



**Summary of the main activities
of the Institute of Animal Biochemistry and Genetics
of the Slovak Academy of Sciences**

Period: January 1, 2007 - December 31, 2011



Ivanka pri Dunaji, April 2012



Questionnaire

Summary of the main activities of a scientific Organisation of the Slovak Academy of Sciences

Period: January 1, 2007 - December 31, 2011

I. Formal information on the assessed Organisation:

1. Legal name and address

Institute of Animal Biochemistry and Genetics
900 28 Ivanka pri Dunaji, Slovak Republic

2. Executive body of the Organisation and its composition

| Directoriat | name | age | years in the position |
|----------------------|-----------------------------|-----|-----------------------|
| director | RNDr. Ivan Hapala, CSc. | 57 | 10 |
| deputy director | RNDr. Ľubor Košťál, CSc. | 55 | 10 |
| scientific secretary | RNDr. Jana Antalíková, PhD. | 45 | 3 |

3. Head of the Scientific Board

RNDr. Peter Griač, CSc.

4. Basic information about the research personnel

- i. Number of employees with a university degree (PhD students excluded) engaged in research and development and their full time equivalent work capacity (FTE) in 2007, 2008, 2009, 2010, 2011 and average number during the assessment period

ii. Organisation units/departments and their FTE employees with the university degree engaged in research and development

| Research staff | 2007 | | 2008 | | 2009 | | 2010 | | 2011 | | average | |
|--|------|------|------|------|------|------|------|------|------|------|---------|------|
| | No. | FTE | No. | FTE | No. | FTE | No. | FTE | No. | FTE | No. | FTE |
| organisation in whole | 27.0 | 25.6 | 23.0 | 22.7 | 28.0 | 24.4 | 31.0 | 23.9 | 35.0 | 20.7 | 28.8 | 23.5 |
| Department of Membrane Biochemistry | 13.0 | 13.1 | 10.0 | 10.2 | 15.0 | 13.8 | 16.0 | 11.0 | 20.0 | 9.4 | 14.8 | 11.5 |
| Department of Physiology and Ethology | 6.0 | 4.5 | 8.0 | 7.5 | 9.0 | 6.6 | 10.0 | 7.8 | 10.0 | 6.5 | 8.6 | 6.6 |
| Department of Gravitational Physiology | 3.0 | 3.0 | 0* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.6 |
| Department of Immunogenetics | 5.0 | 5.0 | 5.0 | 5.0 | 4.0 | 4.0 | 5.0 | 5.0 | 5.0 | 4.8 | 4.8 | 4.8 |

*one working group of the Department of Gravitational Physiology fused with the Department of Physiology and Ethology and the second one with the Department of Membrane Biochemistry

5. Basic information on the funding

i. Total salary budget¹ of the Organisation allocated from the institutional resources of the Slovak Academy of Sciences (SAS) in 2007, 2008, 2009, 2010, 2011 and average amount for the assessment period

| Salary budget | 2007 | 2008 | 2009 | 2010 | 2011 | average |
|---------------------------------------|------|------|------|------|------|---------|
| total salary budget (millions of EUR) | 0,38 | 0,38 | 0,39 | 0,40 | 0,38 | 0,39 |

6. URL of the Organisation's web site

www.ubgz.sav.sk

II. General information on the research and development activity of the Organisation:

1. Mission Statement of the Organisation as presented in its Foundation Charter

- The mission of the Institute of Animal Biochemistry and Genetics of the Slovak Academy of Sciences activity is to perform fundamental research in fields of biological and agricultural sciences oriented at molecular-biological, physiological, biochemical and genetic processes undergoing in animals and microorganisms. The main focus is on neurobiological and physiological mechanisms of animal behaviour in normal and extreme conditions, cell biology of membranes and the role of membrane in energy transformation, the role of membrane antigens in

¹ Objem mzdových prostriedkov bez odvodov do poisťovní so započítaním sumy miezd pracovníkov THS, ktorú organizácii poskytne ETO Úradu SAV. Rozpočet v Sk prepočítajte na eurá podľa konverzného kurzu 1€ = 30,126. (Podobne aj v ďalších tabuľkách.)

immunological and reproduction processes, as well as at the application of the knowledge on membrane processes in nanotechnologies, biotechnologies and biomedical disciplines.

- The Institute provides consulting and expertise services related to its main activities.
- The Institute provides the PhD. studies according to the legal regulations in force.
- The Institute administers the publication of the results of the research and development activities and their popularization via periodic and occasional press and other information media. Publishing of periodic and occasional press is guided by the resolutions of the Presidium of the SASci.

2. Summary of R&D activity pursued by the Organisation during the assessed period, from both national and international aspects and its incorporation in the European Research Area (recommended 5 pages, max. 10 pages)

Although the scope of problems covered by research teams of the Institute of Animal Biochemistry and Genetics is rather wide, most of our activities are for a prolonged period of time connected with the biological membrane research. Membranes and their functions under normal and pathological conditions have been in the centre of our research interests also during the assessed period. We were studying membrane phenomena at various levels of complexity (Fig. 1), such as molecular interactions at membrane-like interfaces, membrane bioenergetics in *Methanoarchaea*, formation and maintenance of membranes in eukaryotic cells, roles of membranes in cell-cell recognition, and/or membrane receptors in neural signalling and control of behaviour. Activity pursued by the Institute during the years 2007-2011 is summarized according to the organizational structure (departments) that nevertheless respects the above mentioned levels.

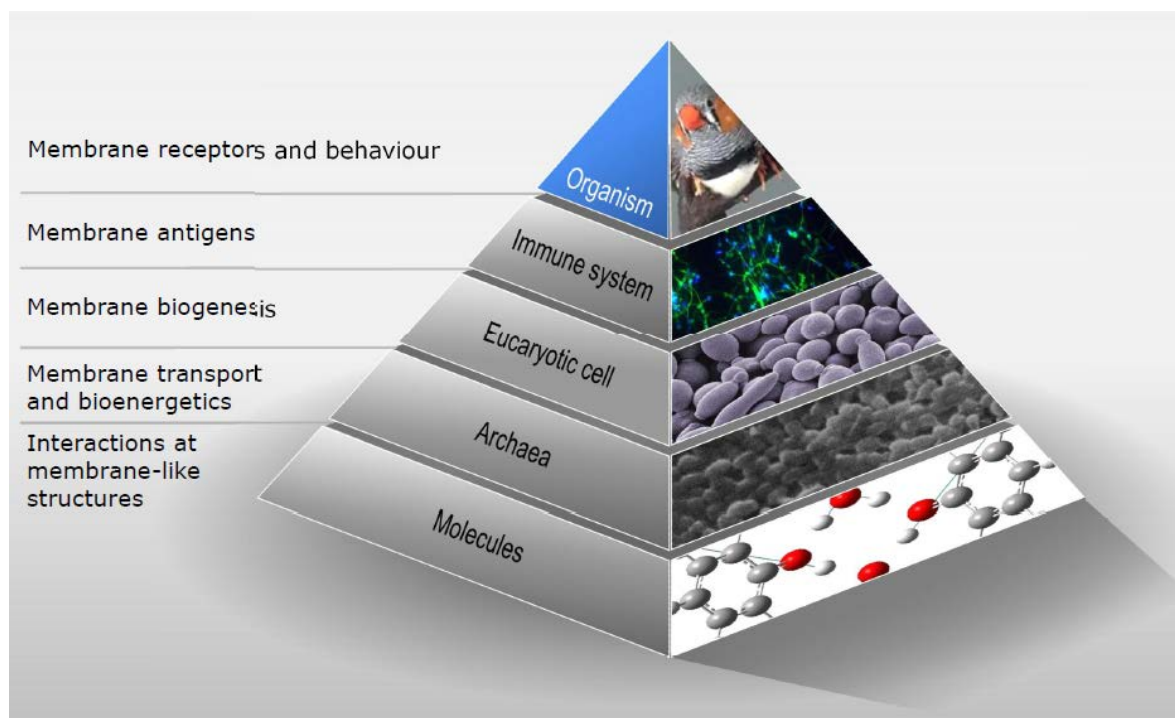


Fig. 1 Membrane functions studied at different levels of biological complexity at the Institute of Animal Biochemistry and Genetics.

Department of Membrane Biochemistry

Interactions at the molecular level and development of novel biosensors

The interactions between molecules and surfaces are some of the most exciting and widely studied aspects of modern surface science. The study of these interactions has also an important technological aspect, development of novel biosensors. DNA aptamers are synthetic, functionalized oligonucleotide receptors engineered with high affinity and specificity towards diverse targets including proteins, cells and small molecules. Compared to antibodies, aptamers have a comparable or greater affinity as capture molecules. We studied the surface properties of an aptasensor specific to human IgE using the transverse shear mode (TSM) method. We showed that interaction of IgE with the DNA aptamer resulted in decrease of the series resonant frequency of the quartz crystal transducer and in increase of motional resistance. Thus, the changes in the series resonant frequency are connected not only to changes of the mass, but also to increased friction between the sensor surface and the surrounding buffer (Šnejdárková et al., 2008).

One of the most intensely studied aptamers is the thrombin-binding aptamer. The activation of thrombin is a crucial process in physiological as well as pathological coagulations. Thrombin aptamer binding strength and stability is dependent on sterical parameters when used for atomic force microscopy (AFM) sensing applications. To obtain more information about the mechanisms of interaction between thrombin aptamers and thrombin, we applied single molecule force spectroscopy to optimized immobilization method allowing attachment of a single molecule at the AFM tip. An effective strategy was devised to bind biotinylated aptamers to PEG-streptavidin functionalized tips. This modification increased significantly the potential of DNA aptamers for biosensor applications and simplified the characterization of aptamer-thrombin interaction at the single molecule level (Neundlinger et al., 2011).

Dopamine (DA) belongs to the family of excitatory chemical neurotransmitters. It plays an important role in the function of central nervous system, renal, hormonal, and cardiovascular systems. Defects in DA homeostasis are linked to several diseases such as schizophrenia and parkinsonism. DA concentrations in the extracellular fluid of central nervous system and in human plasma are very low (nM-sub μ M) necessitating the development of a highly sensitive and selective DA sensors. We prepared and analysed 25,26,27,28-tetrakis(11-sulfanylundecyloxy)calix[4]arene (CALIX) for use as a self-assembled monolayer (SAM) sensitive to DA. We have shown that this calixarene bearing four thiol groups and its mixtures with alkanethiols form compact SAMs on the gold surface allowing detection of DA with high sensitivity (limit of detection 50 pM) and selectivity (discrimination between dopamine and epinephrine) (Šnejdárková et al., 2010).

Our investigations during the last few years revealed that artificial receptors, calixarenes and aptamers combined with quartz crystal microbalances and atomic force microscopy show enormous potential in development of a novel generation of highly sensitive and specific biosensors.

Bioenergetic mechanisms of ATP synthesis in Methanoarchaea

Methanoarchaea are phylogenetically very ancient organisms with extremely interesting energetics. In these microorganisms methanogenesis is coupled to the generation of an electrochemical proton gradient $\Delta\mu_{H^+}$ and electrochemical sodium ion gradient $\Delta\mu_{Na^+}$. Both of these gradients are directly utilized for ATP synthesis. To understand the molecular mechanisms of this unique and complex bioenergetic machinery we suggested a systematic genetic approach to modulate or eliminate individual bioenergetic sub-systems in *Methanothermobacter thermoautotrophicus*. This approach has resulted in the isolation and biochemical and molecular characterization of several mutants of *M. thermoautotrophicus*.

A spontaneous mutant of *M. thermoautotrophicus* resistant to the ATP-synthase inhibitor *N,N'*-dicyclohexylcarbodiimide (DCCD) was isolated (Nováková et al., 2009a).

Our results suggested upregulation of some enzymes involved in methanogenesis as well as an increase in the production of ATP synthase components in this mutant. The underlying regulation of the *atp* operon in *M. thermautotrophicus* has not been resolved but the increased expression of ATP synthase components seen in the DCCD-resistant mutant offers an opportunity for its elucidation. To extend our knowledge on ATP synthesis, a spontaneous mutant of *M. thermautotrophicus* resistant to tributyltin chloride (TBT), the inhibitor of the A_0 domain of A_1A_0 -ATP synthase, was isolated (Nováková et al. 2009b). The results obtained suggested modification in the ATP-synthesizing system of the mutant strain. The sequence of the complete A_1A_0 -ATP synthase operon identified three mutations leading to amino acid substitutions in two A_1A_0 -ATP synthase subunits. Moreover, this study revealed the changes in expression of several proteins that may contribute to TBT resistance. The study of the Na^+/H^+ antiporter in the amiloride-resistant mutant of *M. thermautotrophicus* (Šurín et al. 2007) has shown that this mutant exhibits very specific phenotypic characteristics, reduced Na^+/H^+ antiport and elevated production of methane and ATP. The molecular study of amiloride-resistant mutant did not allow us to assign a Na^+/H^+ antiporter activity to a product of a particular gene from the *M. thermautotrophicus* genome or to identify protein(s) participating in this complex process. Therefore, we decided to isolate mutants resistant to harmaline as another specific inhibitor of Na^+/H^+ antiporter in methanoarchaea (Vidová and Šmigáň 2010). The Na^+/H^+ exchange activity in mutant cells was remarkably decreased compared to the wild-type cells. This decreased Na^+/H^+ exchange activity was accompanied by increased methanogenesis both in the presence and absence of harmaline. These results indicate that harmaline resistance in this mutant has arisen as a consequence of mutation(s) in antiporter gene(s) or protein(s) linked to antiporter activity. Moreover this work provides the evidence that Na^+/H^+ exchanger deficiency in harmaline-resistant mutant can induce overexpression of several proteins participating in methanogenesis.

Taken together, systematic genetic approach applied in our Institute helped to solve important problems of archaeal bioenergetics and opened new possibilities for studying the problems of unique mechanisms of energy transformation in these ancient organisms.

Neutral lipid homeostasis in eukaryotic cells

Neutral lipids are structural components of eukaryotic membranes (cholesterol and ergosterol) while some of them serve also as storage forms of lipid synthesis precursors and energy-rich compounds (triacylglycerols (TAG), sterol esters (SE) and squalene (SQ)). Our research activities were focused on following aspects of neutral lipid homeostasis:

To study the activity of clinically relevant antimycotic agents in yeast we used terbinafine-resistant and terbinafine-hypersensitive mutants for mutational mapping of the *ERG1* gene encoding the enzyme squalene epoxidase (Ruckenstuhl et al., 2007). This work was done in collaboration with the Institute of Chemistry, University of Graz (Austria). Yeast cells hypersensitive to terbinafine accumulate excessive amounts of sterol precursor squalene which could contribute to the antimycotic effect of terbinafine. This finding has been further extended in our study on the biotechnological production of squalene in yeast (see below). In collaboration with the Department of Microbiology and Virology, Comenius University (Bratislava, Slovakia) we have studied the mechanisms of the activity of 7-chlorotetrazolo[5,1-c]benzo[1,2,4]triazine (CTBT). This substance displays weak antifungal activity and strongly increases the sensitivity of several yeast species to sub-inhibitory concentrations of other antifungals (Cernicka et al., 2007). A detailed study of the chemosensitization by CTBT revealed that it induces intracellular superoxide production and oxidative stress in fungal cells and is thus enhancing antimycotic drug effects by a secondary stress (Batova et al., 2010). This novel chemosensitisation by CTBT can overcome multidrug resistance in yeast and thus may prove useful in combined treatment of infections caused by drug-resistant fungal pathogens.

