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Comparative Analysis of Electrophysiological Research Methods

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Abstract: *The first theory about the nature of electropotential was developed by the Russian physiologist V.Y. It is Chagovchi's theory. The achievements of electrophysiology greatly influenced the human conquest of space and the development of modern sciences such as cybernetics and bionics. According to German's calculations, a muscle in tetanus (infectious disease) secretes 6.5 times more CO2 than in a calm state. At the same time, the number of metabolites in that part increases. Carbonic acid dissociates into hydrogen and carbon dioxide ions. The report shows that the potential between the excited part and the unexcited part is 0.038 V. Chagovech verified the received report through experience. He places the electrodes on the longitudinal surface and transversely on the injured part. It measures 30 times. The average value is 43 mV. Measurement results are between 35 mV and 50 mV.*

Keywords — Electrophysiology, electric charges, electric potentials, living tissues, quiescent current, excited part, membrane theory, cell structure

INTRODUCTION

Electrophysiological research methods are widely used in the field of medicine. It is mainly used in the field of evaluating the functional state of various organs and tissues, in diagnostic processes and in the treatment of diseases. The achievements of electrophysiology greatly influenced the human conquest of space and the development of modern sciences such as cybernetics and bionics.

A. B. Kogan in his textbook "Electrophysiology" (1969) noted three spheres of connection with the electrical theory of physiology.

1) Study of electrical potentials generated in living tissues;

2) Effect of electricity on vital processes;

3) Physical properties of living tissues as electrical conductors.

Gray in England in 1731 and Halle in France in 1746 reported that they detected electric charges in living things (plants, animals, people) with an electroscope. In 1773, Wales showed that certain fish had a certain effect similar to the discharge of a Leyden jar, and that this discharge could be transmitted by conductive means. All these studies gave rise to the idea that the body is a source of electricity. In a word, vital processes are closely related to electrical processes [1, 2].

The first development of electrophysiology is related to the studies of the Italian physiologist Luigi Galvani.

In 1838-1840, Mateucci showed that an electric current is always observed in the muscle. This is how he explains Galvan's second experience. From the depths of the muscle, negative electrical charges enter the nervous system (picture 1).

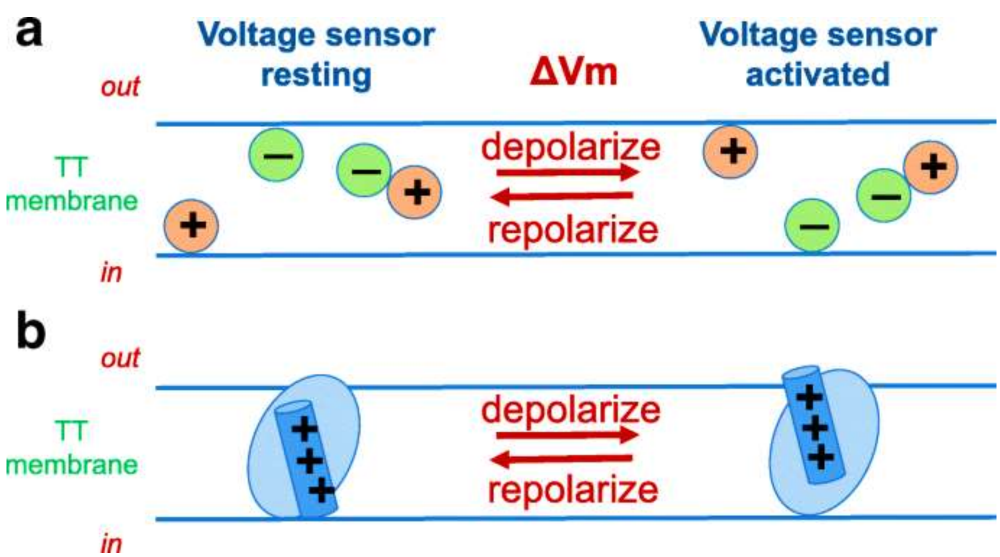

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Figure 1. Scheme of determination of negative electric charges from the depths of the muscle

The electrical current generated when the Mateucci muscle is excited can excite other tissues. He believes that "animal" electric charges excite living tissues. If the muscle contracts, the current to be recorded across the width and length of the muscle decreases. These two facts are mutually exclusive. Mateucci cannot resolve this contradiction. From 1841, the German scientist Dubois came to such a conclusion by repeating the experiments of Raymond Galvani and Mateuchi. The cross-section is negatively charged with respect to the longitudinal surface. He divided the muscle into several parts and observed the repetition of the results. He called the current flowing through the circuit quiescent current.

