

Chapter Ten

Peripheral Nervous System



Day One:

Today, your child should complete their reading and practice problems for the week.

Below are the supplies for this week's lab:

Sugar
One lemon
Spoon
Glass of water

Saltine crackers
Tonic water with quinine
Four drinking glasses

National Science Education Standards covered this week:

12CLS6.1 Multicellular animals have nervous systems that generate behavior. Nervous systems are formed from specialized cells that conduct signals rapidly through the long cell extensions that make up nerves. The nerve cells communicate with each other by secreting specific excitatory and inhibitory molecules.

Definitions

abducens nerve	cranial nerve; responsible for the abduction of the eye
autonomic nervous system	responsible for all of the involuntary activity in the body
cervical nerves	spinal nerve; responsible for functions pertaining to the head, neck, and shoulders
enteric nervous system	localized solely within the smooth muscle tissue of the digestive system
facial nerve	cranial nerve; responsible for the function of facial expressions, taste, secretion of tears and saliva
glossopharyngeal nerve	cranial nerve; responsible for the function of taste, swallowing and secretion of saliva
hypoglossal nerve	cranial nerve; responsible for the movement of tongue during speech and swallowing
lumbar nerves	spinal nerve; responsible for functions pertaining to tissues found within the lower abdomen and all lower extremities
oculomotor nerve	cranial nerve; responsible for the movements of the eye, eyelid, pupil, and lens
olfactory nerve	cranial nerve; responsible for the function of smell
optic nerve	cranial nerve; responsible for the function of vision
parasympathetic nervous system	helps the body to conserve energy and tends to slow the heart rate
sacral and coccygeal nerves	spinal nerve; responsible for functions pertaining to the hips, tail bone, buttocks, rectum, anus, and sex organs
somatic nervous system	nerves which connect the brain and spinal cord to structures such as the skin and the skeletal muscles; works with voluntary muscles only
spinal accessory nerve	cranial nerve; responsible for the function of voice production; movement of head and shoulders
sympathetic nervous system	known as the "fight or flight" system because it usually increases the alertness and generally prepares the body to deal with emergencies

thoracic nerves	spinal nerve; responsible for functions pertaining to tissues found between the shoulders and small intestines
trigeminal nerve	cranial nerve; responsible for the sensations to the face and regulates the act of chewing
trochlear nerve	cranial nerve; responsible for the rotation of the eye
vagus nerve	cranial nerve; responsible for the function of swallowing, coughing, and voice production; also monitors blood pressure and oxygen and carbon dioxide levels in blood
vestibulocochlear nerve	cranial nerve; responsible for the function of hearing and balance of the body

Sample questions to ask your child after completing the weekly reading.

Which type of nerves are associated primarily with functions within the head?

Cranial nerves

Which subsection of the nervous system is responsible for all involuntary movements and what divisions can it be broken down into?

The autonomic nervous system is responsible for all of the involuntary activity in the body and consists of the sympathetic nervous system, parasympathetic nervous system, and the enteric nervous system

What is the main difference between the somatic and autonomic nervous systems?

The somatic nervous system works with voluntary muscles such as skeletal muscles while the autonomic nervous system deals with involuntary muscles such as cardiac and smooth muscles.

Which of the two nervous systems typically have opposing actions towards each other?

The sympathetic and parasympathetic systems typically have opposing actions.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the lab activity and start collecting all of the necessary materials!