In the study of neutral lipids homeostasis in yeast we focused on the role of lipid particles (LPs) in the accumulation of this class of lipids. LPs are important

intracytoplasmic organelles present in various types of prokaryotic and eukaryotic cells. We focused on the role of LPs in storage of technologically important lipids (TAG, fatty acids, squalene). We have studied the accumulation of squalene with the aim to test the suitability of yeast for biotechnological production of this high-value substance. Our results have shown that reducing the activity of squalene epoxidase is the most efficient way to increase squalene content in yeast cells (Garaiova et al., manuscript in preparation). LPs are essential for optimal squalene accumulation (Hapala et al., unpublished results). In lipid particle-deficient cells squalene accumulates in intracellular membranes (Spanova et al., 2010) which may explain the lipotoxicity of high levels of squalene by mechanisms similar to the toxic effect of accumulated fatty acids (Hapala et al., unpublished, Hapala et al., 2011). In collaboration with Centre de Biotechnologie Agro-Industrielle (Thiverval-Grignon, France) we also studied accumulation of industrially important lipids (TAG and fatty acids) in the oleaginous yeast *Yarrowia lipolytica* (Beopoulos et al., 2008).

Uptake and distribution of sterols are important aspects of sterol homeostasis. Uptake of external sterols in the yeast *S. cerevisiae* is a multistep process limited to anaerobiosis or heme deficiency. We applied the fluorescent ergosterol analog dehydroergosterol (DHE) to monitor the initial steps of this process (Kohut et al., 2011). We showed that the entry of sterol molecules into the plasma membrane is not spontaneous but requires assistance of two ABC pumps – Aus1p or Pdr11p. Our results demonstrated also the active involvement of yeast cell wall in binding and uptake of sterols.

To study the role of cholesterol in insulin secretion in mammalian cells the Institute of Experimental Endocrinology SAS initiated collaboration with our Department on membrane aspects of insulin secretion. The major result of our collaborative effort was the finding that cellular cholesterol content substantially affects insulin secretion induced by cell swelling or glucose. Optimal cholesterol concentration is different for either type of stimulation; the difference is likely to reflect the involvement of sequential-type exocytosis after cell swelling. Cholesterol sensitivity of the secretory processes suggests that either hypercholesterolemia or excessive effort to decrease plasma cholesterol in patients could have adverse effect on insulin secretion (Bačová et al., 2012).

Membrane biogenesis: Phospholipid transport and turnover

Lipid transport and turnover are two important mechanisms contributing to the optimal membrane lipid composition of eukaryotic cells. In addition, both these processes generate important signalling molecules. Defects in lipid transport and turnover have been implicated in numerous serious human diseases, including neurodegenerative and cardiovascular diseases (reviewed in Poloncova and Griac, 2011). Our effort concentrated on the study of phospholipid transport and turnover in an important eukaryotic model organism, the yeast *S. cerevisiae* and their interconnection with other cellular processes.

One of our goals was to understand the regulatory mechanisms operational in the biosynthetic pathway leading to a unique mitochondrial anionic phospholipid, cardiolipin (CL). We have found that the yeast open reading frame *YPL206c* encodes a novel phospholipase C specific for CL precursor, phosphatidylglycerol (PG). Our findings demonstrate for the first time the existence of a degradation pathway for PG, an intermediate in the biosynthesis of CL, and an important component of lung surfactant and of the thylakoid membranes (Šimočková et al., 2008). Recently, we have initiated the study of the CL biosynthetic pathway in another model organism, yeast *Schizosaccharomyces pombe*, that will allow us to use comparative methods to better understand the mechanisms behind homeostasis of mitochondrial phospholipids.

Family of yeast phosphatidylinositol transfer proteins (PITPs) is implicated in regulation of many aspects of lipid biogenesis and turnover (reviewed in Griač, 2007). Major yeast PITP is Sec14p, an essential protein with roles in secretion and intracellular signalling. It is able to transfer phosphatidylinositol (PI) and phosphatidylcholine (PC) between membranes in an *in vitro* system. We have shown that phosphatidylcholine (PC) transfer activity of the major yeast PITP, Sec14p, is not essential for its main function to

maintain membrane lipid composition compatible with exocytosis (Tahotna et al., 2007). We have also studied the physiological role of yeast PITP, Pdr16p, implicated in the development of resistance towards azole antimycotics in pathological fungi (Poloncová, manuscript in preparation). In collaboration with the Department of Neuroscience, Physiology & Pharmacology, University College London we contributed to the elucidation of secretory vesicles formation and the role of mammalian PITPs in this process (Carvou et al., 2010).

Department of Immunogenetics

During the assessed period the research program of the department has been concentrated on the identification and characterization of novel immunogenetic markers (CD molecules) and their function in bovine immune system using the monoclonal antibodies (mAbs), produced by hybridoma technique. Our studies focused on the CD molecules expressed in the reproduction tract of cattle, in accordance with the concept presented in time of the last evaluation of the Institute. Major progress has been achieved in the following topics:

Identification of (new) CD molecules (CD46 and CD52) on bull spermatozoa

Two CD molecules have been identified on bovine cells by mAbs IVA-520 and IVA-543 produced at our Institute. The molecule MCP/CD46 (regulatory protein of the complement system) detected by the IVA-520 occurs on similar cell types as the well-defined human molecule. The exception is the high expression of CD46 on red blood cells of cattle and possibly the expression on the outer acrosomal and plasmatic membrane of bull spermatozoa. Furthermore, the molecule identified by IVA-520 functionally behaves as the MCP molecule, showing cofactor activity for the factor I-mediated cleavage of bovine C3 complement factor (Antalíková et al., 2007 a; Jankovičová et al., 2011). The molecule CD52 (sperm maturation molecule) recognized by mAb IVA-543 was detected on blood mononuclear cells (including lymphocytes and monocytes) and on a minor population of polymorphonuclear leukocytes. The bovine CD52 is secreted by the epididymal epithelium and then inserted into the sperm membrane during the epididymal transport in the distal part of epididymis. CD52 was absent on spermatozoa derived from testes and the most reactive sperms were observed in cauda epididymis (91.6%).

The study has shown that the new molecule identified on bovine cells had analogous properties as the previously described CD52 molecule of man (Michalková et al., 2010).

Biochemical and histochemical characterization of the Cattle V red blood cell antigen

In cattle more than 100 blood group factors were serologically identified. However, their biochemical structure has not been studied. In our study the cattle V antigen from FV blood group system was characterized. Haemolytic as well as immunochemical analysis with monoclonal antibody IVA-41 found out that V antigen of bovine red blood cells is the membrane bound, papain- and pronase-sensitive, trypsin- and chymotrypsin-resistant N-glycosylated sialoglycoprotein with molecular weight of 64, 56 and 50 kDa under non-reducing and 23 kDa under reducing conditions. Contrary to some human blood group antigens, the expression of bovine blood group V antigen is restricted to erythrocyte membrane (Antalíková et al., 2007 b).

Expression of adhesion molecules CD18 and CD62L on the mammary gland of cows

Mastitis is the economically most important disease of the mammary gland in dairy cows. Migration of leukocytes from the blood into the mammary gland is an essential element of resistance to infections. Adhesion molecules (CD62L-selectin and CD18- β 2-integrin) are likely to regulate the entry of leukocytes into the mammary gland. Therefore, we studied the expression of both molecules in different parts of the udder (parenchyma,

Fürstenberg's rosette and transverse section of the middle part of teat). We also compared their expression with the expression of CD62L and CD18 on blood leukocytes and somatic cells of milk in healthy and mastitic cows. The results have shown a frequent incidence of L-selectin- and β 2-integrin-positive cells in connective collagenous and loose tissue of Fürstenberg's rosette of mastitic cows and the importance of this part of udder in immune defence of the mammary gland (Simon et al., 2007).

Cross-reactivity of mAbs specific for CD molecules of cattle with rabbit cells

Testing mAbs for cross-species reactivity have proven to be efficient in identifying of previously unrecognized antigens in a number of different species. We tested the cross-reactivity of mAbs with well-defined specificity prepared against bovine CD molecules on rabbit cells. The study has identified CD9 and CD41/61 molecules on rabbit cells by anti-bovine mAbs IVA-50 and IVA-38. It has been shown that IVA-50 is a valuable new CD9 reagent for rabbit immunology which could be used at immunofluorescence staining or ELISA assay, immunohistological and molecular studies of rabbit CD9 antigen. IVA-38 recognizes the CD41/61 on rabbit platelets in indirect immunofluorescence and ELISA assay (Simon et al., 2009).

Department of Physiology and Ethology

Department of Physiology and Ethology is historically focused on the use of avian models. Breeding colony of Japanese quail has been kept on the Institute for decades. The advantages of quail as an experimental model (quick maturation, low body weight, low food consumption, low space requirements etc.) have been used in selection experiments (selection for the high resistance to hypodynamia, selection for the testosterone content in the egg yolk), but also in other behavioural and physiological experiments. Another avian model we use is the domestic chicken. Since the last assessment we have built the small facility with enriched cages for laying hens in concordance with the European law that came into the power on January 1st 2012 and which bans the use of conventional cages. This enables us to run small-scale physiological and behavioural experiments. Although our main focus is fundamental science, the results have clear links to the animal science and poultry production. Since the last assessment of the Institute we built a new colony of zebra finches (aviary, cages, soundproof boxes for song recording), as a part of new area of research related to neurogenesis, animal learning and cognition.

Gravitational physiology

In the field of avian cosmic physiology the objective of our research was to investigate the effects of long-term simulated microgravity (hypodynamia) on the adaptability, reproductive capacity, locomotor apparatus and internal organs of male and female Japanese quail from 3 to 180 days of age. Our results show that Japanese quail of both sexes is able to live for extended time period under the conditions of hypodynamia. Despite of significantly reduced reproductive capacity in comparison to the age-matched control, the males produced cloacal gland foam and sperm and the hens remained in lay at the end of the experimental period (Škrobánek et al., 2009). The elimination of load on the legs of individuals reared under the hypodynamia caused a reduction of tibia weight, length, width, strength, bone index and mineral content. Moreover, the mean body weight, liver, adrenal and thymus weights were reduced. Simultaneously, the content of total proteins, lipids and glycogen in *musculus gastrocnemius* and breast muscle were decreased. The negative effects of chronic hypodynamia on triacylglycerol and cholesterol metabolism of Japanese quail were also observed. On the other side, no significant effects of hypodynamia on the levels of glucose, total proteins, alkaline phosphatase, calcium, phosphorus and magnesium in blood plasma of male and female Japanese quail were observed. These results provide further evidence that although the long-term hypodynamia

affected negatively many investigated variables, Japanese quail of both sexes is able to cope with conditions of simulated microgravity.

The role of maternal androgens in development

In many animal species, embryos are exposed to maternal hormones that affect their development. Maternal hormone transfer varies with environmental conditions of the mother and is often interpreted as being shaped by natural selection to adjust the offspring to prevailing environmental conditions. We have measured the concentration of testosterone and corticosterone in hierarchical follicles and egg yolks of Japanese quail in control and chronic stress conditions. Experimental females were reared under a restraint stress - hypodynamia. Results indicate different mechanism of the deposition of the dominant androgen testosterone and the stress hormone corticosterone into the egg yolk. These specific patterns of hormone deposition may represent signals mediating information about adverse environmental conditions from the mother to progeny (Okuliarová et al., 2010).

The maternal hormone transfer requires genetic variability, which has not yet been experimentally demonstrated. Our study, which as well as the previous study was conducted in collaboration with the Department of Animal Physiology and Ethology, Faculty of Science, Comenius University, Bratislava, provides direct evidence for additive genetic variance of maternal androgens through a bidirectional selection on yolk testosterone (T) levels in Japanese quail. Lines selected for high egg T (HET) and low egg T (LET) concentration differed in yolk levels of this androgen, resulting in high realized heritability ($h^2 = 0,42$) (Okuliarová et al., 2011a). With respect to growth, embryonic growth did not differ between the lines. During the postnatal growth period HET quails were heavier and displayed longer tarsi as compared with LET quail, with more pronounced line differences in males than females. HET males were heavier than LET males from the age of 2 weeks, reached the age of maximum growth rate earlier, and displayed higher asymptotic body weight than LET males. Accelerated growth in HET males was not accompanied by increased postembryonic plasma T concentrations. Line differences in body weight disappeared in adult quail (Okuliarová et al., 2011b). Content of testosterone in the egg yolk can substantially affect via epigenetic mechanisms the behaviour of offspring, which may have important welfare consequences.

Poultry welfare and behaviour

Welfare-related research in poultry is our traditional domain, with the focus mainly on abnormal behaviours, such as stereotyped pecking in restricted fed broiler breeders or feather pecking in laying hens. It has been suggested that feather pecking results when foraging behaviour is redirected to feathers in the absence of adequate foraging incentives. We hypothesised that behaviour, and especially foraging and gentle feather pecking behaviour, of individual birds when young predicts severe feather pecking behaviour by the same birds when adult. We found a positive association between a factor describing foraging when young and severe feather pecking when adult, and a negative association between a factor describing dust bathing when young and severe feather pecking when adult. Levels of severe feather pecking increased following the onset of lay and we found no significant association between factors describing feather pecking when young and severe feather pecking by the same individuals when adult (Newbery et al. 2007). More recently, however, we are moving from abnormal behaviours to the measurement of emotions in poultry. Positive affective states may be as important for animal welfare as the absence of suffering. Thus, there is a need for knowledge of the mechanisms underlying positive affective states, including how they can be induced and assessed. Inducing anticipation is useful for inducing pleasure and reducing stress. Trace classical conditioning can be used for inducing anticipatory behaviour in ad libitum fed laying hens freely moving in the home pen environment. In order to investigate the involvement of dopaminergic transmission in the regulation of reward-related behaviours in

laying hens, the effects of systemic injections of dopamine D2-like receptor antagonist haloperidol 30 min prior to a conditioned cue signalling a reward were tested and compared to the effects of a saline injection. Head movements and latency to initiate display of anticipatory behaviour were significantly affected by 0.3 and 0.5 mg/kg haloperidol, respectively. The findings are consistent with the involvement of dopamine in control of reward-related behaviours in laying hens. A high inter- and intra- observer agreement in the assessment of head movements together with their dopamine dependency further suggest that this behaviour in classical conditioning paradigm represents an indicator of the state of the reward system in laying hens that can be assessed with good reliability (Moe et al. 2011).

Neurobiology of birdsong

Study of singing behavior in songbirds and neurobiology of its regulation is relatively new research area at the department. Song in songbirds, similarly as speech in humans, is learned vocal communication but without doubt songbirds are one of the most suitable models to study processes of neural control of vocal learning and production. There are two discrete pathways controlling singing: the anterior pathway loop necessary for song learning and modification of the song, and the posterior motor pathway necessary for song production (Bosikova et al., 2010). However, it was not clear how the loop exerts control over the motor pathway in adults. Using singing-driven gene expression in birds with unilaterally lesioned different song nuclei we found that the loop modulates activity in the motor pathway in two parallel connections (Kubikova et al., 2007). Moreover, the song nuclei within the loop affect even expression in the motor pathway that differs among social contexts, i.e. if the bird sings alone or during courtship to a female (Kubikova et al., 2007). We also found that the social context differences in gene expression are present not only in the anterior pathway loop but also in the upstream dopaminergic nuclei. Abolishing dopaminergic innervations from these nuclei did decrease gene expression in the loop but not the social context differences suggesting that dopaminergic system is not the only control mechanism for the differences. Decreased amount of songs that the bird sang after lesions of the dopaminergic neurons implies its role in motivation to sing (Hara et al., 2007). Visual contact is not necessary for the singing-driven expression nor for the social context differences (Hara et al., 2009). We were the first to clone and describe distribution of all six avian dopamine receptors in songbirds and chicken (Kubikova et al., 2010) where we found that while D1A, D1B and D2 receptors are richest in striatum (basal ganglia), D1D and D3 receptors are expressed mostly only in pallium and D4 receptors are mostly in cerebellum. We also described kinetics of these receptors in avian brain and found that the D2-like receptors have higher affinity for dopamine than the D1-like receptors (Kubikova et al., 2009). These results provide a good base for studying the role of individual dopamine receptors in the vocal communication control (Kubikova and Kostal, 2010).