The first theory about the nature of electropotential was made by the Russian physiologist V.Y. It is Chagovchi's theory. In other words, this theory, created in 1898, is the diffusion theory of the origin of potential. He was the first to emphasize the application of Arrenins' theory of electrolytic dissociation to understand electrogenesis. Chagovchin theorized about the nature of bioenergy using the following known factors.

German's "current of stillness" is a current of alteration. He explained that if a muscle is irritated, metabolism in that part increases sharply. According to German's calculations, a muscle in tetanus (infectious disease) secretes 6.5 times more CO_2 than in a calm state. At the same time, the number of metabolites in that part increases. Carbonic acid dissociates into hydrogen and carbon dioxide ions. These ions will diffuse from the damaged or irritated part to the non-irritated part. The mobility and rate of change of hydrogen ions is greater than the rate of change of CO_2. As a result, the undamaged part quickly acquires a positive potential. The damaged excitable part has a negative potential [2-4].

The report shows that the potential between the excited part and the unexcited part is 0.038 V. Chagovech verified the received report through experience. He places the electrodes on the longitudinal surface and transversely on the injured part. It measures 30 times. The average value is 43 mV. The results of the measurements were between 35 mV and 50 mV. He explains the reason why the indications are so different: the cross-section is a stronger irritation than the ordinary irritation (in the case of an infectious disease). For his time, Chagovech's theory was well-founded. But there were a few flaws.

- The number of 0.5 mentioned by German is not completely accurate;
- It cannot be agreed that only acidic products play a role in electrogenesis;
- If the damaged surface is neutralized with alkali, a negative charge still remains;
- At that time, new information about the structure of the cell was emerging.

The mentioned created new ideas about the nature of bioelectric potential.

RESTING POTENTIALS AND ACTION POTENTIALS

Bernstein in 1906 created the membrane theory of bioelectric potential generation. According to this theory, the surface of the cell is covered by a layer with one-sided permeability. Potassium ions pass easily, Sodium ions poorly, and cations associated with potassium do not pass. It is known that there is more potassium inside the cell than in the external environment. Therefore, according to the electrochemical gradient, potassium ions must move from the inside of the cell to the outside of the cell. Anions inside the cell create a negative charge and help to keep positive charges outside the cell (Figure 2).

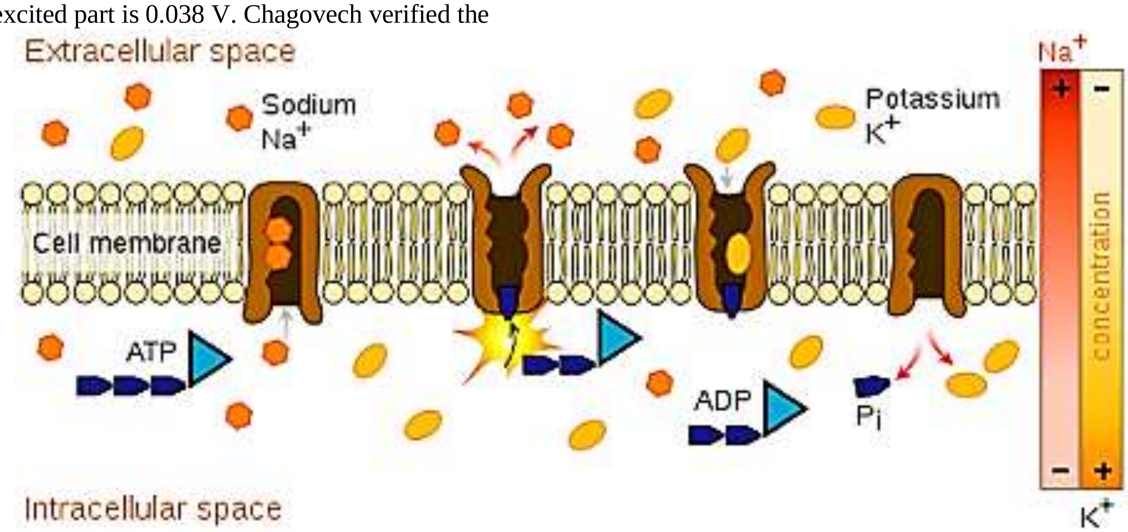

Figure 2. The sodium and potassium ions that remain inside the cell are interconnected