Answer Key for Practice Problems

Vocabulary Review

- | | |
|----------------------------|------------------------------------|
| 1) facial nerve | 12) trigeminal nerve |
| 2) vestibulocochlear nerve | 13) parasympathetic nervous system |
| 3) olfactory nerve | 14) sympathetic nervous system |
| 4) vagus nerve | 15) enteric nervous system |
| 5) glossopharyngeal nerve | 16) somatic nervous system |
| 6) optic nerve | 17) autonomic nervous system |
| 7) spinal accessory nerve | 18) cervical nerves |
| 8) hypoglossal nerve | 19) sacral and coccygeal nerves |
| 9) abducens nerve | 20) thoracic nerves |
| 10) trochlear nerve | 21) lumbar nerves |
| 11) oculomotor nerve | |

Multiple Choice

- | | |
|------|------|
| 1) A | 4) A |
| 2) C | 5) A |
| 3) A | 6) D |

Application Questions

Given the fact that Lindsay was most likely feeling as though she was in an emergency situation, her involuntary autonomic nervous system likely enacted her sympathetic nervous system to react. This "fight or flight" response most likely involved her rapid heartbeat at the time of the scary event along with the presence of goosebumps. It would be a good inference to assume that the development of goosebumps in this situation is a product of the sympathetic nervous system.

Day Three: Lab Activity

Your child should have already read through this lab and has been reviewing all of this week's vocabulary words.

Collect your supplies for the lab:

Sugar
One lemon
Spoon
Glass of water
Saltine crackers
Tonic water with quinine
Four drinking glasses

Scrambling the PNS and the CNS or...

It's not supposed to do that!

The ability to perceive flavors that are not actually present will be demonstrated in this activity.

Materials:

Sugar

One lemon

Spoon

Glass of water

Saltine crackers

Tonic water with

quinine

Four drinking glasses

Procedure:

Part One:

- 1) Sip on the water then suck on the slice of lemon. It should taste very sour.
- 2) Take another drink of water. The water should taste sweet.
- 3) Place a small amount of sugar on a spoon and coat your tongue for 10-20 seconds.
- 4) Take another drink of water. The water should taste sour now.
- 5) Chew on a saltine cracker and give your tongue a brief rest before tackling the next session.

Part Two:

- 6) Fill the four drinking glasses with approximately 6 ounces (177mL) of tonic water and label them #1-4.
- 7) Place a pinch of salt in glass #2, a half teaspoon in glass #3, and a full teaspoon in glass #4.
- 8) Take a sip from glass #1. It should taste bitter to you.
- 9) Take sips from glasses #2-4 in that order and note the difference in bitterness as you progress through the glasses. The bitterness should continually diminish.
- 10) Chew on a cracker and wait a few minutes before going to the next step.

Part Three:

- 11) Reverse the order from the previous activity. Sip from glass #4 first, then #3, #2, and finally #1. Did you experience any change in sensations from steps 6-9?

Explanation:

Three different cranial nerves carry nerve impulses concerning the sensations of taste to the brainstem: facial nerve, glossopharyngeal nerve, and the vagus nerve. These nerve impulses, which originate within the peripheral nervous system on the tongue, include the sensations of sweet, salty, sour, bitter, and umami. Although certain foods are unmistakably sweet or sour based upon the presence of sugar and salt, it has been demonstrated in this activity that our perception of flavor can be altered by the central nervous system.

The possibly confusing perceptions of "sweet and sour water" in the first experiment are an example of **carryover and adaptation**. Food researchers have coined this phrase as it refers to the perception of a stimulus that is impacted by the stimulus directly preceding it. You may have also experienced this phenomenon during the third part of this activity as the bitterness of quinine was perceived to be altered depending upon the order in which you drank the tonic water solutions.

The theory of carryover and adaptation has practical applications in the home when planning a meal. If more than one course is to be served, the tastes from the first course can dramatically affect those within the second course.

