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# University Research Centres (UNCE) - Annotations

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## **UNCE 204001 - Primary Education Research Centre**

The Primary Education Research Centre focuses on building the foundations of education during the period of compulsory schooling. Czech and international research in the last decade has shown a continuing deterioration in the performance of Czech students in both absolute and relative terms, especially in numeracy and reading literacy skills. The project conducted by the Centre uses a secondary analysis of data from Czech and international research with the aim of identifying cultural and social factors, in particular the characteristics of the education system, schools, teachers and students, which could explain students' deteriorating performance. The collection and analysis of data focuses primarily on issues connected with the teaching and learning of the Czech language and mathematics, the understanding of the subject matter by students, and the development of cognitive and self-regulation/motivational components in the acquisition of knowledge in these two key learning areas.

The main benefit of the project conducted by the Centre is its transdisciplinary approach to understanding the processes of learning and teaching in the Czech primary school environment; this approach integrates findings from pedagogy, psychology and subject-specific didactics. The research is based on a combination of quantitative and qualitative approaches, including methods that are currently neglected in Czech social scientific research (experimental methods).

## **UNCE 204002 - University Centre for the Study of Classical and Medieval Thought**

The members of the University Centre for the Study of Classical and Medieval Thought share the idea that it is of vital importance to study the Classical and Medieval epochs and to explore their intellectual heritage in contemporary society. This, of course, does not imply the loss of the ability to distinguish between the present and the past. Neither do we propose doctrinism of any kind. It means being aware of the fact that the intellectual systems of the past represent an invaluable treasure; without knowledge of these systems, we are unable to fully understand the present, including the twists and turns in the development of our modern identity.

Such a reflexive approach towards our intellectual heritage requires a number of tasks which call for a holistic approach. The main aim of the project is therefore to create a framework within which various methods and disciplines, often considered to be antithetical, may enter into fruitful discussion: philosophy and theology, patristic and scholastic studies, Medieval and Early Modern thought, historical and systematic disciplines, various doctrines and philological methods. Only by striving to connect various approaches under a common framework can we speak of interdisciplinarity.

So far the efforts at studying the intellectual heritage of Antiquity and Medieval times at Charles University have been limited to small-scale teams. The present project therefore enables us to gather the individual groups together within one research team, bringing together top researchers from various faculties (Faculty of Arts, Protestant Theological Faculty, Hussite Theological Faculty, Faculty of Humanities).

## **UNCE 204003 - Research of Socio-Geographical Inequalities and Risks in the Early 21st Century**

This research project focuses on the analytical and synthetic assessment of the development and level of regional demographic, socio-economic and socio-cultural differentiation in society during the post-totalitarian and post-industrial transformation. The research also aims to identify key issues and mechanisms of socio-geographical inequalities in different regions, with emphasis on the analysis of their social consequences, including identification of risks and potential problems. Based on empirical results, specific attention is directed towards policy implications and instruments affecting regional and social disparities. Research is carried out on several key themes: 1) the development of interactions between society and its natural environment, 2) the process of globalization and its economic and social consequences, 3) the population reproduction process as well as internal and international migration.

The aim of the research team is focused on linking existing knowledge of the context-dependent development of socio-geographical changes with new theoretical and methodological approaches. The research addresses various hierarchical levels, including the municipal, regional, and national levels. The added value of the research is enhanced

by the application of both qualitative and quantitative research methods and the use of modern, dynamically developing methods involving geographic information systems (GIS). This facilitates the effective linkage of research activities on various themes.

## **UNCE 204004 - Nature and Culture – Interaction of Cultural and Biological Evolution in an Interdisciplinary Perspective**

The mutual relations between biological and cultural evolution represent one of today's most important issues in interdisciplinary scientific research, bringing together both social and biological sciences. Many of the current theoretical models, together with a body of empirical data, suggest that cultural processes are inseparable from the biological traits of their bearers, which could have been shaped by different selection pressures over the course of evolution. It is possible that the precursors of culture, including complex social systems and symbolic language, have evolved as adaptations by means of biological evolution, as was the case with somatic traits. However, a notion that is also of importance to these disciplines is that culture itself creates new selection pressures, which in many respects form the human phenotype in significant ways and, in the long term, may change the human genotype as well. According to this view, on the one hand human culture has arisen thanks to the biological development of specific cognitive and other mechanisms, whilst on the other hand human culture itself creates a specific environment in which these mechanisms are selected. According to some theoretical models, the interaction between genetic and cultural processes may lead to varying developmental trajectories that may differ significantly from trajectories predicted on the basis of, for example, population genetics models. This project thus predominantly draws on current theories and empirical findings according to which culture is a part of human ecology.

