Module 4: Putting the Pieces Together

Introduction

In this module we put "the pieces together"; in other words, we explore the ways in which the skeletal system, the muscular system, and the nervous function together to effect the functions that maintain the health and wellness of Brainington. We will focus on commonly experienced facial expressions, processes of food intake, and the processes by which we perceive our environment. In particular we will examine the processes of: smiling, frowning, winking, chewing, vision, hearing, balance, taste.

Smiling

We are all familiar with the simple smile and recognize instinctually. The process, however, constitutes a complex interaction between three body systems. The smile is produced primarily by contraction of the **Zygomaticus muscles**; in fact, the zygomaticus is often referred to as the smiling muscle. This muscle draws the angle of the mouth upward. The action of the zygomaticus is complemented by the actions of the following muscles. The **Levator Labii Superioris** raises the upper lip and the **Levator Anguli Superioris** raises the angle of the mouth upward while the **risorius** draws the angel of the mouth laterally. These muscles are innervated by **Cranial Nerve VII - the Facial nerve**. The nerve fibers that form this nerve originate in the **Primary Motor Cortex** and then continue to descend within the brain through the **Pons**. The nerve then enters the **internal acoustic meatus** and emerges from the skull via the **Stylomastoid foramen**. From this point the nerve continues to the muscles listed above. The nerve carries the motor output that produces the muscle contractions. To produce the smile, the skeletal system must play its role. The "smiling muscles" must be stabilized by the **facial bones** to form the changes in facial shape that we recognize as a smile. The neuronal pathway in delicate and must be protected from injury. This is accomplished by the **cranial cavity**. The facial nerve must then exit the cranial cavity to reach the muscles it innervates; this is accomplished by the internal acoustic meatus and the

Stylomastoid foramen. To summarize, the smile begins in the **Primary Motor Cortex** → the efferent nerve impulse travels down the **Facial nerve** → the nerve enters the **internal acoustic foramen** and leaves the skull through the **stylomastoid foramen** → the nerve impulse then reaches the **Zygomaticus, Levator Anguli Superioris, Levator Labii Superioris, and the Risorius muscles**. These muscles contract, are anchored to the facial muscles and we smile.

Frowning

In common experience the frown is often considered the opposite of the smile. In fact, the frown, while relying on similar neuronal pathways and similar interactions between body systems, is a complex process that involves a different set of muscles. The frown is produced by the interaction between these muscles. The **Frontalis** elevates the eyebrows. The **Orbicularis Oris** closes the mouth. The **Depressor Anguli Oris** draws the angle of the mouth downward. The **Depressor Labii Inferioris** lowers the lower lip. The **Mentalis** draws the chin upward while the **Platysma** helps draw the lower lip down. Except for the differing muscles, the neuronal pathway and skeletal system input are the same. In summary, the frown begins in the **Primary Motor Cortex** → the efferent nerve impulse travels down the **Facial nerve** → the nerve enters the **internal acoustic foramen** and leaves the skull through the **stylomastoid foramen** → the nerve impulse then reaches the **Frontalis**, the **Orbicularis Oris, the Depressor Anguli Oris**, the **Labii Inferioris**, the **Mentalis** and the **Platysma** These muscles contract, are anchored to the facial muscles and we frown.

Winking

Winking is closely related to blinking and squinting. For each of these actions the Orbicularis Oculi muscle contracts to close the eyelids either completely or incompletely. In both cases the nerve impulse begins in the Primary Motor Cortex and is carried by the Facial Nerve to the Orbicularis Oculi muscle. Insummary, these actions begin in the **Primary Motor Cortex** → the efferent nerve impulse travels down the **Facial nerve** → the nerve enters the **internal acoustic foramen** and leaves the skull through the **stylomastoid foramen** → the nerve impulse then reaches **Orbicularis Oculi** muscle and we blink, wink, or squint.

Chewing

Chewing is necessary to begin the digestion of the food we eat. This action involves the combined contractions of: the **Masseter**, the **Temporalis**, the **Buccinator**, and the **Pterygoid** muscles. The **Massete**r is primarily responsible for jaw closure; i. e. elevation of the jaw. The **Temporalis** assists in jaw elevation. The **Pterygoid muscles (lateral and medial**) assist in mastication by producing side - to - side grinding movements of the mandible. The **Buccinator** compresses the cheeks to keep food between the teeth for chewing. The **Buccinator** is innervated by Cranial Nerve VII - the Facial nerve; this nerve follows the pathway detailed above. The **Masseter**, the **Temporalis**, the **Buccinator**, and the **Pterygoid** muscles are innervated by **Cranial Nerve V - the Trigeminal nerve**. The motor output to these muscles begins in the **Primary Motor Cortex** and then is carried by the Trigeminal nerve. These nerve fibers leave the brain at the level of the **Pons** and then exit the skull through the **foramen ovale** to reach the muscles of mastication. It is the coordinated contraction and relaxation that produces the elevation and depression of the mandible that we call chewing.

