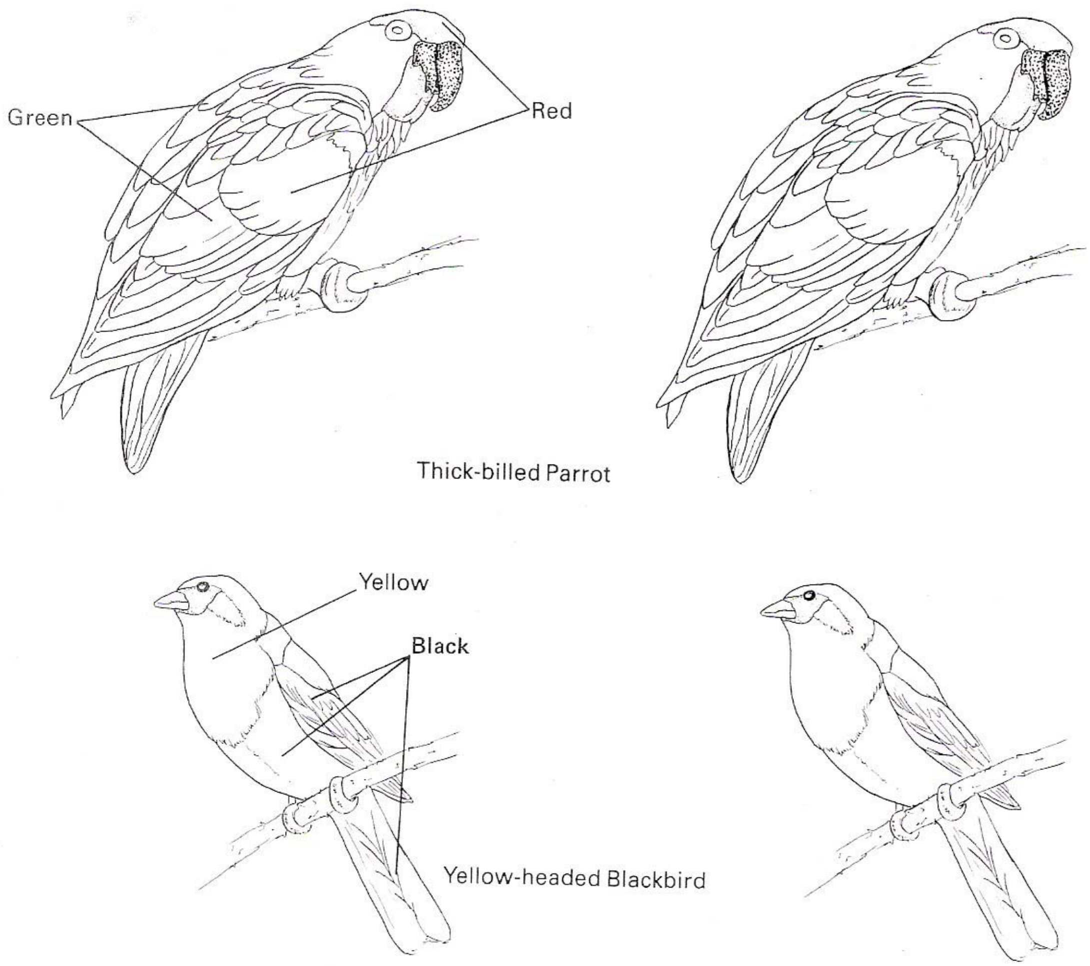
____

B. Afterimages

If you gaze for an extended period at an image then look away, you will see an **afterimage**. The image seems to 'burn' itself into the retina at the back of the eye.

To experience this phenomenon, do the following:

Use felt-tip markers to colour the birds on the left-hand side as labeled. DO NOT COLOR THE BIRDS ON THE RIGHT HAND SIDE.



Stare intently at the eye of the colored parrot for approximately 30 seconds (it helps to have someone time you). When the time is up, quickly move your eyes to the eye of the uncolored parrot. Label the areas of the uncolored parrot with the colours you see.

The primary colours of light are red, green and blue. The secondary colours of light are cyan (green + blue), magenta (red + blue) and yellow (red + green). White light is made up of all the primary colours (red, green and blue).

