BMT-72106, EXERCISE 4

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1. EXERCISE 1

a)The driving force is quantified by the difference between the membrane potential and the ion equilibrium potential ($V_{DF} = VmVeq.$).Driving force of an ion species is the force which acts on the ion that is not at its equilibrium, causing the net movement of the ion across the membrane down its electrochemical gradient.

2)voltage-gate ion channels are a class of trans-membrane proteins forming ion channels activated by changes in the electrical membrane potential near the channel.

3)Action potential to travel backwards is impossible. Because on one hand, if it tries to travel backwards, the absolute refractory period will inactivate it no matter how large the stimulus is and it thus can not generate another action potential. The relative refractory, on the other hand, limit it in the hyper-polarization when the stimulus is larger than normal because some of the voltage-gated sodium ion channels have recovered and thee voltage-gated potassium ion channels are still open.

4)The complementary functions is the procedure Ion pumps first create concentration gradients and ion channels than let ions flowdown these concentration gradients.

5)Electrophysiologists frequently describe cells as electrical equivalent circuits, i.e. a combination of resistors and capacitances.The cell membrane consists of a double lipid layer that separates ions in the extracellular space from ions and charged proteins in the cytoplasm. When we want to apply a voltage across the cell membrane by injecting current with an electrode. The current required to maintain this voltage is determined by the membrane resistance, according to Ohm's Law: Voltage = Resistance * Current (or V = R * I), and the higher the membrane resistance, the lower the current required to maintain a given membrane voltage.The membrane is an electrical insulator separating opposing charges inside and outside the cell, the cell membrane not only has a resistance but also a membrane capacitance. Therefore, to change the membrane voltage, it is necessary to charge the capacitance. The applied charge (Q) divided by the membrane capacitance (CM) gives the membrane voltage (Vm): Vm = Q /CM. We can see that for a given amount of applied charge, the smaller the membrane capacitance, the larger the membrane voltage change. As both the membrane resistance (RM) and the membrane capacitance (CM) occur over the cell membrane, they are electrically parallel. Such a circuit of parallel resistance (R) and capacitance (C) is known as an RC circuit. RC circuits are commonly used in electronics as basic filters to select particular input frequency ranges. Similarly, the cell membrane acts as a filter on current or voltage injected into the cell.

6)Intracellular recording involves measuring voltage and/or current across the membrane of a cell. To make an intracellular recording, the tip of a fine (sharp) microelectrode must be inserted inside the cell, so that the membrane potential can be measured. Typically, the resting membrane potential of a healthy cell will be -60 to -80 mV, and during an action potential the membrane potential might reach +40 mV. Extracellular recording happens outside the cell, including single-unit recording, multi-unit recording and field potential recording and amperometry recording. An electrode introduced into the brain of a living animal will detect electrical activity that is generated by the neurons adjacent to the electrode tip. If the electrode is a microelectrode, with a tip size of about 1 micrometre, the electrode will usually detect the activity of at most one neuron.If the electrode tip is slightly larger, then the electrode might record the activity generated by several neurons. Extracellular field potentials are local current sinks or sources that are generated by the collective activity of many cells. Usually, a field potential is generated by the simultaneous activation of many neurons by synaptic transmission and it is recorded. Amperometry uses a carbon electrode to record changes in the chemical composition of the oxidized components of a biological solution.

2. EXERCISE 2

1)Conductance measures the movement of charge across the membrane. Permeability measures the capability of ions to flow across the membrane, regardless of whether they are moving across the membrane.

2) The difference in electric potential between the interior and the exterior of a biological cell is calculaated. (With

respect to the exterior of the cell, typical values of membrane potential, normally given in millivolts, range from 40 mV to 80 mV.) We need to compare and study the potential difference especially to understand how later the cell moves across the cell membrane causing the action potential, resulting in depolarization. a gap junction is a mechanical and electrically conductive link between two neighboring neurons that is formed at a narrow gap between the pre- and postsynaptic neurons known as. Such cells approach within about 3.8 nm of each other,a much shorter distance than the 20- to 40-nanometer distance that separates cells at chemical synapse. Compared to chemical synapses, gap junction conduct nerve impulses faster, but, unlike chemical synapses, they lack gainthe signal in the postsynaptic neuron is the same or smaller than that of the originating neuron. An important characteristic of gap junction is that they are mostly bidirectional (allow impulse transmission in either direction). The simplicity of gap junction results in synapses that are fast, but can produce only simple behaviors compared to the more complex chemical synapses. Without the need for receptors to recognize chemical messengers, signal transmission at electrical synapses is more rapid than that which occurs across chemical synapses, the predominant kind of junctions between neurons. Chemical transmission exhibits synaptic delayrecordings from squid synapses and neuromuscular junctions of the frog reveal a delay of 0.5 to 4.0 millisecondswhereas electrical transmission takes place with almost no delay. However, the difference in speed between chemical and gap junction is not as marked in mammals as it is in cold-blooded animals. Because electrical synapses do not involve neurotransmitters, electrical neurotransmission is less modifiable than chemical neurotransmission. Long-term changes can be seen in gap junctions. Gap junctions are present throughout the central nervous system and have been studied specifically in the neocortex, hippocampus, thalamic reticular nucleus, locus coeruleus, inferior olivary nucleus, mesencephalic nucleus of the trigeminal nerve, olfactory bulb, retina, and spinal cord of vertebrates.While chemical synapses are biological junctions through which neurons' signals can be sent to each other and to non-neuronal cells such as those in muscles or glands. Chemical synapses allow neurons to form circuits within the central nervous system.

Due to the fact that Tetrodotoxin's block is a sodium channel blocker, it inhbits the firing of action potential of the Na+ and thus the conductance change will be slower and thus the change of the slop of the I-R will be smoother. The V will not be at same voltage value as now at around -20 mV. It will back to its rest potential after reaching higher than -20 mV.

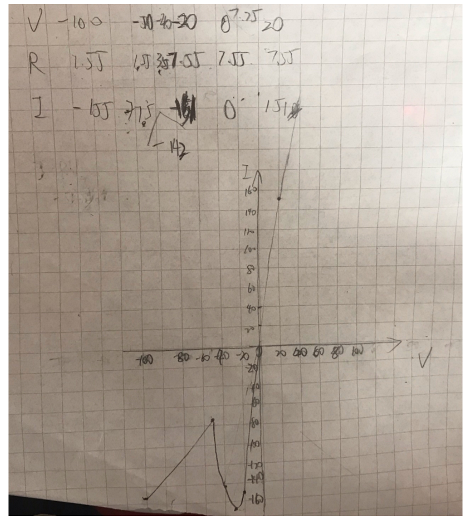

Fig. 1. I-V figure.

3. SUMMARY

To summarize, this weeks exercise review the driving force's concept which is related to previous exercise and keep exploring more related to ion channels. THe focust is on action potential, ion's moving accross the membrane and the relative intra- extracellular cell study. THe Gap junctions and synapses's difference and effects are also compared. As the permeability was covered in the last week's exercise , this week's exercise also compare the conductance with it and in the calculation part, we plot the current -voltage graph and study the TTX's effect as the sodium blocker. The action inside the cell is both phisically and chemically.

REFERENCES

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