To summarize, the focus of the Institute of Animal Biochemistry and Genetics on membranes and membrane-related processes reveals both traditional and innovative aspects. It reflects the continuity of research programs from the previous periods. During the assessed period we have succeeded not only to improve the quality of research in established research areas, but also to introduce novel research directions. Research activities of our institute during the assessed period resulted in several principal findings that significantly contributed to better understanding of the roles of membranes in normal and pathological physiology. Some of these results have direct potential for practical application in agriculture, medicine and/or technology. In general, we consider the last five years of our institute's activity as a successful period in building the modern research institution.

3. Concept of R&D activity of the Organisation for the next four years (recommended 3 pages, max. 5 pages)

- i. Present state of knowledge and status of ongoing research related to the subject of the Concept, from both international and national perspective**
- ii. Organisation's role or significance in the overall research effort within the field of the Concept on both the national and international scales**
- iii. Objectives of the Concept**
- iv. Proposed strategies and methods to be applied, and time schedule**

The long-term scientific mission of our Institute is the promotion of basic and applied research related to agriculture, biomedicine, biotechnology and environmental sciences. The study of biological membranes and membrane-associated processes at different levels of complexity will remain in the focus of our activity for the next four years. Research in individual laboratories ranging from formation of membranes and molecular interactions in the membrane, to the immunology and neural control of animal behaviour will be based on our previous achievements as well as on novel, inventive multidisciplinary approaches related to artificial and biological membranes and surfaces.

Department of Membrane Biochemistry

Interactions at the molecular level and development of novel biosensors

i. Contamination of air, water, food and soil is of increased concern with detrimental effects on human health. There is an expanding need for simple, rapid, cost-effective and field portable screening methods and devices. The communication between proteins and the electrode is subject of an extensive theoretical and experimental research. Novel developments in the field of surface bioelectrochemistry open new possibilities for the construction of small analytical devices – biosensors.

ii. Laboratory of Biosensors belongs to the leading groups in the field of surface bioelectrochemistry nationally and internationally. This fact is well documented by our participation in the 7th Framework Programme project „Ultra-sensitive, stable and easy to use AFM biosensor tips“ and the extensive collaboration with other leading European institutions in this field: Comenius University, Slovakia; Technical University of Budapest, Hungary; Institute of Photonics and Electronics AS, Czech Republic.

iii. Formation of self-assembled monolayers (SAMs) from the novel materials allows us to design more sensitive interface in biosensor technology. The quartz crystal microbalance (QCM) method is an ultra-sensitive weighing device used to measure affinity interactions. A key aspect in the realization of biosensors is the integration of the inorganic (i.e. transducer surface) and organic (i.e. biological element) components of the biosensor. Our research focuses on interfacing three advanced technologies: nanomaterials, biomaterials, and electronic transducers, with the goal to develop improved biosensors in which nanomaterials are applied to the analysis of biomolecules. We will focus on the use of synthetic receptors, calixarenes and aptameres, with affinities comparable to antibodies to measure biologically important ligands like cytochrome c and dopamine.

iv. Atomic force microscopy will be used as a key tool to understand molecular interactions between surfaces and biologically important molecules at the single molecule level. This methodology will be supplemented by electrochemical methods, mostly using newly planned potentiostat and already available quartz crystal monitor. Our research is truly multidisciplinary and other experimental approaches will be possible thanks to collaboration with the Comenius University, Slovakia and other leading European laboratories. Participation in the 7th Framework Programme „Ultra-sensitive, stable and

easy to use AFM biosensor tips“ will provide us with further resources of the international community to successfully fulfil our goals.

Membrane biogenesis - the study of lipid homeostasis in yeast

i. Biological membranes form a protective barrier around cells and their organelles. It is a place where many vital cellular processes take place. The proper functioning of this extremely thin layer of lipids, proteins and carbohydrates is often a matter of life or death for the cell and the whole organism. The yeast, *Saccharomyces cerevisiae*, has emerged as a powerful model system to study membrane-related phenomena. In the course of next few years we will focus on studying the metabolism, cell biology and regulation of eukaryotic lipids using yeast as a model organism. Lipids are not only building blocks of membrane bilayers or energy stores for organisms. They serve also as precursors of steroid hormones, signaling molecules, and second messengers. They are involved in membrane trafficking, membrane identity, cell cycle progression, apoptosis and numerous other vital processes. Thus, further progresses in the field of membrane lipidology will not only help to quench our curiosity in understanding the basic principles of how cells and organisms operate, but may also provide insights into membrane and lipid-related human diseases.

ii. Regulation of membrane lipid composition includes coordination of synthesis, transport, remodelling, storage, and degradation of lipids. Despite current effort, our understanding of the turnover pathways, mechanisms of lipid transport, their storage and degradation lags behind our knowledge of the synthetic processes. Our laboratory belongs to the leading laboratories both nationally and internationally in studying these processes using the yeast *S. cerevisiae* as a model eukaryotic organism. Important is our collaboration with world leading lipidology laboratories: Technical University Graz and Karl Franzens University Graz, Austria; Duquesne University, USA; University of Southern Denmark, Denmark; Université de Poitiers, France.

iii. We will concentrate on the following aspects of lipid-related research in the following years:

- mechanisms of neutral lipids homeostasis – intracellular and trans-membrane transport of sterols, storage of sterols and triglycerides
- the role of lipid transfer proteins in the physiology of eukaryotic cell
- action of antifungal drugs and mechanisms of increased resistance to clinically relevant antimycotics and ways to overcome this resistance
- lipid turnover as an important regulatory aspect of lipid homeostasis
- mechanisms of fatty acids secretion and uptake in the yeast *S. cerevisiae*

Importantly, in addition to study the basic mechanisms of these processes, we will focus on biomedical and technological aspects. For example, squalene, one of the precursors in ergosterol biosynthetic pathway has several positive effects on human organism, including chemoprotective, antioxidant, anticancer and cardioprotective effects. We will study neutral lipid homeostasis and storage of neutral lipids also with the goal to enhance production of squalene by yeast cells. Defects in intracellular lipid transport are implicated in the whole spectrum of serious human diseases, including neurodegenerative and metabolic diseases. By studying intracellular lipid transport we may advance general knowledge of lipid transfer proteins and their connection to serious human diseases. The mechanisms of fatty acids secretion and uptake in simple eukaryotic organisms are important to understand the connection of these processes to metabolic syndromes' in mammals and man. In addition, knowledge how to modify these processes is a necessary prerequisite to use yeast as an effective vehicle to produce high-value fatty acids biotechnologically.

iv. Modern genetic, biochemical, analytical, and molecular biology methods will be applied to achieve the above mentioned scientific objectives. An important part of the methodology will be whole genome genetic and analytical methods. The genetic and

molecular biological tools available for *S. cerevisiae* provide excellent means to study the complex interactions controlling membrane lipid homeostasis. Application of the state-of-the-art methodology available at our institute and through the collaboration with leading lipidology laboratories will enable us to perform the research at the internationally competitive level.

Department of Immunogenetics

i. Identification of CD molecules (antigens) of immunocompetent and other cell is very important for understanding the structure and function of the immune system. Disorders in the expression or function of these molecules lead to primary or secondary immunodeficiency. In man and laboratory animals a set of CD molecules with different immune function as adhesion and transport molecules, receptors for biologically active substances and other functions have been described. Some homologous CD molecules with analogous properties were identified also in farm animals. Our research interest covers the study of the structure and function of the immune system of farm animals. Particularly, our focus on distribution and characterization of bovine cell membrane CD molecules is unique in Slovakia and Czech Republic.

ii. Originally, the majority of CD molecules have been identified on blood cells; however, some of them are present also on male and female gametes. The real function of these molecules in reproduction is not quite clear but some experiments performed in man and model animals suggested that at least the molecules CD9, CD11/18, CD35, CD46, CD55, CD59, CD49f/CD29, CD81, CD151 could participate in some stages of the reproduction process. Our research activity in the next years will be concentrated on the study of the expression of selected CD molecules on male and female gametic cells of cattle and their possible role in bovine reproduction.

iii. The main goals for the next years will be as follows:

- The analysis of CD9 molecule, forming complexes with other molecules within "tetraspanin web". Identification of its partner molecules and their participation in the process of reproduction.
- Detailed biochemical analysis of CD46 and CD52 molecules in the sperm, oocytes and embryos of the cattle, as well as the study of the changes in their expression and modification of these molecules during the process of epididymal maturation, capacitation and acrosome reaction of the sperm.
- We will investigate the function of above mentioned molecules in "in vitro" fertilization by antibody inhibition assay.

iv. The bovine cell-specific mouse monoclonal antibodies prepared in the Department of Immunogenetics will be used to detect the selected CD molecules. The analysis of the expression of CD molecules will be performed by cytometrical, histochemical and biochemical methods (year 1-2). The functional studies will be realized mainly in the second phase of the investigation (year 3-4) using the *in vitro* cultivation and fertilization of oocytes.

Department of Physiology and Ethology

i. Birds are important models in fundamental biological research because of their unique characteristics. One such model is a learned vocal communication in songbirds, which provides opportunities for studying neurobiological control mechanisms of learning. Another example is the study of maternal hormones influences on adjustment of physiological and behavioural phenotype of progeny. In birds as oviparous vertebrates maternal hormones are transferred to egg yolk. This provides an excellent model to assess experimentally the effects of maternal hormones. Birds are also the subject of applied research, due to the fact that poultry industry is one of the largest branches of animal production. Major changes in technology due to the changes in European legislation related to animal welfare represent great challenge to industry, as well as to the research. Even very practical problems raise a lot of fundamental questions, such as do birds have

emotions? How to use cognitive abilities of fowl to evaluate and improve their welfare? How are the changes in housing and technology reflected in physiology and behaviour? We hope that together with other research teams we can contribute meaningfully to this discussion by our own original approach.

ii. All topics covered by the department in the national scale represent the highest standard. That is reflected also by an international recognition of our results. In the field of neurobiology of bird song our main collaborator is prof. Erich Jarvis from the Duke University, NC, USA. During the assessed period this collaboration was funded by FIRCA and resulted in several joint papers. International collaboration in the field of hormone mediated maternal effects is well demonstrated e.g. by the joint publication with top specialist in field prof. Ton Groothuis (University of Groningen, The Netherlands). In the field of farm animal welfare the best illustration of our status is the fact, that our institution (Dr. Kostal) is the leader of one of the work packages within the FP7 project Animal welfare research in an enlarged Europe (AWARE) aiming at increasing the participation of new member countries and candidate countries of the EU in the European farm animal welfare research.

iii. The main goals of the department for the forthcoming period are as follows

- to study the process of neurogenesis in songbirds and compare it to mammals
- to apply the genetic selection approach to the study of maternal hormones effects on behaviour of Japanese quail
- to analyze the consequences of selection for the increased maternal T on other physiological systems and behaviour
- to study emotions and cognition in poultry in relation to measuring and monitoring welfare
- to clarify central mechanisms underlying emotions and cognition in poultry
- to develop further the use of implantable radiotelemetry for measuring physiological parameters in relation to behaviour and welfare of poultry

iv. We propose following strategies and methods to achieve these goals. In field of neurobiology of birdsong and the avian adult neurogenesis we will employ brain lesions, immunohistochemistry, *in situ* hybridization and microarrays, as well as pharmacological manipulation with dopamine agonists/antagonists. These methods will be used to determine the role of dopamine in neurogenesis and to compare the differences in brain gene expression in birds and mammals following brain injury. Japanese quail as a model species of precocial birds will be used to create lines that differ in the content of maternal T in the egg. Growth and behaviour of the offspring with an emphasis on welfare will be analysed and obtained results will be extrapolated to economically important poultry species, broiler chickens and laying hens. The consequences of selection for the increased maternal T on other physiological systems, first of all immune system and cellular and humoral response to stress will be analysed. We plan to study molecular mechanisms affected by the selection with an emphasis on biosynthesis of steroids controlled by luteinizing hormone. For the study of the emotions in poultry we will use the cognitive bias paradigm. Methods of classical and operant conditioning will be used. We will develop the testing devices, such as touch-screen based operant chambers, for testing the cognitive bias, as well as the possibilities of cognitive enrichment. To study the underlying mechanisms we will use pharmacological manipulation by selective dopamine and opioid antagonists/agonists. We will further develop the use of implantable radiotelemetry (DSI inc., USA) in domestic chicken to test the effects of housing conditions on physiological parameters and behaviour, as well as abnormal behaviour (feather pecking) related physiological changes.

III. Partial indicators of the main activities:

1. Research output

i. Principal forms of research outputs of the Organisation

The primary mission of the Institute of Animal Biochemistry and Genetics is to perform high quality basic research. Scientific publications in international scientific journals represent thus a principal form of research output.

ii. List of the selected publications documenting the most important results of basic research. Total number of publications in the whole assessed period should not exceed the average number of the research employees. The principal science outputs (max. 5) underline

- [1] ANTALÍKOVÁ, J. – SIMON, M. – JANKOVIČOVÁ, J. – HOROVSKÁ, Ľ. Identification of MCP/CD46 analogue on bovine erythrocytes using the new monoclonal antibody IVA 520. In *Veterinary Immunology and Immunopathology*. Vol. 115, no. 1-2 (2007), p. 155-159. (1,994-IF2006)
- [2] BEOPOULOS, Athanasios - MROZOVA, Zuzana - THEVENIEAU, France - LE DALL, Marie-Thérese - HAPALA, Ivan - PAPANIKOLAOU, Seraphim - CHARDOT, Thierry - NICAUD, Jean-Marc. Control of Lipid Accumulation in Yeast *Yarrowia lipolytica*. In *Applied and Environmental Microbiology*. ISSN 0099-2240 (print), 2008, roč. 74, č. 24, 7779-7789 (4.004 - if 2007).
- [3] CERNICKA, J. - KOZOVSKA, Z. - HNATOVA, M. - VALACHOVIC, M. - HAPALA, I. - RIEDL, Z. - HAJÓS, G. - SUBIK, J. Chemosensitisation of drug-resistant and drug-sensitive yeast cells to antifungals. In *International Journal of Antimicrobial Agents*. Vol. 29, no. 2 (2007), p. 170-178. (2,221-IF2006)
- [4] GRIAC, P. Sec14 related proteins in yeast. In *Biochimica et Biophysica Acta - Molecular and Cell Biology of Lipids*. Vol. 1771, no. 6 (2007), p. 737-745. (3,117-IF) (2)
- [5] HAPALA, Ivan - MARZA, Esther - FERREIRA, Thierry. Is fat so bad? Modulation of endoplasmic reticulum stress by lipid droplet formation. In *Biology of the Cell*, 2011, vol. 103, no. 6, p. 271-285. (4.898 - IF2010)
- [6] HARA, E. KUBIKOVÁ, Ľ. HESSLER, N.A. JARVIS, E.D. Role of the midbrain dopaminergic system in modulation of vocal brain activation by social context. In *European Journal of Neuroscience*. Vol. 25, no. 11 (2007), p. 3406-3416. (3,709-IF2006)
- [7] HOLIČ, Roman - KUKALEV, Alexander - LANE, Sophie - ANDRESS, Edward J. - LAU, Ivy - YU, Conny W.H. - EDELMANN, Mariola J. - KESSLER, Benedikt M. - YU, Veronica P.C.C. Cks1 activates transcription by binding to ubiquitylated proteasome. In *Molecular and Cellular Biology*, 2010, vol. 30, no. 15, p. 3894-3901. (6.057 - IF2009)
- [8] KOHÚT, Peter - WÜSTNER, Daniel - HRONSKÁ, Lucia - KUCHLER, Karl - HAPALA, Ivan - VALACHOVIČ, Martin. The role of ABC proteins Aus1p and Pdr11p in the uptake of external sterols in yeast: Dehydroergosterol fluorescence study. In *Biochemical and Biophysical Research Communications*, 2011, vol. 404, no. 1, p. 233-238. (2.595 - IF2010)
- [9] KUBIKOVA, L. - TURNER, E.A. - JARVIS, E D. The pallial basal ganglia pathway modulates the behaviorally driven gene expression of the motor pathway. In *European Journal of Neuroscience*. Vol. 25, no. 7 (2007), p. 2145-2160. (3,709-IF2006)