Student Handout

When the retina of the eye has received a certain colour of light for a long time, it can no longer respond to it. This is called **retinal fatigue**. However, the receptors can still respond to the other colours of light. The combination of colours that the eye can still respond to leads to the colour that you can see in the blank parrot.

1. a) When you looked at the uncolored parrot at the right after staring at the colored parrot at the left, what colour did the areas that were red appear? **1 mark**

   ____

   b) Using the information in the paragraphs above, explain why this is the case. **2 marks**

   ____

   ____

Repeat the above procedure with the blackbird.

BONUS +1 – What colour did the areas that were black appear on the uncolored blackbird? Why?

C. Which Eye is Dominant?

Just like people are right or left handed, people have a dominant right or left eye. In this section you will find your dominant eye.

Go outside or to a window that allows you to see some small object that is far off in the distance. Point at that object and keep your hand pointed to it. Close one eye, then the other. The eye that remains in line with the object is your dominant eye. You used this eye when you pointed at the object.

1. Which eye is your dominant eye? **1 mark** ___________________________

2. Are you right-handed or left-handed? **1 mark** ________________________

3. Compare your results with those of your classmates or with friends and family after school.
   a) How many people have a dominant eye and hand on the same side? **1 mark**

   ____

b) What percentage of the people that you tested had a dominant right eye and right hand? (Reminder: To find %, divide the number that had a dominant right eye and right hand by the total number of people that you tested and multiply by 100) **1 mark**

____

c) Why do you think that this is so? **1 mark** ______________________________________

____

<u>D. Perceiving Color</u>

Color gives us the ability to tell the difference between objects in our surroundings. In this section, you will investigate this fact.

Use rubber bands to fasten red cellophane (or three layers of red tissue paper) over a flashlight. When you turn on the flashlight, the light should be red. Using this same procedure, prepare the second flashlight so that the light is green.

Close your eyes. With the flashlights off, have your partner hold one of the colored flashlights in front of one eye and the other in front of the other eye. Have your partner turn on both of the flashlights at the same time. At that same instant, open your eyes.

1. What colour do you see? **1 mark** ______________________________

2. Why do you think that this is so? **1 mark** ____

   ____

   ____

Reverse roles and repeat the steps.

Analysis Questions:

1. Why is being able to see in three dimensions useful? (Hint: Try covering one eye and walk around the room for a while.) **1 mark**

   ____

   ____

2. When fighting fish (sometimes called Beta fish) first see each other, they become very aggressive. If put in contact with one another, a fight will occur. If they are separated by clear glass, however, they soon ignore each other.

Which of the following visual mechanisms may be involved here? **1 mark**
a) perspective
b) afterimage
c) retinal fatigue
d) eye dominance
e) colour perception

Explain your answer. **1 mark**

____

____

3. Think about what you learned in the part C of this investigation. Would a person with a dominant left eye most likely kick a ball with the right or left foot? Explain your answer. **2 marks**

____

____

____

Adapted from Visual Perception, pp. 201-204 *Addison-Wesley Biology – A Systems Approach*

LESSON 5.3 - TESTING THE NERVOUS SYSTEM

Overview:
In the first activity, students respond to the teacher's cues to learn about how the nervous system can be conditioned to a stimulus. In the second activity, students attempt to catch an object in order to find their reaction time and consider factors that affect it.

Suggested Timeline: 2 hours

Materials:
- Stimulus and Response – Conditioning the Nervous System (Student Handout - Group)
- Training Your Virtual Dog (Student Handout – Individual)
- computers with internet access
- Can You Catch Me? - Testing Your Reaction Time (Student Handout)
- Testing the Nervous System (Teacher Support Material)
- wooden rod
- $5, $10 and $20 bill
- meter sticks (1 per 2 students)

Method:

INDIVIDUAL FORMAT:
1. Ask the student(s) if he/she has a dog and how they go about training it. Excite him/her with the possibility of learning how to train a virtual pet!
2. Hand out 'Training Your Virtual Dog (Student Handout – Individual).' Have student(s) access the internet to complete the activity.
3. Allow students to continue their investigation of the nervous system by completing 'Can You Catch Me? - Testing Your Reaction Time' (Student Handout).
4. Have students hand in their activity and discuss the results.

