Cranial Nerves

HASPI Medical Anatomy & Physiology 11b

Lab Activity

Name(s): _____

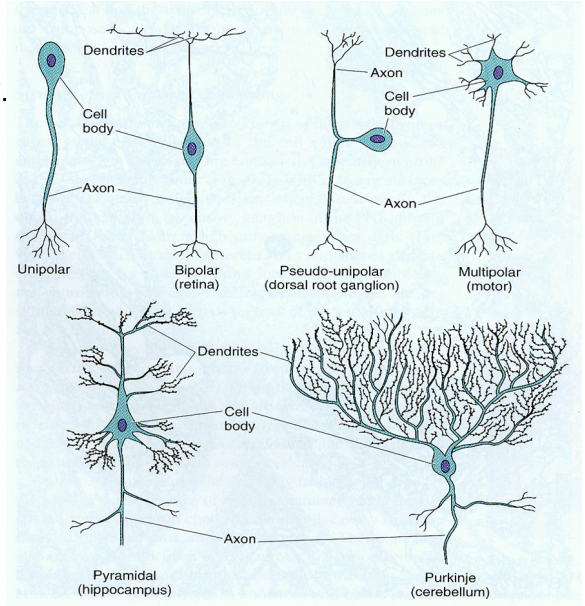
Period: _____ Date: _____

Background

Neurons

The neuron is the cell of the nervous system capable of conducting and sending nerve impulses throughout the body. All neurons share the same basic structure, including a cell body, dendrites, and axons. The cell body, or soma, holds the nucleus and major organelles of the neuron. Nerve impulses are generated in the cell body and the branch-like fibers called dendrites that extend out from the cell body. Once the nerve impulse has been generated, it flows down the dendrite, through the cell body, and down the axon.

The axon is an extension of the neuron that contacts other neurons to propagate (send or continue) the nerve impulse to its target. The axon can branch several times at its end and these branches are called axon terminals. Many axons are also coated with a lipid covering called the myelin sheath, created by Schwann cells that are responsible for insulating and speeding up nerve impulses.



http://web.as.uky.edu/biology/faculty/bonner/HISTOLOGY/Nervous%20system/Nerve%20png/nrv4.png

Just as there are many different types of cells in the body that each perform a specific function, there are also a wide variety of neurons. Neurons can be classified by shape, the direction they relay information, the neurotransmitter they produce, or the location in the body. The following table provides a few examples of different types and classifications of neurons.

Classification of Neurons	
Type of Neuron	**Description**
Direction of Impulse	
Sensory or Afferent Neurons	Have specialized receptors that receive external stimuli and send it to the CNS; the 5 senses: touch, vision, sound, taste, smell
Motor or Efferent Neurons	Transmit impulses from the CNS to glands and muscles throughout the body
Interneurons or Association Neurons	Only found in the spinal cord and brain; capable of relaying information between sensory, motor, and interneurons
Polarity of Axon and Dendrite	
Unipolar Neuron	Dendrite and axon originate from the same location
Bipolar Neuron	Has a single dendrite and an axon at opposite ends of the cell body
Multipolar Neuron	Has more than two dendrites with an axon that projects from the cell body
Shape and Location in the Body	
Purkinje	Huge neurons in the cerebellum
Basket	Found in the cortex and cerebellum
Pyramidal	Pyramid-shaped cell body
Type of Neurotransmitter Produced	
Cholinergic	Produce the neurotransmitter acetylcholine
GABAergic	Produce the neurotransmitter gamma aminobutyric acid (GABA)