The main objective of the project is to interconnect the theoretical-historical perspective with an empirical approach in order to address the issue of biological and cultural coevolution. The focus of the historical-theoretical research is on the analysis of the general problem of the relationship between nature and culture. Specifically, it involves investigations of proto-evolutionary concepts preceding the Darwinian revolution<sup>1</sup>; in more general terms, it involves studies of interactions between philosophy and science during the development of European thought<sup>2</sup>. Another research issue addressed by the project is the conceptualization of cultural transmission in the form of discrete units from the viewpoint of biosemiotics. The empirical part of the project addresses selected aspects of human appearance (such as eye colour)<sup>3</sup>, whose interpopulation variation may have arisen as a consequence of the mutual activity of biological and cultural processes<sup>4</sup>. Another intensively researched area is that of evolution-shaped psychological processes, which may influence cultural variability. Specifically, this issue is studied, for instance, in terms of the phenomenon of body ornamentation or dance and singing from cross-cultural perspective. Identifying the particular factors contributing to the intra- and inter-cultural as well as intra- and inter-individual variability of presumably evolved characteristics may help clarify the complex interconnection of biological and cultural phenomena.

<sup>1</sup> Hladký V, Kratochvíl Z, Kočandrlé R (2012) *Evoluce před Darwinem*, Červený Kostelec: Pavel Mervart, 245 pp.

<sup>2</sup> Hladký V (2013) *The Philosophy of Gemistos Plethon*, Ashgate, 330 pp.

<sup>3</sup> Kleisner K, Priplatova L, Frost P, Flegr J (2013) Trustworthy-Looking Face Meets Brown Eyes. *PLoS ONE* 8: e53285.

<sup>4</sup> Komárek S (2012) Muž jako evoluční inovace? *Academia*, 264 pp.

<sup>5</sup> Havlíček J & Roberts SC (2013). Perfume-body odor complex: An insightful model for culture-gene coevolution? In: *Chemical Signals in Vertebrates XII* (East, M.L. & Dehnhard, M. eds). Springer, New York. pp. 185-196.

## **UNCE 204005 - Centre for Advanced Economic Studies (CAES)**

The main aim of the project is to further improve the quality of basic research in economics at Charles University and to intensify the cooperation between the workplaces engaged in economic research: the Centre for Economic Research and Graduate Education (CERGE) and the Institute of Economic Studies (IES) at the Faculty of Social Studies. The primary research areas involved in this project are macroeconomic theory and models, microeconomic theory and labour markets, and finance. Several of the junior researchers who are involved in the Centre received their doctoral degrees at top universities abroad (e.g. Princeton University, University of Chicago, Johns Hopkins University, London School of Economics) and have experience of long-term research stays at top institutions (e.g. Institute of Technology, Princeton University, New York University). They have already published or begun to publish in leading international research journals and to cooperate with top universities abroad. The financial support of UNCE helps significantly by creating a more stable background for the most talented young economists working at Charles University and allows closer cooperation among senior and junior members of the project team. The aim of this project is the production of high-quality studies published in prestigious international journals, which will help to boost our cooperation with leading international universities and attract internationally renowned academics to work at Charles University.

## **UNCE 204006 - Research Centre for Human Rights**

One of the key paradigms of contemporary law (associated with the concept of the rule of law) is the limitation of state power by its obligation to respect, protect and fulfill the fundamental rights and freedoms of individuals. Regardless of their philosophical foundations in natural law, human rights are now part of positive law (declarations or bills of rights) at the national (constitutional), European and international levels. The influence of these declarations of human rights is currently growing. Impulses to ensure the enforcement of fundamental rights come mainly from international and European law-making and jurisprudence of constitutional and international courts. The dynamics in this field of research are reflected in both its content and its structure. At the international level (but also elsewhere), the question of so-called new human rights is arising. At the national level, research focuses on the relationship between the texts of human rights declarations and their interpretation and development by jurisprudence. The project also offers a comparison of the approaches to human rights taken by different states across legal cultures, both in the present and in the historical perspective.

The Centre offers a platform for a collaborative research carried out by both junior and senior professionals from various branches of law. It was established primarily to stimulate discussion of the theoretical foundations and methods of research on human rights. Another important aspect is the regular exchange of views and opinions within the multidisciplinary team which consists of senior and junior personnel and postgraduate students from various departments of the Faculty.

## **UNCE 204007 - Centre for the Research of Collective Memory**

Collective memory is one of the constitutive features of human societies, related closely to specific local and historical identities. All societies remember, and the need for memory is enshrined in the saying: "Those who forget the past are bound to repeat its mistakes." However, collective memory is also a double-edged sword. It can serve as protection and a safe haven - but it can also mobilize one community against another.

Collective memory has emerged as a significant topic in the social sciences due to the mass traumas that took place in the 20<sup>th</sup> century in many of our societies. The history of the study of memory features great names including Maurice Halbwachs, Jan Assmann, Paul Ricoeur, Pierre Nora, or Paul Connerton.

Today's scholarship approaches collective memory from the position of social constructivism, considering memory a product of different social and mental worlds. Thus, memory is hard to grasp with the use of just one discipline – it is clearly an interdisciplinary field of research.