GROUP FORMAT:
1. Use 'Testing the Nervous System' (Teacher Support Material) to lead students in the stimulus response activity.
2. Have students complete 'Stimulus and Response – Conditioning the Nervous System' (Student Handout - Group). Discuss the answers together as a class.
3. Use 'Testing the Nervous System' (Teacher Support Material) to lead students in the 'Fast Money' activity.
4. Allow students time to find their own reaction time by completing 'Can You Catch Me? – Testing Your Reaction Time' (Student Handout).
5. Have students hand in their activity and discuss the results.

Assessment and Evaluation:
- Level of student understanding of conditioned and unconditioned stimuli through questioning and discussion.
- Grade on 'Can You Catch Me? – Testing Your Reaction Time'

TESTING THE NERVOUS SYSTEM

Stimulus and Response – Conditioning the Nervous System

Teacher-Led Activity

1. Tell students that you are going to begin today's nervous system activities by testing their listening skills.

2. Get a wooden metre stick or rod. Stand at the back of the class behind the students. Ensure that all students are facing away from you.

3. Instruct the students to take out a pen and paper. Tell them to make a tic on their paper every time you say the word "write."

4. At two second intervals, strike the desk and say the word "write" 20 times. Stop saying the word "write" but continue to strike the desk until all students have stopped writing.

5. Instruct students to count their tic marks. Ask students to raise their hand if they counted more than 20.

6. Tell students that you said "write" only 20 times.

7. Have students complete their questions on Stimulus and Response – Conditioning the Nervous System (Student Handout - Group).

8. Discuss the student answers to the questions, including the following information in your explanation of the activity. Encourage students to take jot notes on the concept of conditioning.

The response-eliciting stimulus was saying the word "write." It was paired with a neutral stimulus – in this case, taps with the wooden rod. This caused students to become conditioned to the neutral stimulus, causing it to cause the response!

The reason that everyone eventually stopped writing was because the conditioned stimulus (tapping) was continued without the unconditioned stimulus (saying the word "write"). When this occurs, the conditioning eventually becomes extinguished.

Other everyday example of conditioning: when food preparation is constantly accompanied by the clatter of kitchen utensils, eventually the clattering of utensils alone will stimulate drooling or pangs of hunger

Adapted from How Fast Can You React?, p. 448 *Invitations to Science Inquiry, 2nd Ed.*

Fast Money

Teacher-Led Reaction Time Activity

Materials: $5, $10 and $20 bills

1. Ask students in the class who is interested in making some *quick* cash. Explain to them that all they have to do is catch the money! Tell them that you will even show them how it is done!

2. Hold the forefinger and thumb of your left hand about 5 cm apart. With your right hand, hold a $5 bill vertically and about half way between the two fingers of your left hand.

3. Let the bill fall and catch it between your two fingers.

4. Have a student come to the front. Tell them that any money that they catch, they can keep. Instruct them to position the fingers of their left hand in the same way that you did while you hold the $5 bill between their fingers.
   Rules: They cannot move their hand down. Their fingers must be 5 cm apart.

5. Give the student three tries, varying the time between placing the $5 bill between their fingers and letting go of it.

6. Repeat the activity with other students, increasing the denomination of the bill. Remember to vary the dropping time, or you will lose your money!

7. Discuss the following questions:
   a) Why was the teacher able to catch the bill so easily when he/she dropped it her/himself?
   b) Why did the teacher vary the time between placing the bill between the students' fingers and dropping the bill?
   c) With the teacher dropping the bill for the student, why was it never caught?
   d) What was the stimulus for the response of closing one's fingers?
   e) Where did the information have to go between the stimulus and the response?

Information to include in your discussion/explanation:

The initial stimulus was the eye seeing the bill drop. This had to cause the sensory neurons in your eye to send the message to the brain, which sent the message to the motor neurons. The motor neurons stimulated the effector, in this case the muscles of your hand, to close. Although it takes the information very little time to be sent along this pathway, this time is greater than the time it takes the bill to drop under the influence of gravity. Therefore, the bill could not be caught.

It is easier to catch the bill if you drop it yourself, because you anticipate the bill falling and actually start to close your fingers before the bill starts to drop.