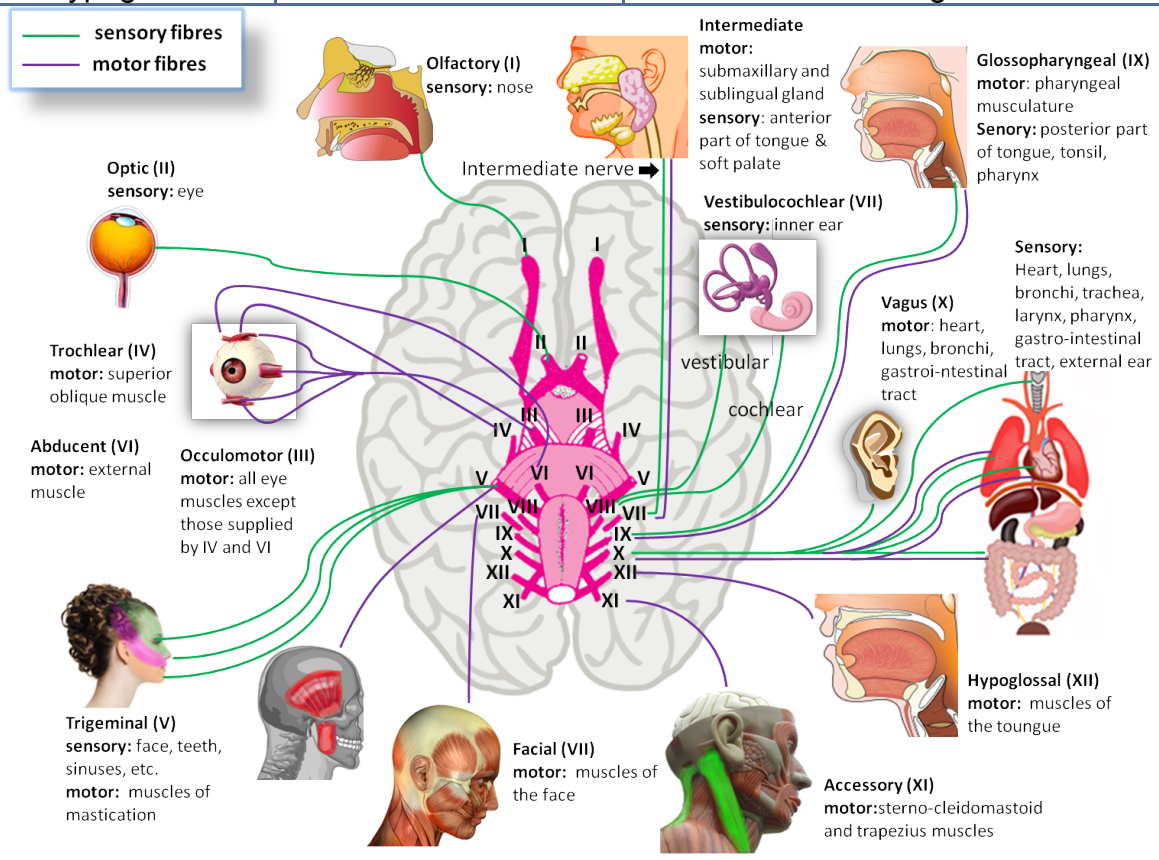
Nerves

Nerves are bundles of axons that extend out from the CNS into the body. Each axon is surrounded by a protective tissue layer called the endoneurium. Bundles of axons together in a group are called fascicles, and each fascicle is surrounded by perineurium. Bundles of fascicles are wrapped together with epineurium to make a nerve. Nerves are generally categorized into two groups depending on where they originate. Spinal nerves are connected to the spinal cord, and cranial nerves are connected directly to the brain. Humans have 31 pairs of spinal nerves and 12 pairs of cranial nerves.

The Cranial Nerves

Most of the cranial nerves extend from the brainstem at the base of the skull, but cranial nerves I and II actually extend from the cerebrum. Cranial nerves are numbered I-XII. The following table is a summary of the number, name, and function of the cranial nerves.

Cranial Nerve		Sensory or Motor	Function
I	Olfactory	Sensory	Olfaction, also known as smell
II	Optic	Sensory	Vision
III	Oculomotor	Motor	Eye movement, pupil dilation
IV	Trochlear	Motor	Eye movement
V	Trigeminal	Both	Sensation in the skin on the face and head, mastication (chewing)
VI	Abducens	Motor	Eye movement
VII	Facial	Both	Facial movement, taste, saliva, and tear secretion
VIII	Vestibulocochlear	Sensory	Balance, posture, and hearing
IX	Glossopharyngeal	Both	Swallowing, taste, and saliva secretion
X	Vagus	Both	Taste, visceral sensation
XI	Accessory	Motor	Movement of the head and shoulders
XII	Hypoglossal	Motor	Movement of the tongue



http://www.andreaurist.com/portfolio/wp-content/uploads/2011/08/brain_nerves1.png

Procedure

Physical examination of the cranial nerves during a medical assessment is common when examining the eyes, ears, nose, throat, neck, and head. The following lab will allow you to test the function of each of your cranial nerves.

Select a partner to test the function of your cranial nerves. Repeat all of the tests on your partner and yourself. Some of these tests do not require any supplies, but your instructor will have materials available for the ones that do.