In 2011, Charles University launched an initiative to gather together representatives of various disciplines (including area studies, history, linguistics, and sociology) who had already been working on the topic of collective memory, and to create an interdisciplinary research cluster on collective memory. As a result of this effort a team was established, consisting of researchers from the Faculty of Arts, the Faculty of Humanities, and the Faculty of Social Sciences. After successfully securing research funding, the Centre for the Research of Collective Memory was established in 2012, and it has found an institutional home at the Institute of International Studies (part of the Faculty of Social Sciences).

The Centre for the Research of Collective Memory focuses on conducting research and producing scholarship through various workshops, seminars and conferences. It aims to interrogate major disciplinary boundaries and explore areas of linkage and dialogue between theoretical and methodological concerns of the above-mentioned disciplines in order to establish fields of shared and feasible joint research.

Hence, the Centre's first discussions and seminars focused on the "exhibition" of epistemological instruments from the disciplines already involved in the research of collective memory. Subsequently some topics (e.g. trauma) have been selected to map out particular disciplinary strengths and weaknesses, as well as highlighting elements shared by several fields of inquiry.

In terms of organization, the Centre works on two parallel levels. The first one focuses on the planning of seminars, workshops and conferences, and helps especially junior researchers participate in conferences organized outside of the Centre (see ( <http://collectivememory.fsv.cuni.cz/>)). The Centre's second level involves the coordination of grants and projects which aim to produce synergy among various research activities related to collective memory, also assisting junior scholars for whom the topic of collective memory is a major concern and a driving force of their academic career. Finally, the Centre has established a community of knowledge to meet and discuss questions of research and scholarship.

## **UNCE 204008 - Transcendence: Its Interpretation in Theology and Art**

The project aims at a formulation of hermeneutics in theology and visual art. Both theology (as inquiry into religious faith) and art (as a particular interpretation of spiritual content, including its scholarly analysis) both necessarily deal with the phenomenon of transcendence.

The research begins with an analysis of points of contact between theological reflection and artistic creation. To achieve this aim, an interdisciplinary dialogue between theology, philosophy, history, and art history must be opened up in order to clarify some essential philosophical and theological categories such as transcendence, inspiration, revelation, etc. Without such clarification, hermeneutics in both fields is hardly conceivable. These aspects will therefore be theoretically considered in a range of individual studies, and subsequently used in the interpretation of Charles IV and the artistic production associated with him.

The core of the project is the attempt to develop a hermeneutics of transcendence in theology and in art. Another key aim is its application to a range of specific topics. The project will also make a valuable contribution by building a research team that is able to approach the issue from various perspectives: philosophy, theology, aesthetics, history, and art.

## **UNCE 204009 - Centre for Phenomenological Research**

The *Centre for Phenomenological Research* was founded to act as a platform for a variety of talented researchers from different backgrounds, who are united by their long-term focus on the phenomenological method. The research primarily addresses traditional topics in philosophy, e.g. the nature of phenomena, the hermeneutics of human existence, the constitution of meaning in speech, the philosophical meaning of time and space, etc. However, other research at the Centre focuses on logic, the history of philosophy and natural sciences, aspects reaching beyond the boundaries of philosophy, literature or natural sciences, as well as research reflecting upon the most recent development in contemporary philosophy both in Europe and overseas.

The research team consists of scholars from the Faculty of Humanities, who have a long-term specialist focus (both in teaching and publications) on the field of phenomenological philosophy. International connections to research institutions throughout the world are already in place from former projects involving the Centre's members; the main aim of the Centre is to contribute through publications and conferences to contemporary discussion and debate on phenomenology and philosophy. The activities of the Centre are also closely connected with the international Erasmus Mundus Master's programme "German and French Philosophy" (which involves key members of the Centre). The Centre will be active from 2012 to 2016. Its Director is Aleš Novák, PhD ([ales.novak@fhs.cuni.cz](mailto:ales.novak@fhs.cuni.cz)).

## **UNCE 204010 - Genetic, Pathophysiological and Epidemiological Aspects of Cardiovascular Diseases**

The main goal of this research project is to incorporate basic research into clinical research in the field of cardiovascular diseases. The project as a whole will involve several separate projects applying an interdisciplinary approach. Topics will include research in the field of atherosclerosis, atherothrombosis, epidemiology of cardiovascular diseases, coronary artery disease, cardiogenetics, the role of infectious agents in cardiovascular disease, valve disease, heart failure, arrhythmias, catheter-based renal denervation and innovative therapies in cardiology. At the present time there are two randomized trials recruiting patients to study the role of catheter-based renal denervation in resistant hypertension and the role of new antiplatelet therapy in patients with myocardial infarction. Furthermore, several prospective registries and observational trials are currently underway.

Some of the results have already been presented at international conferences and are expected to be published soon (results of the PRAGUE-19 registry – short-term outcomes in patients with implanted biodegradable stents in the setting of acute myocardial infarction).

