Kris, Feb 24 –
Class 11
Touch, Smell, and Taste

**Touch:**
Somatosenses:
- Cutaneous senses (touch)
- Kinesthesia, proprioception – Joint and muscle stretch information giving body position and dynamics
- Organic senses – receptors on organs such as stomach and gallbladder

Physical stimulus:
- Vibration – tested with tuning fork
  - Function: texture perception (surface)
- Temperature – tested with water bath
  - Function: body temperature regulation
- Pain – tested chemically, mechanically
  - Function: protection from damage
- Pressure – tested mechanically
  - Function: sensation, protection

Skin layers –
- Epidermis – upper layer, peals off, 27 day cycle, damaged by skin cancer
- Dermis – affected by deep burns, contains hair follicles
- Subcutaneous tissue – fat
  - Functions of the skin: Protection (mechanical, chemicals), prevent fluid loss, temperature regulation, communication (blushing, state of health, camouflage), excretion (urea, water), respiration (oxygen absorption)

Different skin receptors are specialized for different aspects of touch:
- Ruffini corpuscles – free nerve ending, deep in dermis, respond to skin stretch, static force e.g poke
- Pacinian corpuscles – encapsulated nerve ending, large onion like structure, deep in dermis, respond to high frequency vibration e.g tickle
- Meissner’s corpuscles – low frequency/tap vibrations, detection of texture, glabrous skin only (no hair) e.g fingertips
- Merkel’s disk – light mechanical pressure, fingertips, lips, genitalia, mostly on glabrous skin

Sensory perception –
- Sensation = mechanoreceptors: pressure and vibration
  - emotional
  - in some animals used to sense heat
- Sense of touch can be modified by learning/experience
  - Musicians, blind people
- The sensitivity of a body area is reflected in the amount of neurons responsive to touch (recall the homunculus)
- Pathway:
  - Receptors -> spinal cord -> ... -> Somatosensory cortex
- Dermatomes - regions of body that are grouped together in the spinal cord (listed top to bottom):
  - Cervical vertebrae – shoulders and arms
  - Thoracic vertebrae – torso
  - Lumbar vertebrae – hips and legs
  - Sacral vertebrae – genitalia and heels
- Damage to somatosensory cortex called tactile agnosia (tactile apraxia)

Temperature:
- 2 temperature receptors
  - Cold – superficial dermis
  - Warmth – deep dermis
- Transduction mechanisms involve a family of dedicated receptors
- Neural pathways are similar to those of pain
- Hypothalamus in charge of temp regulation:
  - Sweating, vasoconstriction
- Physiology:
  - Adaption to constant temp changes
    - Same temp may feel cold or warm depending on initial condition
  - Thresholds of pain:
    - 47F -> 122F
  - Temp is naturally variable
    - Ex: female reproductive cycle = body temp increases after ovulation
  - Normal ranges:
    - Oral 92F - 101F
    - Rectal 94F – 100F

Pain:
- Pain receptors – nociceptors – free nerve endings
Mechanoreceptors – intense pressure
- Intense heat and acids
- Irritant receptors – chemicals that may produce inflammation (tear gas, chili peppers)

Different components of pain sensations:
- Sensory – receptors -> spinal cord -> thalamus (VPN) -> primary sensory cortex -> pain intensity
- Emotional – sensory cortex -> anterior cingulate cortex = pain ‘color’ (how much is it disruptive from 1-10)
- Long-term psychological (chronic pain) – prefrontal cortex, ‘pain memory’

Pain perception:
- Can be controlled (hypnosis)
- Primary sensory cortex – sensation of pain
- Cingulate cortex – perception of pain
- Pain can be ‘imagined’: empathy
- Pain can be managed with learning and experience
  - Brain plasticity result in reorganization
    ▪ Ex: Phantom limb and the mirror box

Taste:
- Chemical sense
- Taste = gustation, flavor = olfaction
- 6 independent taste dimension/stimuli:
  - Bitterness, sweetness, sourness, saltiness(NaCl), Umami (M.S.G), Fat
- Taste apparatus = tongue + palate + pharynx + larynx
- Taste receptor = taste buds
  - 10,000 receptors, renewed every 10 days
- Has strong genetic basis
  - Super tasters – bitter sensitive, more prevalent in women and Europeans
  - Non-tasters – not bitter sensitive

Tongue –
- Taste transduction
- Dissolve in saliva -> bind to receptor -> ion flow -> receptor potentials
  - Sourness – acidity, bind H+, potassium channels
  - Saltiness – NaCl, sodium channels
  - Bitterness – many receptors, detection of ‘badness’ (rotten or not ripe)
  - Sweetness – specific receptors (absent in felines)

https://doctorlib.info/physiology/physiology-2/23.html
- Umami – glutamate acid, MSG, metabotropic channels

Gustatory pathway-
- Lateral hypothalamus (LH) – perception of hunger, metabolism
- Amygdala – perception of like and dislike, aversion
- Primary gustatory cortex – perception of taste
- Nerves: facial nerve, glossopharyngeal nerve, vagus nerve
- Tastes have been mapped:
  - Vary from person to person
    - Established genetically and through experience
    - Size of map may explain individual differences
      - Ex: ‘sweet tooth’

Olfaction:
- Chemical sense
- Stimulus – volatile molecules
- Receptors – olfactory mucosa/epithelium
  - 6 million receptors
- Transduction – slow sodium channels
- Strong genetic basis
- In humans – good sensation but poor perception
  - Strong link to memory

Olfactory sensation –
- Process:
  - Molecules -> Odorants dissolve in mucus -> bind to olfactory cells (cilia) -> each cell sends one axon to olfactory bulb into Mitral cell -> synapse on mitral cell form glomeruli that are molecule specific -> axons of mitral cells go to association areas in brain (olfactory nerve) -> perception

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