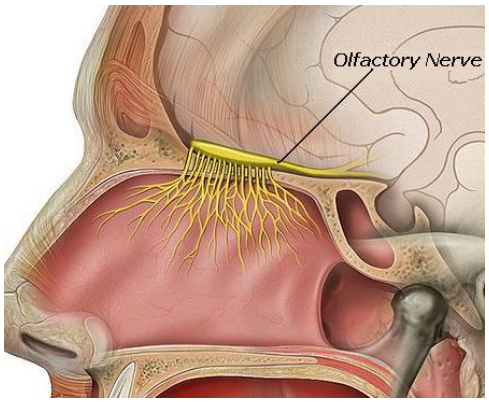
I Olfactory Nerve - Smell

The olfactory nerves end in the upper portion of the nasal cavity. The end of the olfactory nerves form the olfactory bulbs located at the back of the nose and are sensitive to scent.

Materials: Essence A, B, and C		✔when complete
Step 1	Essence A, B, and C contain very common scents.	
Step 2	Remove the lid from Essence A, plug your right nostril, and hold Essence A up to your left nostril.	
Step 3	Record what you smell in Table 1. Replace the lid on Essence A.	
Step 4	Repeat steps 2 and 3 for Essence B and C.	
Step 5	Repeat steps 2-4 but instead by plugging the left nostril and holding the essence up to the right nostril.	

Table 1. Olfactory Smells

Essence	Right Nostril *What do you smell?*	Left Nostril *What do you smell?*
A		
B		
C		



http://upload.wikimedia.org/wikipedia/commons/3/3a/Head_olfactory_nerve.jpg

Damage to the olfactory nerve and/or nasal epithelium can cause anosmia, or an inability to smell. Anosmia can be caused by infection, inflammation, cocaine use, or smoking. Head injury or tumors can also impair the function of the olfactory nerve.

II Optic Nerve - Vision

The optic nerves end at the back of the eyes at the retina. Receptors in the retina are capable of receiving light and color to create vision.

Materials: Snellen eye chart, meter stick, pen/pencil ✔when complete

Visual Acuity

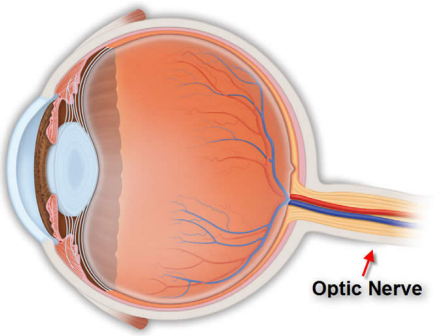
Step 1	Stand 10 feet away from the Snellen eye chart.	
Step 2	Cover your right eye and read each line out loud starting from the top.	
Step 3	Have your partner watch the chart to determine if you are reading the letters/numbers correctly.	
Step 4	Continue moving down and reading each line until you make a mistake. Whatever line you make a mistake on, your vision will be the line above. For example, if you make an error on line 7 your vision would be 20/30.	
Step 5	Record your vision for your left eye in Table 2.	
Step 6	Repeat steps 1-4 covering your left eye and record the vision for your right eye.	

Peripheral Vision

Step 1	Have you and your partner sit directly across from each other about 2 feet away.	
Step 2	Cover your right eye and look directly at your partner.	
Step 3	Have your partner hold a pencil/pen vertically about 6 inches away from your left eye and slowly move it to the right.	
Step 4	Make sure to look straight at your partner. Do not track the pencil. Say stop when the pencil/pen disappears from your peripheral vision.	
Step 5	Use the meter stick to measure from the side of your left temple to the pencil to determine the approximate distance that your peripheral vision extends. Record this measurement in cm in Table 2.	
Step 6	Repeat steps 1-5 covering the left eye and moving the pencil/pen to the left.	

Table 2. Vision

Visual Acuity		
Vision (Snellen eye chart, e.g. 20/20)	**Left Eye**	**Right Eye**
Peripheral Vision		
Distance Peripheral Vision Extends (cm)	**Left Eye**	**Right Eye**



http://www.jovkar.com/images/opticnerve_000.jpg

Blindness, or loss of vision, can be caused by a large variety of factors. Loss of vision in portions of the visual field can often be attributed to lesions or tumors around the retina or optic nerve. Blindness in only a portion of your vision is called hemianopia.

III Oculomotor, IV Trochlear, & VI Abducens Nerves - Eye Movement

There are six muscles that control the movement of the eye. The oculomotor nerve controls the inferior oblique muscle and the superior, medial, and inferior recti muscles. The trochlear nerve controls the superior oblique muscle. The abducens nerve controls the lateral rectus muscle. The oculomotor nerves also control muscles within the eyelid and pupil. Due to the similar function of these three cranial nerves, they are tested together.

