THE ROLE OF STOCHASTIC PROCESSES IN CALCIUM OSCILLATIONS IN PLATELETS

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A platelet is a blood cell capable of activation. Platelet activation plays a key role in stopping arterial bleedings and thrombus formation. During activation, calcium acts as a universal secondary messenger, its concentration can multiply by a factor of 1,000 and change abruptly, forming oscillations.

A platelet's reactions to external stimuli are diverse, so it can be assumed that the oscillations of calcium concentration can "encode" the patterns of cellular response. Decoding these oscillations is complicated by the fact that they have an explicit stochastic component. The stochasticity of oscillations is inevitable since the size of a platelet is only about a micrometer, thus there can be only a few dozen free calcium ions in its cytosol.

There are various deterministic models in which calcium oscillations are generated by a limit cycle. Such models are not capable of recreating the variety of oscillation patterns of platelets, so the construction of stochastic models is necessary.

The goal of our research is to identify how stochasticity influences calcium oscillations. The research is conducted using the Gillespie method of stochastic modeling and comparison with experimental data [1].

Analysis of the stochastic model showed that a new mechanism of impulse generation can be observed in the system outside of the limit cycle. A special "waiting mode" can generate single pulses instead of periodic oscillations. The results are reminiscent of experimental oscillations typical for weak activation of platelets. Further research will help with understanding patterns of cellular response in human platelets.

References.

1. Shepeliuk T.O., Masaltseva A.A., Nechipurenko D.Y., Ataullakhanov F.I., Grishchuk E.L. Dense Granules Are Released Cooperatively in Activated Platelets [abstract] // Res Pract Thromb Haemost. 2021; 5 (Suppl 2).