## **UNCE 204011 - Centre for the Study of Rare Genetically Caused Diseases**

The Centre for the Study of Rare Genetically Caused Diseases investigates the molecular basis of rare disorders - a group of over 8,000 diseases which, according to the WHO definition, affect less than 1 person per 2,000 inhabitants. In the EU alone, this group comprises over 29 million patients, who suffer serious health issues as well as socio-economic problems. However, the causal genes have been identified for less than one half of the known rare disorders. This area of research is characterized by difficulties in diagnosis, limited knowledge of the molecular basis of the diseases, and thus limited therapeutic options. The Centre's goal is to begin addressing these deficiencies.

It employs 21 postdoctoral researchers (juniors), 15 PhD students, 3 senior researchers, and one other established researcher. The team's work is focused on studying mitochondrial diseases, selected inherited metabolic diseases, and inherited kidney and eye diseases. A combination of tools and methods is utilized, taken from the areas of molecular genetics, biology, pathobiochemistry, structural biology, and biological models. The results will be used in the design of new types of biosensors, cell analysis methods, and the preparation of a new generation of molecular chaperones to address different aspects of the diseases.

The findings of the Centre's research are expected to improve our understanding of basic pathophysiological processes in human cells and tissues with an anticipated impact on outcomes for improved diagnosis, targeted therapy and prevention, mortality reduction, and possibly a reduction in morbidity among patients who suffer from these rare disorders.

## UNCE 204012 - Leukocyte Development and Regulation in Childhood

White blood cell homeostasis is essential for human life. Disrupting such homeostasis mostly leads to hematological and immunological diseases. Malignant transformation of leukocytes gives rise to leukemia. Leukocytes undergo development, and especially in childhood the ratios of different leukocyte subtypes as well as their functional repertoire are subject to important changes. Among all childhood malignancies, leukemias are the most prevalent. Over 75% of children with leukemia are saved by contemporary intensive treatment, owing to advances in anti-leukemic and supportive treatment coupled with precise diagnostics.

There are several points of interest for this project with respect to the development and regulation of healthy leukocytes and their malignant counterparts:

- The role of selected fusion genes in the rise and development of (pre)leukemic clones
- Diversity of childhood acute leukemias and better characterization of their subtypes including subtypes discovered by our team
- New molecules characteristic for subtypes of childhood malignancies and a comparison of their roles with genes known to have links to leukemia formation
- Pathogenesis of acute leukemia in relation to regulation of normal hematopoiesis
- Resistance to treatment

These points will be addressed using modern techniques, many of which will be co-developed by our team.

The expected outcome of the project will be major insights into the regulation and development of leukocytes and their malignant transformation.

## UNCE 204013 - Mechanisms of Reprogramming of Complex Cellular Responses

The Centre brings together researchers from the Faculty of Science and the 1<sup>st</sup> Faculty of Medicine dealing with complex mechanisms of cell behaviour at different levels and using different models. The research covers five main areas: (i) development of coordinated cellular behaviour, (ii) control of behaviour of stem cells and induced pluripotent cells, (iii) environmental effects on complex cellular responses, (iv) virus induced reprogramming of cell behaviour, and (v) new mechanisms of coupled transcription and splicing.

The **Laboratory of Yeast Colony Biology** studies molecular mechanisms of regulation and differentiation in yeast colonies as primitive multicellular organisms. The research draws on recent findings regarding the metabolic similarities between colonies and tumour-affected organisms and the identification of defence mechanisms in colonies (important in yeast biofilm resistance). The **Laboratory of Developmental Biology** focuses on the migration and differentiation potential of testicular stem cells derived from the testes of the frog *Xenopus tropicalis*. The anticipated results could bring new insights into the expanding field of human germ pluripotent stem cells (GPSC). The **Laboratory of Cellular Immunology** deals with the complex spatio-temporal behaviour of antigen-presenting cells in the context of the whole immune system. The main tool is genetically altered mice, enabling *in vivo* and *in situ* observations of cellular translocations, such as the establishment of micro-chimerism between mother and foetus and *vice versa*. The 1<sup>st</sup> Faculty of Medicine Research Team investigates human tumours which are composed not only of cancer cells but also of stromal elements participating in the control of the biological properties of cancer cells, such as local aggressiveness and metastasis. Molecular mechanisms of the interaction of cancer cells with stromal cells are studied as a theoretical basis for new therapeutic approaches. The Laboratory of Virology studies interactions among the structural proteins (and virions) of polyomaviruses with cellular membranes and other cell structures during different stages of viral infection. Another area of research at the Laboratory is the development of nanostructures derived from polyomaviral capsids for utilization in diagnostics and therapy. Research at the **Laboratory of RNA Biochemistry** focuses on the role of RNA and RNA-binding proteins in the control of translation initiation in eukaryotes and their viruses. Research at the **Laboratory of Gene Expression Regulation** focuses on the interplay between the status of chromatin on one hand, and transcription and splicing on the other. The Laboratory is mapping both genetic and direct interactions of the splicing factor Prp45p and proteins influencing chromatin status in yeast.