Materials: Penlight ✔when complete

Eye Movement

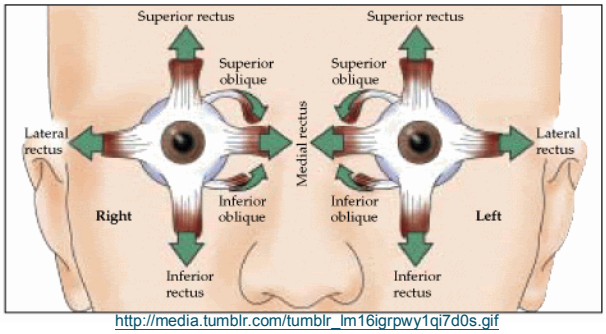
Step 1	Face your partner approximately 2 feet apart.	
Step 2	Hold up your forefinger about 18 inches in front of your partner's eyes.	
Step 3	Tell your partner to follow your finger with both eyes and not to move his/her head.	
Step 4	Watch your partner's eyes as you draw a + with your finger by moving it up and down then left to right. Draw an X with your finger as well.	
Step 5	The eyes should move smoothly and together. Record your observations in Table 3.	

Pupil Constriction

Step 1	Have your partner cover the left eye and shine the penlight into his or her right pupil from approximately 6 inches away.	
Step 2	The pupil should immediately constrict. Record your observations in Table 3.	
Step 3	Repeat steps 1 and 2 with the left pupil.	
Step 4	Now have your partner uncover both eyes and shine the penlight into the right pupil while watching the LEFT PUPIL. Even when shining the light in the other pupil, there is a pupillary reflex that causes both pupils to constrict or dilate at the same time. A lack of pupillary response, and therefore pupils of a different size, may indicate head trauma or injury.	
Step 5	Record whether your partner had a pupillary response in Table 3.	

Table 3. Eye Movement & Pupil Constriction

Eye Movement *Did the eyes follow quickly and smoothly or was the response delayed and/or bouncing?*		
Pupil Constriction *Did the pupil constrict quickly in response to light or was it delayed?*	**Left Eye**	**Right Eye**
Pupillary Response *Did the opposite pupil constrict in response to light?*		



http://media.tumblr.com/tumblr_lm16igrpwy1qi7d0s.gif

Any rapid involuntary movement of the eye (nystagmus) is caused by weakness in the muscles surrounding the eye. It may appear as if the eye is "bouncing" back and forth slightly. Unequal pupils, or anisocoria, can be hereditary or may indicate head trauma, multiple sclerosis, or hemiparalysis. Some medications may also cause pupils to become unreactive to light.

V Trigeminal Nerve - Facial Skin Sensation and Chewing

The trigeminal nerve has both motor and sensory fibers. The motor portion innervates muscles involved in chewing, while the sensory portion receives touch, heat, cold, pressure, and pain stimuli in parts of the face and mouth.

Materials: Cotton ball and ice water ✔when complete

Motor Function

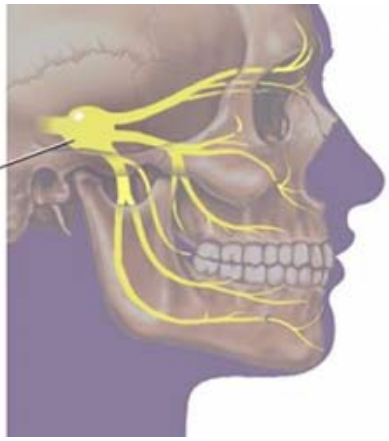
Step 1	The two major muscles involved in chewing, or mastication, are the temporalis and masseter.	
Step 2	Have your partner face you and hold your fingers lightly on his or her temples. Ask your partner to clench and release the jaw three times and feel for the temporalis muscle contraction. The contraction should feel the same on both sides. Record your observations in Table 4.	
Step 3	Hold your fingers at the back of your partner's jaw. Ask him or her to clench and release the jaw three times and feel for the masseter muscle contraction. The contraction should feel the same on both sides. Record your observations in Table 4.	

Sensory Function

Step 1	Have your partner face you and close his or her eyes.	
Step 2	Using the cotton ball, lightly touch the following parts of his or her face. Have your partner say "yes" when he or she feels the cotton ball touching the face. • Forehead • Nose • Right and left temple • Right and left cheek • Right and left jaw	
Step 3	Record your observations in Table 4.	
Step 4	Your partner's eyes should still be closed. Place the cotton ball in ice water and lightly touch the same locations as in step 2. Only have your partner say "yes" if he or she feels cold, not touch. Record your observations in Table 4.	

