

Questionnaire

Summary of the main activities of a research institute of the Slovak Academy of Sciences

Period: January 1, 2012 – December 31, 2015

1. Basic information on the Institute:

1.1. Legal name and address

Institute of Chemistry of the Slovak Academy of Sciences

1.2. URL of the Institute web site

<http://www.chem.sk>

1.3. Executive body of the Institute and its composition

Directoriat	Name	Age	Years in the position
Director	Ing. Miroslav KOŇŠ, DrSc.	63	2011–
Deputy director	RNDr. Ján GAJDOŠ, PhD.	62	2011–
Scientific secretary	RNDr. Desana LIŠKOVÁ, PhD.	62	2009–

1.4. Head of the Scientific Board

Ing. Ján TKÁČ, DrSc. 2010–

1.5. Basic information on the research personnel

1.5.1. Number of employees with university degrees (PhD students included) engaged in research projects, their full time equivalent work capacity (FTE) in 2012, 2013, 2014, 2015, and average number of employees in the assessment period

	2012		2013		2014		2015		total		
	number	FTE	number	FTE	number	FTE	number	FTE	number	averaged number per year	averaged FTE
Number of employees with university degrees	91.0	67.870	90.0	71.330	95.0	73.730	104.0	79.520	380.0	95.0	73.113
Number of PhD students	25.0	20.667	27.0	18.667	23.0	17.000	25.0	18.333	100.0	25.0	18.667
Total number	116.0	88.537	117.0	89.997	118.0	90.730	129.0	97.853	480.0	120.0	91.779

1.5.2. Institute units/departments and their FTE employees with university degrees engaged in research and development

Research staff	2012		2013		2014		2015		average	
	No.	FTE	No.	FTE	No.	FTE	No.	FTE	No.	FTE
Institute in whole	82.0	67.870	81.0	71.330	87.0	73.730	96.0	79.520	86.5	73.113
Enzymology of Saccharides	6.0	3.050	6.0	4.050	7.0	4.370	8.0	4.353	6.8	3.956
Glycobiology	10.0	5.740	10.0	7.550	12.0	7.882	12.0	8.967	11.0	7.535
Glycobiotechnology	18.0	11.186	19.0	13.546	19.0	12.883	24.0	18.013	20.0	13.907
Glycochemistry	13.0	11.117	12.0	10.305	14.0	10.560	15.0	10.823	13.5	10.701
Glycomaterials	5.0	4.050	5.0	4.050	5.0	4.050	5.0	3.800	5.0	3.988
Immunochemistry of Glycoconjugates	9.0	7.000	9.0	7.233	9.0	7.730	10.0	7.675	9.3	7.410
Structure and Function of Saccharides	11.0	6.050	10.0	6.696	10.0	6.284	9.0	6.600	10.0	6.408
Culture Collection of Yeasts	3.0	2.583	3.0	2.333	3.0	3.000	4.0	2.916	3.3	2.708
Analytical Department	6.0	6.000	6.0	6.000	7.0	6.333	7.0	7.000	6.5	6.333
Production Department	1.0	1.000	1.0	1.000	1.0	1.000	1.0	1.000	1.0	1.000

Note: The data for average FTE in the line "Institute in whole" in this Table 1.5.2 are transferred from Table 1.5.1. where "total" data for whole Institute are presented. But in terms of the title of Table 1.5.2., the average No. and FTE data only for employees with university degrees **engaged in research and development** (not total data) should be presented. Therefore, the true values of FTE for individual years and the average No. and FTE should be as follows:

Research staff	2012		2013		2014		2015		average	
	No.	FTE	No.	FTE	No.	FTE	No.	FTE	No.	FTE
Institute in whole	82.0	57.776	81.0	62.763	87.0	64.092	96.0	71.147	81.3	63.945

1.6. Basic information on the funding of the Institute Institutional salary budget and others salary budget

Salary budget	2012	2013	2014	2015	average
Institutional Salary budget [thousands of EUR]	1,139.837	1,147.892	1,153.634	1,182.260	1155.906
Other Salary budget [thousands of EUR]	65.595	152.548	243.476	240.376	175.499

1.7. Mission Statement of the Institute as presented in the Foundation Charter

a) The Institute of Chemistry of the Slovak Academy of Sciences is aimed at the scientific and research activities in the field of chemistry and biochemistry of saccharides with emphasis on following directions:

- synthesis, biosynthesis, structure, function, and transformation of biologically important mono- and oligosaccharides and their derivatives;
- structure and functional properties of polysaccharides, glycoproteins and their conjugates with other polymers;

