- **Lecture 4: Excitable cells**
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- Excitable cells are ones that undergo potential changes across their membranes. They conduct electrical impulses→ they undergo rapid, transient changes in membrane potential.
- Nerve cells and muscle cells are conductible cells.
- **BODY FLUID COMPOSITION:** solutes unevenly distributed between inside and outside of cells.
- Na and Cl dominate extra cellular fluid.
- K and A- (protein anions) dominate intercellular fluid.
- **Cell membrane:** impermeable to stuff it doesn't want inside at a present time- causes a concentration gradient across membrane.
- Movement occurs by active transport and passive transport.
- **HOW DOES CELL MAINTAIN K AND NA BALANCE?**
- Ions can move through membrane down conc gradient.
- K has **leak channels** in the membrane- the membrane has open pores which allow K to leak out of the cell, but since A- and Na are larger, they are too big to exit via leak channels and won't leak out like K.
- K will leak out of the cell down its concentration gradient.
- If some +ve charged particles leave a cell, the overall charge of the cell will **become more negative.**
- **MEMBRANE POTENTIAL:** the separation of ions across the membrane- basis for excitable cell function.
- Size of potential depends on amount of separation of opposite charges.
- Opposite charges across the membrane are attracted to each other: -ve charge on inside of cell will line up against membrane to be attracted to the +ve ions on other side of the membrane.
- If the charges are equal across the membrane- membrane has no potential.
- +ve and –ve charges line up along the membrane→ this causes the rest of the cell to be electrically neutral since all the charges have been lined up against membrane.
- **RESTING MEMBRANE POTENTIAL:** cells at rest have a potential. Neurons have 70mV potential.
- DEFINITIONS: depolarisation, polarisation etc.
- Neurons can change resting membrane potential very quickly and transiently (will change and go back to normal).
- A change in the membrane which allows +ve ion in, the membrane potential becomes less –ve→ known as **depolarisation.**
- When –ve ions re enter or +ve leave→ **repolarises cell.**
- If potential is slightly bigger than normal→ **hyperpolarisation.**
- **MEMBRANE POTENTIAL AND WHAT CHANGES IT:** types of receptors.
- Caused by change in distribution of ions across a membrane triggered by an event that opens channels/pores in to let stuff in/leave. It is triggered by a stimulus.
- **Voltage gated channel:** change in voltage around cell triggers channels to open.

- **Chemical can bind** to channel and then open as a response to that- neurotransmitter.
- **Mechanical:** touch can cause channels to open. Push down on a cell and pores open and ions flow out.
- **TYPES OF POTENTIAL:**
- Action potential is triggered by graded potential
- Voltage gated Na channels open in response to voltage change.
- Na enters cell down conc gradient→ causes a depolarisation. (There is lots of Na outside cell normally)- also an electrical gradient across membrane.
- If only a small stimulus, only a **few channels open**→ only few Na enter. **THIS IS A GRADED POTENTIAL**- not all channels open and only small amount of Na enters.
- Size of graded potential is **proportional** to size of the triggers. IMPORTANT. Big trigger/stimulus= big graded potential- more channels open and larger change in potential.
- Graded potential can go **either way** across the membrane.
- Once graded potential starts, Na enters and changes membrane potential in the surrounding area. This triggers more Na channels to open. This creates a passive movement in both directions.
- **Picture explained:** the action potential is able to flow across the membrane in both ways (left and right). This is because as the Na+ enters it is able to depolarise the membrane next to where it enters. It comes close to the –ve charged ions inside the membrane and causes them to lose their charge and depolarise. They become more positive and this causes the –ve ions next to those ones to depolarise and so on.
- FLOW OF IONS: any flow of electrical charge is called a current. If a current comes across resistance, it will lose its charge. Since membrane has resistance, current **loses charge** as it moves across. **Means the electrical charge is only a short range signal.**
- Graded potential is small and triggered by a stimulus from anywhere.
- **ACTION POTENTIAL:** large stimulus causes membrane to reach threshold level **-50mV - -55mV in neurons.**
- **Large stimulus** causes influx of Na- causes rapid increase in potential which causes all Na channels to open and lots of Na enters until the cell potential increases to **30mV!** Once this happens, Na channels close **AT PEAK POLARISATION,** and K channels open and K flows out. K doesn't flow out as fast as sodium because has a smaller electrical gradient but still flows out due to a **concentration gradient.**
- At the beginning there is an over correction where membrane hyperpolarises (becomes too negative) but then it returns to normal.
- **Pic explained:** At beginning of graph the membrane potential is –ve and Na has not yet begun to enter the membrane. A stimulus occurs and potential increases as Na gates begin to open. At peak of graph, membrane has reached max potential and is starting to repolarise by K leaving the cell. The membrane hyperpolarises as lots of K leaves the cell. The Na and K pumps restore the ion conc to original conc and membrane potential is restored.