Table 4. Motor & Sensory Function

	Temporalis	Masseter
Was the muscle contraction even on both sides?		
	Cotton Ball *Put a + if the cotton was felt in each part of the face or a – if it was not.*	**Cotton Ball w/ Ice Water** *Put a + if cold was felt in each part of the face or a – if it was not.*
Forehead		
Nose		
Right & left temple		
Right & left cheek		
Right & left jaw		



http://uvahealth.com/Plone/ebsco_images/7502.jpg

Damage to the trigeminal nerve may affect an individual's ability to chew on the motor side and/or cause anesthesia of the face on the sensory side. In addition, irritation of the trigeminal nerve can cause trigeminal neuralgia, which can cause constant pain in the associated sensory neurons.

VII Facial Nerve - Facial Movement and Taste

The facial nerve has both sensory and motor fibers. The sensory portion receives taste stimuli from the front 67% of the tongue, while the motor portion innervates muscles in the face and stimulates the salivary glands.

Materials: Cotton swab and sugar solution ✔when complete

Sensory Function

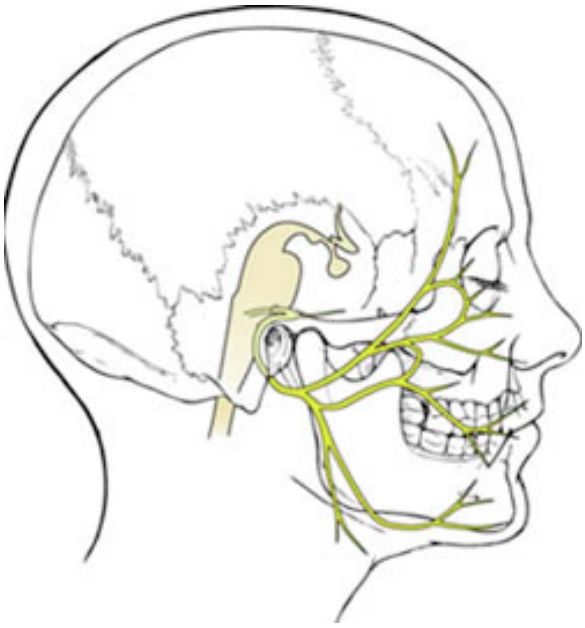
Step 1	Place the cotton swab in the sugar solution.	
Step 2	Have your partner extend his or her tongue and touch the cotton swab to the front, middle, left side, and right side of your partner's tongue. Record whether he or she tasted sugar in each of these locations in Table 5.	
Step 3	Discard the cotton swab after use!	

Motor Function

Step 1	Ask your partner to make each of the following facial expressions. Watch for each movement to be the same on each side of the face and note any asymmetrical expressions in Table 5. • Smile • Cross the eyes • Frown • Close both eyes tightly • Raise the eyebrows	

Table 5. Sensory & Motor Function of the Facial Nerve

	Sugar Taste *Did partner taste sugar – yes or no?*
Front	
Middle	
Left side	
Right side	
	Facial Expression *Was the facial expression symmetrical or asymmetrical?*
Smile	
Cross the eyes	
Frown	
Close both eyes tightly	
Raise the eyebrows	



http://www.daviddarling.info/images/facial_nerve.jpg

Damage to the facial nerve may result in some facial paralysis, and often occurs on only one side of the face. The affected side of the face often droop and will have little to no muscle control. This could be caused by an infection or tumor of the facial nerve and/or surrounding tissue, or a stroke.

VIII Vestibulocochlear Nerve - Balance and Hearing

The vestibulocochlear nerve actually separates and extends into the cochlear nerve and vestibular nerve. Both of these extensions are sensory. The cochlear nerve receives sound stimuli in the cochlea of the inner ear, and the vestibular nerve receives stimuli allowing the brain to determine the position of the body and balance.

