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UNIVERZITA KARLOVA

**Ústav patologické fyziologie**
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**Přednosta: prof. MUDr. Jakub Otáhal, Ph.D.**

REVIEW of Doctoral Thesis

Author: Ing. Katarína Mendová

Title: CELL MECHANICS

Doctoral study programme: Mechanical Engineering

Field of study: Biomechanics

Supervisor: prof. RNDr. Matej Daniel, Ph.D.

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DEPARTMENT OF MECHANICS, BIOMECHANICS AND MECHATRONICS

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The doctoral thesis presented here offers a significant contribution to the field of cellular mechanics, particularly in the standardization of mechanical testing. The research addresses a critical gap in the literature concerning the variability of mechanical properties in living cells, which has been a longstanding challenge for researchers due to the dual factors of inherent biological diversity and experimental discrepancies. The development of a method to create a model of the cell specifically artificial vesicles, liposomes, as a reference standard is a commendable effort that enhances the reliability of mechanical testing.

The utilization of a microfluidic device to produce these liposomes ensures a high degree of control over their production, which is crucial for consistency in testing. The mathematical models of cell indentation that have been developed are particularly noteworthy. By adopting a liquid shell description of the biomembrane, these models offer a more nuanced understanding of the mechanical behavior of cells under testing conditions. The findings that the mechanical properties of liposomes are

significantly influenced by both the test method and the data processing method used are of paramount importance. This underscores the need for standardized testing protocols in the field to ensure that results are not only accurate but also comparable across different studies.

Furthermore, the observation that the Hertz model, commonly employed in the analysis of cell mechanics, underestimates the effect of cell size is a critical insight. This could lead to a re-evaluation of past research that relied on this model and prompt the development of new models that can more accurately account for size effects. The thesis stands as a robust piece of scientific inquiry that not only advances our understanding of cell mechanics but also provides practical tools and insights that can be applied in future research. The implications of this work are far-reaching, potentially affecting how mechanical testing is conducted across various biological disciplines.

In conclusion, this thesis is a well-structured and thoughtfully executed study that addresses a complex issue with clarity and scientific rigor. The methodologies developed herein are likely to set a new standard in the field and will undoubtedly be of great interest to researchers seeking to overcome the challenges associated with the mechanical characterization of cells. The research is presented with a level of detail that reflects a deep understanding of the subject matter, and the results are discussed in a context that highlights their significance to the broader scientific community.

Conclusion

**The submitted dissertation of Ing. Katarína Mendová meets the requirements set by the law and related regulations for obtaining the degree of Ph.D. The thesis demonstrates sufficient knowledge of the candidate in the field of doctoral studies, the author has published results in high-quality publications, therefore I recommend the thesis for defense and the award of the degree of Ph.D. For the defense of the thesis, I list below the questions to be answered by author.** If you have any further questions, please do not hesitate to contact me.

**Questions:**

1. What would happen if the probe was larger than the liposome being measured and what would be the limitations of the models used ?

2. Can you explain the meaning of Poisson's number and its value in biological materials, 0.5 is commonly used in calculations, is this value realistic?

Sincerely,

***Prof.MUDr.Jakub Otáhal, Ph.D.***

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