Adapted from Catch the Dollar Bill, p. 447 *Invitations to Science Inquiry, 2nd Ed.*

Student Handout GROUP

Name: ________________________ Date: ____________

Stimulus and Response

Conditioning the Nervous System

1. What was the stimulus in the activity? ___________________________

2. What was the response? ____

3. Why did the teacher pair the strikes with the saying of “write”?

4. Why do you think that a different stimulus (the strikes with the stick) ended up causing the same response (students adding a tic to their paper)?

5. Why did everyone eventually stop writing?

Notes from class discussion:

Student Handout INDIVIDUAL

Name: ______________________ Date: ___________________ Period: _____

Training Your Virtual Dog

Conditioning the Nervous System

You will need to use a computer with internet access and sound to play this game.

1. Go to http://nobelprize.org/educational_games/medicine/pavlov/

2. Click on 'how to play' to review the procedure for the game.

3. Go back to the main page. Click on 'Play the Pavlov's Dog Game.' Play the game to try to get the dog to salivate at the sound of your horn, drum or bell.

4. Answer the following questions:
   a) What is an unconditioned response or reflex?

   ____

   ____

   ____

   b) When food was the unconditioned stimulus, what was the unconditioned response?

   ____

   c) How did you get the dog to salivate with only the sound of the instrument?

   ____

   ____

   ____

   d) Complete the sentence: When sound was the conditioned stimulus, salivating was the

   ____________________________________.

   e) If you continued to only honk the horn/strike the drum/ring the bell and not deliver food to the dog, do you think that he/she would continue salivating? Why or why not?

   ____

   ____

   ____

f) Who was Ivan Pavlov?

____

____

5. Click on 'learn more.' Read the information on this webpage to answer the following questions:

a) What is conditioning?

____

____

b) What is extinction?

____

____

c) How is Pavlov's research used in treating phobias (such as the fear of heights)?

____

____

____

____

d) What prize did Pavlov receive in 1904?

____

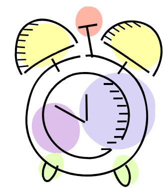
Student Handout

Name: _________________ Partner(s): _________________________ Date: __________
Period: ____

___
25

Can You Catch Me?

Testing Your Reaction Time



Objectives:

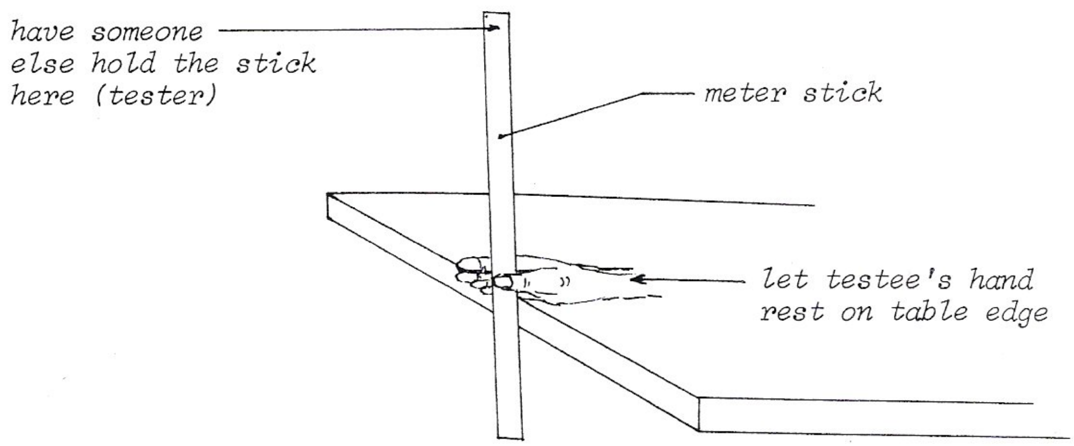
- To determine your reaction time by catching a falling object.
- To consider the factors which affect your reaction time.

Materials:

1 meter stick per group of 2 students

Procedure:

1. Rest your hand over the edge of a table. Leave a space between your thumb and forefinger of about 5 cm.
2. Have your partner hold the meter stick vertically in the space between your fingers. He/she should hold the stick at the top, as is seen in the diagram below.



3. Read off the spot where the top of your thumb is on the meter stick before your partner drops the meter stick. Read the value to one decimal place when measured in cm. Record this value in the column 'Reading on Meter Stick Before It is Dropped (cm)' in the table below. Use this position on the meter stick when starting every trial in this activity.