Materials: Timer and tuning fork ✔when complete

Cochlear Nerve

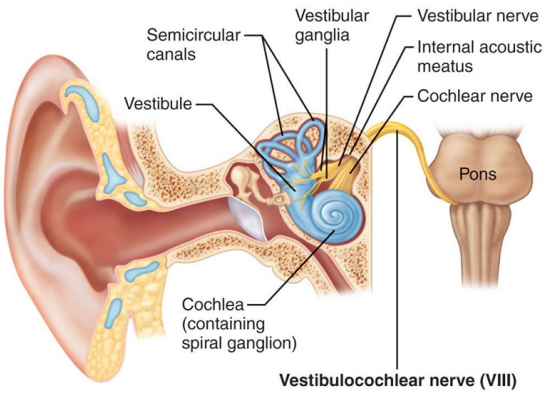
Step 1	Go to the following website: http://www.onlinetuningfork.com/. *(NOTE: an actual tuning fork can also be used for this test; only record time in applicable row.)*	
Step 2	Turn the volume up all the way on the computer. Have your partner cover the left ear and click on the E (329.6 Hz) tuning fork. Start the timer at the same time.	
Step 3	Have your partner say "STOP," and stop the timer when he or she can no longer hear the sound from the tuning fork. Record the time in Table 6.	
Step 4	Repeat steps 2 and 3 covering the right ear.	
Step 5	Repeat this activity for tuning fork A (440 Hz) and tuning fork C (523.3 Hz).	
Step 6	The time for each ear should be roughly the same and a difference of more than 5 seconds may indicate a degree of hearing damage or loss.	

Vestibular Nerve

Step 1	Have your partner spin around 10 times. Stand close and watch him or her carefully to make sure he or she does not fall over or run into anything.	
Step 2	Immediately have your partner stop and observe his or her eyes. You should still see some rapid eye movement in response, as the brain still thinks the body is spinning. It will take a few seconds for the eye movement to stop and the brain to acknowledge that the body is standing still.	
Step 3	Record your observations in Table 6.	

Table 6. Cochlear & Vestibular Nerves

	Right Ear Time (s)	Left Ear Time (s)
Tuning Fork E *(329.6 Hz)*		
Tuning Fork A *(440 Hz)*		
Tuning Fork C *(523.3 Hz)*		
Was rapid eye movement present or absent following spinning? Describe what you observed.		



http://antranik.org/wp-content/uploads/2011/11/vestibulocochlear-nerve-vestibular-cochlear-semicircular-canals-ganglia.jpg

Hearing loss can be caused by trauma or damage to the eardrum, infection or inflammation of the middle or inner ear, and damage to the cochlear nerve. A build-up or blockage of fluid or wax can also affect hearing ability. In addition, an infection or trauma to the middle ear can result in vertigo and dizziness caused by the inability of the brain to determine the correct body position.

IX Glossopharyngeal & X Vagus Nerves - Swallowing, Taste, and Internal Organ Sensation

The glossopharyngeal and vagus nerves both have sensory and motor fibers. The sensory portion of the glossopharyngeal nerve receives stimuli from the back 33% of the tongue, and stimuli from blood content and pressure from the carotid artery. The motor portion of the glossopharyngeal nerve innervates muscles in the soft palate, pharynx, and larynx that function in swallowing and speech.

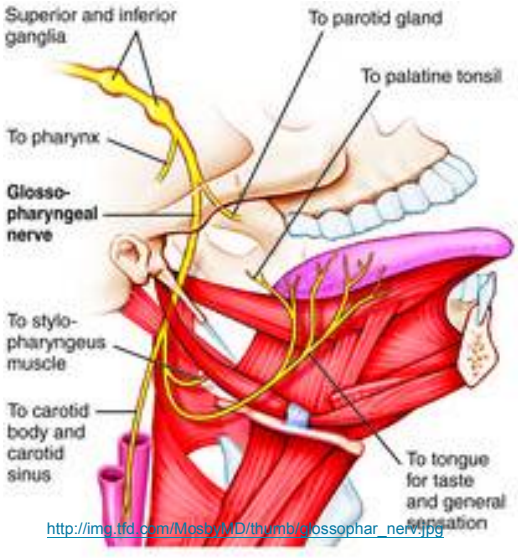
The motor portion of the vagus nerve also innervates muscles in the pharynx and larynx, but also controls several involuntary muscles in the intestines, stomach, esophagus, bronchi, pancreas, and heart. The sensory portion of the vagus nerve is also connected to these internal organs. Because of the similar functions of these nerves, they are often tested together.