The Centre is aiming to achieve application outputs in the fields of regenerative medicine and the influencing of tumour cell behaviour, to improve understanding of viral pathogenesis, and to develop antiviral therapies and new methods of treatment for mycoses.

## UNCE 204014 - MathMAC - University Centre for Mathematical Modelling, Applied Analysis and Computational Mathematics

The mission of MathMAC is the systematic and creative usage of mathematics as the language of natural and social sciences. The guiding idea of the Centre is the search for interesting mathematical problems and the application of state-

of-the-art mathematical tools in applied sciences such as material science (non-Newtonian fluids, non-linear solids), geophysics, biophysics and medicine. The members of the Centre see the applied sciences as an unlimited source of challenging mathematical problems that can stimulate the development of pure mathematics; they will also cooperate with applied scientists on the application of the latest mathematical techniques to real-world problems.

The members of the Centre strive to develop mathematically rigorous descriptions of natural phenomena on all levels of mathematical modelling – the development of a mathematical model, the study of its mathematical properties, the design of suitable numerical methods, and finally computer simulations. Successful description of natural phenomena requires excellence on all levels; for this reason the team is composed of top researchers working in mathematical modelling, mathematical analysis and numerical mathematics. The Centre focuses particularly on research in continuum mechanics and thermodynamics, the theory of partial differential equations, and numerical analysis with a special interest in matrix computations. Research also focuses on related concepts in the realm of pure mathematics, such as the theory of function spaces.

## **UNCE 204015 - University Centre for the Study of Energetic Metabolism**

The project focuses on basic research in the field of energetic metabolism. It draws on previously successfully completed research projects and integrates several research groups in order to utilize both human and technical resources to their full capacity. The project addresses the following issues: molecular causes of beta cell dysfunction and beta cell apoptosis, ER stress and obesity as inductors of adipocyte cell dysfunction, the influence of different factors on mitochondrial dysfunction, nutritional-toxic factors in the pathogenesis of cell damage, energetic metabolism of people with diabetes mellitus type 1 and MODY diabetes, determination of epigenetic changes in genes involved in growth and metabolic processes and its connection with metabolic diseases, and the role of iron metabolism and iron transport in the regulation of energetic metabolism.

The context of the project covers important fields of applied research including the early stages of atherosclerosis, muscle atrophy, insulin resistance and pathogenesis of diabetes; other research focuses on the role of metabolism in relation to cancers.

The UNCE project represents one of theoretical bases for the Centre for Diabetes, Metabolism and Nutrition Research which has been operating at the Faculty for several years. The Centre also collaborates with another project (PRVOUK - "Initial Stages of Diabetes Mellitus, Metabolic and Nutritional Disorders").

Thanks to the UNCE project, several research laboratories have undergone modernization. The project has also resulted in significant publication outputs (twelve papers in top international journals in the first four months of 2013), as well as supporting the continuing education and training of post-graduate students. The topics of seminars regularly organized by the Centre are often closely related to the core areas of research carried out within the UNCE project.

One of the practical outcomes of the UNCE project involves preventive medicine and hygiene, including the preparation of materials to various specifications and a range of public health promotional activities related to nutrition.

The project creates conditions enabling researchers to address complex problems related to theoretical issues with application in clinical research, disease prevention, and training at undergraduate and post-graduate levels.

## **UNCE 204016 - Centre for Biodiversity Dynamics**

The Centre for Biodiversity Dynamics integrates working groups and researchers involved in biodiversity research at all levels, from genetic diversity in populations to distribution patterns at the global scale. The problems studied range from evolution-oriented research (focusing e.g. on factors influencing intraspecific genetic and phenotypic diversity, patterns and processes of speciation, or impacts of interspecific hybridization) to ecologically-oriented studies of community composition and the processes affecting it, macroecological approaches to the evolution of diversity at continental and global scales, and recent changes of biodiversity due to climate change, biological invasions, and various anthropogenic factors. The research topics thus range from those of general relevance to applied topics relevant for the conservation and management of natural resources.

The teams involved in the Centre for Biodiversity Dynamics are drawn from four departments of the Faculty of Science (Botany, Ecology, Zoology, and the Institute for Environmental Studies) and from the Centre for Theoretical Study. These specialists have already established international reputations; they often study similar questions on different model organisms, and they offer complementary expertise. The main aims of the project are to support the excellent junior members of the teams and to further integrate and boost the biodiversity research at all departments involved. We benefit from modern laboratory and statistical methods, intensive involvement of undergraduate and doctoral students in the projects, and wide-ranging international collaboration.

Many of the projects are conducted not only in European countries but also in overseas regions, including Antarctica, African and South American mountain regions, Southeast Asia, Southern Africa, and New Zealand.