- structure, function, and mechanism of action of glycanases;
 - development of physicochemical methods for structural analysis of carbohydrates;
 - gene engineering of nutritional and biologically active proteins;
 - environmental and industrial biotechnology, biotechnological potential of microorganisms, nanotechnology;
 - ecology, physiology, taxonomy, and phylogenesis of yeasts and yeasts-like microorganisms;
- b) The Institute contributes to development of new technologies for isolation of natural compounds and preparation of new materials based on saccharides and their derivatives for commercial purposes.
- c) The Institute realises its own production of rare saccharides for commercial purposes. In this respect, the Institute provides facilities for a large-scale isolation of natural compounds and synthesis of saccharides, cooperations, know-how, licences, and consulting and expert's services. For popularisation of its outputs, the Institute takes part in specialised exhibitions and trades.
- d) The Institute closely cooperates with many research establishments and universities abroad and within the country, mainly in the framework of common research grant projects and agreements.
- e) The Institute provides publication of research results through scientific periodicals, lectures, and patents. The main editing activity of the Institute is the publishing of Chemical Papers, the only Slovak chemistry journal printed in English, published and distributed by De Gruyter (2015–2016) (during 2006–2014 it was co-published by Versita and Springer-Verlag and distributed by Springer-Verlag; since 2017 it will be published and distributed by Springer).
- f) The Institute regularly organises international scientific conferences/symposia (Bratislava Symposium on Saccharides, Annual Conference on Yeasts).
- g) The Institute houses the Culture Collection of Yeasts, the largest yeast collection in Central Europe, registered as a member of ECCO and WFCC.
- h) The Institute is a training base for education of experts and scientific workers in research fields: organic chemistry, biochemistry, microbiology, physical chemistry, macromolecular chemistry, biotechnology, and plant biology. In these fields, doctoral and postdoctoral studies, including also foreign students, respectively, are organised. The Institute provides also participation on pedagogic process at universities.

In addition to above mentioned scientific directions, current research activities are also focused on following specialised area:

- structure, function and catalytic properties of glycoside hydrolases, carbohydrate esterases, glycosyltransferases and transglycosylases;
- biochips and biosensors for determination of activity of carbohydrate-active enzymes and for determination of structure of saccharides;
- environmental and industrial glyco-biotechnology; biotechnological potential of selected microorganisms and plants, biofuel cells and nanotechnology.

1.8. Summary of R&D activity pursued by the Institute during the assessment period in both national and international contexts

The R&D activities are mainly pursued by eight scientific Departments constituting the Centre for Glycomics and partially by the Analytical Department and Production Department supplying mainly services.

Department of Enzymology of Carbohydrates

One group of this Department studied enzymatic synthesis of sialo-oligosaccharides, and the other group studied xylanolytic enzymes responsible for degradation of xylan polysaccharides.

Sialo-oligosaccharides are well known for their crucial roles in many physiological and pathological processes. Improvement in the efficacy of protein drugs, an increase in the anti-

inflammatory activity of intravenous immunoglobulin, preparation of infant milk and the diagnosis of diseases are examples of why there is a need for efficient in vitro sialylation. The α 2,3-sialyltransferase from bacteria *Bibersteinia trehalosi* (BtST1) was characterised. It is homologous to sialyltransferases belonging to GT80 family. This enzyme was effective in sialo-oligosaccharide production by systems biocatalysis (artificial metabolic pathway for in vitro synthesis).

Two additional xylanases of *Trichoderma reesei*, XYN IV and XYN VI, the best known and the most efficient producer of (hemi)cellulolytic enzymes were characterised. Although both enzymes belong to GH30 family, they differ significantly in catalytic properties. Xylanolytic esterases were also studied. Positional specificity of acetylxylan esterases from different carbohydrates esterase families was clarified and was found to be complementary to that of CE16 exodeacetylases, thus demonstrating the importance of both classes of xylan deacetylases for a complete deacetylation of hardwood xylan generated in non-alkaline bioraffinery procedures. Moreover, our recent reports suggest that CE16 enzymes are divergent and at least some of them exhibit both exo- and endo-deacetylase activity towards xylan. Another type of hemicellulolytic carbohydrate esterases, glucuronoyl esterase, was shown to be active on polymeric xylan, indicating their participation in breakdown of covalent cross-linkages between hemicellulose and lignin in plant cell walls. This research has significantly contributed to the current knowledge on the industrially important xylanolytic enzymes.

Department of Glycobiology

High resolution tools were applied for study of glycoconjugate structural changes in the case of congenital disorders of glycosylation (CDG) and some glycosomal storage disorders (GSD). In the CDG patient, an abnormal glycosylation was observed at the whole serum glycoproteins as well as glycoproteins of selected human blood biomarkers. Structural analysis led to the selection of number of potential deficient enzymes encoded by glyco-genes, including enzyme donor substrate transporter. For monitoring of Pompe disease especially, in enzyme replacement therapy the MS- and NMR-techniques were applied in determination of clinically relevant glyco-biomarkers. O-Glycosylation profile was underlined on the patients suffering from various glycogenosis and hyperlipidemias what resulted in discovery of the new glyco-biomarker in glycogen degradation.