- [10] KUBÍKOVÁ, Ľubica - KOŠŤÁL, Ľubor. Dopaminergic system in birdsong learning and maintenance. In *Journal of Chemical Neuroanatomy*, 2010, vol. 39, no. 2, p. 112-123. (1.753 - IF2009)
- [11] KUBÍKOVÁ, Ľubica - VÝBOH, Pavel - KOŠŤÁL, Ľubor. Kinetics and Pharmacology of the D1- and D2-Like Dopamine Receptors in Japanese Quail Brain. In *Cellular and Molecular Neurobiology*, 2009, vol. 29, no. 6-7, p. 961-970. (2.550 - IF2008)
- [12] KUBÍKOVÁ, Ľubica - WADA, Kazuhiro - JARVIS, Erich D. Dopamine receptors in a songbird brain. In *Journal of Comparative Neurology*, 2010, vol. 518, no. 6, p. 741-769. (3.718 - IF2009)
- [13] MAJERNIK, Alan - CHONG, James P. J. A conserved mechanism for replication origin recognition and binding in archaea. In *Biochemical Journal*, 2008, vol. 409, part 2, p. 511-518 (4.009 - IF2007)
- [14] MICHALKOVÁ, Katarína - SIMON, Michal - ANTALÍKOVÁ, Jana - KLÍMA, J. - HOROVSKÁ, Ľubica - JANKOVIČOVÁ, Jana - HLUCHÝ, S. Identification of bovine CD52-like molecule by monoclonal antibody IVA-543 : distribution of CD52- like molecule in the bull genital tract. In *Theriogenology : international journal of animal reproduction Theriogenology (Los Altos)*, 2010, vol. 74, no. 6, p. 1066-1074. (2.073 - IF2009)
- [15] MOE, Randi - NORDGREEN, Janicke - JANCZAK, Andrew M. - SPRUIJT, Berry M. - KOŠŤÁL, Ľubor - SKJERVE, Eystein - ZANELLA, Adroaldo J. - BAKKEN, Morten. Effects of haloperidol, a dopamine D2-like receptor antagonist, on reward-related behaviors in laying hens. In *Physiology & Behavior*, 2011, vol. 102, no. 3-4, p. 400-405. (2.891 - IF2010)
- [16] NEUNDLINGER, Isabel - POTURNAYOVÁ, Alexandra - KARPISOVÁ, Ivana - RANKL, Christian - HINTERDORFER, Peter - ŠNEJDÁRKOVÁ, Maja - HIANIK, Tibor - EBNER, Andreas. Characterization of Enhanced Monovalent and Bivalent Thrombin DNA Aptamer Binding Using Single Molecule Force Spectroscopy. In *Biophysical Journal*, 2011, vol. 101, no. 7, p. 1781-1787. (4.218 - IF2010)
- [17] NEWBERRY, R.C. - KEELING, L.J. - ESTEVEZ, I. - BILČÍK, B. Behaviour when young as a predictor of severe feather pecking in adult laying hens: The redirected foraging hypothesis revisited. In *Applied Animal Behaviour Science*. Vol. 107, iss. 3-4 (2007), p. 262-274. (1.177- IF2006)
- [18] OKULIAROVÁ, Monika - GROOTHUIS, Ton G. G. - ŠKROBÁNEK, Peter - ZEMAN, Michal. Experimental Evidence for Genetic Heritability of Maternal Hormone Transfer to Offspring. In *American Naturalist*, 2011, vol.177, no. 6, p. 824-834. (4.736 - IF2010)
- [19] OKULIAROVÁ, Monika - ŠARNIKOVÁ, Božena - RETTENBACHER, Sophie - ŠKROBÁNEK, Peter - ZEMAN, Michal. Yolk testosterone and corticosterone in hierarchical follicles and laid eggs of Japanese quail exposed to long-term restraint stress. In *General and Comparative Endocrinology*, 2010, vol. 165, no. 1, p. 91-96. (2.732 - IF2009)
- [20] OKULIAROVÁ, M. - ŠKROBÁNEK, P. - ZEMAN, M. Effect of Increasing Yolk Testosterone Levels on Early Behaviour in Japanese Quail Hatchlings. In *Acta Veterinaria Brno*. Vol. 76, no. 3 (2007), p. 325-331. (0,491-IF2006)
- [21] RUCKENSTUHL, C. - LANG, S.- POSCHENEL, A. - EIDENBERGER, A. - BARAL, P. K. - KOHÚT, P. - HAPALA, I. - GRUBER, K. - TURNOWSKY, F. Characterization of Squalene Epoxidase of *Saccharomyces cerevisiae* by Applying Terbinafine-Sensitive Variants. In *Antimicrobial Agents and Chemotherapy*. Vol. 51, no. 1 (2007), p. 275-284. (4,153-IF2006)
- [22] ŠIMOČKOVÁ, Mária - HOLIČ, Roman - TAHOTNÁ, Dana - PATTON-VOGT, Jana - GRIAC, Peter. Yeast Pgc1 (YPL206c) Controls the Amount of Phosphatidylglycerol via a Phospholipase C-type Degradation Mechanism. In *Journal of Biological Chemistry*. ISSN 0021-9258, 2008, vol. 283, no. 25, p. 17107-17115 (5.581 - if 2007)

- [23] ŠNEJDÁRKOVÁ, Maja - POTURNAYOVÁ, Alexandra - RYBÁR, Peter - LHOTÁK, Pavel - HIML, Michal - FLÍDROVÁ, Karolína - HIANIK, Tibor. High sensitive calixarene-based sensor for detection dopamine by electrochemical and acoustic methods. In *Bioelectrochemistry*, 2010, vol. 80, special Issues, p. 55-61. (2.652 - IF2009)
- [24] ŠNEJDÁRKOVÁ, Maja - SVOBODOVÁ, Lenka - POLOHOVÁ, Vladimíra - HIANIK, Tibor. The study of surface properties of an IgE-sensitive aptasensor using an acoustic method. In *Analytical and Bioanalytical Chemistry*. ISSN 1618-2642, 2008, vol. 390, p. 1087-1091 (2.867 - if 2007)
- [25] ŠPAŇOVÁ, Miroslava - CZABANY, Tibor - ZELLNIG, Günther - LEITNER, Erich - HAPALA, Ivan - DAUM, Günther. Effect of lipid particle biogenesis on the subcellular distribution of squalene in the yeast *Saccharomyces cerevisiae*. In *Journal of Biological Chemistry*, 2010, vol. 285, no. 9, p. 6127-6133. (5.328 - IF2009)
- [26] ŠURÍN, S. - ČUBOŇOVÁ, Ľ. - MAJERNÍK, A.I. - MCDERMOTT, P. - CHONG, J.P.J. - ŠMIGÁŇ, P. Isolation and characterization of an amiloride-resistant mutant of *Methanothermobacter thermoautotrophicus* possessing a defective Na⁺/H⁺ antiport. In *FEMS Microbiology Letters*. Vol. 269, no. 2 (2007), p. 301-308. (2,068-IF2006)
- [27] TAHOTNA, D. - HOLIC, R. - POLONCOVA, K. – SIMOCKOVA, M. - GRIAC, P. Phosphatidylcholine transfer activity of yeast Sec14p is not essential for its function in vivo. In *Biochimica et Biophysica Acta - Molecular and Cell Biology of Lipids*. Vol. 1771, no. 1 (2007), p. 83-92. (3.117-IF2006)

iii. List of monographs/books published abroad

iv. List of monographs/books published in Slovakia

- [1] Fifty years of Czech and Slovak yeast research: Period 2000-2009. Eds. Breierová E., Farkaš V., Hapala I., Siegler K. Bratislava: Commission on Yeasts, Czechoslovak Microbiological Society, 2010. ISBN 978-80-89257-20-1.

v. List of other scientific outputs specifically important for the Organisation

vi. List of patents registered abroad, incl. revenues

vii. List of patents registered in Slovakia, incl. revenues

viii. Table of research outputs

Table **Research outputs** shows research outputs in number of specified entries; these entries are then divided by FTE employees with a university degree (from Tab. Research staff) for all Organisation at the respective year; finally these entries are divided by the total salary budget (from Tab. Salary budget).

| Research outputs | 2007 | | | 2008 | | | 2009 | | | 2010 | | | 2011 | | | total | | | |
|--|--------|-----------|---------------------|--------|-----------|---------------------|--------|-----------|---------------------|--------|-----------|---------------------|--------|-----------|---------------------|--------|--------------------------|---------------|-------------------------|
| | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | averaged number per year | av. No. / FTE | av. No. / salary budget |
| chapters in monographs, books published abroad | 0 | 0.000 | 0.00 | 1 | 0.044 | 2.67 | 0 | 0.000 | 0.00 | 0 | 0.000 | 0.00 | 1 | 0.048 | 2.62 | 2 | 0.4 | 0.017 | 1.04 |
| chapters in monographs, books published in Slovakia | 0 | 0.000 | 0.00 | 0 | 0.000 | 0.00 | 0 | 0.000 | 0.00 | 0 | 0.000 | 0.00 | 0 | 0.000 | 0.00 | 0 | 0.0 | 0.000 | 0.00 |
| WOS publications | 18 | 0.704 | 48.00 | 16 | 0.704 | 42.67 | 12 | 0.491 | 30.77 | 12 | 0.503 | 29.78 | 13 | 0.628 | 34.03 | 71 | 14.2 | 0.605 | 36.88 |
| scientific publications indexed by other databases (AGRIS, CAB, EBSCO, SCOPUS) | 0 | 0.000 | 0.00 | 0 | 0.000 | 0.00 | 0 | 0.000 | 0.00 | 2 | 0.084 | 4.96 | 0 | 0.000 | 0.00 | 2 | 0.4 | 0.017 | 1.04 |
| scientific publications in other journals | 1 | 0.039 | 2.67 | 2 | 0.088 | 5.33 | 1 | 0.041 | 2.56 | 5 | 0.210 | 12.41 | 1 | 0.048 | 2.62 | 10 | 2.0 | 0.085 | 5.19 |
| publications in proc. of international scientific conferences | 42 | 1.643 | 112.00 | 40 | 1.759 | 106.67 | 35 | 1.432 | 89.74 | 26 | 1.090 | 64.52 | 15 | 0.724 | 39.27 | 158 | 31.6 | 1.347 | 82.08 |
| publications in proc. of nat. scientific conferences | 4 | 0.156 | 10.67 | 14 | 0.616 | 37.33 | 14 | 0.573 | 35.90 | 32 | 1.342 | 79.40 | 5 | 0.241 | 13.09 | 69 | 13.8 | 0.588 | 35.84 |
| active participations at international conferences | 38 | 1.486 | 101.33 | 36 | 1.583 | 96.00 | 33 | 1.350 | 84.62 | 24 | 1.006 | 59.55 | 14 | 0.676 | 36.65 | 145 | 29.0 | 1.236 | 75.32 |
| active participations at national conferences | 2 | 0.078 | 5.33 | 10 | 0.440 | 26.67 | 13 | 0.532 | 33.33 | 31 | 1.300 | 76.92 | 9 | 0.435 | 23.56 | 65 | 13.0 | 0.554 | 33.77 |
| patents registered in Slovakia | 0 | 0.000 | 0.00 | 0 | 0.000 | 0.00 | 0 | 0.000 | 0.00 | 0 | 0.000 | 0.00 | 0 | 0.000 | 0.00 | 0 | 0.0 | 0.000 | 0.00 |
| patents registered in abroad | 0 | 0.000 | 0.00 | 0 | 0.000 | 0.00 | 0 | 0.000 | 0.00 | 0 | 0.000 | 0.00 | 0 | 0.000 | 0.00 | 0 | 0.0 | 0.000 | 0.00 |

ix. List of patents and patent applications

x. Supplementary information and/or comments on the scientific output of the Organisation

Positive trend of publishing in high quality international journals continued during this assessment period. Institute of Animal Biochemistry and Genetics published total of 71 papers in journals indexed in CC with average impact factor of 2.11 during this assessment period. This compares positively with the previous assessment periods, IF 1.293 for the years 2003-2006 and IF 1.930 for the years 2003-2006. Notably, we succeeded in publishing our results in outstanding journals, such as *Biology of the Cell* (IF 4.898), *Biophysical Journal* (IF 4.218), *General and Comparative Endocrinology* (IF 3.108), *Molecular and Cellular Biology* (IF 6.057), *Journal of Biological Chemistry* 3x (IF 5.328), *BMC Genomics* (IF 3.759), *Proceedings of the Royal Society of London* (IF 4.248), *Applied and Environmental Microbiology* 2x (IF 4.004), *Biochemical Journal* (IF 4.009), *Journal of Comparative Neurology* (IF 3.718).

Notice: List of all research outputs of monitored assessment period of structure of the Organisation's annual report is included in the separate annex

2. Responses to the scientific output

Table **Citations** shows specified responses to the scientific outputs; these entries are then divided by the FTE employees with a university degree (from Tab. Research staff) for all Organisation at the respective year; finally these entries are divided by the total salary budget (from Tab. Salary budget).

| Citations | 2006 | | | 2007 | | | 2008 | | | 2009 | | | 2010 | | | total | | | |
|---|--------|-----------|---------------------|--------|-----------|---------------------|--------|-----------|---------------------|--------|-----------|---------------------|--------|-----------|---------------------|--------|--------------------------|---------------|-------------------------|
| | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | averaged number per year | av. No. / FTE | av. No. / salary budget |
| Web of Science | 141 | 5.5 | 376.0 | 160 | 7.0 | 426.7 | 192 | 7.9 | 492.3 | 170 | 7.1 | 421.8 | 198 | 9.6 | 518.3 | 861 | 172.2 | 7.3 | 2236.4 |
| SCOPUS (if not listed above) | 19 | 0.7 | 50.7 | 12 | 0.5 | 32.0 | 4 | 0.2 | 10.3 | 9 | 0.4 | 22.3 | 34 | 1.6 | 89.0 | 78 | 15.6 | 0.7 | 202.6 |
| specify Database if relevant (if not listed above) | 1 | 0.0 | 2.7 | 0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 1 | 0.2 | 0.0 | 2.6 |
| in monographs, conf. proceedings and other publications abroad (if not listed above) | 0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 |
| in monographs, conf. proceedings and other publications in Slovakia (if not listed above) | 0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 4 | 0.2 | 10.3 | 0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 4 | 0.8 | 0.0 | 10.4 |

i. List of 10 top-cited publications and number of their citations in the assessment period (2006 – 2010)

