Description of the research topic

General information

Institute: National Research Institute of Animal Production.

Research topic: Hypoxia as a Modulator of the Tumour Microenvironment: Functional and Transcriptomic Studies in Equine Sarcoid Cell Lines.

Scientific discipline: Animal Science and Fisheries.

Name of potential supervisor: dr hab. Ewelina Semik-Gurgul.

Background information

The research focuses on the impact of hypoxia (low oxygen conditions) on the tumour microenvironment in equine sarcoids—the most common skin tumours in horses. Hypoxia is a key factor shaping tumour development, influencing cell survival, metabolism, migratory capacity, and interactions with the surrounding environment. Although the role of hypoxia has been well documented in human cancers, its significance in equine sarcoids remains poorly understood. The aim of this study is to determine how varying levels and durations of hypoxia modulate the properties of sarcoid cells compared with healthy skin fibroblasts. The project will utilise cell cultures exposed to controlled oxygen conditions, and analyses will include assessments of cell proliferation, viability, migration, metabolic changes, and activation of processes such as epithelial–mesenchymal transition (EMT). A key component of the study will also be transcriptomic analysis (RNA-seq), enabling the identification of genes and molecular pathways regulated by hypoxia. The results will contribute to a better understanding of the mechanisms underlying sarcoid development and may indicate new potential therapeutic targets.

The main question to be addressed in the project

The main research questions focus on determining the role of hypoxia in shaping the biological properties of equine sarcoid cells and their microenvironment. In particular, the project aims to address the following issues:

- Do varying levels and durations of hypoxia influence the proliferation, viability, and migratory ability of sarcoid cells compared to healthy skin fibroblasts?
- How does hypoxia modulate cellular molecular activity, including the expression of genes involved in angiogenesis, metabolism, extracellular matrix remodelling, and epithelial–mesenchymal transition (EMT)?

- Does hypoxia drive metabolic reprogramming in sarcoid cells towards increased glycolysis?
- Which factors secreted by cells under hypoxic conditions (e.g., VEGF, TGF-β, MMPs) shape a pro-angiogenic and pro-invasive tumour microenvironment?
- Which molecular pathways and genes show significant changes in expression in response to hypoxia, based on transcriptomic analysis (RNA-seq)?

Answers to these questions will help determine whether hypoxia is a key driver of the aggressiveness of equine sarcoids and may indicate potential therapeutic targets.

Information on the methods/description of work

The study will be conducted using equine sarcoid cell cultures, with healthy skin fibroblasts as controls. Cells will be maintained under controlled oxygen conditions: normoxia (21% O_2) and hypoxia at varying intensities (1% and 5% O_2) for defined time periods (24 h, 72 h, 10 days).

Validation of the hypoxia model will be performed by analysing the expression of HIF-dependent genes (qPCR) and protein levels (ELISA). Assessment of the cellular phenotype will include proliferation and viability assays (MTT), apoptosis analysis (caspase 3/7), and evaluation of cell migration and invasion (scratch assay, invasion assay).

Changes related to epithelial–mesenchymal transition (EMT) and extracellular matrix remodelling will be assessed at both the gene expression level (qPCR) and the protein activity level (ELISA, MMPs). Analysis of secreted factors (e.g., VEGF, TGF-β) will allow evaluation of the impact of hypoxia on the tumour microenvironment.

A key component of the project will be transcriptomic analysis using next-generation sequencing (NGS; RNA-seq), enabling identification of differentially expressed genes (DEGs) and analysis of molecular pathways (GO, KEGG). The results will undergo statistical and bioinformatic analyses.

Additional information

The candidate should have a background in biology, biotechnology, bioinformatics, or related life sciences. A solid knowledge of molecular biology and genetics is required. Experience in laboratory work will be an advantage, particularly in techniques such as cell culture, nucleic acid isolation, and PCR/qPCR assays.

The candidate should demonstrate independence, strong teamwork skills, and strong organisational abilities. Proficiency in English is also desirable, enabling access to scientific literature and the preparation of publications.

Place/name of potential collaborators

Cell-based experiments within the project will be conducted in collaboration with Dr. hab. Ewa Ocłoń, who will serve as the co-supervisor. Experimental work related to cell culture and hypoxia induction will be carried out at the Laboratory of Recombinant Protein Production, Faculty of Veterinary Medicine, University of Agriculture in Krakow (1C Rędzina Street, 30-248 Krakow, Poland).

References

Shaikat AH, Azad SMAK, Tamim MAR, Ullah MS, Amin MN, Sabbir MK, Tarun MTI, Mostaq MS, Sabrin S, Mahmud MZ, Mahmud MA. Investigating hypoxia-inducible factor signaling in cancer: Mechanisms, clinical implications, targeted therapeutic strategies, and resistance. Cancer Pathog Ther. 2025 Jul 12; 4(3): 174-191.

Semik-Gurgul E. Molecular approaches to equine sarcoids. Equine Vet J. 2021 Mar; 53(2): 221-230.