Complementary pairs of the sensations of sweet, salty, bitter, and sour can be served together in order to balance the flavor of a meal. For example:

To complement the sensations of...	...you can serve the following foods which combine them naturally...	...or combine different foods to complement the flavors:
Salty and Sour	Pickles	Salad dressings
Salty and Sweet	Seaweed	Chocolate covered pretzels
Sour and Sweet	Oranges	Lemonade
Bitter and Sour	Cranberries or grapefruit	Tonic water with quinine and lime
Bitter and Sweet	Parsley or Granny smith apples	Coffee with sugar
Bitter and Salty	(N/A)	Mustard greens with bacon

There are other ways you can “trick” the central nervous system by complementing the foods you eat. The following chart can help you out:

Is the food you have prepared...	...you can add foods/spices with the following flavor:
...too sweet?	Add a sour flavor like lemon or vinegar. Sour flavors tend to balance the sweetness of most foods. Check out the ingredients of many candies and it is very likely you will find some form of acid (sour).
...too sour?	Add a dash of sweetness to your food to balance the sourness. This doesn't mean you have to sweeten your food. A little goes a long way. Anyone who has made spaghetti sauce knows the best way to curb the sourness within the acids of tomatoes is with a pinch of sugar!
...too salty?	It is almost impossible to reduce the amount of saltiness within food. However, you can partially block the sensation of salt by preventing it from reaching the taste buds. How? Add a little fat in the form of butter or oil. This will coat the tongue very well and prevent some of the salt from being perceived.
...too bitter?	You just learned in this week's activity that the way to reduce the bitterness of a food is to add a little salt. However, another trick is to warm the food a little bit. If you have ever tasted the difference between hot and cold coffee you know exactly what I am talking about. Warm temperatures hide bitter tastes.

Chapter Eleven

Sense Organs



Day One:

Today, your child should complete their reading and practice problems for the week.

Below are the supplies for this week's lab:

Blue food coloring
Magnifying glass
Paper cup
2 cotton swabs
Flashlight

One sheet of 3-hole punched notebook paper
One sheet of blank white paper
Scissors
2-paper towels or napkins
Digital camera (optional)

National Science Education Standards covered this week:

12CLS6.1 Multicellular animals have nervous systems that generate behavior. In sense organs, specialized cells detect light, sound, and specific chemicals and enable animals to monitor what is going on in the world around them.

Definitions

alkaline	non-acidic compounds
auditory canal	a 1 inch (2.5 cm) tube within the pinna of the external ear
auditory ossicles	three small bones within the tympanic cavity known as the malleus (hammer), the incus (anvil), and stapes (stirrup); vibrations from these bones induce vibrations within the cochlea
chemoreceptors	sensory receptor which responds to chemical compounds such as odor molecules
cilia	branches of fingerlike projections from the cell body of dendrites; responsible for identifying specific chemicals
cochlea	spiral-shaped fluid-filled chamber within the inner ear whose mechanoreceptors transmit nerve impulses to the CNS concerning our sense of hearing
cold receptors	nerve endings within the skin that are sensitive to temperatures that fall under 50°F (10°C)
cones	photoreceptors in the retina; specialized for vision in bright light and can detect color
cornea	refracts (bends) and focuses light rays (much like the lens of a camera or telescope) into the pupil
eardrum (tympanic membrane)	divides the external ear from the middle ear; vibrations from this membrane induce the mechanical act of hearing
eustachian tube	tube which connects the middle ear to the throat and maintains air pressure between both sides of the eardrum
external ear	the visible part of the ear
general senses	senses that can generally be found throughout our body as they are associated with the skin
incus	one of three small bones in the ear known as the "anvil" within the middle ear that induces the sensation of hearing through its vibration
inner ear	contains the cochlea; site where vibrations from middle ear are transferred into nerve impulses