- [1] BILČÍK, Boris - KEELING, Linda J. Changes in feather condition in relation to feather pecking and aggressive behaviour in laying hens. In *British Poultry Science*, 1999, vol. 40, no. 4, p. 444–451. ISSN 0007-1668. 39 (38wos, 1scop)
- [2] ŠNEJDÁRKOVÁ, Maja - SVOBODOVÁ, Lenka - EVTUGYN, G. - BUDNIKOV, H. - KARYAKIN, A. - NIKOLELIS, D.P. - HIANIK, Tibor. Acetylcholinesterase sensors based on gold electrodes modified with dendrimer and polyaniline : a comparative research. In *Analytica Chimica Acta*, 2004, vol. 514, no. 1, p. 79-88. ISSN 0003-2670. 38 (34wos, 4scop)
- [3] HARA, Erina - KUBÍKOVÁ, Ľubica - HESSLER, Neal A. - JARVIS, Erich D. Role of the midbrain dopaminergic system in modulation of vocal brain activation by social context. In *European Journal of Neuroscience*, 2007, vol. 25, no. 11, p. 3406–3416. ISSN 0953-816X. 25 (24wos, 1scop)
- [4] BILČÍK, Boris - KEELING, Linda J. Relationship between feather pecking and ground pecking in laying hens and the effect of group size. In *Applied animal behaviour science*. - Amsterdam, Netherlands : Elsevier, 2000, vol. 68, no. 1, p. 55–66. ISSN 0168-1591. 25 (22wos, 3scop)
- [5] HIANIK, Tibor - ŠNEJDÁRKOVÁ, Maja - SOKOLÍKOVÁ, L. - MESZÁR, E. - KRIVÁNEK, R. - TVAROŽEK, V. - NOVOTNÝ, I. - WANG, J. Immunosensors based on supported lipid membranes, protein films and liposomes modified by antibodies. In *Sensors and Actuators B : chemical*, 1999, vol. 57, no. 1-3, p. 201-212. (1.130 - IF1998). (1999 - Current Contents). 25 (25wos)
- [6] ČUBOŇOVÁ, Ľubomíra - SANDMAN, Kathleen - HALLAM, Steven J. - DELONG, Edward F. - REEVE, John N. Histones in Crenarchaea. In *Journal of Bacteriology*, 2005, vol. 187, no. 15, p. 5482–5485. ISSN 0021-9193. 23 (23wos)
- [7] NEWBERRY, Ruth C. - KEELING, Linda J. - ESTEVEZ, Inma - BILČÍK, Boris. Behaviour when young as a predictor of severe feather pecking in adult laying hens: The redirected foraging hypothesis revisited. In *Applied animal behaviour science*. - Amsterdam, Netherlands: Elsevier, 2007, vol. 107, no. 3-4, p. 262–274. ISSN 0168-1591. 22 (18wos, 4scop)
- [8] SVOBODOVÁ, Lenka - ŠNEJDÁRKOVÁ, Maja - HIANIK, Tibor. Properties of glucose biosensors based on dendrimer layers. Effect of enzyme immobilization. In *Analytical and Bioanalytical Chemistry*, 2002, vol. 373, no. 8, p. 735-741. ISSN 1618-2642. 21 (20wos, 1scop)
- [9] SREENIVAS, Avula - PATTON-VOGT, Jana L. - BRUNO, Vincent - GRIAC, Peter - HENRY, Susan A. A role for phospholipase D (Pld1p) in growth, secretion, and regulation of membrane lipid synthesis in yeast. In *Journal of Biological Chemistry*, 1998, vol. 273, no. 27, p. 16635-16638. ISSN 0021-9258. 21 (21wos)
- [10] ULIČNÁ, Oľga - GREKŠÁK, Miloslav - VANČOVÁ, Olga - ZLATOŠ, L. - GALBAVÝ, Štefan - BOŽEK, P. - NAKANO, M. Hepatoprotective Effect of Rooibos Tea (*Aspalathus linearis*) on CCl₄-Induced Liver Damage in Rats. In *Physiological Research*, 2003, vol. 52, no. 4, p. 461-466. (0.984 - IF2002). (2003 - Current Contents). ISSN 0862-8408. 20 (15wos, 5scop)

ii. List of top-cited authors from the Organisation (at most 10 % of the research employees) and their number of citations in the assessment period (2006 – 2010)

[1] **Šnejdárková M.** - 149 citations (142 WOS; 7 Scopus)

[2] **Zeman M.** - 137 citations (112 WOS; 25 Scopus)

[3] **Bilčík B.** - 121 citations (110 WOS; 11 Scopus)

[4] **Griáč P.** - 119 citations (116 WOS; 3 Scopus)

iii. Supplementary information and/or comments on responses to the scientific output of the Organisation

The long-term goal of our Institute is to perform high quality basic and applied research at the internationally competitive level. International acceptance and relevance of any research can be judged by quality of journals in which the results are published and by responses to the scientific publications produced. Positive trend of publishing in journals with higher impact factor during the last assessment period (see above) was complemented by increased number of citations in international databases WoS and Scopus. Compared to previous evaluation periods, the average number of citations indexed in these two databases increased significantly from 96 citations/year (1998-2001) and 168 citations/year (2002-2005), respectively, to 188 citations/year in the current assessment period (2007-2011). Increasing number of publications in high-impact journals indicates that the positive trend in the citation rate could be retained also in the coming years. We do not specifically follow the citations in books and monographs, which numbers in the Table may thus be significantly underestimated.

3. Research status of the Organisation in the international and national context

- **International/European position of the Organisation**

- i. **List of the most important research activities documenting international importance of the research performed by the Organisation, incl. major projects (details of projects should be supplied under Indicator 4). Collective membership in the international research organisations, in particular within the European Research Area**

[1] *Ultra-sensitive, stable and easy to use AFM bio sensor tips*, IntelliTip, ID 431, ERA-Net FP7 project

[2] *Animal Welfare Research in enlarged Europe*, AWARE, KBBE-265686, FP7 project

[3] *Molecular mechanisms of basal ganglia regeneration in songbirds*, FIRCA R03TW007615-01

- ii. **List of international conferences (co-) organised by the Organisation**

[1] 34th Ethological Conference 7. - 10. 11. 2007, Nitra

[2] Joint East and West Central Europe ISAE Regional Meeting, 15.-17. 5. 2008, Bratislava

[3] 4th Workshop on Fundamental Physiology and Perinatal Development in Poultry, 10. - 12. 9. 2009, Bratislava

[4] 37th Ethological Conference, 15.-17.11. 2010, Smolenice

[5] 39th Annual Conference on Yeasts, 3. - 6. 5. 2011, Smolenice

- iii. **List of journals edited/published by the Organisation:**

1. **WOS (IF of journals in each year of the monitoring period)**
2. **SCOPUS**
3. **other database**
4. **not included in the databases**

- iv. **List of edited proceedings from international scientific conferences and other proceedings**

[1] 34th Ethological Conference, 7.- 10. 11. 2007, Nitra

[2] 4th Workshop on Fundamental Physiology and Perinatal Development in Poultry, 10. - 12. 9. 2009, Bratislava

[3] 37th Ethological Conference, 15. - 17. 11. 2010, Smolenice

[4] 39th Annual Conference on Yeasts, 3. - 6. 5. 2011, Smolenice

- **National position of the Organisation**

- i. **List of selected most important national projects (the EU Structural Funds, Slovak Research and Development Agency (APVV), State Research Programmes, Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA), Centres of Excellence, National Reference Laboratories and others)**

- [1] ***Centre of Excellence for translational research in molecular medicine (TRANSMED1)*** 26240120008, principal coinvestigator RNDr. Ivan Hapala, CSc., 2009 -2011
- [2] ***Centre of Excellence for translational research in molecular medicine (TRANSMED 2)*** 26240120030, principal coinvestigator RNDr. Ivan Hapala, CSc., 2010 - 2012
- [3] ***BIOMEMBRANES: cross-sectional educational program for graduate students and young scientists in life sciences***, European Social Found project JPD 3 2005/1-010, RNDr. Ivan Hapala, CSc., 2006-2008
- [4] ***Education and support of postdoctoral students – young researchers in field of material engineering science, chemical science and molecular biology and genetics, including biotechnologies, with the aim to produce creative experts for research and development***, European Social Found project JPD 3 2005/1-031, Mgr. Ľubica Kubíková, PhD., RNDr. Ľubor Košťál CSc., 2007-2008
- [5] ***Current trends in physiological and behavioural research – higher effectiveness of doctoral studies by widening the practical skills***, Social Found project JPD 3 2005/NP1-032, Prof. RNDr. Michal Zeman, DrSc., 2006 - 2008
- [6] ***Molecular genetic principles of membrane bound processes in normal and pathological animal physiology***, APVT-51-024904, RNDr. Peter Šmigáň, DrSc., 2005 - 2007
- [7] ***Yeast as a model of pathological disturbances of eukaryotic lipid homeostasis***, APVT -51-029504, Mgr. Martin Valachovič, PhD., 2005 - 2007
- [8] ***Yeast as a tool for producing biotechnologically valuable sterols: the biochemical and genetic approach***, APVV-0681-07, RNDr. Ivan Hapala, CSc., 2008 - 2011

- [9] ***Biomembranes: Membrane structure and dynamics in relation to cell functions***, VVCE-0064-07, RNDr. Ivan Hapala, CSc., 2008 - 2011
- [10] ***Epigenetic, physiological and neurobehavioural aspects of poultry welfare***, APVV-0047-10, RNDr. Ľubor Košťál, CSc., 2011- 2014
- [11] ***Behavioural physiology of poultry related to production traits and welfare***, VEGA 2/5127/25. ,RNDr. Boris Bilčík, PhD., 2005-2007
- [12] ***Monitoring of poultry welfare using behavioural and radiotelemetric methods***, VEGA 2/0151/08, RNDr. Boris Bilčík, PhD., 2008-2010
- [13] ***Transport and turnover of phospholipids as regulatory mechanism of membrane lipid composition in yeast *Saccharomyces cerevisiae****, VEGA 2/7136/27, RNDr. Peter Griač, CSc., 2007-2009
- [14] ***Antimycotics as a tool for the study of membrane lipid biogenesis in yeast***, VEGA 2/7135/27, RNDr. Ivan Hapala, CSc., 2007-2009
- [15] ***Neurobiological control mechanisms of the feather pecking in laying hens***, VEGA, 2/0103/08, RNDr. Ľubor Košťál, CSc., 2008-2010
- [16] ***Production and application of monoclonal antibodies in biochemical, histochemical and functional analysis of some CD molecules (antigens) of bovine cell membranes***, VEGA 2/6023/27, Ing. Michal Simon, DrSc., 2006-2008
- [17] ***Development of reproductive ability in Japanese quail exposed to simulated microgravity***, VEGA 2/6024/27, Ing. Peter Škrobánek, CSc., 2006-2008
- [18] ***Study of energy transformation in methanoarchaea *Methanothermobacter thermoautotrophicus*: Isolation and characterization of amiloride, NO₃, DC CD and bafilomycin A1- resistant mutants***, VEGA 2/6025/27, RNDr. Peter Šmigáň, DrSc., 2006-2008
- [19] ***Study of the affinity interaction on the nanostructured substrates dendrimers via quartz crystal microbalances***, VEGA 2/7134/27, Ing. Maja Šnejdárková, CSc. 2007-2009
- [20] ***Neurobiology of vocal communication in birds***, VEGA 2/7168/27, RNDr. Ľubica Kubíková, PhD., 2007-2009
- [21] ***Identification and functional analysis of the CD molecules on the somatic and gametic cells of cattle***, VEGA 2/0001/09, Ing. Michal Simon, DrSc., 2009-2011
- [22] ***Long-term stay of Japanese quail in simulated microgravity***, VEGA 32/0047/09, Ing. Peter Škrobánek, CSc., 2009-2001

- [23] ***Alterations of the ATP synthesizing systems in N,N'-Dicyclohexylcarbodiimide, tributyltin and diethylstilbesterol resistant mutants of methanarchaeon Methanothermobacter thermoautotrophicus***, VEGA 2/0015/09, RNDr. Peter Šmigáň, DrSc., 2009-2011
- [24] ***Lipid transport and turnover: contribution to the understanding of yeast resistance to antifungals and stress***, VEGA 2/0077/10, RNDr. Peter Griač, CSc., 2010-2013
- [25] ***The role of dopaminergic system in neurogenesis and brain regeneration in birds***, VEGA 2/0189/10, RNDr. Ľubica Niederová, PhD., 2010-2012
- [26] ***Neutral lipid homeostasis in yeast: from cell biology to biotechnology***, VEGA 2/0058/11, RNDr. Ivan Hapala, CSc., 2011-2015
- [27] ***Natural brain reward system, its dopaminergic mechanisms and poultry welfare***, VEGA 2/0192/11, RNDr. Ľubor Košťál, CSc., 2011-2013

ii. List of national scientific conferences (co)-organised by the Organisation

- [1] 5th Ivanka Days of Young Biologists, 25.6. 2008, Ivanka pri Dunaji
- [2] Workshop „VVCE Biomembranes '08“, 18.-19.11. 2008, Kočovce
- [3] Workshop "VVCE Biomembranes '09", 10.-11.12. 2009, Harmónia
- [4] Workshop "VVCE Biomembranes '10", 29.-30.11. 2010, Mojmírovce
- [5] 6th Ivanka Days of Young Biologists, 24.6. 2010, Ivanka pri Dunaji
- [6] Workshop "Biomembranes 2011". 3.- 4.10. 2011, Smolenice

iii. List of edited proceedings of national scientific conferences/events

- [1] 5th Ivanka Days of Young Biologists, 25. 6. 2008, Ivanka pri Dunaji
- [2] 2nd Workshop "BIOMEMBRANES 2009", 10. - 11. 12. 2009, Harmónia
- [3] 3rd Workshop "BIOMEMBRANES 2010", 29. - 30. 11. 2010, Mojmírovce
- [4] 6th Ivanka Days of Young Biologists, 24. 6. 2010, Ivanka pri Dunaji

• International/European position of the individual researchers

i. List of invited/keynote presentations at international conferences, documented by an invitation letter or programme

- [1] Tahotná D. – Holič R. – Poloncová K. – Šimočková M. – **Griač P.** Family of phosphatidylinositol transfer proteins in *Saccharomyces cerevisiae*: lipid transfer and beyond. In *35th Annual conference on yeast*, Smolenice, Slovakia, May 16-18, 2007. Programme and abstract book p. 32.

- [2] **Svobodová L.** Electrochemical sensors: amperometric biosensors. In „Present and future of optical biosensors“. Seminar within the project "Sensors and biosensors for biotechnology, medical diagnostics and environment". Praha, 13. 9. 2007.
- [3] **Hapala I.** The role of intracellular fatty acid synthesis in the control of triglyceride levels in the yeast *Saccharomyces cerevisiae*. 12th International Congress on Yeasts, Kyiv, Ukraine, 11. -15. 8. 2008.
- [4] **Zeman M.,** Kršková L., Škrobánek P., Okuliarová M. Maternal testosterone as a sign of epigenetic adaptation to environmental condition. 37th ethological conference Smolenice, 15.-17. 11. 2010.
- [5] **Antalíková J.** Is the CD46 molecule involved in the tetraspanin web in bovine sperm? Genes, gene Expression, and Behaviour, Nové Hradky, Czech Republic, 2.-5. november 2011.

Invited presentations at the foreign institutions

- [1] **Hapala I.** Yeast as a model in the study of human diseases. Medical faculty, University of Rijeka, Croatia (June 2007)
- [2] **Bábelová L.** Electrochemical sensors: amperometric biosensors. Project JD3 "Sensors and biosensors for biotechnology, medical diagnostics and environment". Institute of Photonics and Electronics AS CR, Prague, 5. 3. 2008.
- [3] **Niederová-Kubíková L.** Basal ganglia in learned vocal communication. University of Newcastle, Institute of Neuroscience, 10. 11. 2008.
- [4] **Griac P.** Lipid transfer and turnover in yeast. Department of cell and developmental biology, University College London, 28. 10. 2008.
- [5] **Košťál L.** Brain, behaviour and measurements of animal welfare. NOVA course Abnormal animal behaviour for PhD. students. NOVA University Network, Solvalla, Finland, 10.6.2008.
- [6] **Košťál L.** Neurobiology and physiology of abnormal behaviours in poultry. NOVA course Abnormal animal behaviour for PhD. students. NOVA University Network, Solvalla, Finland, 11.6.2008.
- [7] **Michalková K.** The function of CD molecules in reproductive system. Institute of Biotechnology AS CR Prague, Diagnostic laboratory for reproductive medicine. 7.10. 2010.
- [8] **Bilčík B.** Research in Slovakia. Ege University, Faculty of Agriculture, Department of Animal Science, Izmir, Turkey. 3. 5. 2010.