Methods for activity assay of yeast cell wall transglycosylases were developed and used for characterisation of expressed Phr (pathogenic yeast *Candida albicans*) and Crh enzymes (*Saccharomyces cerevisiae*). Two high-throughput methods for testing of inhibitors of these enzymes were developed. The complete primary structure of unspecific xyloglucan endotransglycosylase from dicotyledonous plant was determined.

The antimicrobial effect of two fatty acids, 10-HDA and sebacic acid, occurring in honeybee royal jelly were investigated against several collection strains and field isolates of *Paenibacillus* larvae bacterial pathogen causing serious honeybee brood disease, American foulbrood (AFB). The variation in sensitivity of the strains and isolates against the acids was revealed. Expression of defensin1 and glucose oxidase in bees of different ages was analysed by developed real-time PCR method.

Department of Glycobiotechnology

Plant biotechnology group developed a new method for preparation of cuttings from thin roots for fluorescence microscopy, which was applied to study the influence of cadmium on the growth/development (Cd distribution; structural changes in root apex and xylem elements; suberin lamellae development; cadmium phytoextraction efficiency) of various plants. Galactoglucomannan oligosaccharides from plant cell walls exhibited the effect against abiotic environmental stress with reduced negative effect of Cd on various physiological functions of plants.

Encapsulation group developed an original immobilisation technique to improve the efficiency of viable microbial cells as biocatalysts for enantioselective production of drug precursors and natural flavours. Several new methods (including CLSM, ESEM) for testing of immobilised *E. coli* overexpressing Baeyer–Villiger monooxygenases have been developed in

cooperation with domestic and foreign partners. Novel biosensors were developed for monitoring of biotechnological processes leading to products interesting for pharmaceutical and cosmetics industries.

Bionanotechnology/glycomics group focused on preparation of biochips and biosensors with the aid of nanotechnology with various transducing platforms modified with proteins, antibodies, lectins and glycans. Both approaches were employed for glycoprofiling of various types of samples including whole cells, lysates, isolated glycoproteins and carbohydrates isolated from patient sera or tissues having various types of cancer and other serious civilisation diseases in order to improve early and prognostic diagnosis and monitoring of targeted therapy.

Department of Glycochemistry

Research activities were mainly devoted to the development of novel synthetic methods of glycomimetics as well as to the studies of the relationship between their chemical structure and biological activity, especially towards enzymes processing sugars and glycoconjugates. Series of mannosyl triazoles, glycosides, thioglycosides, sulfoxides and sulfones were prepared and structurally characterised. Some of them were also evaluated for their antibacterial activity, cytotoxicity, or immunostimulatory activity. The synthetic strategies for transition state analogue inhibitors of glycosyltransferases were extensively studied. The first strategy is based on the psicofuranose and tagatofuranose scaffolds, the other one on quarternisation of glycosylated five-membered ring iminoalditols. The synthetic potential of enzymes was also pursued, and several such methodologies were elaborated for synthesis of sugar glycosides and esters. Valuable results were obtained for the donor specificity and regioselectivity studies in the lipolase mediated acylations and in assays of caffeoyl esterases, as well.

Department of Glycomaterials

Research interests included expansion of knowledge in the field of isolation and structural analysis of neutral and acidic polysaccharides from agro-industrial and forest wastes (bran, chaff, oil-pumpkin fruit, industrial grass, sawdust, etc.) and from the leaves of the invasive plants (*Fallopia sachalinensis*, *Impatiens parviflora* DC.). Due to their biodegradability, biocompatibility and non-toxicity, plant polysaccharides have wide application in various industrial branches. Particular attention was concentrated on the development of new strategies for extraction of polysaccharides more rapidly by ultrasonic and microwave techniques. Response surface methods (RSM) were used to maximise yields. Phenolics-rich xylans, pectic polysaccharides and xyloglucans exhibited antioxidant, immunostimulatory and antitussive activity and some showed activities higher than the positive control. The studies have demonstrated that the molecular structure significantly influence the biological activity of polysaccharides.