iris	changes the size of the pupil thereby regulating the amount of incoming light; colorful part of the eye
lens	refracts (bends) incoming light as well; focuses light onto the retina
malleus	one of three small bones in the ear known as the "hammer" within the middle ear that induces the sensation of hearing through its vibration
mechanoreceptors	sensory receptor which responds to changes in pressure or movement
middle ear (tympanic cavity)	a small, air-filled space within the skull which contains the tympanic membrane and three small bones (auditory ossicles)
optic nerve	transmits nerve impulses to the brain
pain receptors	sensory receptor which responds to stimuli that result in the sensation of pain
papillae	visible mushroom-shaped projections on your tongue which contain taste buds
photoreceptors	sensory receptor which responds to light
pinna	funnel-shaped structure within the center of the visible, external ear
pupil	black part of the eye which allows light to enter the eyeball
retina	absorbs light; forms nerve impulses which are transmitted to brain
rods	photoreceptors in the retina; specialized for vision in dim light and cannot detect color
sclera	white part of the eye; maintains the eye's shape
special senses	senses produced by very specific organs found only in certain areas of the body; includes the senses of smell, hearing, vision, taste, and balance
stapes	one of three small bones in the ear known as the "stirrup" within the middle ear that induces the sensation of hearing through its vibration
taste buds	bundles of specialized cells located on the surface of the tongue, the roof of the mouth, and within the throat

taste hairs	specialized structures on the surface of taste buds which identify specific molecules
thermoreceptors	sensory receptor which responds to changes in temperature
umami	a flavor associated with a particular chemical called monosodium glutamate (MSG)
warm receptors	nerve endings within the skin that are sensitive to temperatures above 113°F (45°C)

Sample questions to ask your child after completing the weekly reading.

Sensory receptors signal the CNS through which type of neuron - afferent or efferent?

Afferent nerves are used to send information to the CNS.

How are chemoreceptors different from normal nerve cells?

These sensory receptors do not contain dendrites but branches of fingerlike projections from the cell body called cilia which contain attachment sites for molecular "keys" found on the surface of inhaled objects.

What is the similarity between taste hairs and chemoreceptors on the tongue?

Both are able to detect specific molecules using a similar "lock and key" mechanism.

How does the ear maintain equal amounts of air pressure on both sides of the tympanic membrane?

When our bodies experience an increase in air pressure, the eardrum is pushed inward and causes a decrease in hearing; however, as more air is allowed to pass through the Eustachian tube (an open chamber linking the middle ear with the throat), the air pressure inside the tympanic cavity can increase as well. This results in our eardrum being forced back to its normal position. In this instance, we experience the "popping" of our ears.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the lab activity and start collecting all of the necessary materials!

Answer Key for Practice Problems

Vocabulary Review

- | | | |
|------------------------------------|----------------------|-----------------------|
| 1) auditory canal | 13) warm receptors | 26) chemoreceptors |
| 2) umami | 14) alkaline | 27) photoreceptors |
| 3) middle ear
(tympanic cavity) | 15) incus | 28) pain receptors |
| 4) retina | 16) malleus | 29) taste hairs |
| 5) pupil | 17) stapes | 30) cochlea |
| 6) cilia | 18) cones | 31) external ear |
| 7) taste buds | 19) rods | 32) auditory occicles |
| 8) iris | 20) cornea | 33) optic nerve |
| 9) inner ear | 21) lens | 34) eustachian tube |
| 10) eardrum | 22) special senses | 35) papillae |
| 11) pinna | 23) general senses | 36) sclera |
| 12) cold receptors | 24) mechanoreceptors | |
| | 25) thermoreceptors | |

Multiple Choice

- | | |
|------|------|
| 1) C | 5) C |
| 2) A | 6) T |
| 3) B | 7) T |
| 4) D | |

Application Questions

By removing the polyps, some of the cilia attached to epithelium of the sinuses was likely damaged or removed as well. This decreases the number of "locks" which are receptive to the "keys" located on the molecules that are being inhaled. Without these receptors, the ability to smell particular odors will be reduced. A larger concentration of these molecules will likely need to be inhaled before Phil will be able to sense the particular smell.

Day Three: Lab Activity

Your child should have already read through this lab and has been reviewing all of this week's vocabulary words.