- [9] **Bilčík B.** Monitoring of poultry welfare using behavioural and radiotelemetric methods. Ege University, Faculty of Agriculture, Department of Animal Science, Izmir, Turkey. 3. 5. 2010.

ii. List of employees who served as members of the organising and/or programme committees for international conferences

- [1] **I. Hapala** - Member of the Program Committee, 36th Annual Conference on Yeast, Smolenice, 2008, chairman
 - Member of the Program Committee, 37th Annual Conference on Yeast, Smolenice, 2009
 - Member of the Program Committee, 38th Annual Conference on Yeast, Smolenice, 2010
 - Head of the Organising Committee and member of the Program Committee, 39th Annual Conference on Yeasts, Smolenice, 2011
- [2] **B. Bilčík** - Head of the Organising Committee, Member of the program committee; **Ľ. Košťál** - Member of the program and organising committees, **E. Bosíková, Ľ. Niederová, M. Šimočková, P. Výboh** - Members of organising committee Joint East and West Central Europe ISAE Regional Meeting, 15.-17.5. 2008, Bratislava
- [3] **B. Bilčík, Ľ. Košťál, M. Zeman** - Members of the program and organising committees, **E. Bosíková, M. Cviková** – Members of the organising committee, 37th Ethological Conference, 15.-17.11. 2010, Smolenice
- [4] **M. Zeman** - Head of the Program committee, **Ľ. Košťál** - Member of the program and organising committee, **B. Bilčík** - Member of the organising committee, The 4th Workshop on Fundamental Physiology and Perinatal Development in Poultry, 10.-12.9. 2009, Bratislava
- [5] **M. Zeman, Ľ. Košťál** - Members of the Program committee, The 5th Workshop on Fundamental Physiology and Perinatal Development in Poultry, 31.8.-3.9. 2011, Wageningen, Holland
- [6] **M. Valachovič** - Member of the organizing committee, ATP Binding Cassette (ABC) Proteins: From Multidrug Resistance to Genetic Diseases, March 2008, Innsbruck, Austria
 - Member of the organizing committee, ATP Binding Cassette (ABC) Proteins: From Multidrug Resistance to Genetic Diseases, March 2010, Innsbruck, Austria

- Member of the organizing committee, ATP Binding Cassette (ABC) Proteins: From Multidrug Resistance to Genetic Diseases, March 2012, Innsbruck, Austria
- Member of the local organizing committee, 3rd FEBS Advanced Lecture Course on Systems Biology: From Molecules to Function, March 2009 Alpbach, Austria

[7] **M. Šnejdárková, A. Poturnayová** - Members of the organizing committee, Project meeting „Ultra-sensitive, stable and easy to use AFM bio sensor tips“, 26.-29.9. 2011, Bratislava

iii. List of employees who served as members of important international scientific bodies (e.g. boards, committees, editorial boards of scientific journals)

- [1] **Antalíková J.** - Member of the International Reviewers Panel, Medical Science Monitor (USA)
- [2] **Košťál L.** - Member of the International Advisory Board, Acta Veterinaria, Brno (ČR)
- [3] **Simon M.** - Member of the Editorial Board, Animal Science Papers and Reports, Jastrzebiec (Poland)
- [4] **Zeman M.** - Associate Editor, Neuroendocrinology Letter, Stockholm, (Sweden)
- [5] **Zeman M.** - Member of the Editorial Board, Biológia (SR)
- [6] **Greksák M.** - Member of the Editorial Board, General Physiology and Biophysics (SR)
- [7] **Hapala I.** - Member of the Editorial Board, General Physiology and Biophysics (SR)
- [8] **Šmigáň P.** - Member of the Editorial Board, General Physiology and Biophysics (SR)
- [9] **Griáč P.** - Member of the Editorial Board, General Physiology and Biophysics (SR)
- [10] **Bilčík B.** (Committee Member) - *Czech and Slovak Ethological Society*
- [11] **Zeman M.** (Committee Member) - *Farm Animal Endocrinology Association*
- [12] **Hapala I.** - *International Commission on yeasts (ICY) of International Union of Microbiological Societies (IUMS) (representative for Slovakia)*
- [13] **Hapala I.** (Chairman of the Commission on Yeast) - *Czechoslovak Society for Microbiology*

- [14] **Bilčík B.** (*Regional Secretary of the East Central Europe Region*) - *International Society for Applied Ethology*
- [15] **Košťál L., Bilčík B.** - *World Poultry Science Organization, Working Group 9: Welfare and Management*
- [16] **Juráni M.** (Committee Member) - *National Committee COSPAR*
- [17] **Greksák M.** (member of the committee of the Slovak branch) - *Society for Arts and Sciences Washington*
- [18] **Zeman M.** (Committee Member) - *World Society for Animal Endocrinology*

iv. List of international scientific awards and distinctions

Employees awarded by travel grants from international bodies:

- [1] **Valachovič M.**, 2008, FEMS Travel Grant, ATP Binding Cassette (ABC) Proteins: From Multidrug Resistance to Genetic Diseases, Innsbruck, Austria
- [2] **Holič R.**, 2008, FEBS Travel grant , FEBS Workshop “Lipids as regulators of cell function”, Island of Spetses, Greece
- [3] **Valachovič M.**, 2010 FEBS Travel grant, ATP Binding Cassette (ABC) Proteins: From Multidrug Resistance to Genetic Diseases, Innsbruck, Austria
- [4] **Holič , R.** 2011, ASBMB Travel award Special Symposia “Cellular Traffic of Lipids and Calcium at Membrane Contact Sites”, Snowbird, Salt Lake City, Utah, USA
- [5] **Poturnayová A.** - “Poster Award” for the poster “Calix[4]arenes-Supramolecular structures sensitive to dopamine” on the 5th International conference of nanosciencies, nanotechnologies, nanomaterials, nanomedicine and technology transfer, Bratislava, Slovakia, 2010
- [6] **Holič R.** - “Poster Award” for the poster “PITPbeta is required to maintain the shape of the nuclear envelope” on the ASBMB Special Symposia “Cellular Traffic of Lipids and Calcium at Membrane Contact Sites”, Snowbird, Salt Lake City, Utah, USA, 2011

v. List of employees with the highest H – index indicating field of science by WOS

- [1] **Zeman M.** - 15
- [2] **Šnejdárková M.** - 14
- [3] **Hapala I.** - 14
- [4] **Košťál L.** - 10
- [5] **Griáč P.** – 10

• National position of the individual researchers

i. List of invited/keynote presentations at national conferences documented by an invitation letter or programme

- [1] **Balážová M., Griáč P.** Identification of phosphatidylglycerol specific phospholipase in C yeast *Saccharomyces cerevisiae*. XXII. Biochemický zjazd. Martin, 8.-12. 9. 2010.
- [2] **Hapala, I., Valachovič, M.** Biochemical genetics: genetic excursion to the study of serol metabolism in yeast. History, the present and perspectives of genetics. Bratislava 11.-12. 9. 2008. - Bratislava: IRIS, 2008. ISBN 978-80-223-2413-7, p. 14

Invited lectures at the influential research institutions

- [1] **Griáč P.** Lipid transfer proteins in the physiology of eukaryotic cell. Institute of Experimental Oncology SAS, 6.10. 2010.

ii. List of employees who served as members of organising and programme committees of national conferences

- [1] **Hapala I., Griáč P.**
 - Members of the organising committee, 4th Ivanka Days of Young Biologists, Ivanka pri Dunaji, 2008;
 - Members of the organising committee, 5th Ivanka Days of Young Biologists, Ivanka pri Dunaji, 2010
- [2] **Hapala I., Antalíková J.**
 - Members of the organising committee, Workshop “VVCE Biomembranes '08“ Kočovce, 2008;
 - Members of the organising committee, Workshop “VVCE Biomembranes '09“, Harmónia 2009;

- Members of the organising committee, Workshop “VVCE Biomembranes'10“, Mojmírovce, 2010;
- Members of the organising committee, Workshop “VVCE Biomembranes '11“, Smolenice 2011

[3] **Šnejdárková M., Poturnayová A.** - Members of the organising committee, 5th Slovak Biophysical Symposium, 19.-21.3.2012, Bratislava

iii. List of employees serving in important national scientific bodies (e.g. boards, committees, editorial boards of scientific journals)

iv. List of national awards and distinctions

- [1] **Niederová Ľ.** - The winner of Competition of young scientists of the SAS for the best collection of publications “ Basal ganglia and behaviour of birds”, 2008
- [2] **Bosíková E.** - The winner of the competition 5th Ivanka Days of Young Biologists, 2008, section of physiology and general biology
- [3] **Balážová M.** -The Winner of the national competition of young scientist “Drobnicov memorial 2009”
- [4] **Greksák M.** - Commemorative Plaque of the Slovak Academy of Sciences on the occasion of the 20th anniversary of the Institute of Animal Biochemistry and Genetics, 2010
- [5] **Hapala I.** - The prize of the Slovak Academy of Sciences for science infrastructure, 2010 (as a member of the consortium BITCET)
- [6] **Hapala I.** – The bronze medal of Comenius University on the occasion of the 20th anniversary of the Institute of Animal Biochemistry and Genetics, 2010
- [7] **Hapala I.** – Commemorative medal on the occasion of the 70th anniversary of the Faculty of Natural Sciences of the Comenius University, 2010
- [8] **Hapala I.** - Commemorative Plaque of the The Faculty of Chemical and Food Technology of the Slovak University of Technology on the occasion of the 20th anniversary of the Institute of Animal Biochemistry and Genetics, 2010
- [9] **Košťál Ľ.** - Engraving of the Faculty of Natural Sciences of the Comenius University on the occasion of the 20th anniversary of the Institute of Animal Biochemistry and Genetics, 2010
- [10] **Bosíková E.** – The winner of the competition of students posters on the 37th Ethological Conference, Smolenice 2010

- [11] **Hapala I.** - The prize of the Slovak Academy of sciences for the science infrastructure building, 2011
- [12] **Niederová L.** – Prize of the Literary Fund for the exceptional scientific response to the publication in the field of natural and medical sciences, 2011

v. Supplementary information and/or comments documenting international and national status of the Organisation

With respect to the national status of the Institute of Animal Biochemistry and Genetics, we are especially proud to our role in establishing the network of Slovak laboratories studying various aspects of biological membranes in the year 2007. Four members of the consortium are from the institutes of the Slovak Academy of Sciences (the Institute of Animal Biochemistry and Genetics, the Institute of Molecular Physiology and Genetics, the Institute of the Experimental Endocrinology and the Institute of Animal Physiology), three from the top Slovak universities (Faculty of Science and Jessenius Faculty of Medicine, both Comenius University and the Faculty of Chemical and Food Technology of the Slovak University of Technology) and one partner is from the Animal Production Research Centre. Partners of the project represent not only different institutions, but are also geographically spread over the whole Slovakia (Bratislava, Nitra, Martin, and Košice). Project succeeded in a very competitive call of the Slovak Research and Development Agency and we (Dr. Hapala) became the coordinator of the Research and Education Centre of Excellence project Biomembranes (VVCE-0064-07, 2008-2011). The project was successfully completed in 2011 exceeding significantly most of the planned measurable outputs (including produced scientific publications and their citations, number of diploma and PhD students involved in the project, etc.)

This project was built on the experience from the two previous successful Research and Development Agency funded projects oriented at biological membranes (APVV-20-016502 'Membrane-associated processes in the physiology and pathophysiology of farm animals and their symbiotic microorganisms', 2002-2005 and APVV-51-024904 'Molecular genetic principles of membrane-associated processes in normal and pathological physiology of animals', 2005-2007, both coordinated by Dr. Smigan) and the European Social Fund project "Biomembranes: cross-sectional educational programme for graduate students and young scientists in life sciences " (13120200072, JPD NUTS II - Bratislava Aim 3, 2006-2008, coordinated by Dr. Hapala).

With respect to the international status, the Institute continued in a number of formal and informal collaborations with top institutions in Europe, USA and Japan.

Practically all research groups have collaborations with leading international laboratories, several of them lasting for longer than a decade. Members of our research teams are being invited as speakers to international conferences and to universities and research institutes and are active in the international professional organizations, and in organization of international conferences. Bi-lateral collaboration with the Duke University, USA (NIH FIRCA), and multilateral collaborations within IntelliTip (ERA-Net) and AWARE (coordination and support action FP7) were of special importance during the assessed period.

4. Project structure, research grants and other funding resources

- **International projects and funding**

- i. **List of major projects within the European Research Area – 6th and 7th Framework Programme of the EU, European Science Foundation, NATO, COST, INTAS, CERN, etc. (here and in items below please specify: type of project, title, grant number, duration, total funding and funding for the Organisation, responsible person in the Organisation and his/her status in the project, e.g. coordinator, work package leader, investigator)**

[1] FP7

Ultra-sensitive, stable and easy to use AFM bio sensor tips, MNT-ERA.Net II ID 431, duration 1.2010 - 31.12.2012 ; Ing. Maja Šnejdárková, CSc.- principal coinvestigator

Total funding: 1085449 €, Funding for the organization: 150 000 €

[2] Coordination and support action, FP7

Animal Welfare Research in enlarged Europe AWARE, KBBE – 265686, duration 1.3.2011 - 28.2.2014; RNDr. Ľubor Košťál, CSc., work package leader

Total funding: 188213 €, Funding for the organization: 59920 €

- ii. **List of other international projects incl. total funding and funding for the Organisation**

[1] ***Molecular mechanisms of basal ganglia regeneration in songbirds***, FIRCA R03TW007615-01, duration 1.7.2006 - 30.6.2011, Mgr. Ľubica Kubíková, PhD. – Principal coinvestigator, Total Funding: 116466 €, Funding for the Organisation: 61560 €

- [2] ***Molecular biology and molecular genetics of the regulation of polyunsaturated fatty acids (PUFA)***, Japan Society for the Promotion of Science (JSPS), 2010-2011, Mgr. Roman Holič, PhD - principal coinvestigator, Funding: 1mil Yen

iii. List of other important projects and collaborations without direct funding

- [1] Ege University, Faculty of Agriculture, Department of Animal Science, İzmir, (Turkey). Cooperation in field of health, welfare and poultry behaviour, 2010-ongoing (Prof. Dr. Sezen ÖZKAN) – RNDr. Boris Bilčík, PhD.
- [2] Institute of Biochemistry, University of Technology Graz (Austria): collaboration on the project Fonds zur Förderung der wissenschaftlichen Forschung „Formation and mobilization of neutral lipids in the yeast (P18857)“ (prof. G. Daum, 2006-2010).
- [3] Institute of Molecular Biosciences, University of Graz (Austria): lipid homeostasis in yeast. (collaborators: Prof. S.D. Kohlwein, Assoc.Prof. F. Turnowski, 2007-2008)
- [4] Department of Biology, Duquesne University Pittsburgh, PA (USA): Lipid modifying enzymes (collaborator: Prof. J. Patton-Vogt, 2007 – 2011)
- [5] Department of Biochemistry and Molecular Biology, University of Southern Denmark, Odense (Denmark): fluorescent probes in the study of sterol homeostasis in yeast. (collaborator: Assoc. Prof. D. Wustner, 2009-ongoing)
- [6] Department of Medical Biochemistry, Max F. Perutz Laboratories, Medical University of Vienna (Austria): role of ABC proteins in lipid homeostasis in yeast. (collaborator: Prof. K. Kuchler, 2008-2011)
- [7] Department of Cell and Developmental Biology, University College, London (Great Britain): Role of lipid transfer proteins in eukaryotic cell physiology (collaborator: Prof. S. Cockcroft, 2007-2011)
- [8] Department of Biology, University of York (Great Britain): development of a transformation system for extremophilic Archaea – two short-term stays supported by Slovak Academic and Information Agency (2 months) and EBMO (5 weeks) (collaborator: Prof. J. Chong, 2007-2008).

