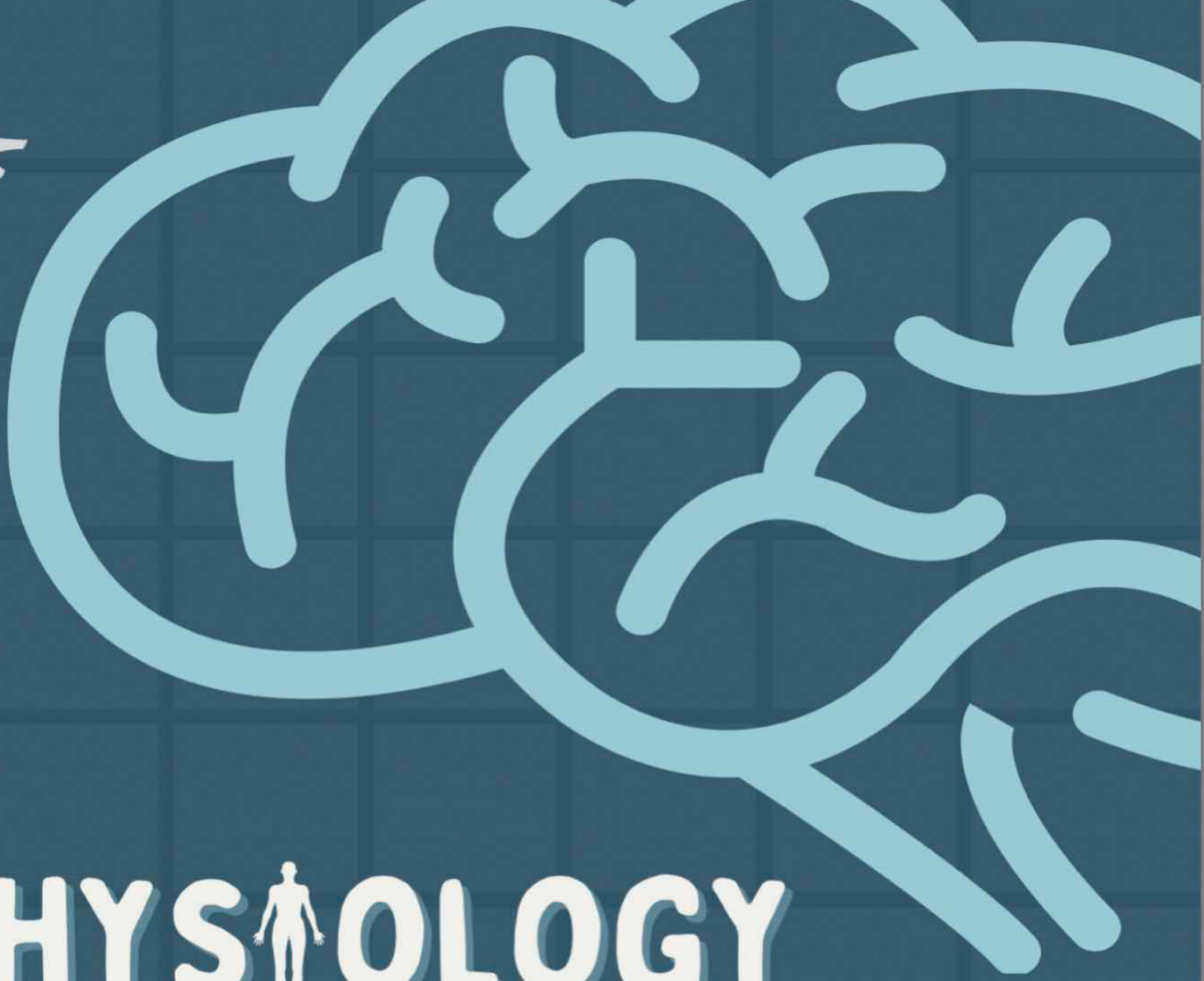

PHYSIOLOGY

SHEET NO. 1

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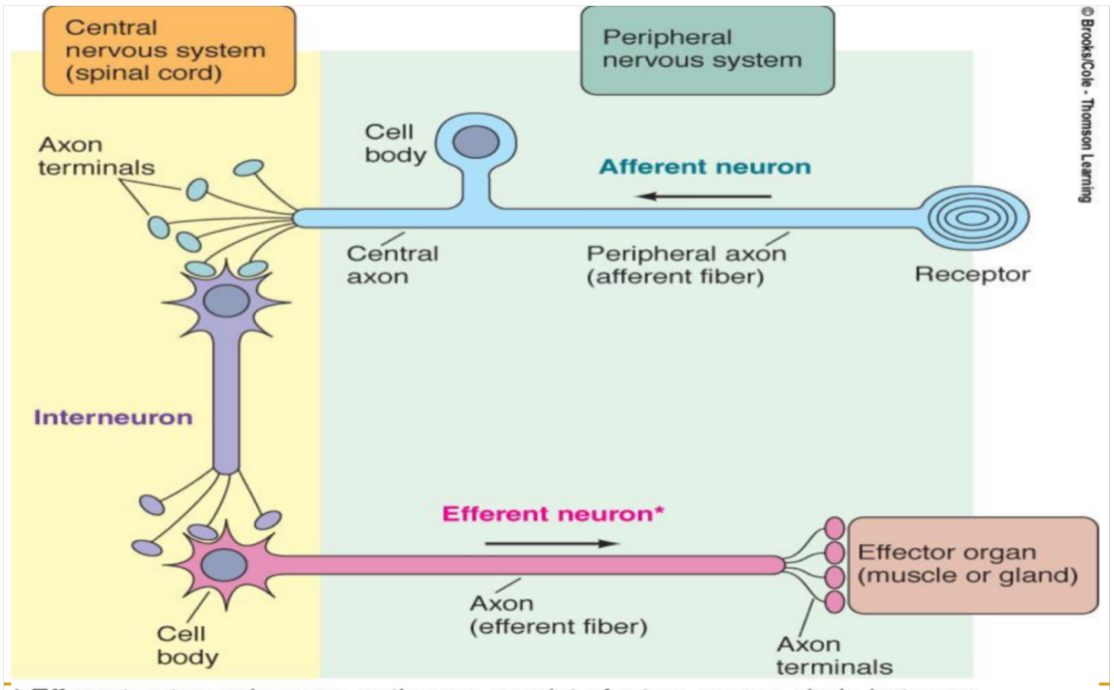
This lecture outcomes:

- State the parts of the central nervous system (brain stem & spinal cord).
- Describe the level of organization of the CNS (1- Lower level of spinal cord. 2- Middle: brain stem. 3-Higher: cerebral cortex)
- List the major functions of the CNS
- Compare the Endocrine system and nervous system
- Describe the anatomy of the functional unit of the nervous system
- Determine the area of communication in the CNS (synapse): the idea of adaptation at the level of the synapse; like when you set on a chair, at the beginning you feel the chair but then you stop feeling it because your body adapt with the "chair" sensation.

✍ Comparison between Nervous and Endocrine Control System:

- Nervous system:
  - is fast compared to endocrine system because it uses action potentials which travel through axons that might reach 120 m\s and even in nonmyelinated neurons might reach 2 or 5m/s.
  - it has low gain:
    The normal MAP=100mmHg, if it rises to be 120mmHg: -The baroreceptors which are referred to nervous system might
    bring the bp to 105 for example, so the gain
    is equal -3 (negative feedback).
  - It affects skeletal muscles and glands
- Endocrine system:
  - the endocrine system is slow because it uses hormones that are going to be secreted from gland and travel in blood and then they go to the target cell to bind with the receptors that will end in receptor hormone interactions and this process is a slow process.
  - Has a very high gain:
    In the endocrine system, the hormones try to bring blood pressure back to almost 100 with zero error; the gain will be infinite.
  - It affects growth, metabolism, and reproduction.

