

Doctoral study program: Biomedical Sciences

Form: *doctoral (present)*

Department: Department of Histology and Embryology

Supervisor: doc. Mgr. Jan Krivánek, Ph.D.; <https://histology.med.muni.cz/jan-krivanek> ; <https://x.com/KrivanekLab>

Ph.D. position: Novel roles of innervation and vasculature in tooth regeneration

Annotation:

Teeth are highly vascularized and innervated tissues. This results not only in their extreme sensitivity, but this also allows them to react promptly to stimuli coming from the outer environment. Although vascularization and innervation of the tooth is a rather traditionally well-described phenomenon in terms of morphology, it is a completely unexplored area from a functional point of view related to regeneration, repair or keeping dental homeostasis. This research will focus on the exploration of new, previously undescribed cell types in teeth, cellular and molecular processes underlying tooth regeneration and repair, work on a theory of tooth as a sensory organ and revise the vascular supply and innervation of the tooth. To achieve this a combination of state-of-the-art methods and experimental approaches will be used. This will include new experimental surgical approaches, advanced three-dimensional imaging methods (micro-CT, confocal and light sheet microscopy), single-cell RNA-sequencing, spatial transcriptomics, genetically modified animals, lineage tracing methods, *in silico* tooth modeling, and others. Taken together, this work will provide a new understanding of the tooth from an evo-devo and morphological perspectives. This project is based on numerous international collaborations (Karolinska Institutet, University of Connecticut, University of Sheffield, Leipzig University and others). Selected PhD candidate will be an active part of this network and will have the opportunity to do internships at these institutions.

Funding of the research:

This project is funded by GA CR (The Czech Science Foundation).

Information on funding PGS positions:

The student will have a 0,5 FTE covered by the grant support + scholarship + will have our full support in applying for other sources of funding (Brno PhD talent, travel grants, individual research projects etc.). Student will have a possibility to present his/her results on various international conferences.

Requirements for the student according to the Doctoral Board:

The student's minimum publication activity within the course of study is one first-author publication with an IF value above the median in the field or 2 first-author publications in journals with an IF value in the 3rd quartile in the field (Q3). A condition for successful completion of the studies is also a foreign internship of at least 1 month, which is an inseparable part of the studies. As part of their studies, students will also participate in the teaching.

Information about supervisor:

The supervisor of this project is a developmental biologist who is interested in various aspects of developmental and dental biology with a particular focus on tissue regeneration, stem cell plasticity,

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mechanosensation or micropatterning and hard tissues. During his scientific career he has gained international research experience at several distinguished institutions (Karolinska Institutet, Medical University of Vienna, University of Connecticut, University of Helsinki and others) and collaborates with many research teams worldwide. For research, we mainly use *in vivo* approach utilizing diverse genetically modified mouse strains, a wide range of modern experimental approaches, and in collaboration, for example, the mathematical *in silico* modelling of development and tissue repair. We are international research team consisting of colleagues at all stages of their research careers, ranging from high school students, undergrad and PhD students to postdocs. We are committed to fair access, an equality and work closely together as a team. We socialize outside the work environment and organize lab retreats. Our team is focused on publishing larger and meaningful research papers in highly visible journals.

Selected publications:

- Gonzalez Lopez, M., Huteckova, B., Lavicky, J., Zezula, N., Rakultsev, V., Fridrichova, V., Tuaima, H. R. A., Nottmeier, C., Petersen, J., Kavkova, M., Zikmund, T., Kaiser, J., Lav, R., Star, H., Bryja, V., Henys, P., Vorechovsky, M., Tucker, A. S., Harnos, J., Buchtova, M., Krivanek, J. Spatiotemporal Monitoring of Hard Tissue Development Reveals Unknown Features of Tooth and Bone Development. Aug 2;9(31):eadi0482.
Science Advances, 2023. IF: 13,6
- Petersen, J., Englmaier, L., Artemov, A. V., Poverennaya, I., Mahmoud, R., Boudierlique, T., Tesarova, M., Deviatiarov, R., Szilvasy-Szabo, A., Akkuratov, E. E., Pajuelo Reguera, D., Zeberg, H., Kaucka, M., Kastriti, M. E., Krivanek, J., et al. Previously Uncharacterized Factor Associated with Metabolism and Energy (FAME/C14orf105/CCDC198/1700011H14Rik) is Related to Evolutionary Adaptation, Energy Balance, and Kidney Physiology. May 29;14(1):3092.
Nature Communications, 2023. IF: 16,6
- Kastriti, M. E., Faure, L., Ahsen, D., Boudierlique, T. G., Boström, J., Solovieva, T., Jackson, C., Bronner, M., Meijer, D., Hadjab, S., Lallemand, F., Erickson, A., Kaucka, M., Dyachuk, V., Perlmann, T., Lahti, L., Krivanek, J., Brunet, J. F., Fried, K., Adameyko, I. Schwann cell precursors represent a neural crest-like state with biased multipotency. Sep 1;41(17):e108780.
EMBO J. 2022. IF: 11,6
- Krivanek, J., Soldatov, R. A., Kastriti, M. E., Chontorotzea, T., Herdina, A. N., Petersen, J., Szarowska, B., Landova, M., Kovar Matejova, V., Izakovicova Holla, L., Kuchler, U., Zdrilic, I. V., Balic, A., Marangoni, P., Klein, O. D., Neves, V. C. M., Yianni, V., Sharpe, P. T., Harkany, T., Metscher, B. D., Bajenoff, M., Mina, M., Fried, K., Kharchenko, P. V., Adameyko, I. Dental cell type profiling reveals new stem and differentiated cell types in mouse and human teeth. Sep 23;11(1):4816.
Nature Communications. 2020. IF: 14,9
- Lavicky, J., Kolouskova, M., Prochazka, D., Rakultsev, V., Gonzalez, M., Steklikova, K., Bartos, M., Vijaykumar, A., Kaiser, J., Porizka, P., Hovorakova, M., Mina, M., Krivanek, J. The Development of Dentin Microstructure Is Controlled by the Type of Adjacent Epithelium. Res. 37, 323–339.
J Bone Miner Res. 2022. IF: 6.7

Selected research grants

The Czech Science foundation (GACR), standard projects, Cellular basis of dental healing (2025-2027)

The Czech Science foundation (GACR), standard projects, Fluctuation of the stem cell niche as a source of tissue adaptability in health and disease (2023 – 2025)

The Czech Science foundation (GACR), standard projects, Mechanosensing as a control mechanism for tooth growth and dental tissue repair (2022-2024)

Grant Agency of Masaryk University, High risk/High gain individual research project: Understanding of tooth developmental trajectories as a novel approach for dental regeneration (2019-2021)