Materials: Cotton swab and tongue depressor

		✔when complete
Step 1	Rest your hand lightly on your partner's throat and have him or her swallow. You should feel a slight up/down movement as the epiglottis opens and closes. Record your observations in Table 7.	
Step 2	Have your partner open his or her mouth. Hold down the tongue with the tongue depressor.	
Step 3	Use the cotton swab to VERY CAREFULLY and lightly touch the uvula at the back of the throat. This should initiate the gag reflex if these nerves are working correctly. Record your observations in Table 7.	
Step 4	Continue to hold down the tongue with the tongue depressor and have your partner say "AH." Observe the movement of the uvula and record your observations in Table 7.	
Step 5	Discard the cotton swab and tongue depressor.	

Table 7. Swallowing, Gag Reflex, & Vocalization

How did the throat feel when your partner swallowed?	
What happened when you touched the uvula with a cotton swab? Why?	
How did the uvula move when your partner said "ah"?	



http://img.tfd.com/Mosby/MD/thumb/glossophar_nerv.jpg

Absence of a gag reflex may be the result of a tumor or lesion on one side of the brain near these nerves. In addition, paralysis of the glossopharyngeal and/or vagus nerves will cause the uvula to move, or deviate, to one side when sound is made.

XI Accessory Nerve - Movement of Head and Shoulders

The accessory nerves are motor fibers that innervate multiple muscles of the head and shoulders. The trapezius and sternocleidomastoid muscles are two of these. The trapezius elevates the shoulders, while the sternocleidomastoid turns the head side to side.

Materials: None ✔when complete

Trapezius Muscle

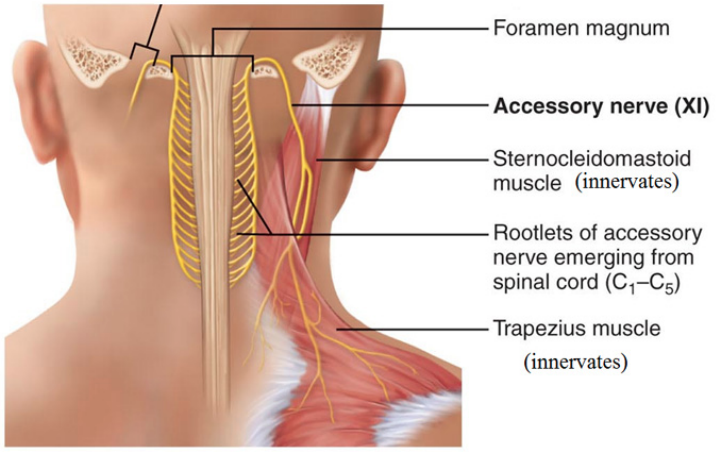
Step 1	Place both hands on your partner's shoulders.	
Step 2	Ask your partner to shrug both shoulders as you press down.	
Step 3	The muscle strength should feel the same on both sides. Record your observations in Table 8.	

Sternocleidomastoid Muscle

Step 1	Lightly rest your hand on the right side of your partner's neck and ask him or her to turn the head to the left. Feel for the contraction of the sternocleidomastoid muscle.	
Step 2	Repeat by holding your hand on the left side of your partner's neck and have him or her turn the head to the right.	
Step 3	Both muscles should feel the same and contract equally. Record your observations in Table 8.	

Table 8. Trapezius & Sternocleidomastoid Muscles

Did the trapezius muscle have the same strength on both sides? Explain what you felt.	
Did the sternocleidomastoid muscle contract equally on both sides? Explain what you felt.	



http://antranik.org/wp-content/uploads/2011/11/accessory-nerve-xi-rootlets.jpg

Injury or damage to the accessory nerves can result in diminished function in portions of the trapezius and sternocleidomastoid muscles. Excessively drooping weak shoulders, inability to smoothly turn the head, or an asymmetrical neckline are indicative of damage to the accessory nerves.

XII Hypoglossal Nerve - Movement of the Tongue

The hypoglossal nerve contains motor fibers that innervate the tongue and allow movement. As a result, the hypoglossal nerve functions in speech and eating.

