SENSORY, MOTOR, AND INTEGRATIVE SYSTEMS

Chapter 16

Anatomy and Physiology Lecture

SENSORY, MOTOR, AND INTEGRATIVE SYSTEMS

(To survive very well on your own, one would be able to "**sense**" his/her environment and make necessary homeostatic adjustments.)

(At any given time, our brain receives and responds to many varieties of information. However, we are aware only of the information that we consciously focus upon.)

(The Central Nervous System selects only those bits of information that are important for the moment, and it is only those bits of information that are brought to our conscious level.)

(There is no question that we would collapse into nervous wrecks if our consciousness were forced to deal with all the information arriving at once.)

(The conscious mind is turned off to protect itself from over stimulation.)

(A lack of sight would increase the risk of injury from unseen obstacles:

- A loss of smell would allow a harmful gas to be inhaled;
-A loss of hearing would prevent recognition of automobile horns; and
-A lack of taste would allow toxic substances to be ingested.)

SENSATION

Senses – Are the means by which the brain receives information about the environment and the body.

General senses – Are those with receptors distributed over a large part of the body.

Two Groups of General Sense:

1. **Somatic Senses** – Provide sensory information about the body and the environment, include touch, pressure, temperature, proprioception, and pain.

2. **Visceral Senses** – Provide information about various internal organs, consist primarily of pain and pressure.

Special Senses – Are more specialized in structure and are localized to specific parts of the body. Are smell, taste, sight, hearing, and balance.

Sensation or Perception – Is the conscious awareness of stimuli received by sensory receptors.

SENSORY RECEPTORS

Types of Sensory Receptors

A. **Classification Based on the Type of Stimuli**

Mechanoreceptors – Respond mechanical stimuli, such as compression, bending, or stretching of cells.

Touch, pressure, vibration, proprioception, hearing, equilibrium, blood pressure

Chemoreceptors – Respond to chemicals that become attached to receptors on their membranes.

Smell and taste depend on chemoreceptors.

Thermoreceptors – Respond to changes in temperature at the site of the receptor and are necessary for the sense of temperature.

Photoreceptors – Respond to light striking the receptor cells and are necessary for vision.

Nociceptors or Pain Receptors – Respond to painful mechanical, chemical, or thermal stimuli.

B. **Classification Based On Location:**

Exteroceptors (Cutaneous receptor) – Are associated with the skin.

Provide information about the external environment

Sensitive to stimuli outside the body and transmit sensations of hearing, vision, smell, taste, touch, pressure, vibration, temperature, and pain.

Visceroceptors – Are associated with the visceral or organs.

Provide information about the internal environment

These sensations arise from within the body and often do not reach conscious perception.

Occasionally, may be felt as pain or pressure.

Proprioceptors – Are associated with joints, tendons, and other connective tissues.

Provide information about body position and movement

Eight Sensory Nerve Endings In The Skin:

1. Free Nerve ending
2. Merkel's disk
3. Hair follicle receptor

4. Pacinian corpuscle
5. Meissner's corpuscle
6. Ruffini's end organ
7. Muscle spindle
8. Golgi tendon organ

Responses Of Sensory Receptors

Receptor (Generator) Potential – Is a local potential produced by the interaction of a stimulus with a sensory receptor.

Primary receptors – Are sensory receptors cells that have axons that conduct action potential in response to the receptor potential.

Secondary receptors – Are sensory receptor cells that have no axons and the receptor potentials produced in those cells do not result in action potentials.

Note: Some sensations have the quality of **Accommodation**, or **Adaptation**, a decreased sensitivity for a continued stimulation.

Tonic receptors – Generate action potential as long as a stimulus is applied and accommodate very slowly.

Phasic receptors – Accommodate rapidly and are most sensitive to change in stimuli.

SENSORY NERVE TRACTS

Spinal Cord and **Brainstem** contain a number of sensory pathways that transmit action potentials from the periphery to various parts of brain.

Each pathway is involved with specific modalities (the type of information transmitted).

Names of most ascending pathways, or tracts, in the CNS indicate their origin and termination.

Example: Spinothalamic tract (Originate from the spinal cord and terminate in the thalamus).

Major Ascending Pathways or Tracts Involved in the Conscious Perception of External Stimuli are: (1) Spinothalamic System, and (2) Dorsal-Column/medial-Lumniscal System.

1. **Spinothalamic System** – Is one of the two major systems that convey cutaneous sensory information to the brain.

   This is the least able to localize the source of the stimuli.

Two Divisions of the Spinothalamic System:

(a) **Lateral Spinothalamic Tract** – Carries pain and temperature information.

(b) **Anterior Spinothalamic Tract** – Carries light touch, pressure, tickle, and itch sensation.

Note: Light touch is also called crude touch (poorly localized).