## **UNCE 204017 - Molecular Mechanisms of the Host-Parasite Relationship and New Strategies for Control of Parasitic Infections**

The project "Molecular Mechanisms of the Host-Parasite Relationship and New Strategies for Control of Parasitic Infections" brings together the most experienced teams in the fields of human and veterinary parasitology at Charles University. In the past, these teams participated in several significant projects including the Centre for Basic Research (Ministry of Education) and the Research Programme (Ministry of Education); the Charles University UNCE project will enable the teams to extend and further develop their previous activities. The project builds on cooperation among three teams at the Faculty of Science and a team from the Institute of Immunology and Microbiology at the 1<sup>st</sup> Faculty of Medicine. The aim of the project is to establish a centre for molecular and biochemical parasitology, which allows researchers to combine established knowledge in the field of parasite biology (living strategy, morphology, immunopathology) and modern approaches of molecular biology, biochemistry and cell biology. The outstanding results achieved by the teams are documented by over 250 research papers that were published in international impact factor journals since 2006.

The research will be focused on three groups of parasitic organisms: (i) parasitic protists, (ii) helminths, and (iii) blood-feeding insects. A common theme is the study of host-parasite interactions with the aim of uncovering unique functions/molecules of the parasites as potential targets for new antiparasitic strategies. The research plan includes the investigation of the molecular mechanisms employed by the parasites for penetration into the hosts; the parasites' adaptations to the host environments; the strategies used by parasites to acquire host nutrients; molecular mechanisms of pathogenesis; and the modulation of the host immune system.

## **UNCE 204018 - Supramolecular Chemistry**

Supramolecular chemistry is based on the formation of "supermolecules" in which the individual species are bound by non-covalent interactions. Non-covalent interactions are weaker than the classical covalent bonds, which offers a large field for the development of dynamic systems. The Centre will be focused on the development of new supramolecular materials (constitution-dynamic conjugated polymers for application in optoelectronics, photovoltaics and non-linear optics), supramolecular systems for application in medicine (tomographic and magneto-optic imaging techniques, radiodiagnostics and radiotherapy), supramolecular sensors (selective separation and detection of biomolecules and other materials), and catalysts based on *in situ* generated supermolecules.

The Centre brings together experts from different chemical disciplines, enabling the synthesis and preparation of different supramolecular systems and their investigation using a large number of special spectroscopic, electrochemical and other analytic methods, as well as a theoretical treatment using methods of computational chemistry. The interconnection of all these approaches will lead to a significant improvement of our knowledge about the given systems and the introduction of rational designs for new materials.

## **UNCE 204019 - Centre for the Study of Toxic and Protective Effects of Drugs on the Cardiovascular System**

Cardiovascular toxicity of drugs is among the most important complications of modern pharmacotherapy. Numerous drugs have an off-target potential to damage the heart and blood vessels; however, the most important problem has been associated with anticancer chemotherapy.

Main objectives of the Research Centre

1. Research of molecular mechanisms of cardiovascular toxicity of both established and new anticancer drugs
2. Study of the possibilities for protection of the heart using established and newly synthesized drugs, including structure-activity and pharmacodynamic/pharmacokinetic relationships, effects on anticancer effectiveness and advanced drug delivery methods
3. Study of vascular protection and development of new drugs with vascular-targeted photodynamic therapy

This Centre is characterized by a multidisciplinary approach, ranging from the rational design and synthesis of potential drugs, through the assessment of their therapeutic effects using *in vitro* and *in vivo* experiments and determinations of safety/toxicity, to the analysis of their pharmacokinetics. The research team is composed of 20 researchers (senior faculty staff and post-doctoral researchers) and around the same number of PhD and Master's students from 7 departments of the Faculties of Pharmacy and Medicine in Hradec Králové. This project therefore aims to bring together complementary skills, knowledge, and resources in new ways in order to jointly address the research problems.

## **UNCE 204020 - Research of the Earth and the Universe by Methods of Theoretical, Computer and Experimental Physics**

The project combines the efforts of six groups working at different physics departments of the Faculty of Mathematics and Physics. Its objective is to carry out basic research into the structure and dynamics of matter, fields and energy transfer

in geophysical, astrophysical and planetary systems. We aim to contribute to a better understanding of the processes in the Earth and its atmosphere, including those affected by human activity; to study the dynamics of asteroids, solar wind and magnetic fields in the plasma in the solar system; to carry out research of astrophysical systems, both classical (e.g. binaries) and those whose strong gravitational field requires the application of the general theory of relativity (in particular neutron stars and black holes); and finally to research cosmic radiation and nuclear and particle processes, which are of key importance in the physics of supernovae in the early universe.

This proposal involves the use of (and linkages between) various techniques, ranging from purely mathematical approaches, through computer modelling and numerical simulation, to observation and experiments using modern technologies.

The project will be implemented in cooperation with a number of top international scientific institutes and universities.

## **UNCE 204021 - Experimental Pathology: Genetic Manipulation of Stem Cells**

The project is run by the Institute of Pathological Physiology at the 1<sup>st</sup> Faculty of Medicine. Four leading researchers and professors (senior researchers), together with thirteen post-docs (junior researchers) are involved, plus several graduate students and technical staff. The project addresses research into stem cells and tumour cells using highly sophisticated animal models.