Vision

Viewing an object begins with directing our eyes to the object we wish to see view. The eyes are moved by the extrinsic eye muscles. This set of six muscles produces a finely coordinated series of eyeball movements that play a vital role in vision and allow the eyes to express emotions. There re six extrinsic eye muscles. The **Lateral and Medial Rectus muscles** move the eye laterally and medially respectfully. The **Superior Rectus muscle** moves the eye elevates the eye and turns it medially. The **Inferior Rectus muscle** depresses the eye and turns it medially. The **Inferior Oblique** muscle elevates the eye and turns it laterally. The **Superior Oblique** muscle depressed the eye and turns it laterally. These muscles have varied innervations. **The Medial Rectus, the Superior Rectus, the Inferior Rectus, and the Inferior Oblique** muscles are innervated by **Cranial Nerve III - the Oculomotor nerve**. This nerve originates in the midbrain and then enters the orbit through the **Superior Orbital Fissure**. While the bony orbit provides vital protection for the eyeball, it limits access to the eyeball. This fissure provides access to the Oculomotor nerve. The nerve then reaches these extrinsic eye muscles. The **Superior Oblique** muscle is innervated **by Cranial Nerve IV - The Trochlear nerve**. This nerve exits the midbrain and courses ventrally and enters the orbit via the **Superior Orbital Fissure.** The **Lateral Rectus muscle** is innervated by the **Cranial Nerve VI - the Abducens** Nerve. This nerve emerges from the brain from the **Pons** and courses to the orbit through the **Superior Orbital Fissure**. While the brain is safely located in the cranium the **Superior Orbital Fissure** provides access to the extrinsic eye muscles for the nerves that innervate them.

Visual input begins in the retina when photoreceptors convert light waves into electrical impulses. These nerve impulses converge on **the Optic Nerve - CN II**. The **Optic nerve** exits the orbit through the **optic canal** into the cranium. The optic nerves from each eye converge and cross at the optic chiasma where input from the medial aspect of each eye cross over to the nerve from the opposite eye. The nerves continue as the **optic tracts to the Visual Cortex.**

Hearing and Balance

The receptors for hearing and balance are located in the **bony labyrinth** located within the **temporal bone.** Sensory input from these organs travel in the **Vestibulocochlear nerve - Cranial Nerve VIII.** This nerve leaves the bony labyrinth and passes through the **internal acoustic meatus** and enters the brain at the level of the brainstem.

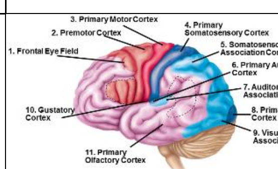
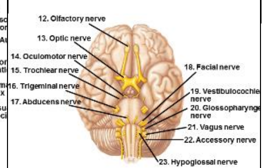
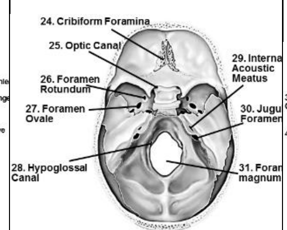
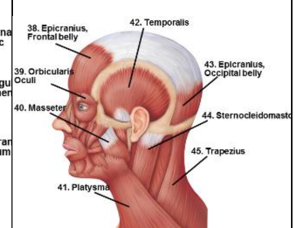
Taste

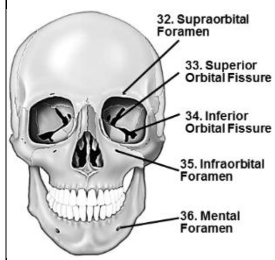
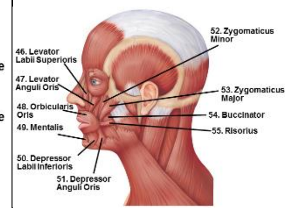
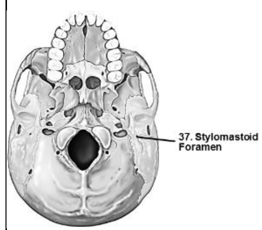
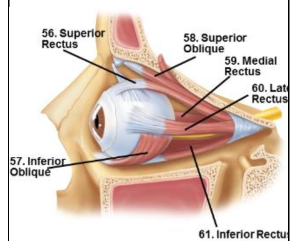
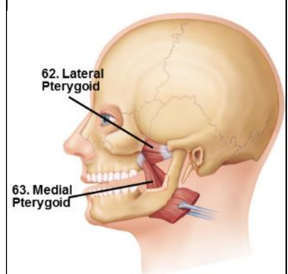
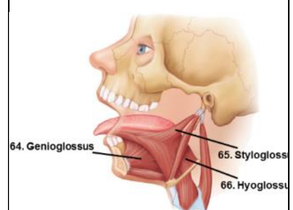
The sense of taste begins with receptors known as taste buds located in the tongue. The receptors are chemoreceptors that detect various chemicals in our food by producing nerve impulses. This chemical input is carried by three different cranial nerves. Taste input from the anterior two-thirds of the tongue is carried by the **Facial Nerve (CN VII**). Taste input from the posterior one-third of the tongue and pharynx is carried by the **glossopharyngeal nerve (CN IX**). Input from a few taste buds located in the epiglottis and lower portion of the pharynx is carried by the **vagus nerve (CN X**). The pathway of the facial nerve has previously been discussed and will not be covered again here. These **Glossopharyngeal nerve - CN IX** fibers enter the skull through the **jugular foramen** and then the medulla before reaching the **gustatory cortex**. These **Vagus nerve** fibers enter the skull via the **jugular foramen** and travel to the medulla and the **gustatory cortex**.

