The role of calcium in heart contraction

Portrait of Sydney Ringer (1835-1910)

Sydney Ringer's short biography

Sydney Ringer, born in March 1835 in Norwich, England and deceased on October 14, 1910 in Lastingham, Yorkshire, was a British scientist known for creating Ringer's fluid.

1. Abstract

Calcium plays an essential role in muscle contraction, as demonstrated by an accidental scientific discovery made by Sydney Ringer in the 19th century. This article explores the link between calcium ions and heart contraction, tracing Ringer's research and its impact on cardiac physiology. Ringer's inadvertent discovery highlighted the importance of calcium in heart function.

2. Introduction

At the end of the 19th century, the mechanisms of cardiac contraction were poorly understood, particularly the role of ions in the blood. Sydney Ringer conducted research to understand the factors influencing heart contraction. During his experiment, he observed an unexpected phenomenon: the presence of calcium in the saline solution irrigating an isolated heart was necessary so that it continued to beat as usual. This discovery revolutionized the understanding of the cardiac process.

Problem: What is the link between heart contraction and calcium?

Hypothesis: Calcium ions are essential to cardiac muscle contraction because they trigger the activation mechanism of cardiac cells.

3. Experimentation

A. Concept of the study

Sydney Ringer conducted his experiments in London in the late 1880s. At that time, researchers used isolated frog's hearts to study the cardiac physiology, as these models allowed the observation of heartbeats out of the body.

B. Methodology

An accidental error occured when Ringer's assistant used tap water instead of distilled water to prepare the saline solution. Surprisingly, the frog's heart continued to beat in the tap water-based solution, whereas in a calcium-deprived saline solution, the heartbeats would stop.

C. Experiment steps:

Step 1: Prepare an isolated frog's heart and immerse it in a calcium-free saline solution.
Step 2: Observe the heart's activity in this solution. The heartbeats stop.
Step 3: Add calcium to the saline solution and observe the changes in heart activity.
Step 4: Repeat the experiment with other calcium concentrations to determine their effects on contraction intensity and rate.

Ingredients necessary for the experience: calcium, saline solution and frog heart

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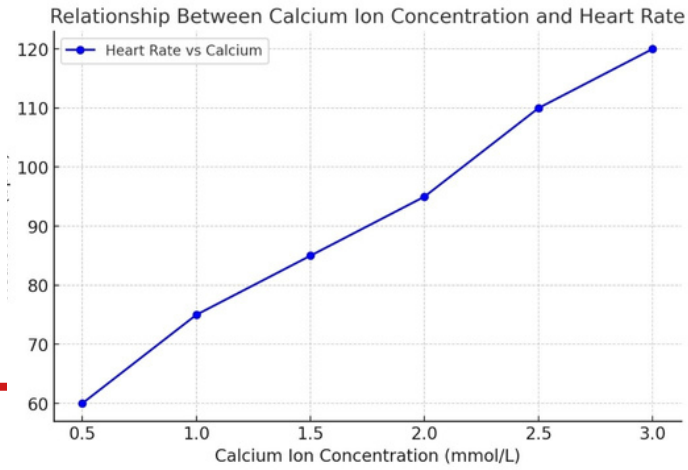
D. Experiment results

Ringer's experiment clearly demonstrated that:

1. In a calcium-free saline solution, the isolated heart stopped beating.
2. Adding calcium to the solution immediatley restored heart activity.
3. Heartbeat intensity and rate increased proportionally with calcium concentration.



The graph illustrates the relation between calcium ion concentration in the solution (in mmol/L) and heart rate (in beats per minute).

The heart rate increases with higher calcium concentrations, highlighting calcium's vital role in heart contraction.

4. The discussion

Ringer's observations confirmed that calcium is indispensable for cardiac muscle contraction. When an electric signal (action potential) reaches cardiac cells, calcium ions enter the cells and trigger a cascade of reactions that cause the muscle contraction. This discovery revealed that calcium ions act as critical «messengers» in the contraction process. Moreover, Ringer's work paved the way for further research into electrolytes'role in cardiac physiology and contributed to medical advancements in maintaining cardiac function.

5. Conclusion

Sydney Ringer's experiments established a fundamental link between heart contraction and calcium. His accidental breakthrough, provided compelling evidence that calcium ions are indispensable to activate heart contractions. His work had a major impact on the understanding of cardiac physiology and keeps influencing modern medicine.

Picture of a physiological laboratory in the 19th century

References

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