Collect your supplies for the lab:

- Blue food coloring
- Magnifying glass
- Paper cup
- 2 cotton swabs
- Flashlight
- One sheet of 3-hole punched notebook paper
- One sheet of blank white paper
- Scissors
- 2-paper towels or napkins
- Digital camera (optional)

Mapping the Location of your Taste Buds

What are those bumps on my tongue?!?!?

The number of visible papillae will be counted on the surface of the tongue.

Materials:

Blue food coloring
Magnifying glass
Paper cup
2 cotton swabs
Flashlight

One sheet of 3-hole punched notebook paper
One sheet of blank white paper
Scissors
2-paper towels or napkins
Digital camera (optional)

Procedure:

Put a few drops of blue food coloring into a paper cup.

Dip the tip of a cotton swab into the blue food coloring and use it to paint the first inch (2-3cm) of your tongue.

Move your tongue around in your mouth and swallow to distribute the food coloring evenly.

Lightly pat your tongue dry (once or twice only) with a paper towel or napkin.

Use the scissors to cut out the holes of the notebook paper. You will be using the holes as "windows" by placing the paper on the tip of your tongue as shown in the following picture:



If you wish, you can take a picture of your tongue at this time for analysis. If not, you may need a partner to shine a light on this area of your tongue and use a magnifying glass to examine the blue-stained area inside the circle.

You may also attempt to create a tongue print to analyze the amount of papillae on your tongue.

To do this, press a piece of white paper firmly onto the dried blue surface of your tongue.

Remove the paper and place the notebook paper "window" over the paper to create a sample reading. The papillae will appear as light colored circles within the blue background.

Using whichever method you choose, count the number of light-colored circles within the "window" and compare it to the following chart:

Number of papillae within window	Title for Taster
<10 within window	Non-taster
10-30 within window	Taster
>30 within window	Supertaster

What does this mean? Read the explanation below...

Explanation:

Papillae, as you learned in this week's readings, are visible mushroom-shaped projections on your tongue which contain taste buds. There is a relatively large difference in the number of papillae throughout the population. And since papillae contain the tongue's taste buds, their concentration has a profound effect on a person's food preference.

It has been documented that people with a higher number of papillae on their tongue are more likely to be sensitive to bitter tastes. The additional column will help provide a more thorough understanding of what it means to be a "Non-taster", "Taster", or "Supertaster".

Number of papillae within window	Title for Taster	Explanation
<10 within window	Non-taster	Generally do not find foods to be bitter in taste
10-30 within window	Taster	Typically perceive some foods to be bitter, but not intensely so
>30 within window	Supertaster	Generally are very sensitive to bitter tastes, and generally perceive the following to be bitter in taste: raw broccoli, raw cauliflower, Brussels sprouts, saccharin, unsweetened chocolate, black coffee and salt substitute

Unit Quiz (Weeks 10-11)

Choose the correct answer in the following questions:

- 1) Which of the following effects is characteristic of the parasympathetic nervous system:**
 - a) increases heart rate
 - b) stimulates sweat glands to produce perspiration
 - c) decreases heart rate
 - d) increases activity of the digestive system
 - e) decreases activity of the digestive system

- 2) Which one of the following is the correct sequence of nerves that exist within the spinal cord, going from superior to inferior:**
 - a) cervical, lumbar, thoracic, sacral
 - b) cervical, thoracic, sacral, lumbar
 - c) thoracic, cervical, sacral, lumbar
 - d) thoracic, cervical, lumbar, sacral
 - e) cervical, thoracic, lumbar, sacral

- 3) The function of the olfactory nerve concerns:**
 - a) smell
 - b) chewing
 - c) vision
 - d) eye movement
 - e) hearing

- 4) True or False:** Cranial nerve XI is the nerve that controls the movement of the eye.

