Lecture 10, Feb 14, 2023

White and Grey Matter

- Grey matter is where the synapses are (inner region of the spinal cord)
- White matter are the tracks for messages to run through
  - Myelinated axons

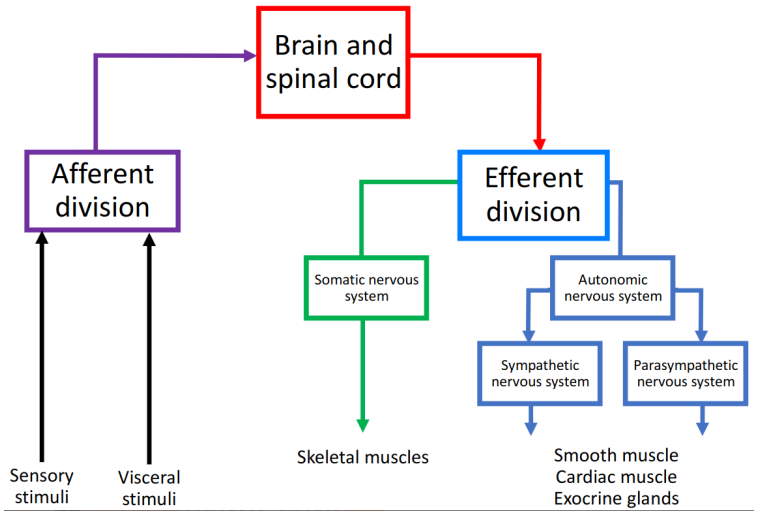

Figure 1: Strcture of the nervous system

Mechanically-Gated Ion Channels

- Also known as mechanoreceptors
- PIEZO channels open and let ions through when the membrane is being depressed through mechanical force
- These are non-selective cation channels, so more sodium is going to come in and depolarize the cell
  - This can then open the voltage gated ion channels and generate an action potential
- There are also other receptor cells, e.g. photoreceptor cells

Triggering Receptors

- MILD: modality, intensity, location, duration
- Modality
  - Mechanoreceptors:
    * Somatosensory: touch
    * Barorceptors: pressure
    * Proprioceptors: joint angles
    * Osmoreceptors: osmotic pressure between cells
  - Thermoreceptors: temperature
  - Nociceptors: pain
  - Photoreceptors: light
  - Chemoreceptors: smell
  - No sensor that detects “wet” directly
- Nerve endings can be free or encapsulated (e.g. in tissue layers)
- Sensory cells release neurotransmitters to activate a synapse
  - e.g. photoreceptors
  - These have cell bodies midway along the neuron

- For peripheral processes (e.g. olfactory receptor, stomach) the cell body is at the tip

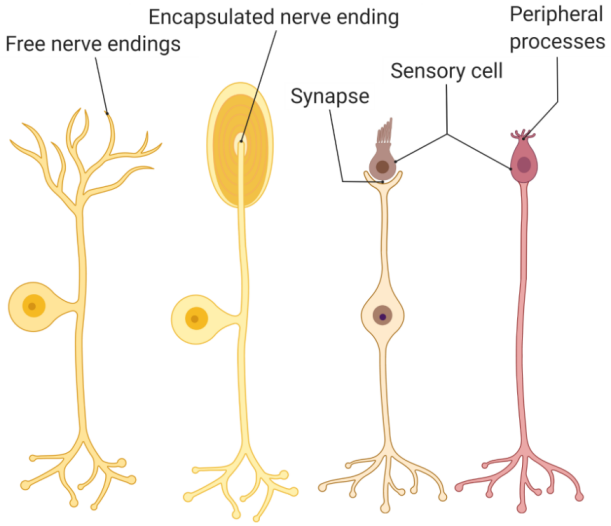

Figure 2: Sensory cells

- Intensity
  - Frequency coding: the higher the receptor potential, the greater the frequency of action potentials
  - Larger signals are generated when more receptors or neurons are activated (e.g. with more pressure, larger area of force)
- Location
  - Receptive field: in some places there are more receptors closer together
    - Smaller receptive field means greater acuity
  - Lateral inhibition: to figure out where exactly the stimulus comes from, the sensory neuron connects with interneurons with IPSPs and inhibits the neurons next to it
    - In places with more receptors, often multiple receptors are triggered by a single stimulus
    - Lateral inhibition reduces the signal coming from sensory neurons next to where the stimulus is the strongest, so the signal is sharper
    - Good lateral inhibition happens in places like touch on the skin
    - Poor lateral inhibition would be like cold or pain, which aren't often localized

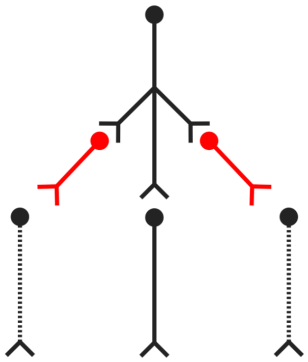

Figure 3: Lateral inhibition; red neurons pictured are IPSPs (inhibitory)

- Duration
  - *Phasic* receptors are rapidly adapting; *tonic* receptors are slowly adapting
  - Phasic receptors activate immediately to stimulus, then return back to normal; when the stimulus goes away there is also a small depolarization and repolarization

    * This gives action potentials immediately when the stimulus comes, and a few more when the stimulus is removed
    * If the stimulus is held down, there are no action potentials
    * Meissner's corpuscle detect things like grip; they are phasic receptors
    * Pacinian corpuscles are also phasic and have even more rapidly adapting action potentials
        - This is for perception of vibrations
- Tonic receptors stay depolarized while the stimulus is held (might gradually repolarize); the receptor repolarizes when the stimulus is removed
    * Action potentials fire continuously while the stimulus is held
    * Ruffini endings are tonic; there may be background activity happening stochastically when there is no stimulus; when there is a stimulus it behaves tonically
        - This is for muscles and sensing where limbs are
    * Merkel's discs are also tonic (this one has no background activity)
        - This is for continuous touch and pressure
        - There are a lot of them so there is great resolution
- Phasic receptors have an on-response and off-response; tonic receptors adapt slowly and have sustained action potentials