ℵ Organization of Nervous System



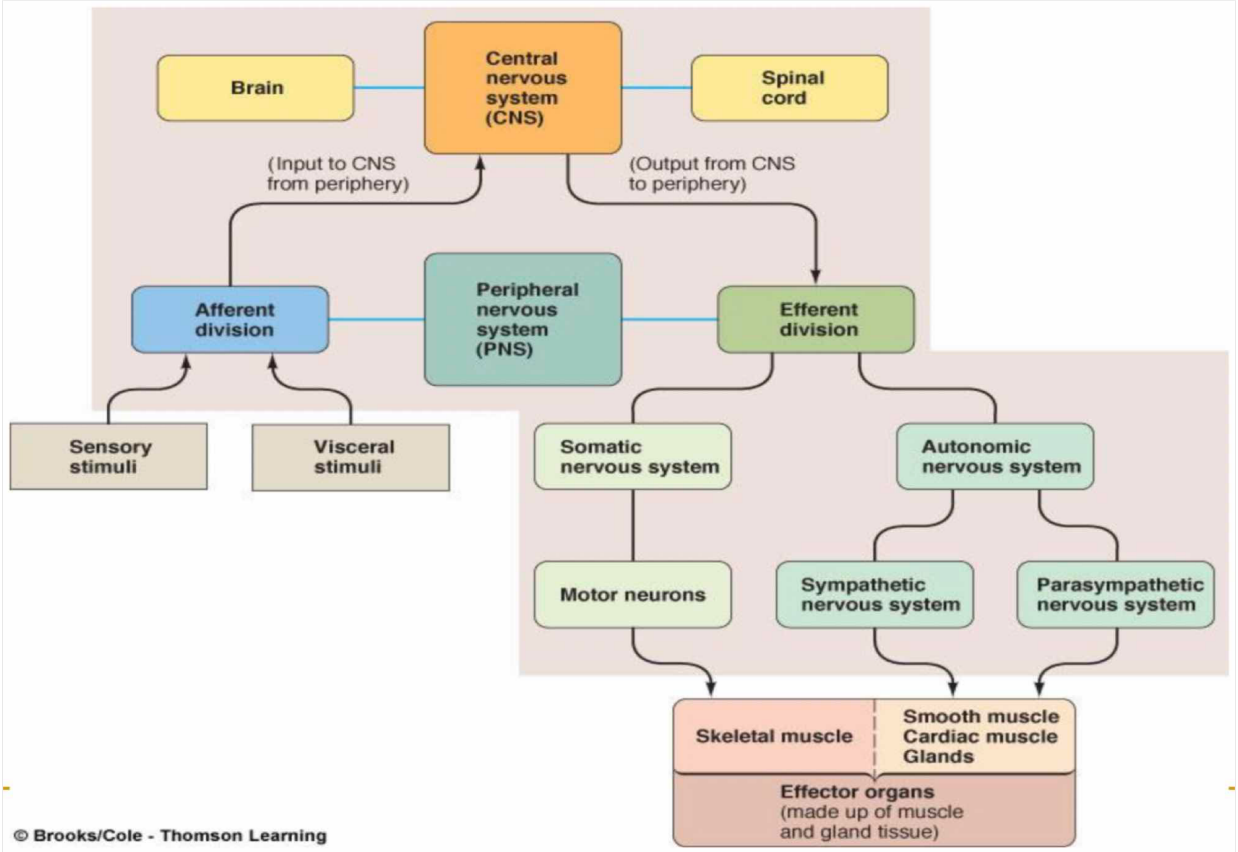
* Efferent autonomic nerve pathways consist of a two-neuron chain between the CNS and the effector organ.

ℵ Notes:

- In the CNS, **afferent** is sensory, **efferent** is motor.
- The sensory receives its information form the sensory stimuli whether it's somatic or visceral.
- The **motor** part goes to somatic nervous system that supplies the skeletal muscles or autonomic nervous system the supplies smooth muscles.
- Divisions:
  - Sensory Division: **general sensations**: tactile and others. **Special sensations**: visual, auditory, olfactory.
  - Integrative Division: process information, creation of memory.
  - Motor Division: respond to and move about in our environment

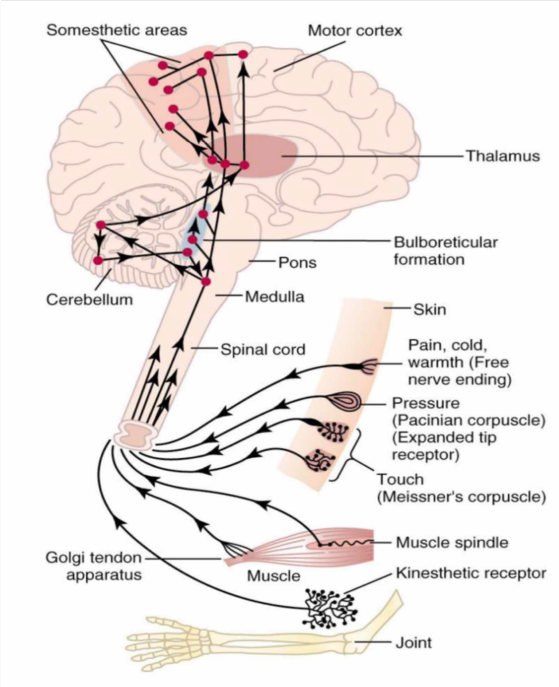
These notes are related to the next image:

- The receptors sense any changes in the environment; tactile sensations are mechanical, visual are electromagnetic energy and so on.
- The receptors are transducers; they covert any type of energy into electrical energy (action potential)
- The cell bodies of afferent neurons are found in the dorsal root ganglia, then it enters the spinal cord to synapse with interneurons.
- The interneurons connect the sensory to the motor.
- The efferent neurons go out from spinal cord to the effector organ.