4. Let your partner drop the meter stick. The moment when you see the stick drop, catch the stick as fast as you can. Your wrist must remain rested on the table. After you have caught the stick, do another reading of where your thumb is. Remember to read the value where the top of your thumb grasps the stick, to one decimal place and measured in cm. Record this value in the column 'Reading on Meter Stick After It is Dropped (cm)' and in the 'Trial 1' spot.

5. Repeat step 4 for trials 2 and 3 for this activity.

6. Position your thumb at the starting position on the meter stick. Look away from the meter stick. When your partner says 'go', close your fingers as quickly as possible to catch the

meter stick. Read the value on the meter stick where you have caught it, as before. Record this under ‘Trial 1’ for activity B in your chart. Repeat for trials 2 and 3.

7. Complete three more trials, but this time, look away from the meter stick and have your partner <u>touch</u> your other hand when he/she drops the stick. Close your fingers as quickly as possible. As done for the other activities, record readings for the three trials in the chart.

8. Find the difference between the readings before and after the meter stick was caught by subtracting values. Complete the appropriate columns in your chart.

9. Find an average distance dropped for each activity by adding together the difference values for the three trials and dividing by three.

Activity	**Reading on Meter Stick Before it is Dropped (cm)**	**Reading on Meter Stick After it is Dropped (cm)**			**Difference Between Before and After Readings (cm)**			**Average Distance Dropped for this Activity (cm)**
		TRIAL 1	**TRIAL 2**	**TRIAL 3**	**TRIAL 1**	**TRIAL 2**	**TRIAL 3**	
A. When *looking* at the meter stick								
B. When *listening* for the word ‘go’								
C. When *touched* by the tester								

Chart values worth 5 marks

10. Find your reaction time for activity A – When looking at the meter stick. You will need to use the following formula to do this:

$$t = \sqrt{\left[\frac{2d}{a}\right]}$$

where t= reaction time in seconds
d = distance the meter stick falls in cm
a = acceleration due to gravity = 980 cm/s^2

Show your calculation here: **2 marks**

11. Find your reaction times for activities B and C. Show your calculations for each in the spaces below.

Calculation of reaction time for activity B – When *listening* for the word ‘go’ **2 marks**

Student Handout

Calculation of reaction time for activity C – When *touched* by the tester **2 marks**

Analysis Questions:

1. The average fingertip reaction time for humans when looking at a meter stick is between 0.20 and 0.25 seconds.
   a) How did your reaction times for activity A (looking at the meter stick) compare to this average value? **1 mark**

   ____

   ____

   b) How did your reaction times for activities B and C compare to this average? **1 mark**

   ____

   ____

   ____

   c) Do you think that your average reaction time for this activity and others would have changed if you were allowed to do more trials? Why or why not? **2 marks**

   ____

   ____

   ____

2. Which of your three reaction times is the smallest? Why do you think that this is so? **2 marks**

3. What factors in this experiment may have caused there to be error in one or more of your reaction times? In other words, what may you or your partner have done, perhaps unavoidably, that could have affected your times? List at least two sources of error. **2 errors x 2 marks/ea = 4 marks**

4. Think about activities that you do everyday. Give an example of how a distraction could slow down reaction time. **1 mark**

5. List three occupations in which reaction time is important. **3 marks**

LESSON 5.4 - NEUROLOGICAL DISORDERS

Overview:
Through research, students will learn about a neurological disorder and make a brochure on the disorder that will be used to educate others on the disease.

Suggested Timeline: 3 hours

Materials:
- Neurological Disorders (Student Handout)
- brochure on a disorder from a medical clinic OR sample of student's past work
- computers with internet access

Method:
1. Introduce the research project by showing students a brochure on a medical disorder from a medical clinic or a sample brochure made by a student in a previous class. Discuss what aspects of the brochure they find useful and what could be improved upon.
2. Hand out 'Neurological Disorders' (Student Handout) and discuss expectations for the project. Include an explanation of the grading rubric.
3. Allow students time on computers with internet access to work on their project.

Evaluation:
Grade on completed project

NEUROLOGICAL DISORDERS

A Science 21 Research Project

DUE DATE: ________________________

OBJECTIVE:
To research a specific disorder of the nervous system and make a brochure that a doctor would give to a person who has been diagnosed with the disorder. (Alternatively, you may make your target audience a parent of a child with the disorder.)