A. Linking Skeletal, Muscular and Nervous Systems for Sensory Input and Motor Output.

Motor Action

Write down the numbers (using the figures from the previous page) of the brain centers, cranial nerves, skull openings, and muscles innervated for each of the following actions. Some actions may require more than one muscle and more than one skull opening.

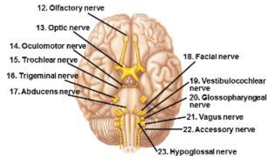
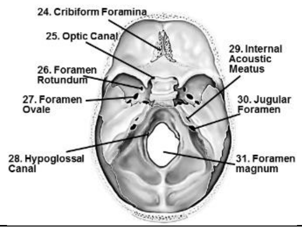
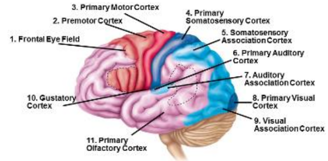
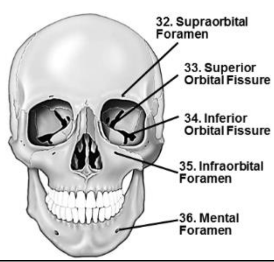
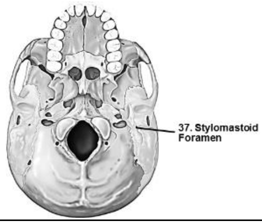
Motor Action	**Brain Center directing the output**	**Cranial Nerve**	**Skull Opening that Cranial nerve passes through**	**Muscles Innervated by Cranial Nerve**
Kissing				
Smiling				
Chewing				
Blinking				
Raising your eyebrows				
Moving your tongue				
Moving your eyes				
Turning your head from side to side				
				