From selected medicinal plants, which are used in traditional medicine (*Swertia chirata*, *Lythrum salicaria*, *Solidago canadensis*, *Fragaria vesca*, *Salvia officinalis*, *Fagus sylvatica*, *Arnica montana*, *Echinaceae purpurea*) and from algae (*Rhodella grisea* and *Capsosiphon fulvescens*), polysaccharide–protein or polysaccharide–protein–phenolic conjugates were isolated and their pharmaco-dynamic profiles have been studied using the animal test system. Screening directed to the identification of potential biological effects of glycoconjugates revealed a wide range of their biological effects. The most active glycoconjugate isolated from *Echinacea* flowers showed significant bronchodilatory, antitussive and anti-inflammatory effects. The glycoconjugate demonstrated potency to suppress both airway hyperreactivity and airway inflammation and its pharmacological effect was similar to that of synthetic drugs commonly used in a clinical practice. Preliminary studies provided a scientific basis for the application of *Echinacea* conjugate in herbal medicine for the treatment of allergic airways disorders.

Cinnamoyl and feruloyl derivatives were prepared as models of polysaccharide–phenolic complexes. Esters of the commercial (KMC, HEC) and non-commercial (xylans) polysaccharides were prepared by efficient and mild esterification methods of the biopolymer with cinnamic or ferulic acid via *in situ* activation of the carboxylic groups as well as by conventional esterification method with chloride. The effect of the functional groups on the antioxidant activity and thermal/thermo-oxidative stability of the derivatives was evaluated.

Native polysaccharides and derivatives with biological and associative effects are suitable as additives in healthy food products, in pharmaceutical and cosmetic industries or can be used as thickeners, carries of active substances, etc.

Department of Immunochemistry of Glycoconjugates

Since 2000, the research has been focused on immunochemistry of carbohydrates as dominant surface antigens of yeasts and bacteria. Special chemistry of semisynthetic glycoconjugate preparation based on natural microbial isolates/glycocalix was started. New methods for modification of polysaccharide antigens, the methods of their linking to protein carriers, as well as newly prepared linkers were developed. The glycoconjugates based on surface carbohydrates of *Candida* sp., and *Vibrio cholerae* O1, O135 and O139 were also prepared and characterised.

Series of model semisynthetic α - and α/β -oligomannoside conjugates based on *Candida* mannan side chain structures were prepared and studied in cooperation with foreign partner.

Antisera showing elevated levels of specific class IgM, IgG, and IgA antibodies upon immunisation of the experimental animals with our glycoconjugates were obtained. The raise of IgG antibody levels with all mentioned glycoconjugates considerably surpassed the effect of immunisation with whole cell microbes. Binding affinities of anti-mannan IgGs induced by conjugates were evaluated by inhibition ELISA using manno oligomers isolated from *C. dubliniensis* mannan as inhibitors. Th1 domination, which is important for vaccination, was verified by subclass IgG and cytokines analysis. Immunological tests were extended to cytometrical studies of cell-mediated immune responses. Active immunisation increased CD25 subpopulation of B-lymphocytes and induced increase of CD4/CD8 ratio at T-lymphocytes. Acceleration of phagocytic capacity and respiratory burst of neutrophils was recorded too.

The results obtained show high efficiency of combination of purposely aimed syntheses, exact chemical and physico-chemical analyses of glycoconjugates and final monitoring of immune response. Effective immunomodulating properties of conjugate pointed out and encourage further studies, namely immune memory activation and development.

A new approach to obtain broadly cross-reactive antisera against important yeast pathogens by intensive hyperimmunisation with polysaccharide-protein conjugates was discovered. This can be effectively applied in microbial biotechnology.

Mannan from *Candida albicans*, dextran from *Leuconostoc* spp. and their carboxymethyl (CM)-derivatives were tested on antioxidant and thrombolytic activities. The results confirmed that modification/substitution of the structure brings different biophysical properties, namely carboxymethylation of mannan and dextran shows benefits which can contribute to pharmacology and health. New alkylether derivatives of hyaluronan as polysaccharides with wide biomedical applications were also prepared, characterised and studied.

Department of Structure and Function of Saccharides

Research activities were aimed at structural analysis of saccharides, analysis of NMR parametres, molecular modelling of sugar-processing enzymes, mechanisms of actions of glycosyltransferases and glycoside hydrolases. Solution structures of glycosaminoglycans (heparin oligosaccharides), derivatives of monosaccharides (rhamnosides, lyxosides, xylosides) as well as polysaccharides such as xylans, chitosans, pectins and polysaccharides originated from the agricultural waste were analysed by NMR. In addition, the effort was also made to development of diagnoses of inherited metabolic errors of metabolism based on the NMR analysis of human body fluids (urine, blood plasma and blood serum) collected from children patients. Methodologically, all these biologically active saccharides have been studied by high-resolution NMR spectroscopy and theoretical methods, including DFT, QM/MM and molecular dynamics methods. Quantum-chemical methods also showed that contributions to the Fermi terms to isotropic coupling constants can originate also from neighbouring monosaccharide units and that the magnitudes of paramagnetic and diamagnetic terms can significantly contribute to overall spin-spin coupling constants.

