Department of Biology

/ Faculty of Medicine
/ Masaryk University

INSTITUTE CONTACT

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THEMATIC RESEARCH FOCUS

RESEARCH AREA

- Pluripotent stem cell research
- Molecular mechanisms of DNA damage and repair
- Functional genomics of pathogenic bacteria
- Experimental cancer biology

EXCELLENCE

We are the world leader in several aspects of stem cell biology, including molecular mechanisms of self-renewal and genomic instability.

MISSION

Advances in biomedicine depend on multidisciplinary approaches, in which knowledge and technology from diverse areas of biology and medicine intersect to inspire new ideas and discoveries. Therefore, our aim is to create a stimulating environment for high-achieving scientists and to build an internationally renowned department with several diverse groundbreaking research programmes. Currently we are particularly interested in the biology of embryonic and induced pluripotent stem cells, genome instability and DNA repair, bacterial genetics and genomics, and cancer biology.

DEVELOPED TECHNOLOGIES

CONTENT OF RESEARCH

- Understanding growth factor signalling in maintaining the non differentiated state and regulating differentiation of human pluripotent stem cells
- Development and testing of new culture conditions suitable for propagation and/or the differentiation of clinical grade human stem cells involving synthetic hydrogel supports, alternative serum replacements and feeder-free culture
- High-throughput biochemical tests for nuclease, helicase and polymerase activities
- Identification of nuclease inhibitors or other biological targets
- Biochemical characterization of proteins involved in genomic instability and DNA repair
- Identification of posttranslational modification by SUMOylation and identification of conjugation sites
- Deciphering of genome differences among groups of pathogenic treponemes causing different human diseases
- Analyses of bacteriocin-encoding determinants as markers and/or factors of bacterial virulence
- Understanding the function and regulation of oncogenes Mdm2 and MdmX – key regulators of tumour suppressor p53 in normal and cancer cells
- Identification of potential targets for novel anti-cancer therapies through understanding the regulation of cellular metabolism and stress response signalling pathways in malignant melanoma

MAIN CAPABILITIES

- Development of stem cell therapies
- Biology of cancer stem cells
- Development of targeted anti-cancer therapies
- Genomic instability
- DNA repair and homologous recombination
- Evolution of bacterial genomes and identification of virulence factors
- Bacterial ecology in the human gastrointestinal system
- Development of specific diagnostic tools for treponemal diseases

Located in the Masaryk University new campus in Brno-Bohunice, the Department of Biology is ideally situated for interaction with several internationally recognized research groups in the neighbouring National Centre for Biomolecular Research, the Department of Functional Genomics and Proteomics of the Faculty of Sciences and with Brno's main hospital – the Faculty Hospital Bohunice. The Department of Biology provides state-of-the-art equipment and facilities for stem cell culture, live cell imaging, biochemistry, gene expression analysis (qRT-PCR and microarrays), flow cytometry and sequencing.

FIELDS OF RESEARCH RESULTS APPLICATION

- Pharmacology
- Biotechnology
- Diagnostic
- Therapeutic
- Medical treatment

ALUMNI PROFILE

The teaching and training curriculum of the Department has been designed to educate and train pre-gradual and Ph.D. students to become clinicians and researchers who can acquire and assimilate the increasing amount of knowledge of human health and disease-related cell biology, molecular biology, and genetics. The overall ambition is to develop an innovative and highly dynamic education programme based on the expert knowledge of group leaders and principal scientists of the Department.

NUMBER OF RESEARCH POSITIONS ↘

SENIOR RESEARCH STAFF

8

JUNIOR RESEARCH POSITIONS (INCL. PH.D. STUDENTS)

31

KEY RESEARCH EQUIPMENT ↘

LIST OF DEVICES

- Cell culture: O2/CO2 incubators Sanyo; Laminar flow biohazard boxes; Horizontal flow box; Automatized N2 cryostorage facility; Cs137 Gamma irradiator for cells and animals; other equipment for routine cell culture in three independent culture rooms
- Cell analysis/imaging: Confocal microscope Olympus Fluoview 5000; Inverted fluorescence microscope Olympus IX51; Inverted fluorescence microscope Olympus IX71; Upright fluorescence microscope Olympus BX51; Multipurpose zoom fluorescent microscope AZ100; Flow cytometer Cytomix XC500; Cell viability analyzer Vi-CELL XR; several other microscopes for routine observation of live cells
- General molecular biology: Real-Time PCR system LightCycler 480; Ultracentrifuge Avanti J-30I; Affymetrix GCS3000 System; standard equipment for protein analyses and recombinant DNA work
- The laboratory of Molecular mechanisms of DNA damage and repair disposes of two AKTA FPLC purifiers, French press, cryo-mill, two large-scale incubators and high-volume centrifuge, fluorescent scanner (FUJI FLA9000), two deep freezers and standard equipment for molecular biology.