We aim to study the molecular mechanisms through which hematopoietic stem cells are able to convert themselves into various types of blood cells with definite functions (red blood cells, platelets, various cells of the immune system). Differentiation of hematopoietic stem cells at the molecular level occurs as a highly coordinated process of switching on and off genes encoding specific cellular functions. This process is driven by molecules, such as transcription factors, enzymes changing the spatial structure of DNA strand around the nucleosome, or molecules known as microRNAs with the function of broad inhibitors of gene expression. The project aims to study the function of these molecules in the development of particular cell types using experimental murine models. We also aim to study the specific self-renewal capacity of hematopoietic stem cells, the role of the bone marrow microenvironment in their production, and the mechanisms by which the cells ensure the regeneration following chemo- or radiotherapy.

We aim to translate our data and develop a preclinical model of aggressive lymphoma. The model will be based on xenotransplantation of human tumour cells into immunodeficient mice. The model is currently used to characterize the infiltration and spreading of cancer cells in various organs in mice; to elucidate the role of adhesion molecules and tumour cell receptors in lymphoma attachment, growth, proliferation and neovascularization; and to compare the gene expression of tumour cells grown in culture with cells growing in vivo.

A major outcome of the project is a series of publications in recognized scientific journals. Data are also presented at specialized research conferences abroad and within the Czech Republic, and at the annual symposium organized by the lab (G3, <http://g3.lf1.cuni.cz/en>). Junior and senior researchers are also involved in teaching. Both scientific and teaching backgrounds facilitate the career growth of highly educated and experienced academic professionals.

## **UNCE 204022 - Chromatin Structure, Organization and Dynamics**

This project is focused on a highly competitive field of biomedicine – chromatin. The structure, organization and dynamics of chromatin determine genome function. The behaviour, metabolism and fate of every cell depends on chromatin structure and function.

The project draws on the most recent research findings and involves the study of gene expression regulatory mechanisms from the nucleosome level to the spatial distribution of chromosome territories.

The project will focus particularly on the structure of the nucleosome, the organization of viral genomes, gene silencing, ribosomal DNA transcription and synthesis, RNA posttranscriptional modifications, possible prion-chromatin interactions, chromatin structure during embryogenesis, and the influence of chromatin structure on nuclear receptors. Mammalian and human cell lines, cells from selected clinical material and model organisms will be employed for this purpose.

In addition to genetic, biochemical, and molecular approaches, researchers will utilize state-of-the-art microscopy methods including live cell imaging, super-resolution microscopy, cryo-electron microscopy of vitrified samples, electron tomography, single particle analysis, and correlative light and electron microscopy.

## **UNCE 204023 - Physics of Condensed Matter and Functional Materials**



The project includes three main topics: basic research in solid-state physics, the development of experimental methods, and functional materials. The first topic concerns collective and cooperative phenomena in solids, namely magnetism and superconductivity of selected alloys and multiferroic materials, as well as quantum effects and superfluidity of liquid He. The second topic involves the development of advanced experimental methods, namely nuclear magnetic resonance methods for the study of the atomic, electronic and magnetic structure of solids and its dynamic behaviour. Research within this topic also includes the development of methods of positron annihilation spectroscopy, which are used for the study of point defects in crystalline materials, and advanced x-ray scattering methods applied in the investigation of nanocrystalline materials and epitaxial layers. The third topic will involve the development of new materials for catalytic converters and fuel cells, as well as new functional metallic alloys.

The project team will include 18 junior researchers, approx. 15 senior researchers and approx. 30 PhD students from four departments of the Faculty of Mathematics and Physics.

## **UNCE 204024 - Modern Diagnostic Methods in Treatment Tailoring and Morbidity Reduction in Gynecology**

The main aim of this project is to establish a multidisciplinary university research diagnostic center. The Centre is engaged in the research of new diagnostic methods focusing on better individualization of treatment and reducing long-term morbidity of patients in several fields in gynecology. It is the most clinically-oriented of all the University centres, aiming to transform the results of clinical research into routine clinical practice.

The main objective is to combine the expertise and inventions of several teams in oncogynecology, urogynecology and endoscopy with other diagnostic fields - pathology and radiology. The Centre focuses on three groups of gynecologic patients: women with gynecological malignant tumors, women with endometriosis, and women with pelvic floor disorders.

In the field of oncogynecology, the project focuses on the use of ultrasound, magnetic resonance imaging and positron emission tomography in the clinical staging of cervical, endometrial and ovarian cancer in combination with histopathology examination. The complex and detailed pre-treatment evaluation enables the individual tailoring of treatments in operable stages (different radicality of parametrial resection; fertility sparing treatment - radical or simple trachelectomy, nerve-sparing surgery, surgery after neoadjuvant chemotherapy; laterally differentiated radicality of parametrial resection, prediction of optimal debulking) and its optimal combination with other treatment modalities.