Synthetic procedures including methods that utilise catalytic effects of molybdate ions for preparations of biologically active carbohydrate derivatives and new natural non-ionic

surfactants were also studied. The newly-prepared polysaccharide composites have shown better thermal and mechanical properties than those based on cellulose and could be used as packing materials.

Changes in protein glycosylation are early indicators of cellular changes in many diseases, and aberrant glycosylation has been linked with various severe diseases as cancer, inflammation, and neurodegenerative diseases including Alzheimer's disease. Therefore, glycosyltransferases are validated targets for therapeutic intervention. Consequently, the development of potent and specific inhibitors for glycosyltransferases has attracted increasing interest. The understanding of the mechanisms utilised by these enzymes and determination of the transition state structure are, therefore, of great concern. In this respect, the catalytic mechanism of several glycosyltransferases using various the state-of-the-art hybrid QM/MM methods was investigated. These calculations determined the structure of transition states of the catalytic reaction and identified, for the first time for glycosyltransferases, the substrate-assisted mechanism in which the donor participates in the catalytic mechanism.

Culture Collection of Yeasts

Phylloplane of fruit trees is occupied by diverse microorganisms, among them yeasts, which can influence a quality of fruits. The composition of yeast microbiota depends on the variety of fruit tree, plant organ examined and locality. In this respect, yeast strains from matured fruits and fully open blossoms of healthy apple, pear and plum trees were isolated. The samples were collected in the locality of southwest Slovakia, during two consecutive years.

The major objectives of the research project were: i) to discover a spectrum of yeast species occupying various fruit tree species cultivated in southwest Slovakia localities; ii) to determine enzymatic activities and assimilation profiles within the yeast species isolated; iii) to ascertain the tolerance of yeasts and to discover a composition of protective substances produced under stress conditions. These results have contributed to a comprehensive understanding of yeasts associated with the phylloplane of healthy fruit trees (previous project was focused on the yeasts associated with the leaves of fruit trees). The representatives of the yeast species isolated are deposited in the Culture Collection of Yeasts to make them available to research and industry for further studies and the maintenance of these yeast cultures and the service works take approximately 50% of research capacity of the staff.

The Culture Collection of Yeasts is a corporate member of the European Culture Collections' Organisation and the World Federation for Culture Collections.

2. Partial indicators of main activities:

2.1. Research output

2.1.1. Principal types of research output of the Institute: basic research/applied research, international/regional (ratios in percentage)

Principal types of research output of the Institute are basic research (90 %) and applied research (10 %). It is difficult to express unambiguously this ratio because the border between these two terms is often not too sharp. In addition, most of research activities performed at the Institute are nearly always directed to be somehow/somewhere applied/utilised. Therefore, this ratio of 90/10 should be regarded as only approximately estimated value. The international/regional ratio of research output should be estimated as 90/10.

2.1.2 List of selected publications documenting the most important results of basic research. (the total number of publications listed for the assessment period does not exceed the average number of employees with university degrees engaged

in research projects; the principal research outputs, including Digital Object Identifier - DOI, are underlined)

