Series 4 BIO-105 (2023)

Resting membrane potential

Question 1
Among the following cell types, which cell type does not have a resting membrane potential ?
a. nerve cells (neurons)
b. striated muscle cells
c. smooth muscle cells
d. cells in a salivary gland
e. none of the above
All cells have a resting membrane potential; not all cells generate action membrane potentials.

Question 2
By convention, during an electrophysiological recording of the resting membrane potential the recoding electrode is located
a. inside the cell
b. outside the cell, in the extracellular fluid.
The negative value of the RMP indicates that the recording electrode is on the side of the membrane where there is an excess of anions (negatively charged)

Question 3
A potassium ion channel that opens when a ligand binds to the channel is
a. a leakage channel
b. a gated channel
Leakage channels are "constantly" open under the usual conditions.

Question 4
The Na+/ K+ ATPase pump moves
a. 1 K+ out of the cell for each Na+ moved into the cell
b. 3 Na+ out of the cell for 2 K+ moved into the cell
c. 2 Na+ out of the cell for 3 K+ moved into the cell
d. 3 K+ out of the cell for 2 Na+ moved into the cell
e. 2 K+ out of the cell for 3 Na+ moved into the cell
The pump contributes to the higher K+ concentration and the lower Na^+ concentration inside cells. The pump is eletrogenic because the number of + charges moved out is different from the number of + charges moved in.

Question 5
If a cell plasma membrane had only leakage channels specific for potassium and no leakage channels for the 3 other mains ions, its resting membrane potential would be
a. about – 70 mV, the typical value observed in human cells
b. about 70 mV, the typical value observed in human cells
c. lower than -70 mV, about – 90 mV
d. higher than – 70 mV, around – 20 mV

The RMP of such a cell would be equal to the **Nernst equilibrium** for K^+ which is around -94 mV

Question 6
In humans, the normal K+ plasma concentration is 4.5 mM. What happen to the resting membrane potential of cells when the plasma concentration increases up to 6 mM ?
a. it remains unchanged dur to homeostasis
b. it increases (becomes less negative), cells get depolarized
c. it decreases (becomes more negative), cells gets hyperpolarized

The movement of K^+ through leakage channels is driven by diffusion which depends on ΔConcentration. When the K^+ concentration outside the cell increases (hyperkaliemia), ΔConcentration decreases, less + charges leave the cell, more + charges remain in the cell. Therefore the excess of negative charges inside the cell becomes lower: the cell gets depolarized.
This can lead to death: nerve cells and cardiac cells rely on action potentials to work properly. Hyperkaliemia can lead to cardiac arrest.

Question 7
Aquaporin 1 is a channel allowing water to cross the plasma membrane.
The movement of water through aquaporin is
a. a passive transport
b. an active transport

Transports through channels are always passive. Only pumps receiving energy from ATP can mediate active transport.

Question 8
A knock out mouse was generated in which the gene encoding aquaporin 1 is inactivated. Aquaporin 1 is the only aquaporin present in the red blood cells' plasma membrane.
When red blood cells taken for the KO mice are put in pure distilled water
a. the red blood cells volume remains unchanged
b. the red blood cell burst open but it takes more time than for the red blood cells from a control mouse
c. the red blood cells shrink but it takes more time than for the red blood cell from a control mouse
d. the red blood cells shrink faster than the red blood cells from a control mouse
Because water can diffuse through the membrane, aquaporin only accelerates the movement. In an hypotonic solution cells burst, they do not shrink !