The endoscopic part of the project aims to discover new approaches to the individualization of surgical treatment in patients with deep infiltrating endometriosis (DIE), which is associated with a significant impact on quality of life. An important part of the management of this condition is an adequate preoperative evaluation, which is a key prerequisite for tailoring the treatment, choosing the treatment modality, lowering the risk of intraoperative and postoperative morbidity, and optimizing treatment outcomes. Another fields of interest are hyperandrogenic syndrome, implementation of new diagnostic criteria, and the role of hormonal and surgical interventions in treatment of symptoms and prevention of long term complications.

Urogynecology group focuses on two key areas - pelvic organ prolapse and dysfunction of the lower urinary tract after the treatment of gynecological malignant tumors.

## **UNCE 204025 - Innovative Technologies for the Identification and Optimization of the New Generation of Anti-Cancer Drugs**

The team (consisting of seven senior and sixteen junior researchers) is composed of members of the Department of Biochemistry, the Department of Analytical Chemistry, and the Department of Physical and Macromolecular Chemistry. Research focuses on key aspects of tumour recognition and elimination. The anti-cancer or immunomodulatory drugs have been identified, discovered, and optimized based on detailed research of their biochemical or immunological mechanisms.

The research team consists of three distinct yet closely co-operating groups addressing the following topics: (i) the structure and function of biotransformation enzymes (cytochrome P450, membrane or soluble reductases, conjugation enzymes), their cell topology and involvement in molecular carcinogenesis and drug metabolism (investigation of the molecular mechanisms of antitumour drug action in detail, drug development, examination of the effect of genotoxic stress on tumour development), (ii) protein expression, structural biochemistry, and therapeutic applications of soluble forms of immune-cell receptors, tumour proteomics and glycoproteomics (structural-functional analysis of protein/carbohydrate moiety), (iii) biosynthesis of secondary plant metabolites with anti-cancer effects, structural and functional analysis of anti-tumour plant metabolites and their modification by chemosynthesis. The research findings of the project have recently been published in prestigious scientific or medical journals including Analytical Chemistry, Journal of Immunology, Toxicology and Applied Pharmacology, Toxicology, Current Medicinal Chemistry, Cancer Research, and Carcinogenesis.

The detailed knowledge of molecular mechanisms of cancer cell recognition by the immune system, together with biochemical, structural-functional, toxicological and immunological findings, enable us to define the next generation of anti-cancer drugs with high efficiency against a broad spectrum of tumours that are active even in low doses, thereby causing minor negative side effects to weakened and immune-suppressed patients suffering from cancer.

## **UNCE 204026 - Centre for the Study of Drugs and other Biologically Active Substances from the Perspective of the Prevention and Treatment of Important Lifestyle Diseases**

The aim of the project is to study newly used drugs in clinical medicine as well as biologically active substances of natural origin from the perspective of the prevention and treatment of important lifestyle diseases, especially cardiovascular and oncological diseases and degenerative diseases associated with human ageing.

The project involves studying the influence of significant biological markers in the early diagnosis of these diseases along with the identification of new potential biomarkers and the isolation and identification of new enzymes as potential targets for the inhibition associated with the treatment of these diseases. An integral part of the project is the isolation and identification of new substances of natural origin, especially those with anti-oxidation activity in relation to the prevention of cardiovascular and oncological diseases.

This multi-disciplinary project focuses strongly on the work of young researchers (junior researchers), creating linkages between their work and that of experienced, extensively published researchers (senior researchers) from several departments at the Faculty of Pharmacy in Hradec Králové who specialize in the prevention and treatment of lifestyle diseases.

Detailed information can be found at <http://portal.faf.cuni.cz/Centers/UNCE2>.

## **UNCE 204027 - Centre for Modern Computer Science**

The Centre for Modern Computer Science focuses on top-level research in theoretical computer science, with motivation from and impact into certain applied areas. Current computer science needs to deal with new challenges arising from extremely large data sets, huge software and web systems, etc. Successful methods in this new research area are often based also on new theoretical results. In turn, new fundamental questions motivated by massive systems and data sets are an important motivation of new theoretical research.

## **UNCE 204028 - Peace Research Center Prague**

This inter-faculty project establishes a new interdisciplinary research center in the tradition of continental Peace Research. It brings together scholars with expertise in International Relations, Security Studies, History, Law, Sociology, Economics, Anthropology, and Social Psychology. The Center pursues three main aims: first, to advance theoretical and empirical knowledge in peace and conflict studies; second, to build a permanent platform for collaborative interdisciplinary research at Charles University; third, to provide an opportunity for junior scholars to develop their academic career.

The joint focus of the Centre is on the prevention, management, and transformation of conflicts in three issue-areas: Nuclear Non-Proliferation and Disarmament; Frozen Conflicts; and Power Shifts in Global Order. The team treats these areas separately in individual research groups but also explore possible linkages between them in joint collaborative forums. To fulfill all objectives with the highest academic excellence and the best practices of project management, the research is supervised by Prof. Harald Müller, a long-time director of Peace Research Institute Frankfurt.

You can find more at <https://www.prcprague.cz/>