Sensory systems

- **Sensation** - is how the senses deliver signals to the CNS about the current state of the world

- **Perception** - is how an individual interprets these signals in terms of previous experience, knowledge of the world and expectation

- sensory systems: sensory receptor, afferent pathway, central projection

Components of sensory pathways

Stimulus

- any change in the external environment or internal milieu

- a stimulus is only registered to the extent that we possess the machinery to transduce that stimulus into a neural signal

- sensory organs steer stimuli to sensory receptors

Stimulus

- <u>transduction</u> – conversion of stimulus energy into a receptor potentials (mostly depolarization)
- <u>transformation</u> – conversion of receptor potential into action potential

All sensory systems convey

types of information:

1. **modality** (what it is)
2. **location** (where)

       1 and 2   -   labelled line coding

3. **intensity** (how much)
4. **timing** (when)

       3 and 4   -   frequency coding

Modality

- is a property of sensory nerve fiber that is activated primarily by a certain type of stimulus

- the axon of the receptor functions as a modality-specific line of communication; activity in the axon necessarily conveys information about a particular type of stimulus

- each sensory nerve fiber makes specific connections to structures in the CNS whose activity give rise to specific sensation

Sensory receptors - types of energy

mechanical - touch, pressure, sound …

chemical - taste, olfaction, osmoreceptors…

thermal - warm and cold receptors (skin, hypothalamus)

electromagnetic - photoreceptors

Sensory receptors - structure

- encapsulated receptors - touch, pressure..
- free nerve endings – myelinated and unmyelinated – nociceptors, thermoreceptors

Receptors

- **slowly adapting** - tonic (carotid bodies, nociceptors ..)
- **rapidly adapting** - phasic (cones, muscle spindle, olfactory receptors.....)

Receptive field

- the range of locations
where stimulation will
excite a sensory receptor

eg. skin sensation, vision

Stimulus intensity coding

Frequency of AP and a number of receptors activated

Perception and stimulus intensity

psychophysical law:

$$R = K \times S^A$$

R...sensation felt

S...stimulus intensity

K,A...constants

Stimulus duration coding - pattern of generated APs

Sensory systems have a common plan

- populations of sensory neurons convey sensory information + somatotopic organization
- hierarchy: cortex - thalamus
- parallel and serial processing

Somatosensory system

- different types of receptors

1) touch, vibratory sense, proprioception
2) crude sensation, temperature, pain

- primary somatosensory cortex - postcentral gyrus

Pain

- an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage."
- subjective
- stimuli:
  - thermic above 45°C or below 5°C (thermoreceptors)
  - intensive mechanical - sharp, localized pain (mechanoreceptors)
  - mechanic, thermic and chemical - diffuse pain (polymodal receptors)

Pain

- acute (physiologic) x chronic (pathologic)
- surface, deep, visceral

- referred pain

- modulation of pain:
  - endogenous opioids
  - spinal cord mechanisms (rubbing close to the wound decrease pain)
  - brainstem mechanisms: periaqueductal grey, serotoninergic and noradrenergic descending pathway

The ear has three functional parts

- capturing mechanical energy
- transmission to the receptor organ
- transduction into electrical signals

Optical apparatus

- refractive power (app. 60 D): cornea and lens
- accommodation: changes of refractive power of the lens to focus on near point or far point

Myopia (nearsightedness)

Hypermetropia (farsightedness)

Presbyopia

Pupils

- 2-8 mm
- regulation of light intensity

- miosis (constriction, parasympathetic NS, m. sphincter)
- mydriasis (dilatation, sympathetic NS, m. dilatator)

- pupillary light reflex: direct and consensual