EXPECTATIONS:

STEP 1 – Choose one of the following disorders. If one that you would like to do is not on this list, check with your teacher to see if it is appropriate.

- Alzheimer's Disease
- Asperger's Syndrome
- Attention Deficit Disorder
- Autism
- Bipolar Disorder
- Cerebral Palsy
- Dyslexia
- Epilepsy
- Fetal Alcohol Syndrome
- Huntington's Disease
- Multiple Sclerosis
- Narcolepsy
- Parkinson's Disease
- Rett Syndrome
- Schizophrenia
- Spina Bifida
- Tourette Syndrome

STEP 2 – Research your disorder. Be sure to choose trustworthy online resources.

STEP 3 – What is expected in your brochure.

Information - to be included in the following order:

1. Description of the disorder – focus on the anatomy and physiology of the brain and nervous system
2. Symptoms – what can be expected in someone that has the disorder as time passes
3. Statistics – number of people with the disease (<u>in CANADA</u>, if possible) or chances of getting the disease
4. Treatment options

Format:

Student Handout

- Your brochure must be typed in font that is large enough to be easily read.
- Include pictures. Use clipart or internet sources.
- Tri-fold the brochure with printing on the back and front (to accommodate school printers, you can print out two pages and then tape them together)
- HINT – Use the following website to help you to make a brochure if using Microsoft Word:
- http://www.computorcompanion.com/LPMArticle.asp?ID=143
- You MUST include a list of at least three sources of information that you used in creating the brochure.

Notes:
Pamphlets, just like essays, have a logical order. When you fold the brochure, please ensure it is done so that your work will make sense.

DO NOT copy and paste information from your sources. Your job is to synthesize the information, put it into your own words and organize it.

Student Handout

EVALUATION:

The following rubric will be used to grade your brochure. You should read through the rubric carefully before you begin so that you clearly understand what is to be expected of you.

35

CATEGORY	SCORES →		
	10	**7**	**3**
Information – Focus • The number of facts included that relate to the disorder • The extent to which the information relates to the human nervous system **__/10**	• an extensive number of well-described facts are provided • included information relates well to what was studied in class on the nervous system	• an adequate number of facts on the disorder are included • some of the information provided relates to the nervous system	• few relevant facts on the disorder are included • the reader would likely have many questions about the disorder after having had read the brochure • a small amount of the information relates to the nervous system
Information – Audience • How well the target audience is addressed • How well the included information is written and in terms that someone with little science background would understand **__/10**	• information is clear and concise • no spelling or grammatical errors are made • information is written in a way that could be easily understood by someone with little science background, such as a patient or the parent of a patient	• some of the information in the brochure is unclear and includes too much or not enough detail • there are a few spelling +/or grammatical errors • information is too technical at times – someone with little science background could have trouble in understanding	• too much or not enough detail provided • many spelling +/or grammatical errors • information is often too technical or lacks enough detail • it is unlikely that an average reader would have a good grasp of the disorder
	5	**3**	**1**
Organization • How well the brochure is arranged so as to follow a logical order and is easy to read **__/5**	• set-up of the brochure is logical, easy to follow and organized well into appropriate sections	• most of the information in the brochure is easy to follow • the rearrangement of some sections would make reading the information easier and could possibly aid in understanding	• information in the brochure is scattered and follows an illogical sequence • the reader's understanding would be negatively affected by the lack of organization
Format and References • How well the expectations for format are followed • List of at least three references included **__/5**	• brochure is typed in font that is easy to read • appropriate pictures are included • brochure is tri-folded • 3 or more references are listed on the brochure	• brochure is typed – font choice *could* be smaller or larger to make reading easier • pictures included • brochure is tri-folded • less than three references are included	• font choice is inappropriate – much too small or large OR information is not typed at all • few or no pictures • brochure is not folded properly • 1 or no references listed
Creativity • How interesting the brochure is • The extent to which appropriate pictures and graphics are included so as to make the brochure attractive and engaging **__/5**	• brochure is interesting and engaging • information is presented in a unique way that would aid in one's understanding of the disorder	• most of the brochure is interesting • some parts of the brochure are unique	• it is unlikely that the reader would find the information in the brochure interesting • little or no attempt is made to make the brochure attractive and engaging to the reader