TOPIC IV: NERVOUS SYSTEM II - SENSORY "INPUT"

Learning Outcomes: Upon completion of Topic IV (4), you should be able to

a) Define sensory receptor.
b) Distinguish between tonic and phasic receptors.
c) Compare and contrast the three types of sensory receptors, based on their stimulus origin (e.g. exteroceptors, interoceptors, proprioceptors).
d) Compare and contrast the types of sensory receptors based on the type of stimulus to which they respond (e.g. thermoreceptor, photoreceptor, chemoreceptor, mechanoreceptor, and nociceptor.
e) Explain how the brain perceives different types of stimuli.
f) Explain how the brain perceives different stimuli strengths.
g) Describe the pathways of transmission from a Meissner's corpuscle for touch to the postcentral gyrus, including the neurons Involved (1st, 2nd and 3rd order) and the electrical events occurring along the pathway.
h) Describe the pathway of events after light enters the eye until it reaches the visual cortex. Include the electrical events occurring along the pathway.
i) Describe the pathway of events from stimulation of a hair cell for hearing to perception in the auditory cortex, including the electrical events occurring along the pathway.
j) Describe the pathway of events from stimulation of a hair cell involved in equilibrium to the brain areas that process the information, including the electrical events occurring in the pathway.

A) Afferent Nervous System

1) Interpretation of Sensory Stimuli:

- Stimuli are detected by receptors (only respond to a specific stimulus e.g. temp.)
- Receptors can be:
  - a) dendrites on a unipolar neuron
  - b) an individual cell that synapses to a neuron e.g. hair cell (internal ear)
- What happens when a receptor (R) is stimulated?
  - a) stimulus causes opening of gated channels (usually Na^+) on receptor membrane
  - b) GP on receptor membrane (stim. becomes electrical)
    - IF:
      - i) receptor = dendrite of unipolar neuron and GP (depol) directly generates an AP = a generator potential
      - ii) receptor = individual cell e.g. hair cell (no axon) = a receptor potential → nt onto associated neuron → EPSP on neuron → generates an AP

2) Types of Receptors

a) Phasic receptors

- receptors respond to stimulus change
- in the presence of a constant stimulus, show **adaptation** (usually ↓ in sensitivity)
- e.g. 1: put a hat on → bursts of APs (feel it) → then get ↓ in AP frequency to CNS (can't feel it) even though stim. maintained at constant strength
- e.g. 2: take hat off – bursts of APs – feel it again

b) Tonic receptors

- frequency of APs remains constant - NO adaptation
- give continuous info e.g. posture, condition, pain ⇒ protective
- monitor presence + intensity of stimulus

3) How does brain perceive different types of stimuli?

- mainly by type of receptor stimulated
- axon activated by receptor → synaptic connections to part of CNS concerned with that sense (hardwired from receptor to brain - always knows 'who' is calling (type of receptor) and from where (location))
- e.g. 1: stimulate Meissner's corpuscle (touch receptor) in right index finger ⇒ impulses to postcentral gyrus region for right index finger
- e.g. 2: mechanical pressure on eyeball → "seen" as light - ALL signals received from retina perceived as light

4) How does brain perceive stimuli of different strengths?

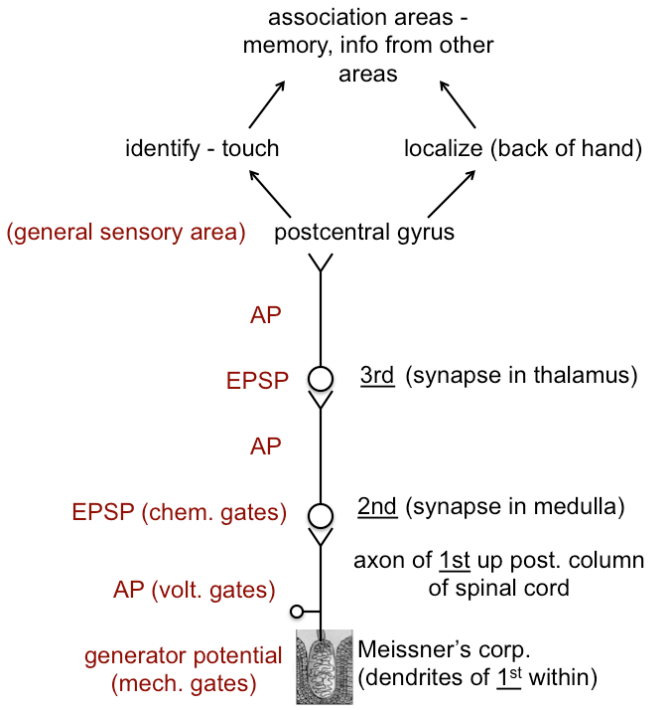
- e.g. determining if feather or brick on foot
- mainly by frequency of ap (#/time) going to CNS e.g. ↑ stimulus = ↑ AP frequency
- stronger stimulus also activates more receptors (e.g. pressure + touch)

Insert MyFigures Topic IV #1 Feather
Insert MyFigures Topic IV #2 Brick

5) Sensory (ascending) Pathways:

e.g. Posterior (Dorsal) Column Pathways for touch

- 3 neurons in succession - 1st, 2nd and 3rd order



B) <u>Special Senses</u>

1) <u>Vision:</u>

a) Light enters the pupil & image focused on retina (reduced + inverted)

b) Light stimulates chemical reaction on rods and cones - produces a receptor potential (GP)

rod or cone
(receptor potential, no AP)
↓ nt
bipolar neuron
(graded potential, no AP)
↓ nt
ganglion cell
(EPSP, get AP)
↓
optic nerve
(formed by axons of ganglion cells)
↓
optic tracts
↓
visual cortex of occipital lobe

2) Hearing:

hair cell in cochlear duct stimulated
(receptor potential, no AP)
↓
nt release onto associated neuron
(EPSP, get AP)
↓
AP on axon in cochlear branch of cranial nerve VIII
↓
auditory cortex (temporal lobe)

3) Equilibrium:

hair cell in semicircular ducts or saccule & utricle (in vestibule)
(receptor potential, no AP)
↓
nt release onto associated neuron
(EPSP, get AP)
↓
ap on axon in vestibular branch of cranial nerve VIII
↙ ↓ ↘
cerebellum(coordinates ↔ brain stem ↔ thalamus
muscle contraction) ↙ ↘
eye muscles other muscles of neck, trunk etc for balance