- [1] PALEČEK, Emil - TKÁČ, Ján - BARTOŠÍK, Martin - BERTÓK, Tomáš - OSTATNÁ, Veronika - PALEČEK, Jan. Electrochemistry of non-conjugated proteins and glycoproteins. Towards sensors for biomedicine and glycomics. In *Chemical Reviews*, 2015, vol. 115, p. 2045-2108. (46.568 - IF2014). (2015 - Current Contents). ISSN 0009-2665. DOI: 10.1021/cr500279h
- [2] PUCHART, Vladimír. Glycoside phosphorylases: Structure, catalytic properties and biotechnological potential. In *Biotechnology Advances*, 2015, vol. 33, p. 261-276. (9.015 - IF2014). (2015 - Current Contents). ISSN 0734-9750. DOI: 10.1016/j.biotechadv.2015.02.002
- [3] HUSHEGYI, András - BERTÓK, Tomáš - DAMBORSKÝ, Pavel - KATRLÍK, Jaroslav - TKÁČ, Ján. An ultrasensitive impedimetric glycan biosensor with controlled glycan density for detection of lectins and influenza hemagglutinins. In *Chemical Communication*, 2015, vol. 51, p. 7474-7477. (6.834 - IF2014). (2015 - Current Contents). ISSN 1359-7345. DOI: 10.1039/c5cc00922g
- [4] HANSEN, Steen Uldall - DALTON, Charlotte E. - BARÁTH, Marek - KWAN, Glenn - RAFTERY, James - JAYSON, Gordon Charles - MILLER, Gavin John - GARDINER, John Michael. Synthesis of L-iduronic acid derivatives via [3.2.1] and [2.2.2] L-iduronic lactones from bulk glucose-derived cyanohydrin hydrolysis: A reversible conformationally-switched super-disarmed/re-armed lactone route to heparin disaccharides. In *Journal of Organic Chemistry*, 2015, vol. 80, p. 3777-3789. (4.721 - IF2014). (2015 - Current Contents). ISSN 0022-3263.
- [5] SCHENKMAYEROVÁ, Andrea - BERTÓKOVÁ, Anikó - ŠEFČOVIČOVÁ, Jana - ŠTEFUCA, Vladimír - BUČKO, Marek - VIKARTOVSKÁ, Alica - GEMEINER, Peter - TKÁČ, Ján - KATRLÍK, Jaroslav. Whole-cell *Gluconobacter oxydans* biosensor for 2-phenylethanol biooxidation monitoring. In *Analytica Chimica Acta*, 2015, vol. 854, p. 140-144. (4.513 - IF2014). (2015 - Current Contents). ISSN 0003-2670.
- [6] KLUKOVÁ, Ľudmila - BERTÓK, Tomáš - PETRIKOVÁ, Miroslava - ŠEDIVÁ, Alena - MISLOVIČOVÁ, Danica - KATRLÍK, Jaroslav - VIKARTOVSKÁ, Alica - FILIP, Jaroslav - KASÁK, Peter - ANDICSOVÁ-ECKSTEIN, Anita - MOSNÁČEK, Jaroslav - LUKÁČ, Jozef - ROVENSKÝ, Jozef - IMRICH, Richard - TKÁČ, Ján. Glycoprofiling as a novel tool in serological assays of systemic sclerosis: A comparative study with three bioanalytical methods. In *Analytica Chimica Acta*, 2015, vol. 853, p. 555-562. (4.513 - IF2014). (2015 - Current Contents). ISSN 0003-2670.
- [7] SLÁDEK, Vladimír - HOLKA, Filip - TVAROŠKA, Igor. Ab initio modelling of the anomeric and exo anomeric effects in 2-methoxytetrahydropyran and 2-methoxythiane corrected for intramolecular BSSE. In *Physical Chemistry Chemical Physics*, 2015, vol. 17, p. 18501-18513. (4.493 - IF2014). (2015 - Current Contents). ISSN 1463-9076.
- [8] BERTÓK, Tomáš - HOLAZOVÁ-ŠEDIVÁ, Alena - FILIP, Jaroslav - ILČÍKOVÁ, Markéta - KASÁK, Peter - VELIČ, Dušan - JÁNÉ, Eduard - MRAVCOVÁ, Martina - ROVENSKÝ, Jozef - KUNZO, Pavol - LOBOTKA, Peter - ŠMATKO, Vasilij - VIKARTOVSKÁ, Alica - TKÁČ, Ján. Carboxybetaine modified interface for electrochemical glycoprofiling of antibodies isolated from human serum. In *Langmuir*, 2015, vol. 31, p. 7148-7157. (4.457 - IF2014). (2015 - Current Contents). ISSN 0743-7463.
- [9] BIELY, Peter - MALOVÍKOVÁ, Anna - HIRSCH, Ján - MØRKEBERG KROGH, Kristian B.R. - EBRINGEROVÁ, Anna. The role of the glucuronoxylan carboxyl groups in the action of andoxylanases of three glycoside hydrolase families: A study with two substrate mutants. In *Biochimica et Biophysica Acta: General Subjects*, 2015, vol. 1850, p. 2246-2255. (4.381 - IF2014). (2015 - Current Contents). ISSN 0304-4165.
- [10] NAHÁLKA, Jozef - HRABÁROVÁ, Eva - TALAFOVÁ, Klaudia. Protein-RNA and protein-glycan recognitions in light of amino acid codes. In *Biochimica et Biophysica Acta: General Subjects*, 2015, vol. 1850, p. 1942-1952. (4.381 - IF2014). (2015 - Current Contents). ISSN 0304-4165.
- [11] JOLLY, Pawan - FORMISANO, Nello - TKÁČ, Ján - KASÁK, Peter - FROST, Christopher - ESTRELA, Pedro. Label-free impedimetric aptasensor with antifouling surface chemistry: A prostate specific antigen case study. In *Sensors and Actuators B: Chemical*, 2015, vol. 209, p. 306-312. (4.097 - IF2014). (2015 - Current Contents). ISSN 0925-4005.
- [12] ŠIMKOVIČ, Ivan - MENDICHI, Raniero - KELNAR, Ivan - FILIP, Jaroslav - HRICOVÍNI, Miloš. Cationization of heparin for film applications. In *Carbohydrate Polymers*, 2015, vol. 115, p. 551-558. (4.074 - IF2014). (2015 - Current Contents). ISSN 0144-8617.