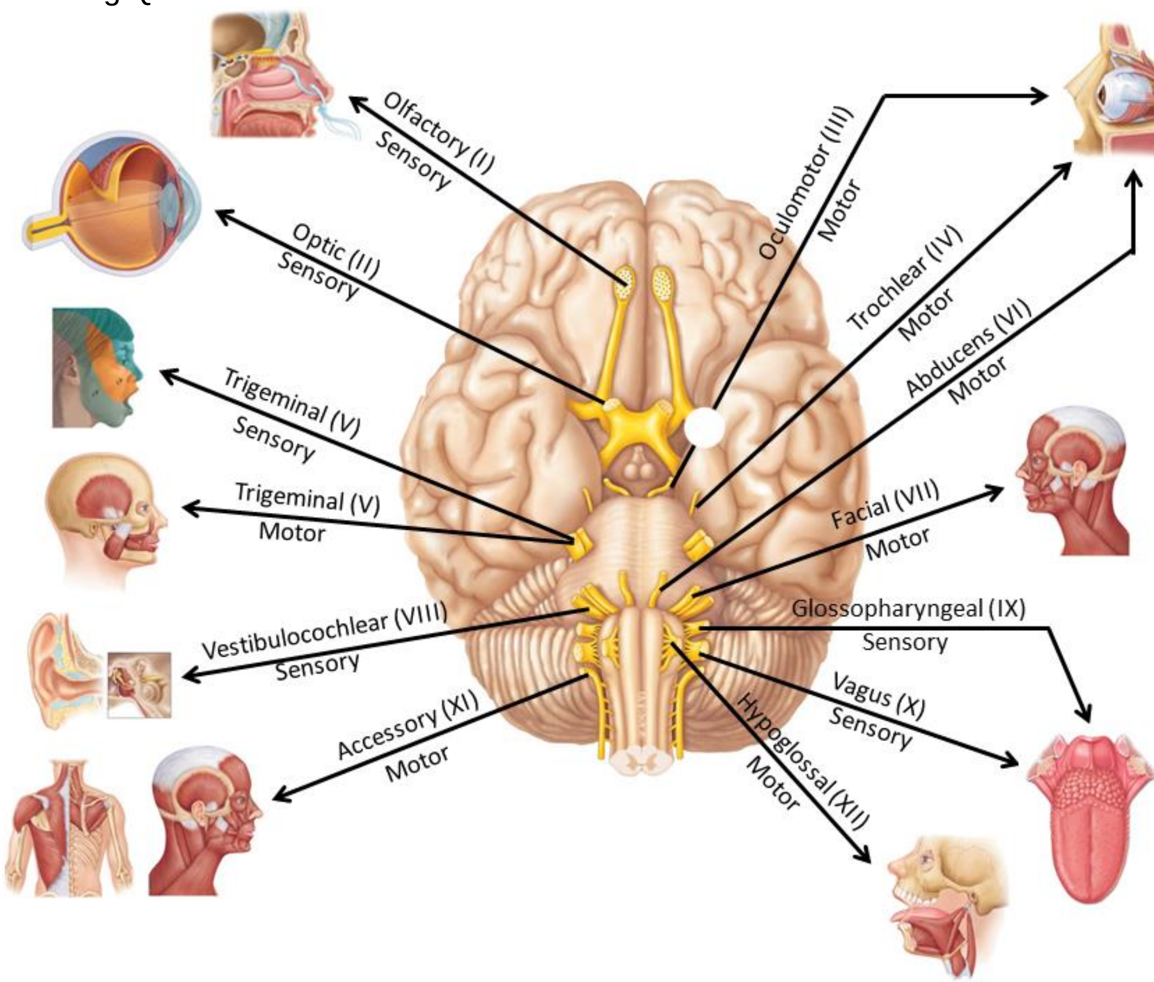
<u>Sensory Action</u>

Write down the numbers (using the figures from the previous page) of the cranial nerves, skull openings, and brain centers used for each of the following actions. Some sensory actions may require the same cranial nerve but different skull openings.

Sensory Action	Cranial Nerve	Skull Opening that Cranial nerve	Brain Center processing the input

		passes through	
Vision			
Hearing			
Balance			
Tasting			
Smelling			
Feeling pressure on your forehead			
Feeling pressure on your upper jaw			
Feeling pressure on your chin			
			
			
			

B. Matching Questions:



Exercise 1: Match the nerve with the Action that it performs. Be aware that some nerves perform the same action. Also, some actions are performed by the same nerve.

Nerve	Matching	Action
Olfactory Nerve (I)		A. Eye movement
Optic Nerve (II)		B. Tongue movement
Oculomotor Nerve (III)		C. Blinking
Trochlear Nerve (IV)		D. Smiling
Trigeminal Nerve (V)		E. Chewing
Abducens Nerve (VI)		F. Vision
Facial Nerve (VII)		G. Frowning

Vestibulocochlear Nerve (VIII)		H. Tasting
Glossopharyngeal Nerve (IX)		I. Neck movement
Vagus Nerve (X)		J. Hearing
Accessory Nerve (XI)		K. Sensing Balance
Hypoglossal Nerve (XII)		L. Sensing Facial feelings (e.g.: pain)
		M. Smelling

C. Review: Fill the blanks using any references you may seek.

Part 1

Complete the Following Table

	smiling	Frowning	Winking	Chewing
Brain Centers Involved				
Cranial Nerves Involved				
Muscles Involved				
Skeletal Structures Involved				

Module #4 Review

Part 2

Complete the Following Table

	Vision	Hearing and Balance	Taste
Receptors involved			
Skull Openings Involved			
Brain Centers Involved			
Skeletal Muscles (if any) Involved			

Critical Thinking Questions to follow.

Post Evaluation

On a scale of 1-5 with

1- Strongly disagree

2- Somewhat disagree

3- Neither agree nor disagree

4- Somewhat agree

5- Strongly agree

Evaluate your experience in linking three organ systems.

1. Before the semester began, I did not know how skeletal markings linked with nerves.

[1] [2] [3] [4] [5]

2. Overall, I understand how cranial nerves pass through skeletal marking to get to the effectors.

[1] [2] [3] [4] [5]

3. Before the semester began, I was familiar with skeletal, muscular and nervous system.

[1] [2] [3] [4] [5]

4. Overall, this exercise improved my understanding and appreciation for the processes and techniques used to analyze each organ system's contribution for smiling, chewing etc.

[1] [2] [3] [4] [5]

5. I have a better understanding of the relationship between the anatomical structures and processes of physiology after performing those exercises than if I had just heard about them in lecture or read a textbook.

[1] [2] [3] [4] [5]

6. Linking organ systems was easier than I initially thought it would be.

[1] [2] [3] [4] [5]

7. I feel more comfortable using the online resources and hands-on activities at anatomy lab now than I did before starting this exercise.

[1] [2] [3] [4] [5]