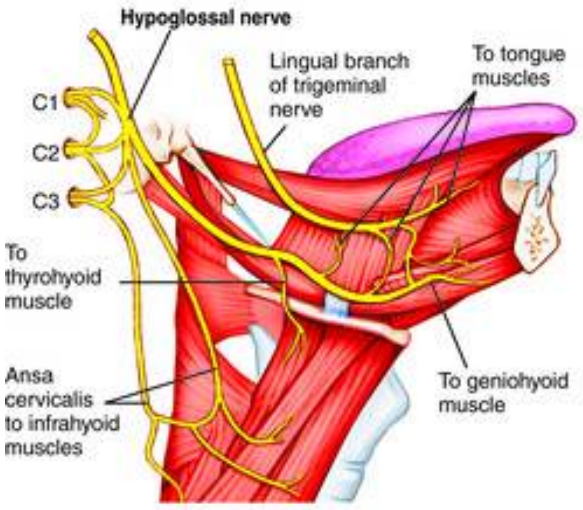
Materials: None ✔when complete

Step 1	Ask your partner to stick out his or her tongue. The tongue should be perfectly oriented in the middle of the mouth and any deviation left or right may indicate an issue with the hypoglossal nerve.	
Step 2	Ask your partner to move the tongue to the right, left, up, and down. The movement should be quick and the tongue should extend the same distance right/left and up/down. Record your observations in Table 9.	
Step 3	Ask your partner to repeat the following statement: *There was a fisherman named Fisher* *who fished for some fish in a fissure.* *'Til a fish with a grin,* *pulled the fisherman in.* *Now they're fishing the fissure for Fisher.*	
Step 4	Note any speech issues. The movement of the tongue is necessary to correctly form consonant and vowel sounds. Record your observations in Table 9.	

Table 9. Tongue Movement

	Was the movement quick and did the tongue extend the same distance in each direction? Explain what you observed.
Right	
Left	
Up	
Down	

Was the speech normal and consonant and vowel sounds normal? Explain what you heard.



http://img.tfd.com/MosbyMD/thumb/hypoglossal_nerve.jpg

Injury or damage to the hypoglossal nerve can result in deviation of the tongue to one side or the other. Long-term damage will result in muscle atrophy of one side of the tongue.

Analysis Questions - *on a separate sheet of paper complete the following*

1. What is the function of the olfactory nerves? Hypothesize why smell might be slightly different between the right and left nostril.
2. What is the function of the optic nerves? Why do you think vision gets worse as we age?
3. What is the function of the oculomotor nerves?
4. What is the function of the trochlear nerves?
5. What is the function of the abducens nerves?
6. Why does the pupil constrict in response to light?
7. What is the function of the trigeminal nerves? Hypothesize why you might not have feeling in a portion of your face.
8. What is the function of the facial nerves? What might you suspect is the problem if you were unable to taste anything at the back of the tongue?
9. What is the function of the vestibulocochlear nerves? List 2 things that might cause hearing loss.
10. What is the function of the glossopharyngeal nerves?
11. What is the function of the vagus nerves? Why might the lack of a gag reflex be an issue?
12. What is the function of the accessory nerves?
13. What is the function of the hypoglossal nerves?

14. Indicate the cranial nerve(s) that are involved in the following functions:
   a. Movement of the eyes
   b. Sense of hearing
   c. Sense of smell
   d. Shrugging the shoulders
   e. Sense of sight
   f. Sense of taste
   g. Sense of equilibrium
   h. Sensory impulses from the teeth
   i. Adjusting the amount of light entering the eyes
   j. Stimulating salivary secretion
   k. Smiling
   l. Tongue movement

15. Damage or injury of which cranial nerve(s) could lead to the following:
   a. Drooping shoulders
   b. Inability to turn the head
   c. Vertigo
   d. Muscle atrophy in half of the tongue
   e. Facial paralysis
   f. Nystagmus (involuntary eye movement)
   g. Anosmia (inability to smell)
   h. Inability to smile
   i. Anisocoria (unequal pupils)
   j. Blindness
   k. Hemianopia (partial blindness)
   l. Neuralgia of the face (pain in the face)
   m. Lack of gag reflex
   n. Hearing loss

16. Create a mnemonic AND a drawing of the mnemonic to remember the names of the 12 cranial nerves. Example:

   Oh **O**dorous **O**dors **T**he **T**aiwan **A**lbino **F**ig **V**iper **G**ives **V**ultures **A**wful **H**eadaches!

17. **CONCLUSION**: In 1-2 paragraphs summarize the procedure and results of this lab.

Review Questions - *on a separate sheet of paper complete the following*

1. What is the function of the neuron?
2. Draw and label a neuron including the soma, dendrites, axon, myelin sheath, and Schwann cells.
3. What is the difference between a sensory, motor, and interneuron?
4. What is the difference between a unipolar, bipolar, and multipolar neuron?
5. What is a nerve?
6. What is the difference between the endoneurium, perineurium, and epineurium?
7. What is the difference between spinal nerves and cranial nerves? How many do humans have of each?
8. Which cranial nerves are involved in vision and eye movement?
9. Which cranial nerves are involved in taste and smell?
10. Which cranial nerves are involved in movement of the face, tongue, and head?