24/4 – Hearing in Birds, Lizards and Mammals

- Basic anatomy and physiology of hearing
    - Cochlea: sensory transduction of sound (pressure) into electrical signal
    - Auditory nerve runs from cochlea to:
        - Superior olivary nucleus
        - Inferior colliculus
        - Thalamus
        - Primary auditory cortex (perception)
- Depolarisation/ hyperpolarisation depending on type movement
- Mammalian Ear
    - External ear
        - Pinna
        - Ear canal
    - Middle ear
        - Ear drum
        - Middle ear bones (Ossicles)
            - Malleus
            - Incus
            - Stapes
        - Oval window
    - Inner ear
        - Cochlea
        - Vestibular organs
- Mammalian cochlea
    - 3 fluid filled compartments
        - Scala vestibuli
        - Scala Tympani
        - Scala Media
    - 2 different fluids
        - Perilymph (SV, ST), similar to blood plasma
        - Endolymph (SM), high K+, low Na+
    - Sensory epithelium in mammals
        - Organ or corti
            - Mammalian sensory epithelia
            - Basilar membrane: separates the ST from the SM
            - Inner hair cells: Movement of basilar membrane rubs hair cells against the tectorial membrane – opening stereocillia → graded potential of gangion cells (NT release) → AP of the auditory nerve fibres
            - Outer hair cells: allows amplification of sound – stimulation makes hair cells change length, changing distance btwn tectorial and basilar membranes
        - <u>Mechano Transducers</u>
            - Inner hair cells
            - Outer hair cells
    - Tonotopic organisation
    - Hair cell types
        - Inner hair cell (IHC): release glutamate following DP
        - Outer hair cell (OHC): provide mechanical amplification
    - The smaller the head, the higher the audible frequency
- Sensory epithelium in Birds
    - Basilar papilla

        - Flat instead of spiral (like cochlea)
        - High frequency is amplified near narrow rigid base (oval window)
        - Low frequency is amplified near wide floppy apex
        - Concentration of hair cells increase towards the wider (floppy) end of the papilla
        - Size of papilla increases as the weight of the animal increases
            - As the size increases, the receptive range shifts
            - Heavier animals are able to hear more low frequency sounds
            - Lighter animals hear more high frequency sounds
    - 1 middle ear bone (Ossicle): columella
    - Tonotopic organisation
    - Hair cells
        - Height increases from base (narrow) to apex (wide)
    - Has tectorial membrane for stimulation
    - Hair cell types in birds
        - Frequency – SAME IN MAMMALS
            - High frequency basal: shorter cells
            - Low frequency apical: longer cells
        - Outer hair cells have many more efferent stereocillia than afferent stereocillia
        - Hair cells in birds and reptiles DON'T MOVE
    - Hair cells In birds and lizards are able to re-grow
- Sensory epithelium in Lizards
    - Hair cell orientation changes from 1 side to the other
        - There is no set movement for depolarisation OR hyperpol. some hair cells are always depol. while others are hyperpol. even from the same movment
    - Have a basilar papilla
    - Tonotopic organisation
- Innervation density
    - 1 IHC stimulates many ganglion cells
    - Many OHC stimulates 1 ganglion cell
- Stereocillia
    - Mammals
        - 3 rows per hair cell
        - OHC in the shape of a V
    - Birds/ lizards
        - Multiple rows per hair cell
    - Stereolocating animals have a large ratio of inner to outer hair cells

1/5 – Sensory ecology

- Sensory diversity – causes
    - Evolutionary history
    - The body (size, energy, etc)
    - The environment
    - Signals (Communication & others)
    - Information - Behaviour
- Sensory diversity – Ways of studying
    - Comparative approaches
    - Psychophysics
    - Ecology (behavioural interactions)
    - Detailed behavioural studies (what is their goal in life)