

# Resting membrane tension

**Resting membrane voltage (RMT)** is the difference in potentials inside (intracellular) and outside (extracellular) the cell under resting conditions (i.e. when the cell is not stimulated). The value of KMN is close to the value of the electrochemical equilibrium voltage of the ion for which the cell is most conductive under resting conditions – in most cells, this is potassium. E.g. The KMN of skeletal muscle cells is  $-80$  mV, of neurons it is approximately  $-70$  mV, of Purkinje cells in the heart it is up to  $-95$  mV. A negative sign before the KMN value indicates that the internal environment of the cell is negative compared to the extracellular environment under resting conditions. A shift of KMN to more negative values is referred to as hyperpolarization, a shift toward zero is referred to as depolarization.

The cause of KMN is the uneven distribution of ions between the extracellular and intracellular fluid and the different permeability of the cell membrane for individual ions. Among the most important ions that participate in the creation of resting membrane tension are  $K^+$ ,  $Na^+$  and  $Cl^-$ . The value of the membrane voltage is determined by the permeability of the membrane, the intra- and extracellular concentration of these ions. The Goldman-Hodgkin-Katz equation is used to calculate the current membrane voltage:

$$MN = 61 \times \log \left( \frac{p_K [K^+]_e + p_{Na} [Na^+]_e + p_{Cl} [Cl^-]_i}{p_K [K^+]_i + p_{Na} [Na^+]_i + p_{Cl} [Cl^-]_e} \right)$$

- **MN** = membrane voltage (mV)
- **R** = universal gas constant [8.3 J/(mol.K)]
- **T** = absolute temperature in K (body temperature  $37^\circ\text{C} = 310$  K)
- **F** = Faraday's constant (96,500 C/mol)
- **ln** = natural logarithm
- **P X** = membrane permeability for a given ion
- **X e** = extracellular concentration of X ion
- **X i** = intracellular concentration of X ion

If we measure the membrane tension at a body temperature of 310 K (i.e.  $37^\circ\text{C}$ ) and if we convert the natural logarithm to a decimal ( $\ln x = 2.3 \log$ ), then  $RT/F \cdot 2.3 = 61$ . After these adjustments, the new form of the equation is as follows:

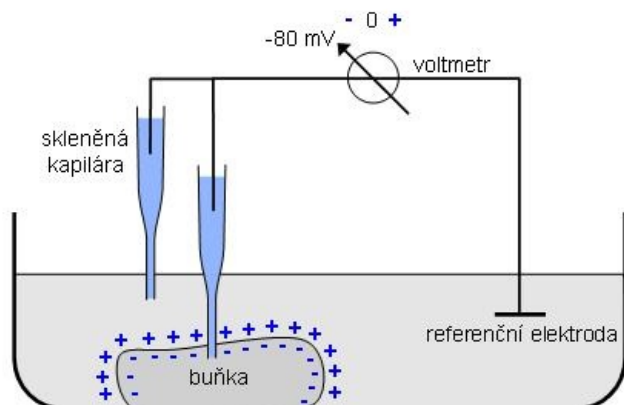
$$MN = 61 \times \log \left( \frac{p_K [K^+]_e + p_{Na} [Na^+]_e + p_{Cl} [Cl^-]_i}{p_K [K^+]_i + p_{Na} [Na^+]_i + p_{Cl} [Cl^-]_e} \right)$$

- **MN** = membrane voltage (mV)
- **log** = decimal logarithm
- **P X** = membrane permeability for a given ion
- **X e** = extracellular concentration of X ion
- **X i** = intracellular concentration of X ion

The above equations are actually an extended version of the Nernst equation .

KMN is a property of all living cells in the human body, but only some of them (nerve and muscle) have the ability to respond to irritation by changing the membrane tension. This change is referred to as an action potential.

The Goldman-Hodgkin-Katz equation was described by David Goldman, Alan Lloyd Hodgkin and Bernard Katz (the last two scientists mentioned are Nobel Prize winners in physiology and medicine).



*Membrane voltage can be measured using glass microelectrodes. One electrode is placed extracellularly (in the nutrient solution), the other electrode is introduced into the cell. The resulting membrane voltage is the potential difference between the two electrodes.*

## Links

### Related articles

- Membrane potential and its changes

### Source

ŠVÍGLEROVÁ, Jitka. *Klidové membránové napětí* [online]. The last revision 2/18/2009, [cit. 10/11/2010]. <<https://web.archive.org/web/20160306065550/>; [http://wiki.lfp-studium.cz/index.php/Klidové\\_membranové\\_napětí](http://wiki.lfp-studium.cz/index.php/Klidové_membranové_napětí)>.