Three Neurons involve in the Pathway from Peripheral receptor to the Cerebral Cortex:

(a) **Primary Neurons** – Relay sensory input from the periphery to the posterior horn of the spinal cord, where they synapse with interneurons.

(b) **Secondary Neurons** – Axons from secondary neurons cross to the opposite side of the spinal cord through the anterior portion of the gray and white commissures and enter the spinothalamic tract, where they ascend to the thalamus.

(c) **Tertiary Neurons** – Project from the thalamus to the somatic sensory cortex.

2. **Dorsal-Column/Medial-Lemniscal System** – Carries the sensations of two-point discrimination, proprioception, pressure, and vibration

   Note: Axons of the primary neurons of the dorsal-column/medial-lemniscal system enter the spinal cord, without crossing to its opposite side, and synpase with secondary neurons located in the Medulla Oblongata.

Two Divisions of the Dorsal-Column/Medial-Lemniscal Sytem in the Spinal Cord:

1. **Fasciculus Gracilis** – Conveys sensation from nerve ending below the midthoracic level.

   Terminates by synapsing with secondary neurons in the **nucleus gracilis**.

2. **Fasciculus Cuneatus** – Convey impulses fro nerve ending above the midthorax.

   Terminates by synapsing with secondary neurons in the **nucleus cuneatus**.

SENSORY AREAS OF THE CEREBRAL CORTEX

Primary Sensory Area – Are sensory pathways projected to specific regions of the cerebral cortex where sensations are perceived.

Note: Most of the postcentral gyrus is called the **Primary Somatic**

Sensory Cortex, or General Sensory Area.

Other Primary sensory areas of the Cerebral Cortex:

1. Taste Area
2. Olefactory Cortex
3. Primary Auditory Cortex
4. Visual Cortex

Projection – This is a process by which Cutaneous sensation, although integrated within the cerebrum, are perceived as though they were on the surface of the body.

Indicates that the brain refers the cutaneous sensation to the superficial site at which the stimulus interacts with the sensory receptors.

Association Areas – Are Cortical areas immediately adjacent to the primary sensory centers.

Involved in the process of recognition.

Somatic Sensory Association Area – Is posterior to the primary somatic sensory cortex.

Visual Association area – Is anterior to the visual cortex.

CLINICAL FOCUS

1. Pain
2. Referred Pain
3. Phanton Pain
4. Chronic Pain
5. Sensitization in Chronic Pain

CONTROL OF SKELETAL MUSCLES

Motor System of Brain and Spinal Cord is responsible for maintaining the body's posture and balance; as well as moving the trunk, head, limbs, and eyes; and communicating through facial expressions and speech.

Voluntary Movements – Movements consciously activated to achieve a specific goal, such as walking or typing.

Voluntary movements depend on the following Neurons:

(a) Upper Motor Neurons
(b) Lower Motor Neurons

Voluntary Movement depends upon the following:

1. The initiation of most voluntary movement begins in the premotor areas of the cerebral cortex and results in the stimulation of upper neurons.

2. The axons of the upper motor neurons form the descending nerve tracts. They stimulate lower motor neurons which stimulate skeletal muscles to contract.

3. The cerebral cortex interacts with the basal nuclei and cerebellum in the planning, coordination, and execution of movement.

MOTOR AREAS OF THE CEREBRAL CORTEX

Precentral Gyrus (Primary Motor Cortex or Primary Motor Area) – Action potential in this region control many voluntary movements, especially the fine motor movements of the brain.

Premotor Area – Located anterior to the primary motor cortex, is the staging area in which motor functions are organized before they are initiated in the motor cortex.

Prefrontal Area – Is where the motivation and foresight to plan and initiate movement occur.

MOTOR NERVE TRACTS

Motor Nerve Tracts – Are descending pathways containing axons that carry action potentials from regions of the brain to the brainstem or spinal cord.

Names of Descending Pathways are based on their origin and termination.

Note: Know the Pathway, Functions Controlled, Origin, Termination, and Crossover.

CLINICAL FOCUS

Dyskinesias

BRAINSTEM FUNCTIONS

OTHER BRAINSTEM FUNCTIONS

Speech

Right and Left Cerebral Cortex

Brain Waves And Sleep

Memory

Integrative functions include cerebral activities such as memory, sleep and wakefulness, and emotional responses.

Memory is the ability to recall thoughts.

Without memory, we would repeat mistakes and be unable to learn--would not be able to repeat our successes or accomplishments, except by chance.

Learning - Is the ability to acquire knowledge or a skill through instruction or experience.

-Short term memory lasts only seconds or hours and is the ability to recall bits of information.

-Long term memory last from days to years.

Wakefulness and sleep

Humans sleep and awaken in a fairly constant 24-hour cycle called a circadian rhythm.

Limbic System

CLINICAL FOCUS

General CNS Disorders.
EFFECTS OF AGING ON THE NERVOUS SYSTEM