- National projects and funding²
 - i. List of State Research Programmes, and their funding
 - ii. List of project supported by APVV

| Start | Project title | Project number | Duration in months | Funding for the Organisation (EUR) | Role of the Organisation |
|-------|--|----------------|--------------------|------------------------------------|--------------------------|
| 2007 | 1. Cell volume and insulin secretion | APVV-0235-06 | 36 | 15 867 | cooperator |
| 2008 | 1. Yeast as a tool for producing biotechnologically valuable sterols: the biochemical and genetic approach | APVV-0681-07 | 31 | 118502 | coordinator |
| | 2. Biomembranes: membrane structure and dynamics in relation to cell functions | VVCE-0064-07 | 40 | 178951 | coordinator |
| | 3. Exploitations of complex organic materials by means of non-traditional micro-organisms for energetic purposes | APVV-0642-07 | 28 | 4949 | cooperator |
| | 4. Nanostructures for development of biosensors | APVV-0362-07 | 28 | 21972 | cooperator |
| 2009 | 1. Mitochondrial lipid homeostasis: the yeast <i>Saccharomyces cerevisiae</i> as a model organism | LPP-0291-09 | 36 | 5300 | coordinator |
| 2010 | | | | | |
| 2011 | 1. Molecular architecture, dynamics and evolution of chromosomes in yeast mitochondria | APVV-0123-10 | 42 | 30000 | cooperator |
| | 2. Epigenetic, physiological and neurobehavioural aspects of poultry welfare | APVV-0047-10 | 36 | 128340 | coordinator |
| | 3. Effect of body condition and some immunological factors (CD molecules) on fertilization process in cattle | APVV-0137-10 | 36 | 80942 | cooperator |
| | 4. The mechanisms of interaction small molecules with DNA aptamers | APVV-0410-10 | 42 | 57000 | cooperator |

LPP-0291-09 - postponed to 2015

² Excluding projects for the popularisation of science

iii. Number of projects supported by the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA) for each year, and their funding

| VEGA | 2007 | 2008 | 2009 | 2010 | 2011 |
|---------------------------|-------|-------|-------|-------|-------|
| number | 11 | 12 | 11 | 9 | 9 |
| funding in the year (EUR) | 53475 | 49658 | 42335 | 57470 | 55068 |

• Summary of funding from external resources

| External resources | 2007 | 2008 | 2009 | 2010 | 2011 | total | average |
|--|-------|-------|-------|-------|-------|-------|---------|
| external resources (millions of EUR) | 0.180 | 0.251 | 0.347 | 0.379 | 0.303 | 1.460 | 0.292 |
| external resources transferred to cooperating research organisations (millions of EUR) | 0.000 | 0.071 | 0.152 | 0.159 | 0.110 | 0.492 | 0.098 |
| ratio between external resources and total salary budget | 0.480 | 0.670 | 0.889 | 0.940 | 0.793 | - | 0.754 |
| overall expenditures (millions of EUR) | 0.653 | 0.666 | 0.787 | 0.739 | 0.736 | 3.581 | 0.716 |

iv. List of projects the EU Structural Funds

- **Summary of external resources of the EU Structural Funds (ERDF/ESF)**

| Year | Project title | Project number | Duration in months | Funding for the Organisation (EUR) | Role of the Organisation |
|------|--|----------------|--------------------|------------------------------------|--------------------------|
| 2007 | | | | | |
| | | | | | |
| | | | | | |
| 2008 | | | | | |
| | | | | | |
| | | | | | |
| 2009 | Centre of Excellence for translational research in molecular medicine (TRANSMED1) | 26240120008 | 25 | 15601 | cooperator |
| | | | | | |
| | | | | | |
| 2010 | Centre of Excellence for translational research in molecular medicine (TRANSMED 2) | 26240120030 | 24 | 8439 | cooperator |
| | | | | | |
| | | | | | |
| 2011 | | | | | |
| | | | | | |
| | | | | | |

v. Supplementary info and/or comments on research projects and funding resources

The support from the Scientific Grant Agency of Ministry of Education SR and Slovak Academy of Sciences VEGA represents traditionally the most stable and reliable funding important for maintaining the research activities of the Institute. In comparison with previous period of assessment during the recently assessed period (2007-2011) the number of VEGA funded projects and their size increased. Compared to the previous assessment period we were also more successful in competing for the Slovak Research and Development Agency's APVV funding within the regular calls (2007, 2010), as well as in the special and very competitive call - Support for Creation and Activities of Research and Education Centres of Excellence, where only two projects with biomedical background have been funded. During the evaluated period we were the partners in two structural EU

funds consortia Transmed 1 and Transmed 2. We have improved also our participation in the FP7 projects, with ERA-net project IntelliTip and Coordination and Support Action AWARE.

5. Organisation of PhD studies, other pedagogical activities

- i. List of accredited programmes of doctoral studies (as stipulated in the previously effective legislation as well as in the recently amended Act on the Universities). Period of validity of accredited scientific disciplines, characterization of perspectives of PhD study on the Organisation**

[1] Animal Physiology

- 15-17-9 (old legislation –131/1997 Ordinance)
- 4.2.10 (new legislation - 131/2002 Act) contract with Comenius University, Faculty of Science

[2] Biochemistry

- 14-10-9 (old legislation –131/1997 Ordinance)
- 4.1.22 (new legislation - 131/2002 Act) contract with Comenius University, Faculty of Science and Slovak Technical University, Faculty of Chemical and Food Technology

Due to the fact that the guarantor of the program exceeded the age limit of 65 years, we provide PhD study in programme Biochemistry 4.1.22 in collaboration with the Institute of Chemistry, SASci.

ii. Summary table on doctoral studies (number of internal/external PhD students; number of students who completed their study by a successful thesis defence; number of PhD students who quitted the programme)

| PhD study | 31.12.2007 | | | 31.12.2008 | | | 31.12.2009 | | | 31.12.2010 | | | 31.12.2011 | | |
|---|------------|-----------------|------------------|------------|-----------------|------------------|------------|-----------------|------------------|------------|-----------------|------------------|------------|-----------------|------------------|
| number of potential PhD supervisors | | | | | | | | | | | | | | | |
| PhD students | number | defended thesis | students quitted | number | defended thesis | students quitted | number | defended thesis | students quitted | number | defended thesis | students quitted | number | defended thesis | students quitted |
| internal | 6 | 1 | 3 | 7 | 2 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 0 |
| external | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| supervised at external institution by the research employees of the assessed organisation | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 6 | 1 | 0 | 8 | 0 | 0 |

iii. Postdoctoral positions supported by

a) external funding (specify the source)

Ing. Jana Jankovičová, PhD., SRDA project VVCE-0064-07 (2008 – 2009)

Mgr. Ľubica Niederová, PhD., SRDA project VVCE-0064-07 (2008 – 2009)

Mgr. Roman Holič, PhD., SRDA project VVCE-0064-07 (2009 – 2010)

Mgr. Zuzana Slezáková, PhD., SRDA project VVCE-0064-07 (2010 – 2011)

Ing. Katarína Michalková, PhD., SRDA project VVCE-0064-07 (2010 – 2011)

Mgr. P. Kohút, PhD., SRDA project VVCE-0064-07 (2011)

Mgr. Mária Šimočková, PhD., SRDA project APVV-0681-07 (2008 - 2009); SRDA project LPP-0291-09 (2009 - 2011)

b) internal funding - the Slovak Academy of Sciences Supporting Fund of Stefan Schwarz

Mgr. Martin Valachovič, PhD., 2004-2008

RNDr. Lenka Bábelová (Svobodová), PhD., 2005-2009

iv. Summary table on pedagogical activities

| Teaching | 2007 | 2008 | 2009 | 2010 | 2011 |
|--|------|------|------|------|------|
| lectures (hours/year) ³ | 68 | 66 | 62 | 62 | 58 |
| practicum courses (hours/year) ³ | 104 | 120 | 0 | 32 | 0 |
| supervised bachelor thesis (in total) | 2 | 3 | 2 | 2 | 0 |
| supervised diploma thesis (in total) | 3 | 9 | 10 | 11 | 6 |
| supervised rigorous thesis (in total) | 0 | 0 | 0 | 0 | 0 |
| members in PhD committees (in total) | 6 | 6 | 3 | 7 | 3 |
| members in DrSc. committees (in total) | 3 | 1 | 0 | 0 | 1 |
| members in university/faculty councils (in total) | 0 | 0 | 0 | 0 | 0 |
| members in habilitation/inauguration committees (in total) | 1 | 0 | 0 | 0 | 0 |

List of published university textbooks

- [1] Súčasný trendy vo fyziologickom a behaviorálnom výskume - rozširovaním praktických zručností k vyššej efektívite doktorandského štúdia (in Slovak; Current trends in physiological and behavioural research) / Bilčík Boris, Herichová Iveta, Kiss Alexander, Košťál Ľubor, Križanová Oľga, Kršková Lucia, Kubíková Ľubica, Okuliarová Monika, Talarovičová Alžbeta, Výboh Pavel, Zeman Michal. - 1. vyd. - Nitra: ASAP-translation.com, s.r.o., 2007. - 107 s. - (edícia eBook.sk). - ISBN 978-80-96970-0-1.

v. Number of published academic course books

vi. List of joint research laboratories/facilities with the universities

- [2] *Faculty of Science, Comenius University Bratislava*, collaboration with Department of Animal Physiology and Ethology
- [3] *Faculty of Science, Comenius University Bratislava*, collaboration with Department of Biochemistry
- [4] *Faculty of Science, Comenius University Bratislava*, collaboration with Department of Microbiology and Virology

- [5] *Faculty of Science, Comenius University Bratislava*, collaboration with Department of Genetics
- [6] *Faculty of Mathematics, Physics and Informatics, Comenius University Bratislava*, collaboration with Department of Nuclear Physics and Biophysics
- [7] *Faculty of Chemical and Food Technology, Slovak Technical University, Bratislava*, collaboration with Institute of Biochemistry, Nutrition and Health Protection
- [8] *Faculty of Chemical and Food Technology, Slovak Technical University, Bratislava*, collaboration with Institute of Biotechnology and Food Science
- [9] *University of Veterinary Medicine and Pharmacy Košice*, collaboration with Department of Normal Anatomy, Histology and Physiology

Two additional long-term collaborations based on joint projects, but not covered by an official written agreement on joint research facilities were active during the assessment period:

- [10] *Faculty of Agrobiology and Food Resources, Slovak Agricultural University*, Department of Veterinary Disciplines
- [11] *Faculty of Medicine, Comenius University, Bratislava*, 3rd Department of Internal Medicine, Laboratory of Pharmacobiochemistry

vii. Supplementary information and/or comments on doctoral studies and pedagogical activities

Based on the agreements with the Comenius University and Slovak Technical University our employees are involved in teaching activities such as lecture courses, seminars and laboratory courses, as well as supervising the diploma theses of students who carry out their experimental work at our Institute. These activities are very important for the Institute in the recruitment of PhD students from the rather limited pool of motivated graduates from Slovak universities.

PhD education has been one of the priorities of our institute during the evaluation period. In this regard there are particularly important projects supported by several educational projects supported by grants of the European Social Fund "Biomembranes: cross-sectional educational programme for graduate students and young scientists in life sciences" (13120200072, JPD NUTS II - Bratislava Aim 3, 2006-2008, coordinated by Dr. Hapala); "Current trends in physiological and behavioural research – higher effectiveness of doctoral studies by widening the practical skills" JPD 3 2005/NP1-032, Prof. RNDr. Michal Zeman, DrSc., 2006 – 2008. Increasing the level and efficiency of the PhD studies

in the field of membrane research at participating institutions was also one of important aims of the Research and Education Centre of Excellence project “*Biomembranes: Membrane structure and dynamics in relation to cell functions*” VVCE-0064-07, 2008-2011, that has been focused in this respect on direct financial support of PhD students and young researchers, support of their active participation on domestic and international conferences, organisation of specialized lecture and laboratory courses, and exchange programs of PhD students between the partner laboratories.

During the evaluation period, two minisymposia “Ivanka days of young biologists” have been organised (in 2008 and 2010). This competition gives PhD students the possibility to present their results in 3 areas (Biochemistry and molecular biology; Cell biology and microbiology; Physiology and general biology. More information about the minisymposia can be found on <http://www.ubgz.sav.sk/ivanskedni>

6. Applied research

(Applications of results)

- i. List of the most important results of applied research projects**

- ii. List of the most important studies commissioned for the decision-making authorities, the government and NGOs, international and foreign organisations**

- iii. List of licences sold abroad, incl. Revenues**

- iv. List of licences sold in Slovakia, incl. Revenues**

v. List of contracts with industrial partners, incl. revenues⁴

Monoclonal antibodies against human antigens are widely used for scientific and diagnostic purposes. Most of these mAbs are commercially available. However, mAbs specific for antigens of domestic animals are much less common and only a small portion (about 7%) of human mAbs are cross-reactive and could be used for testing in domestic animals. The mAbs produced in our Institute enlarge the palette of monoclonal antibodies for detection of the cell surface antigens of cattle. Some of the mAbs could be used for immunodiagnostic purposes as IVA 281 suitable for measuring the immunoglobulin concentration or/and for the study of cattle immune system. mAbs with potential commercial value that were produced in our institute were distributed by the company EXBIO Praha, Czech Republic. As a part of the agreement, the mAbs IVA50 (CD9), IVA 35 (CD18), IVA 30 (CD41/61), IVA 103 (CD45R), IVA 94 (CD62 L), IVA 285 (Ig light chain) are offered in the product catalogue of EXBIO Praha www.exbio.cz (veterinary reagents).

vi. List of research projects with industrial partners, incl. revenues³

[1]

vii. Supplementary information and/or comments on applied activities

| | 2007 | 2008 | 2009 | 2010 | 2011 | total |
|---|------|------|------|------|------|-------|
| studies for the decision sphere, government and NGOs, international and foreign organisations | | | | | | 0 |

7. Popularisation of Science (outreach activities)

i. List of the most important popularisation activities

[1] Rats and quails from Slovakia flew to space. Newspaper article in the daily PRAVDA (3.11.2007)

³ If not included in documentation of projects in chapter 4 (Projects structure, research grants and other funding resources).