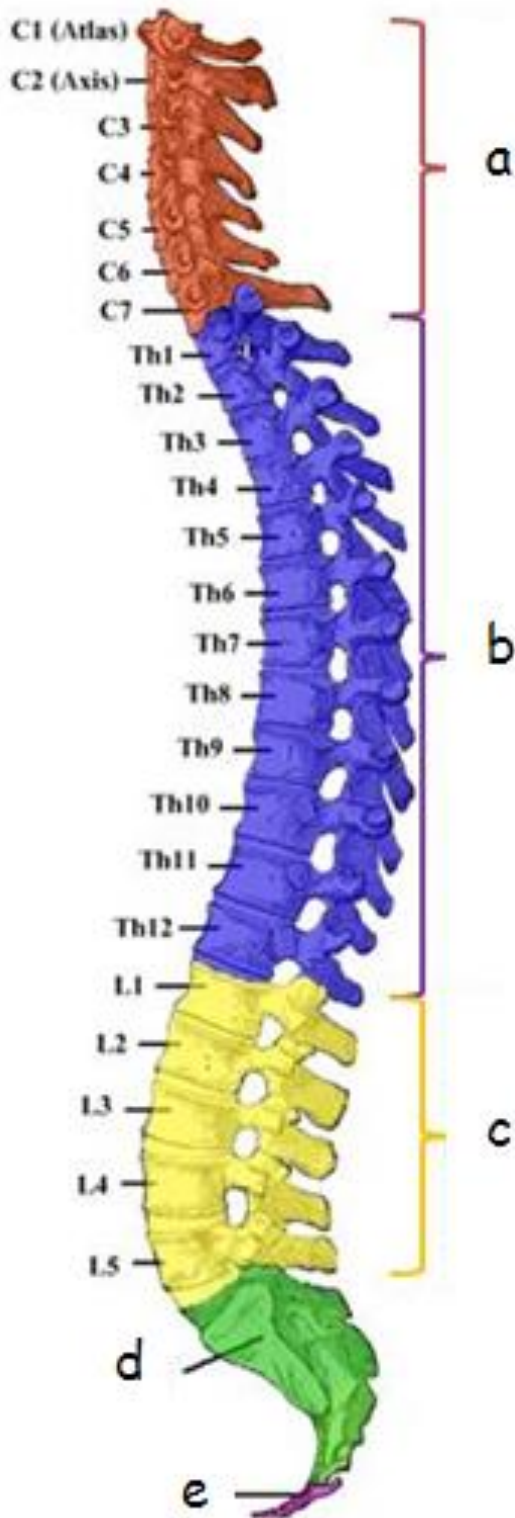
- 5) True or False:** If exposed to bright light, the pupil will enlarge.

- 6) **True or False:** The olfactory receptors are responsible for the sense of taste.
- 7) **True or False:** The "stirrup" is also referred to as the stapes.
- 8) Some student nurses are at a party. Because they love anatomy and physiology so much, they are discussing the functions of the special senses. They make the following observations:
- a) When entering a room, an odor like cooking bacon is easily noticed. A few minutes later, the odor might be barely, if at all, detectable, no matter how hard one tries to smell it.
 - b) When entering a room, the sound of a ticking clock can be detected. Later the sound is not noticed until a conscious effort is made to hear it. Then it is easily heard.

Explain the reasons for both of these observations.

- 9) Professional divers are exposed to increased pressure as they descend to the bottom of a large body of water. Sometimes this pressure can lead to damage to the ear and loss of hearing. How does the body adjust to changes in pressure and explain how the increased pressure might cause loss of hearing.