If the cell is damaged, the one-way permeability of the membrane is disturbed, anions come out. In that part, the potential is zero. A potential is created between the damaged part and the undamaged part. Current flows from the damaged part to the undamaged part. If the injury is not healed, the "quiescent current" will always flow, otherwise the cell's one-sided permeability is restored. The calculated result is very close to the experimentally found result. Bernstein's theory is confirmed by several factors [1-3].

According to Bernstein, when the nervous system is excited, the quiescent current should drop to zero. However, after depolarization at rest, the potential difference increases. This indicates that the irritated surface has a negative potential (Figure 3).

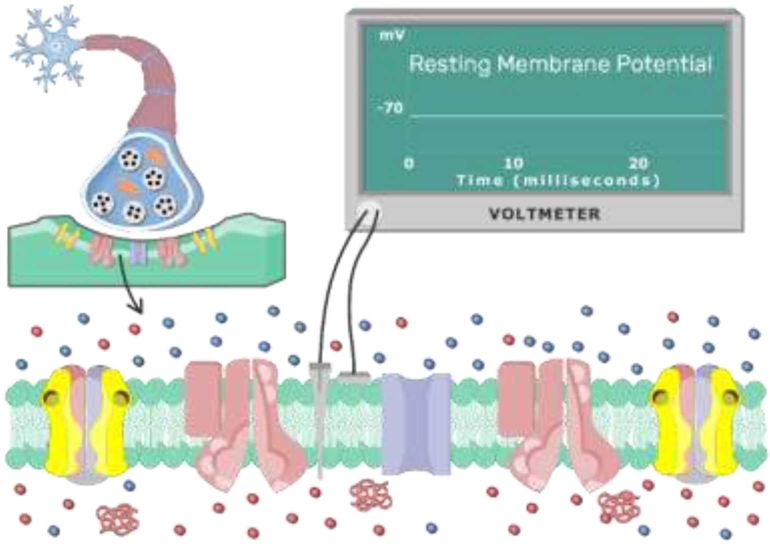

Figure 3. Resting potential

This fact contradicts the membrane theory. However, later studies brought the membrane theory to life in a new form. Studies have shown that membranes are also permeable to sodium ions. This conductivity is much lower than that of potassium ions at rest. Various experiments have shown that the permeability of sodium ions increases when the cell membrane is irritated. The concentration of these ions outside the cell is greater than the concentration of ions inside the cell [3, 4-6].

Sodium ions move into the cell spontaneously, and a change in potential occurs at a certain time. The outer surface of the cell is negatively charged, and the inner surface is positively charged. The reduction of ions outside the cell reduces the excitation current. Other ions do not have this effect. Since the excitation current flows quickly, the potential lasts 0.5-0.8 seconds. Then the quiescence potential is restored. The potential is reduced. It goes down in the first cases. The surface of the cell acquires a higher positive potential at a certain time than before the irritation (Figure 4).