Functional Classes of Neurons

- Afferent neurons Inform CNS about conditions in both the external and internal environment.
- Efferent neurons Carry instructions from CNS to effector organs – muscles and glands.
- Interneurons:
  - -Found entirely within CNS; most of neurons are interneurons.
  - Responsible for:
    - ✓ Integrating afferent information and formulating an efferent response
    - ✓ Higher mental functions associated with the mind and memory

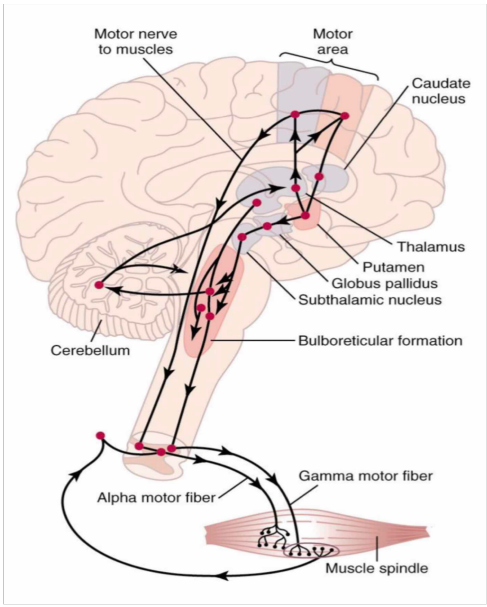


Somatosensory Axis of the Nervous System:

- It starts with sensory receptors for pain and temperature (usually free nerve ending), receptors for pressure in the dermis (Pacinian corpuscle), for touch in the epidermis (Meissner's corpuscle), receptors that are found in the muscle (muscle spindles) and the receptors that are found around the joints (kinesthetic receptors; proprioceptors).
- Afferent neurons carry these signals to the spinal cord and these signals will go to

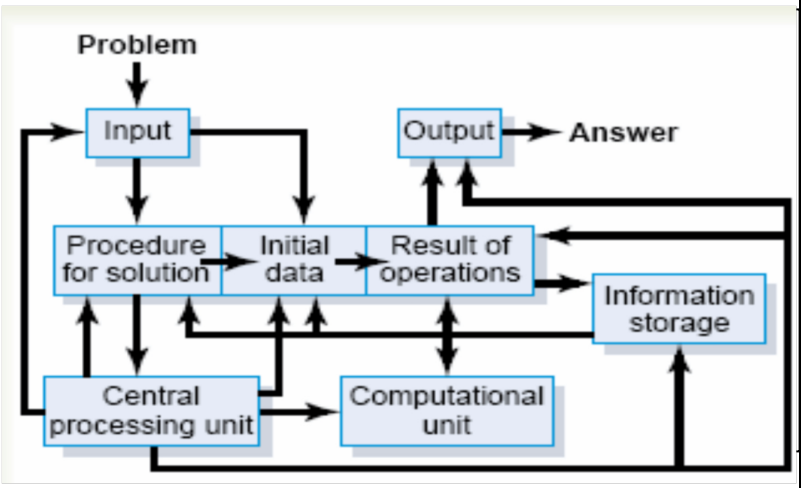
cerebral cortex (highest order area)>>**primary somatosensory area** in the postcentral gyrus.

- These sensations usually stop at the thalamus, so the **thalamus** is the relay station for almost all sensations except olfaction.
- From the thalamus they go to their destinations in the cerebral cortex in the **postcentral gyrus**.
- The motor tract (descending tract) starts from motor area in the cortex and descends as upper motor neuron and ends in the spinal cord to synapse with the lower motor neuron that will go to skeletal muscles to initiate the contraction.