- 10) Correctly identify the following structures within the following image. Use the words from the word bank below:



WORD BANK: coccyx, cervical nerves, sacrum, lumbar nerves, thoracic nerves

a)

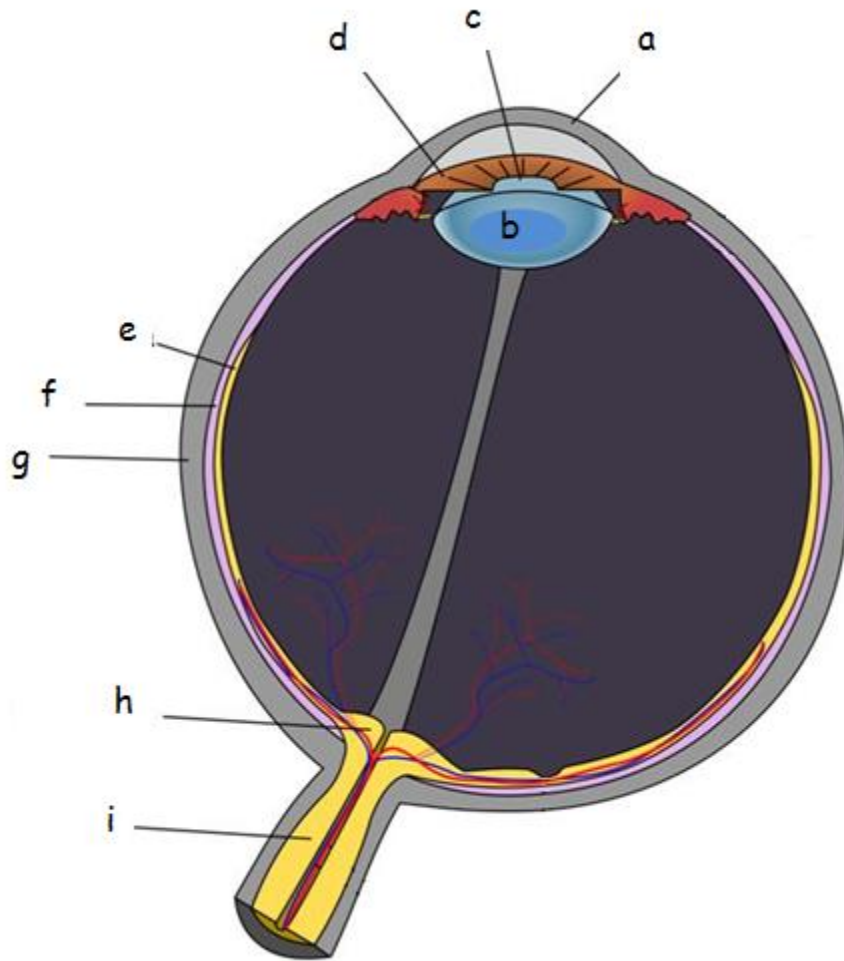
b)

c)

d)

e)

11) Correctly identify the following structures within the following image. Use the words from the word bank below:



WORD BANK: iris, pupil, retina, optic disk, lens, optic nerve, choroid, cornea, sclera

- | | |
|----|----|
| a) | f) |
| b) | g) |
| c) | h) |
| d) | i) |
| e) | |

Unit Quiz Answer Key

- 1) c
- 2) e
- 3) a
- 4) F

- 5) F
- 6) F
- 7) T

8) a - The most likely explanation is that the lack of an extreme response by the body throughout a flooding of chemoreceptors with odor molecules from the bacon results in the brain no longer responding to this stimulus.

b- Much like with the previous answer, the brain no longer responds to this stimulus until you consciously pay attention to it. Much like hearing your name called in a crowded room will cause you to consciously pay attention to the single conversation concerning you throughout a potential sea of conversations around you.

9) Normally, as pressure changes, the Eustachian tube opens to allow an equalization of pressure between the middle ear and the external environment. If this doesn't occur, then the buildup of pressure in the middle ear can rupture the tympanic membrane, or the pressure can be transmitted to the inner ear (cochlea) and cause damage to its mechanoreceptors.

10) Word match from picture:

- a) cervical nerves
- b) thoracic nerves
- c) lumbar nerves

- d) sacrum
- e) coccyx

11) Word match from picture:

- a) cornea
- b) lens
- c) pupil

- d) iris
- e) retina
- f) choroid

- g) sclera
- h) optic disk
- i) optic nerve