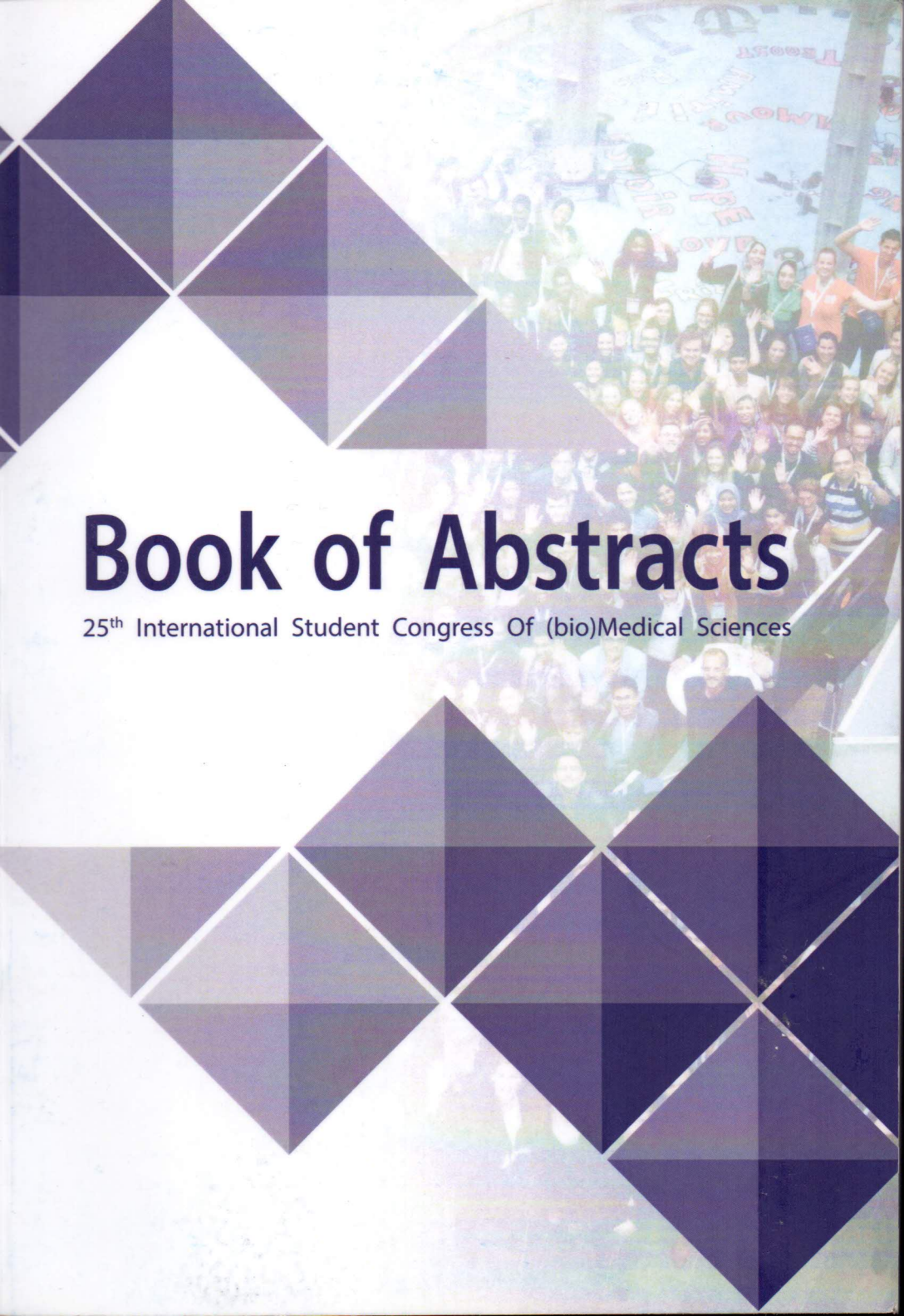

Book of Abstracts

25th International Student Congress Of (bio)Medical Sciences

Progesterone-induced calcium signaling in human spermatozoa

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Introduction

Two main events involved in the process of fertilization, acrosome reaction and hyperactivation, are regulated by free calcium ion concentration in spermatozoa cytoplasm. Rise of calcium concentration can be induced by progesterone, which activates CatSper, a cation channel located in sperm flagella. Calcium ions enter cell cytosol through the open channel and then diffuse into spermatozoon neck, where a specific isoform of phospholipase C, PLCδ, is located. This enzyme activity is upregulated by calcium concentration rise; PLCδ catalyzes inositole-1,4,5-triphosphate (IP3) production from a membrane phospholipid phosphatidylinositol 4,5-bisphosphate. IP3 activates IP3 channel-receptors (InsP3-R) located on the spermatozoon calcium store, redundant nuclear envelope (RNE) – a sperm-specific organelle. Activation of those channel-receptors leads to calcium release from sperm RNE.