Central nervous system compared to computer system

- The sensation represents the input system
- Brain represents the processing part
- reflexes and responses represent commands



Levels of CNS Function

1. The spinal cord level:
   It's more than just a conduit for signals from periphery of body to brain and vice versa; it contains:
   - ✓ walking circuits
   - ✓ withdrawal circuits
   - ✓ circuits for reflex control of organ function
2. The Lower Brain Level:
   - ✓ Contains: brainstem (medulla, pons, mesencephalon), hypothalamus, thalamus, cerebellum, and basal ganglia.
   - ✓ support against gravity circuits for antigravity muscles that are important for position(posture), equilibrium and balance.
   - ✓ Controls subconscious body activities: arterial pressure, respiration, equilibrium, feeding reflexes, emotional patterns

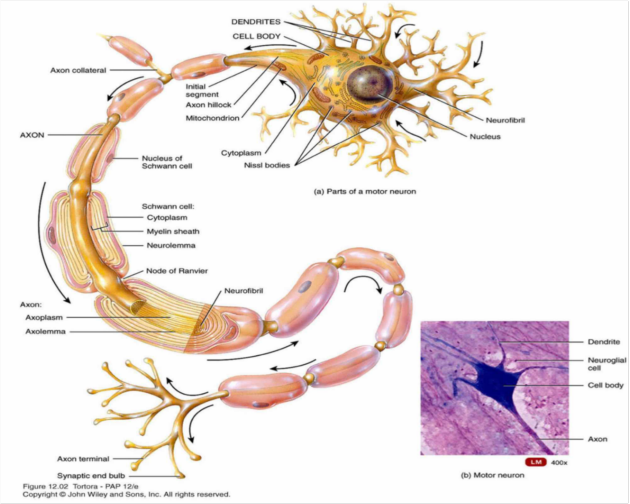
>> subconscious is in between consciousness and unconsciousness.

3. the Higher Brain or Cortical Level:
   - ✓ Cortex never functions alone, always in association with lower centers
   - ✓ Large memory storehouse
   - ✓ Essential for thought processes
   - ✓ Each portion of the nervous system performs specific functions, but it is the cortex that opens the world up for one's mind.

Anatomy of a Neuron

3 major components:

1. **Soma:** main body of the neuron
2. **Axon**: extends from soma to the terminal the effector part of the neuron
3. **Dendrite**: projections from the soma the sensory portion of the neuron

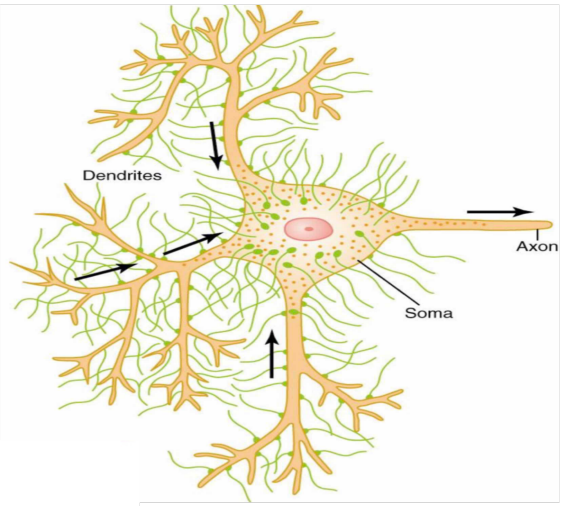


NOTES:

- ✓ Dendrites have a very high resistance, they're unable to produce action potential because they have very low density of sodium voltage gated channel.
- ✓ Sometimes action potential is produced at the soma but the best area to produce action potential is the axon hillock.
- ✓ Axon hillock is the first unmyelinated area of the axon; it has the highest density of sodium voltage gated channels, so it has the lowest threshold for action potential.
- ✓ The soma contains all organelles as in other cells except the centrioles; neurons are unable to divide and regenerate (problem in CNS).
- ✓ The CNS is enclosed by bony structures for protection; the brain is enclosed by the skull and the spinal cord by vertebral column.
- ✓ CNS is also protected by meninges,3 layers of protection from outside to inside, dura mater, arachnoid mater, and pia mater.
- ✓ Some neurons are myelinated by myelin sheath that is formed from Schwann cells in PNS and from oligodendrocytes in the CNS.
- ✓ Myelin is interrupted by unmyelinated area called node of Ranvier.
- ✓ At the end we have axon terminals (buttons, knobs) that contain chemical substances (neurotransmitters) that are released upon stimulation of neurons by action potential, we have 50 types of neurotransmitters in CNS.

anterior motor neuron:

it’s a kind of neurons, contains many synapses; axosomatic with soma, axodendritic with dendrites and axoaxonic with axons.



Communication Between Neurons

- ✓ Through release of chemical transmitters more than 50 compounds have been identified as transmitter substances.
- ✓ General characteristics of neuronal communication: **one-way conduction** from presynaptic to postsynaptic neuron, always transmits signals in one direction this allows signals to be directed toward specific goals (chemical synapse).
  - Note: signals might go both ways in the electrical synapse which isn’t common in CNS.

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