- [13] VALACHOVÁ, Katarína - BAŇASOVÁ, Mária - TOPOLSKÁ, Dominika - SASINKOVÁ, Vlasta - JURÁNEK, Ivo - COLLINS, Maurice N. - ŠOLTÉS, Ladislav. Influence of tiopronin, captopril and levamisole therapeutics on the oxidative degradation of hyaluronan. In *Carbohydrate Polymers*, 2015, vol. 134, p. 516-523. (4.074 - IF2014). (2015 - Current Contents). ISSN 0144-8617.
- [14] KORCOVÁ, Jana - MACHOVÁ, Eva - FILIP, Jaroslav - BYSTRICKÝ, Slavomír. Biophysical properties of carboxymethyl derivatives of mannan and dextran. In *Carbohydrate Polymers*, 2015, vol. 134, p. 6-11. (4.074 - IF2014). (2015 - Current Contents). ISSN 0144-8617.
- [15] ILČÍKOVÁ, Markéta - MRLÍK, Miroslav - ŠPITALSKÝ, Zdenko - MIČUŠÍK, Matej - CSOMOROVÁ, Katarína - SASINKOVÁ, Vlasta - KLEINOVÁ, Angela - MOSNÁČEK, Jaroslav. A tertiary amine in two competitive processes: Reduction of graphene oxide vs. catalysis of atom transfer radical polymerization. In *RSC Advances*, 2015, vol. 5, p. 3370-3376. (3.840 - IF2014). (2015 - Current Contents). ISSN 2046-2069.
- [16] ILČÍKOVÁ, Markéta - TKÁČ, Ján - KASÁK, Peter. Switchable materials containing polyzwitterion moieties. In *Polymers*, 2015, vol. 7, p. 2344-2370. (3.681 - IF2014). (2015 - Current Contents). ISSN 2073-4360.
- [17] LUX, Alexander - LACKOVIČ, Ann - VAN STADEN, Johannes - LIŠKOVÁ, Desana - KOHANOVA, Jana - MARTINKA, Michal. Cadmium translocation by contractile roots differs from usual, non-contractile roots. In *Annals of Botany*, 2015, vol. 115, p. 1149-1154. (3.654 - IF2014). (2015 - Current Contents). ISSN 0305-7364.
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2.1.3 List of monographs/books published abroad

2.1.4. List of monographs/books published in Slovakia

- [1] ZIGO, František (author) - FERKO, Miroslav - FARKAŠ, Pavol (eds.). The influence of supplementation of selenium and vitamin E on the health condition of lacteal gland of wet cows. Banská Bystrica: Občianske združenie PREVEDA, 2015. 40 p. ISBN 978-80-970712-7-1. (in Slovak)

2.1.5. List of other scientific outputs specifically important for the Institute

Following very important publications (in highly impacted journals; selected 10 items) were produced in the framework of extensive cooperations with many scientific institutions abroad:

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- [6] PEDERSEN, Henriette L. - FANGEL, Jonatan U. - McCLEARY, Barry - RUZANSKI, Christian - GRO RYDHAL, Maja - RALET, Marie-Christine - FARKAŠ, Vladimír - VON SCHANTZ, Laura - MARCOS, Susan E. - ANDERSEN, Mathias C.F. - FIELD, Rob - OHLIN, Mats - KNOX, J. Paul - CLAUSEN, Mads H. - WILLATS, William G.T. Versatile high-resolution oligosaccharide microarrays for plant glycobiology and cell wall research. In *Journal of Biological Chemistry*, 2012, vol. 287, p. 39429-39438. (4.773 - IF2011). (2012 - Current Contents). ISSN 0021-9258.
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- **Selected chapters in monographs and books published abroad**

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- [4] KRONEK, Juraj - PAULOVÍČOVÁ, Ema - PAULOVÍČOVÁ, Lucia - KRONEKOVÁ, Zuzana - LUSTOŇ, Jozef. Biocompatibility and immunocompatibility assessment of poly(2-oxazolines). In ANDRADE, Adriano O. - PEREIRA, Adriano Alves - NAVES, Eduardo L. M. - SOARES, Alcimar B. Practical Applications in Biomedical Engineering. Rijeka, Croatia: InTech, 2013, chapter 11, p. 257-284. ISBN 978-953-51-0924-2.
- [5] EBRINGEROVÁ, Anna. The potential of xylans as biomaterial resources. In HABIBI, Youssef - LUCIA, Lucian A. Polysaccharide Building Blocks: A Sustainable Approach to the Development of Renewable Biomaterials. Hoboken, NJ, USA: John Wiley & Sons, Inc., 2012. ISBN 978-0470874196. Chapter 13. p. 331-365.
- [6] KOROLENKO, Tatyana A. - KISAROVA, Yana A. - FILJUSHINA, Elena E. - DERGUNOVA, Marina A. - MACHOVÁ, Eva. Macrophage stimulation and β -D-glucans as biological response modifiers: the role in experimental tumor development. In TAKAHASHI, Rikiya - KAI, Hibiki. Handbook of Macrophages: Life Cycle, Functions and Diseases (Series: Cell Biology Research Progress). Hauppauge, NY, USA: Nova Science Publishers, Inc., 2012. ISBN 978-1620811627. Chapter 9. p. 249-276.
- [7] LATTOVÁ, Erika - PERREAULT, Hélène - POLÁKOVÁ, Monika. Glycans as potential diagnostic biomarkers and the importance of developing methods for glycan analysis. In MORA-MONTES, Hector Manuel. Glycans: Biochemistry, Characterization and Applications. (Series: Biochemistry Research Trends). Hauppauge, NY, USA: Nova Science Publishers, Inc., 2012. ISBN 978-1619425606. Chapter 1. p. 1-26.