- [2] Greksák M.: Science is a continuous finding of truth. Newspaper article in the DIMENZIE, Central European independent monthly magazine about people, society and the world 8/1, 2008
- [3] Niederová Ľ.: Young scientists. Radio-broadcast Regina, Košice (12.6.2008)
- [4] Niederová Ľ.: About language genesis. The differences between human and animal speech, when was the language created, what is common for human and bird brain. Radio-broadcast Slovenský rozhlas (29.7.2008)
- [5] Niederová Ľ.: Discussion themed "The birds also can learn" Radio-broadcast Lumen (12.6.2008)
- [6] Niederová Ľ.: Interview for the article: "They joined scientists and artists" Košický Korzár (12.6.2008)
- [7] Niederová Ľ.: Interview for the article: The citizens of Košice have not disappeared. Oceľ východu (2.7.2008)
- [8] Niederová Ľ.: Birds and human speech discussion in the programme "Night pyramid". Radio-broadcast Slovenský rozhlas (31.7. 2008)
- [9] Zeman M.: The light is the human body's conductor. Newspaper article in the daily PRAVDA (8.7.2008)
- [10] Košťál Ľ.: Scientists to children - children to scientists. TV - shot within the European Science Week (TV channel JOJ, The first news 30.11.2008)
- [11] Antalíková J., Niederová Ľ.: Exposition "Eurobiotech" 2008 Krakow
- [12] Exposition of Centers of excellence in research and development, Incheba Expo, Bratislava (5.11. 2009)
- [13] Šmigáň P.: Summary and results of APVV project 'Membrane-associated processes in the physiology and pathophysiology of farm animals and their symbiotic microorganisms' Publication: The achievements of science and technique supported by Slovak Research and Development Agency.
- [14] Hapala I.: Biological membranes: the edge and prerequisite of life. Special supplement of journal Quark 9, 2010 supported by Slovak Research and Development Agency.
- [15] Košťál Ľ., Niederová Ľ.: Dopamine and pleasure. Special supplement of journal Quark 9, 2010 supported by Slovak Research and Development Agency.
- [16] Šmigáň, P.: The prehistoric membranes. Special supplement of journal Quark 9, 2010 supported by Slovak Research and Development Agency.
- [17] Košťál Ľ.: The animal in us. Debate in the programme "Night pyramid" Radio-broadcast Rádio Slovensko, 2010

- [18] Košťál Ľ., Bilčík B., Niederová Ľ., Bosíková E., Píchová K.: “Avian brain and learning - from singing to neurotransmitters.” TV programme: Spectrum of Science, (TV channel STV2 , 2011)
- [19] Collaboration with the Elementary School, Ivanka pri Dunaji “Scientists to Children – Children to Scientists” (excursions to Institute laboratories, performing simple experiments, competition of graphic works “Science by children’s eyes” – each year during the European Science Week)

ii. Summary of outreach activities

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iii. Supplementary information and/or comments on popularisation activities

We consider popularization activities to be an indispensable part of scientific work. Our commitment to serve the general public and especially the young generation is reflected in numerous popularization activities from appearances in telecommunication media, through newspaper articles and popularization papers to the presentations at expositions (e.g. the highly visited display on the Exposition of Centers of Excellence in Research and Development, Incheba Expo, Bratislava in November 2009) . The highlight of every year’s popularization activity is the “Science week” during which we traditionally host children from the local Elementary school and students from the Evangelical lyceum in Bratislava. They get the possibility to experience the excitement of scientific work through numerous hands-on activities and popularization lectures prepared specially for them. In return children from the elementary school present us every year with paintings and drawings illustrating their reflection of scientific work.

Of the special importance for making our work visible to general public is the publication of the special supplement to the popular science magazine Quark in September 2010, where together with our partners from the Research and Education Centre of Excellence project Biomembranes (VVCE-0064-07) we have published eight popular essays three of which were authored by researchers from our Institute. Because of special position of television among the other media, we were also very glad that with the support of the Presidium of the SASci we could present the work of the Laboratory of Neurobiology and Physiology of Behaviour in a popular science series Spectrum of Science on the 2nd channel of the Slovak Television in May 2011 in a cca 30 min part entitled ‘Avian brain and learning - from singing to neurotransmitters’.

iv. Status and development of research infrastructure incl. experimental, computing and technical base (description of the present infrastructure, premises, and material and technical resources. Infrastructure, instrumentation and major technical equipment necessary for the achievement of the objectives specified in the research Concept)

To perform high quality experimental research, modern sophisticated instruments are essential. Thanks to the funding through the combination of resources, State research programs (APVV), Institutional funds, EU framework programs, European Structural Funds, and International collaborative grants scientific infrastructure of the Institute improved considerably over the assessment period. The situation is far from ideal but the current status of Institute's research infrastructure combined with the instruments available to us at the collaborating institutions of SAS and universities in Bratislava enable us to perform research at the internationally competitive level. The modernization of the Institute's research infrastructure has concentrated into three major areas:

1. *Development of research infrastructure to study the interactions between molecules and surfaces:* a state-of-the-art joint laboratory between our Institute and the Department of Nuclear Physics and Biophysics, Comenius University to study interactions between surfaces and biologically important molecules is being built. The major instruments currently available are Atomic force microscope (Agilent) – obtained by the Department of Nuclear Physics and Biophysics and Research quartz crystal monitor - obtained by our Institute through MNT.ERA.NET project „Ultra-sensitive, stable and easy to use AFM biosensor tips“. These instruments enable to measure motional resistance and changes of frequency on physico-chemical interface (RQCM) and to measure topology of surfaces as well as the forces between individual molecules and surfaces (AFM). For the current year our Institute plans to buy AUTOLAB – potentiostat / galvanostat for the analysis of electrochemical properties of the substrates.

2. *Development of the instrumental base for membrane research:* the Agilent HPLC apparatus equipped with diode array detector and ESA CoronaCAD detector was purchased during the previous assessment period thanks to the joined support from the Presidium of SAS and the project BITCET. During the current assessment period the HPLC instrumentation was completed purchasing HPLC fraction collector (using funds from the EU Structural Funds Project TRANSMED) and Agilent Evaporative Light Scattering Detector (TRANSMED 2). Analytical instrumentation for membrane research was further improved by purchase of semi-automatic system for Thin Layer Chromatography consisting of CAMAG sample applicator Linomat 5 and a TLC scanner for densitometric evaluation of TLC chromatograms (TRANSMED). Completion of this

instrumentation base by GC-MS and LC-MS in the coming years would extend our experimental possibilities to the area of lipidomics. Recently purchased Ultracentrifuge Beckman Optima XP (TRANSMED 2) and 2D-electrophoretic apparatus Multiphor II allows us to carry out the whole range of separation and analytical methods used in membrane research. During the assessment period we have also purchased a new CO₂ incubator BINDER C150 and container for liquid nitrogen ARPEGE 100, the equipment necessary for production and cryopreservation of hybridoma and for gamete membrane research in “*in vitro*” fertilization experiments. Planned purchase of microscope Motic SMZ-168 will further improve our infrastructure to perform IVF experiments.

3. *Infrastructure for neurobiological and behavioural research.* We made major reconstruction of our animal facility to comply with the new EU requirements. Enriched cages for laying hens, cages and deep litter system for Japanese quail and aviary and cages for zebra finch are now part of our accredited animal facility. Additionally, we built bird song recording studio, with 20 soundproof boxes, each able to accommodate 1-2 zebra finches and equipped with air supply, light, IP camera (D-Link, Taiwan) and highly sensitive microphone (Shure, USA). During the assessed period we obtained small animal anesthesia equipment - Matrix VIP 3000 Isoflurane Vaporizer (Midmark, USA) with Oxygen Concentrator OXYMAT 3 (Weinmann, Germany). This, together with already possessed stereotaxic apparatus Kopf 900 (David Kopf Instruments, USA) allows us to do specific brain surgery procedures for experiments on our avian models. With the help of newly obtained automated microprocessor controlled microinjection pipette Nanoject II (Drummond Scientific, USA; used to inject small volumes (nanoliters) of neurotoxins into zebra finch brain) lesions are produced and then studied with fluorescent microscope Leica DM5500 B and digital camera Leica DFC340 FX (Leica, Germany) purchased with support from the FIRCA project. We have upgraded our implantable radiotelemetry system (DSI, USA) which now allows us continuous recording of physiological variables such as blood pressure, body temperature, heart rate and ECG/EEG in up to 8 animals. In the future we would like to obtain software upgrade to synchronize videorecording of behavior with recording of physiological variables. We have build ‘in house’ operant conditioning chambers for testing the cognitive abilities in birds, using up to date touchscreen monitors technology (ELO 1529 L, Elo Systems, USA) and the Biopsychology Toolbox, an open source Matlab toolbox for the control of behavioral experiments.

4. *Computer infrastructure:* Distant location of our Institute from the main campus of SAS created a number of serious problems in connectivity to the computing centre of SAS in Bratislava. Majority of these problems were resolved during the last assessment period. We completely rebuilt our internal computer network infrastructure, which was rather outdated and problematic. Local area network based on coaxial cabling with ring topology

and the speed of 10 Mbs (10BASE2) was replaced with structured cabling and speed of 100 Mbit/s and 1 Gbit/s, respectively. The slow and unreliable radio connection to the computing centre of SAS in Bratislava was recently changed to metallic/optic connection through the local provider in Ivanka pri Dunaji with guaranteed download/upload speed of 6 Mbit/s. In the future we would like to implement automatic backup system and enhance data storage capacity.

v. Describe how the results and suggestions of the previous assessment were taken into account

Previous assessment report contained three main recommendations:

1. To increase activity in getting the EU projects

We have increased our activity in applying for the EU projects. In the period 2007-2011, three laboratories participated in 5 applications to EU project programmes:

- Laboratory of Membrane Biogenesis was a member in the consortium of 10 laboratories from 7 European countries submitting the proposal entitled „Collaboration on lipid-modifying and –activating enzymes for industrial application (acronym: CLIMAX)“ (call ID „FP7-KBBE-2007-1 project proposal No 212427). Proposal received favourable evaluation and ranking, due to budgetary limits it did not pass the final stage to the process of grant negotiations.
- In 2008, the same laboratory participated in the project proposal applied in European Science Foundation programme EUROCORES: Membrane Architecture and Dynamics (EuroMEMBRANE). Proposal entitled “The lipid requirements of mitochondrial dynamics (acronym LIMIT)“ (ID 08-EuroMEMBRANE-OP-013) included 5 partners from 5 countries; it was also rejected
- The useful exercise was the experience of workers from the Laboratory of behavioural physiology and neurobiology with coordinating consortium of 17 countries (based on the World Poultry Science Working Group 9 – Poultry Welfare and Management) preparing the COST proposal ‘Poultry Welfare – Bridging the Gap Between Basic and Applied Research’ (oc-2008-1-2170). Although in the very last stage this proposal did not pass through the review process, we (Laboratory of Neurobiology Physiology of Behaviour) gained a lot of experience.

Two proposals with participation of our Institute to FP7 programmes were successful:

- Laboratory of biosensors succeeded in 2009 to join the ERA-Net consortium in the project “Ultra-sensitive, stable and easy to use AFM bio sensor tips (IntelliTip)” (MNT-ERA.Net II ID 431). The project oriented at the use of atomic

force microscopy in the construction of DNA aptamer-based biosensors includes 5 partners (1 from Austria, 2 from Finland and 2 from Slovakia) and our worker Ing. Maja Šnejdárková is the coordinator of the Slovak part of the project.

- o Laboratory of behavioural physiology and neurobiology succeeded as a member of the consortium of 14 partners from 13 countries with the FP7 coordination and support action Animal Welfare Research in an Enlarged Europe (AWARE) FP7-KBBE-2010-265686. Our institution has a significant role in the AWARE activity (WP leader) and the contacts with leaders of the farm animal welfare science in the European research area – partners in the consortium, seems to be promise of further FP projects in the next period. One of the aims of this project is to increase the participation of the new and candidate countries of the EU on the EU funded animal welfare research.

2. To finish the process of the relocation of the institute into the new premises in the shortest possible time

The management of the institute and the whole staff devoted a lot of effort to the project of relocation of the institute premises. With the approval of the Presidium of the Slovak Academy of Sciences we have obtained the building ground (state property administered by the Institute) in the Slovak Academy of Sciences campus in Bratislava Patronka. We have prepared a tender for the architectural design and construction project of the new Institute building and in 2010 after finishing the project preparation we have got the Building Permission from the Building Department of the local authority (Bratislava Karlova Ves district). Due to various objective reasons related mainly to the general financial crisis and conditions for the application to European structural funds (e.g. Bratislava region was excluded from the possibility to apply for the construction of new buildings) we nevertheless, were not able to raise sufficient funding to proceed with the building process.

In the meantime the situation has changed. Presidium changed its priorities and decided in a response to the recent Structural Funds call for the research parks and scientific centres to build the Biomedical park in the Patronka campus of SASci. Based on the affirmation of the Vice-president of the SASci for the II Section, in case of the success of this application within this process will Presidium also solve our urgent need of relocation.

3. To maintain the trend of increasing the quantity and quality of the publications and to decrease the differences between the working groups

We have continued in increasing the quantity and quality of the publications (see Supplementary information and/or comments on the scientific output and Supplementary information and/or comments on responses to the scientific output).

As a response to the appeal to decrease the differences between the working groups the Institute management in coordination with the scientific board decided to change the organizational structure. These changes were conditioned also by retirement of several scientific workers during the assessment period and included the abolishment of the Department of Gravitational Physiology and the fusion of its one working group oriented at space physiology with the Department of Physiology and Ethology and the other working group studying biosensors with the Department of Membrane Biochemistry.

Another tool to decrease the differences between the individuals and teams is the continuous effort of the management to motivate the researchers for high quality research based on annual evaluation of scientific workers and adjustment of the moveable part of the salary according to the ranking in tis evaluation. However, this tool is limited by continuous restrictions in the Institute's budget severely affecting the total sum available for this purpose.

vi. Supplementary information and/or comments on management, research infrastructure, and trends in personnel development

The period 2007-2011 has been characterized by extensive changes in the general organization of the Institute. These changes were realized with the aim to improve the cooperation between laboratories in related research areas and were stimulated by the preparation of the building project for the new building at SASci campus. Due to changes in our plans for the relocation (as mentioned in the previous section III.8.v.) and due to urgent need to reduce the maintenance and operation costs in the current premises in Ivanka we decided to realize these changes in the shortest time possible. In 2008 we reduced the number of departments from 4 to 3: Department of Membrane Biochemistry with 3 laboratories (Biosensors, Membrane Biogenesis and Bioenergetics of Archaea), Department of Physiology and Ethology with 2 laboratories (Gravitational Physiology and Neurobiology and Physiology of Behaviour). The Department of Immunogenetics remained as the only one unaffected. This re-organization of the Institute has not been the final change in the assessment period. From January 1, 2013 we had to cancel the activities/existence of the Laboratory of Bioenergetics of Archaeae. Although this laboratory was historically one of the most successful research groups in our Institute and its research was unique both nationally and internationally, personal changes during the assessed period (2 senior scientists retired; 3 young scientists with PhD. degree left our Institute - 1 for position in private company, 1 at US university, 1 at domestic university; 1 young scientist with PhD. degree is on maternal leave) pressed us to make this uneasy decision.

Retirement of several senior scientists resulted also in extensive changes in the institute management. New appointments have been realized in the assessment period 2007-2011 in positions of Scientific Secretary, Chair of the Scientific Board, and two department heads (Dept. of Membrane Biochemistry, Dept. of Physiology and Ethology). "Fresh and younger blood" in these positions will surely bring new stimuli in our work and improvement in our results in the next years.

The changes in Institute's research infrastructure have been treated in detail in section III.8.iv. Status and development of research infrastructure. A significant improvement in the scientific equipment could not be complemented by corresponding changes in the standards of our premises. Severe budgetary restrictions especially in the capital investments prohibited any major improvements and repairs of buildings during the assessed period. The only exception has been the rebuilding of animal facilities that was essential for direct continuation of research activities and was realized to a great extent by activity of our own employees. Although some extensive rebuilding would be in some sense counterproductive with respect to our efforts to re-locate the Institute to the SASci campus in Bratislava, we perceive this situation as getting unbearable.

Period 2007-2011 was characterized by extensive changes in the personal development. A very positive trend with respect to the future of the Institute is the reduction of average age of the research staff with university degree from 48 in 2007 to 45 in 2010/2011. However, this was accompanied by a negative reduction by 20% in FTE of research staff (reflecting the real number of staff working in the Institute). This reduction has been caused by retirement of 5 researchers and termination of employment of 4 young but experienced researchers with PhD. degree for better paid positions. Our attempt to substitute these losses mostly by fresh PhD. graduates is complicated by a real "baby boom" at our Institute. 8 newly appointed female scientists have become pregnant during the assessment period and are currently on maternal leave. These turbulent changes in the research personnel have surely affected Institute's scientific productivity. Only the increased effort of the remaining research staff made possible continuous improvement in both quantitative and qualitative parameters of the major outcomes of our research in the assessment period 2007/2011 (see section III.1.x. Supplementary information on the scientific output).

Other information relevant to the assessment