Material & Methods

Our mathematical model of calcium signaling in spermatozoa is based on several existing models. The main advantage over those is presence of RNE calcium dynamics simulation. Also, a different InsP3-R model was used; it describes the InsP3-R present in sperm more correctly. Maximum calcium current provided by InsP3-R was estimated based on single channel maximum current and mean number of channels in sperm. System of differential equations was integrated with Python lib SciPy; model constants were chosen to fit the experimental data on calcium dynamics from external sources and our experiments. Spermatozoa cytosol calcium dynamics was measured through relative changes in fluorescence level of dye Fura-2. Cells were fixed on poly-L-lysine cover glass and stimulated with 0.01-10 μM progesterone.

Results

By means of mathematical modeling, it was shown that steady-state calcium concentration in RNE reaches 10 μM. Also, certain values of model parameters lead to calcium concentration low-frequency oscillations; it comes in accordance with experimental observance of calcium oscillations, which were detected in 18-30% of progesterone-activated spermatozoa (those were also observed in our experiment, frequency reaching ~300 secs).

Conclusion

This particular model of calcium signaling in spermatozoa succeeds in experimental data description and is able to simulate calcium oscillations and describe calcium concentration dynamics in RNE, which cannot be described by existing mathematical models.

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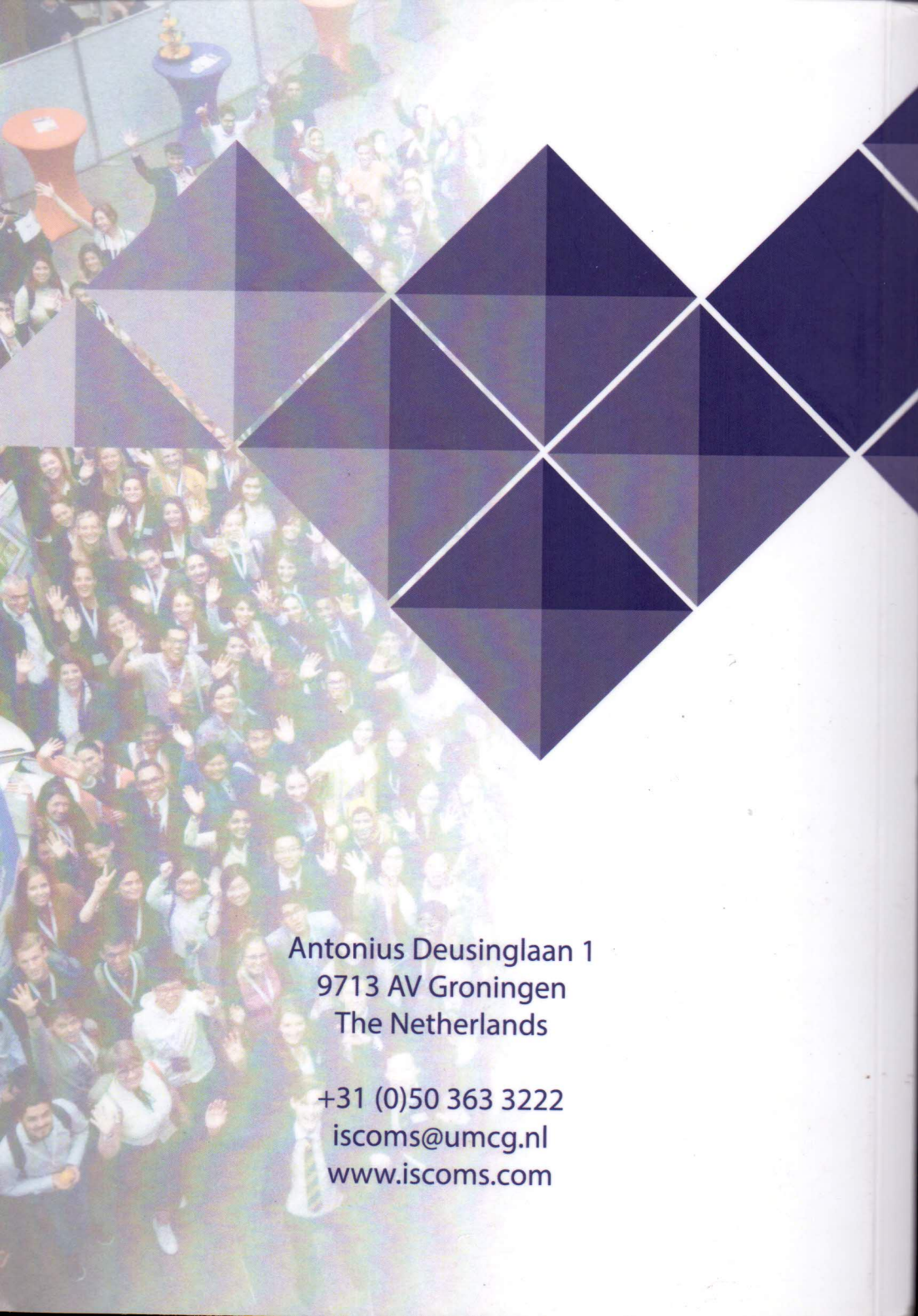

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