- Repolarisation occurs at very tip of the graph.
- **AFTER THE ACTION POTENTIAL:** Na and K channels have reset and are back to normal and membrane potential is normal. The K and Na conc are restored via K and Na pump. This pump doesn't occur after every single action potential event.
- **ALL OR NOTHING RULE:** action potentials always last for the same amount of time- if a membrane is stimulated its has a huge potential change (action potential) that spreads along the membrane in an undiminished way or it DOES NOT RESPOND AT ALL.
- Nervous system sends multiple signals to convey the strength of the initial signal- this is because the action potential
- Action potential moves in only one way- it is prevented from moving backwards by the refractory period. The neuron has got an absolute and relative refractory period.
- **Absolute refractory period:** Na channels are open and they cannot be triggered to reopen until the membrane has returned to resting potential.
- **Relative refractory period:** an action potential can be triggered again after one has just happened but only with a **huge** signal/stronger stimulus.
- When an original site has recovered from the refractory period, the action potential has moved too far away to trigger another.
- Neuronal cells will take the signal only in one direction.
- **Action potentials only occur in one direction.**
- Permeability is the number of holes in membrane that are open to allow things through.
- **CONDUCTION: an** action potential depolarises an area next to the area affected at an adjacent region. This triggers another action potential along the axon (at the neuron). **THIS IS LIKE A MEXICAN WAVE OF ACTION POTENTIAL-** means the signal can be sent along the axon a very long way. The original action potential doesn't actually travel down the axon, it just triggers new action potentials to occur .
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- **<u>Lecture 3: INTRO TO ANATOMY</u>**
- Bring dissection kit to labs- can wear overalls.
- Prac stuff is important.
- **<u>ANATOMICAL TERMINOLOGY</u>**:
- Directional terms: used to describe where things are in the body.
- Cranial- towards head
- Caudal- towards tail
- Dorsal- towards the back
- Ventral- towards belly
- Medial- towards median plane- NOTE: medial divides an animal into left and right longitudinal sides.
- Lateral-towards side.
- The nose is dorsal to the sternum- means nose is above the sternum.
- Caudal- means things are going towards the tail.
- WITHIN TUBULAR STRUCTURES E.G. INTESTINE:
- Proximal- toward the body- near the body.

- Distal- further from the body e.g. my elbow is distal to my shoulder- it is further away from the body.
- If dorsal/above the wrist you use different terms than if dorsal/above tarsus (hock).
- Dog leg- front face of leg is dorsal.
- On front leg of dog, the back of the leg is palmar.
- On back leg of dog, back of leg is plantar.
- Within the head: caudal- towards the tail.
- Rostral- towards the front of head/muzzle of dog. Rostrum means muzzle- latin meaning.
- PLANES OF DISSECTION: these planes are used to describe cuts through a cadaver in order to view structures.
- Three standard planes:
- 1. Dorsal- parallel to the back
- 2. Transverse- perpendicular to long axis- it cuts across the long axis e.g. chopping and arm in half at the elbow.
- 3. Sagittal- divides body into left/right sections- the median plane is a saggital plane that divides body into symmetrical left and right halves.
- Dorsal plane is parallel to the back- think- cutting the dog lengthways from the anus to the chest- the cut would be parallel to the back.
- Transverse plane- perpendicular/cuts across the long axis e.g. cut the head off- it cuts through the long axis of the neck.
- Sagittal plane: divides body into left and right axis.
- Median plane- symmetrical L/R axis.
- **NOTES I MADE FROM THE LECTURE SLIDES:**
- Dorsal- pointing towards the back- think dorsal fin
- **Ventral**- pointing towards belly/floor- think ventricle which is in heart which is near belly which is closer to the floor.
- Medial- towards median plane- the middle of the animal.
- Lateral- towards the side of the animal.
- Cranial-towards the head.
- Caudal-towards the tail.
- Proximal- towards the point the limb attaches to the body.
- Distal- further away from the point of attachment e.g. shoulder joint.
- **Within limbs and tubular structures e.g. intestine:** use proximal and distal.
- **Within proximal limb (think the arm above the elbow):** use cranial and caudal- towards front and towards the rear.
- **Within distal limb (think arm below elbow):** use dorsal- towards front of limb. Palmar- towards back of forelimb (think palm of hand). Plantar- towards rear of hind limb (back leg- think plantar wart on the sole of the foot).
- **Carpus (wrist):** use dorsal for front of wrist and palmar for back.
- **Tarsus (hock-back legs of dog):** use dorsal for front of hock and plantar for back.
- **WITHIN THE HEAD:** use **caudal-**towards tail, and **rostral-**towards muzzle.

- **PLANES OF DISSECTION:** we use planes of dissection to describe cuts through a cadaver to view certain structures. There are three standard planes:
- **Dorsal-**parallel to back- think cutting a dog from mouth to anus lengthwise.
- **Transverse**-perpendicular to long axis- think chopping a dog in half through the stomach from the back to the belly.
- **Sagittal**-divides body into left and right sections- think cutting a dog in half from head to tail all the way down so it is in two upright pieces. If the plane is symmetrical it is a **median plane.**
- **Quiz:**
- The head is at the cranial end of body.
- Tail is at caudal end of body.
- Neck is cranial to rump.
- Hip is caudal to shoulder.
- Horn is dorsal to ear.
- Udder is ventral to abdomen.
- The foreleg is lateral to the chest wall. Lateral means away from the midline.
- The chest wall is medial to the foreleg. Medial means closer to the midline.
- Elbow is proximal to hand. Elbow is closer to body than hand.
- Foot is distal to knee.
- Stomach is proximal to small intestine. It comes before the small intestine
- Small intestine is distal to stomach. It comes after the stomach.