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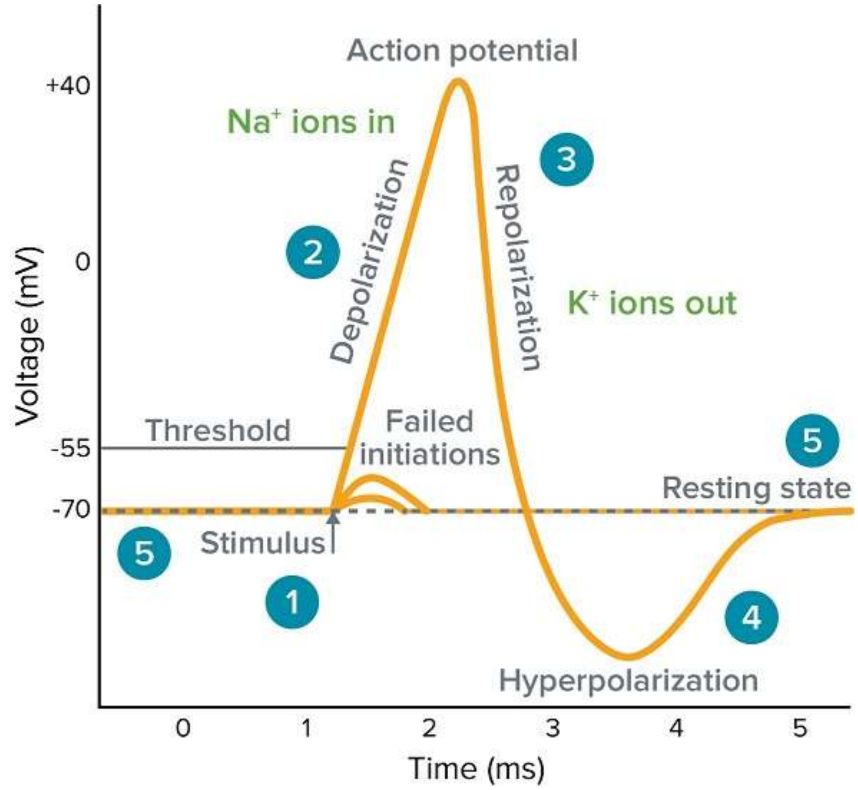

Figure 4. Dependence of the reduction of ions outside the cell on the action current

The recovery process is difficult to understand. For example, why does the sodium ion move to the side where sodium ions are in majority? So there is some force. Conventionally, let's call this force the Potassium-Sodium pump.

In modern times, the process of irritation (excitation) and recovery is understood as follows: at the beginning of irritation, the permeability of the membrane increases for sodium ions, and they enter the cell. To some degree, they depolarize the membrane. The release capacity increases to such an extent that sodium ions enter the cell and the sign of the potential changes, a peak is formed. After that, the membrane's ability to release sodium ions decreases. increases for K ions. K ions leave the cell and the potential changes. The number of K ions reaching the outside of the membrane is greater than the number of Sodium ions entering the membrane, and as a result, the inner surface of the membrane has a very negative potential compared to the surface before irritation for a few milliseconds, hyperpolarization occurs. This process can be very repetitive. The number of moving sodium and potassium ions is so small that the ionic composition of the cell can change during a large number of stimuli. In reality, such a situation, that is, a change in the ion structure, does not occur [5, 6-8].

During the distribution of substances inside and outside the cell, three factors of sorption play a role: dissolution, chemical connection, adsorption. It is related to the name of A.S. Torshi. If the substance is well dissolved, in contact with the protoplasm, it will enter with great speed and accumulate there. Special experiments show that Potassium and Calcium are in close contact with protoplasm. Sodium has a small amount of contact. Cl ions do not bond at all. Unlike the previous ones, Torshin explains the abundance of potassium ions inside the cell and sodium ions outside the cell like this. During irritation and damage, the physiological properties and chemical activity of the protoplasm change.

As a result, cell colloids have less chemical and adsorption properties. This is a stable and quickly disappearing electrical potential during injury and irritation. The account of this theory is close to the practical derived factors. The phase theory in its classical form denies the modern state, the microelectronic technique proves that the cell membrane is in a state of polarization. When the electrode is inserted, it is damaged, but this cell continues to function normally for several hours, sometimes a day. Therefore, the membrane theory is more popular among physiologists and biophysicists.

CONCLUSION

A comparative analysis of electrophysiological research methods was carried out. Studies have shown that membranes are also permeable to sodium ions. This conductivity is much lower than that of potassium ions at rest. Various experiments have shown that the permeability of sodium ions increases when the cell membrane is irritated. The concentration of these ions outside the cell is greater than the concentration of ions inside the cell.

According to Bernstein, when the nervous system is excited, the quiescent current should drop to zero. However, after depolarization at rest, the potential difference increases. This indicates that the irritated surface has a negative potential. The report shows that the potential between the excited part and the unexcited part is 0.038 V. Chagovech verified the received report through experience.

According to German's calculations, a muscle in tetanus (infectious disease) secretes 6.5 times more CO2 than in a calm state. In recent years, they have been trying to eliminate the contradictions between membrane and phase theories of electrogenesis. Not only the membrane of the cell plays an important role in the process of electrogenesis, but also the physico-chemical properties of the cytoplasm

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