BUDGET ↘

TOTAL (MIL. CZK/ MIL. EUR)

35 / 1.4

PART OF THE TOTAL BUDGET FROM PRIVATE RESOURCES (%)

0

PART OF THE TOTAL BUDGET FROM FOREIGN RESOURCES (%)

20

MAIN PROJECTS ↘

2007–2013: Functional and molecular characteristics of cancer and normal stem cells – identification of targets for novel therapeutics and therapeutic strategies (Ministry of Education, Youth and Sports, No. MSM0021622430, Principal investigators: Aleš Hampl, Petr Dvořák)

2006–2011: Centre for Chemical Genetics (Ministry of Education, Youth and Sports, No. LC06077, Principal investigator: Petr Dvořák)

2006–2010: Platforms for biomedical discovery with human ES cells, acronym ESTOOLS (EU 6th FP, Integrated project No. 018739, Principal investigator: Petr Dvořák)

ACHIEVEMENTS

- Significant contribution to the discoveries of molecular mechanisms such as the regulated self renewal and pluripotency of stem cells
- Discovery of molecular mechanisms of homologous recombination regulation in eukaryotic cells
- Identification of factors causing the pathogenicity of bacteria

Research articles in prestigious scientific journals focused on biomedicine, biotechnology, stem cell and cancer research, and molecular microbiology. In the last few years, the Department has published research articles, for example in Journal of Cell Biology, Nature Biotechnology, New England Journal of Medicine, Molecular Cell, Stem Cells.

MAIN COLLABORATING PARTNERS ↘

COLLABORATION WITH ACADEMIC PARTNERS

A. External collaboration in the Czech Republic

- Institute of Molecular Genetics, Academy of Sciences of the Czech Republic; High-throughput screening of bioactive compounds; Dr. P. Bartůněk (Prague, CZ)
- Institute of Molecular Genetics, Academy of Sciences of the Czech Republic; Molecular regulation of cell death; prof. Ladislav Anděra (Prague, CZ)
- Institute of Experimental Medicine, Academy of Sciences of the Czech Republic; Functional analysis of neural cells; prof. Eva Syková (Prague, CZ)

» Palacky University, Olomouc; Modelling cancer in stem cells and mice; Dr. Vladimir Divoký (Olomouc, CZ)
» Institute of Biophysics, Academy of Sciences of the Czech Republic; Wnt, FGF and STAT signaling; Dr. Vitězslav Bryja, Dr. Pavel Krejčí, Dr. Jiří Pacherník (Brno, CZ)
» Charles University, Prague and Institute of Physiology, Academy of Sciences of the Czech Republic; Chromatin structure; prof. Ivan Raška (Prague, CZ)
» Masaryk University, Faculty Hospital; experimental oncology; prof. Roman Hájek (Brno, CZ)

B. External collaboration outside of Czech Republic

» University of California San Diego; differentiation of embryonic stem cells; prof. Martin Marsala (US)
» University of Sheffield; self-renewal and differentiation of pluripotent stem cells; prof. Peter W. Andrews (UK)
» The Hebrew University of Jerusalem; genomic instability in pluripotent stem cells and disease modelling; prof. Nissim Benvenisty (Jerusalem, IL)
» Australian National University; synthetic biology; prof. Mathew Wilce (AU)
» European Media Laboratory; synthetic biology; Dr. Rebecca Wade (DE)
» International Institute of Molecular and Cell Biology; synthetic biology; Dr. Janusz Bujnicki (PL)
» University of Newcastle, Newcastle upon Tyne; differentiation of pluripotent stem cells and intracellular signaling; Dr. Majlinda Lako (UK)
» Universita degli studii de Milano; neural differentiation of embryonic stem cells; prof. Elena Cattaneo (Milano, IT)
» Institute of Reconstructive Neurobiology, University of Bonn; neural differentiation of embryonic stem cells; prof. Oliver Brustle (Bonn, DE)
» Rutgers University; DNA repair mechanism; prof. Steve Brill (US)
» Washington University; DNA repair mechanism; prof. Peter Burgers, prof. Tom Ellenberger (US)
» Yale University; DNA repair mechanism; prof. Patrick Sung (US)
» Beatson Institute for Cancer Research; p53 and Mdm2/X regulations; prof. Karen Vousden (Glasgow, UK)

COLLABORATION WITH COMPANIES

» Enantis; protein engineering and enzyme technologies; Dr. Zbyněk Prokop (CZ)
» LentiKat's, production of immobilized cells and enzymes; Dr. Radek Stloukal (CZ)

EXPECTATIONS ↘

REQUIREMENTS

» New complementary technologies
» New models for stem and cancer cell research
» New tools for cell manipulation, e.g. stem cell fate, stem cell differentiation, genomic stability, and cell survival
» Biophysical or microscopic analysis on single molecule level
» Development of specific diagnostic kits to differentiate between syphilis and yaws infections
» New techniques suitable for analyses of cancer cell metabolism, growth and survival in vitro and in vivo

OFFERS

» Human pluripotent stem cell expertise
» Biochemical characterization of proteins (Protein-DNA and protein-protein interactions, Y2H, etc.)
» Knowledge on treponemal genome structure and variability including suitable genome targets for diagnostic detection
» Expertise in cancer biology – with emphasis on malignant melanoma, cancer cell metabolism, and regulation of the key tumour suppressor p53

04 / 2011