2.1.6. List of patents, patent applications, and other intellectual property rights registered abroad, incl. revenues

- [1] Pub. No.: US 2013212740 (A1)
Inventors: MUCHA, J. - ALTMANN, F. - LEITER, H. - GLOSSL, J. - STAUDACHER, E.
Title: Fucosyl transferase gene

2.1.7. List of patents, patent applications, and other intellectual property rights registered in Slovakia, incl. revenues

- [1] Pub. No.: SK 288023 B6
Inventors: FARKAŠ, V. - NEMČOVIČ, M. - JAKUBÍKOVÁ, L. - ŠUBÍKOVÁ, V. - DRIMAL, J. - JANITOR, A. - KUNCA, A. - LEOINTOVYČ, R.
Title: Strains of microorganism *Trichoderma atroviride* and *Trichoderma harzanium* and preparation for plant protection containing them.
- [2] Pub. No.: SK 288046 B6
Inventors: FARKAŠ, V. - KOSÍK, O.
Title: Method of simultaneous determination of enzyme activity of transglycosylase type.

2.1.8. Table of research outputs (as in annual reports)

Papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) have to be listed separately.

Scientific publications	2012			2013			2014			2015			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	averaged number per year	av. No. / FTE	av. No. / salary budget
Scientific monographs and monographic studies in journals and proceedings published abroad (AAA, ABA)	0.0	0.000	0.000	0.0	0.000	0.000	0.0	0.000	0.000	0.0	0.000	0.000	0.0	0.0	0.000	0.000
Scientific monographs and monographic studies in journals and proceedings published in Slovakia (AAB, ABB)	0.0	0.000	0.000	0.0	0.000	0.000	0.0	0.000	0.000	1.0	0.010	0.001	1.0	0.3	0.003	0.000
Chapters in scientific monographs published abroad (ABC)	6.0	0.068	0.005	2.0	0.022	0.002	3.0	0.033	0.003	2.0	0.020	0.002	13.0	3.3	0.035	0.003
Chapters in scientific monographs published in Slovakia (ABD)	0.0	0.000	0.000	0.0	0.000	0.000	0.0	0.000	0.000	0.0	0.000	0.000	0.0	0.0	0.000	0.000
Scientific papers published in journals registered in Current Contents Connect (ADCA, ADCB, ADDA, ADDB)	63.0	0.712	0.055	52.0	0.578	0.045	60.0	0.661	0.052	68.0	0.695	0.058	243.0	60.8	0.662	0.053
Scientific papers published in journals registered in Web of Science Core Collection and SCOPUS (ADMA, ADMB, ADNA, ADN B)	15.0	0.169	0.013	12.0	0.133	0.010	4.0	0.044	0.003	9.0	0.092	0.008	40.0	10.0	0.109	0.009
Scientific papers published in other foreign journals (not listed above) (ADEA, ADEB)	0.0	0.000	0.000	0.0	0.000	0.000	1.0	0.011	0.001	0.0	0.000	0.000	1.0	0.3	0.003	0.000
Scientific papers published in other domestic journals (not listed above) (ADFA, ADFB)	0.0	0.000	0.000	0.0	0.000	0.000	0.0	0.000	0.000	0.0	0.000	0.000	0.0	0.0	0.000	0.000
Scientific papers published in foreign peer-reviewed proceedings (AEC, AECA)	1.0	0.011	0.001	5.0	0.056	0.004	0.0	0.000	0.000	1.0	0.010	0.001	7.0	1.8	0.019	0.002
Scientific papers published in domestic peer-reviewed proceedings (AED, AEDA)	2.0	0.023	0.002	8.0	0.089	0.007	6.0	0.066	0.005	0.0	0.000	0.000	16.0	4.0	0.044	0.003
Published papers (full text) from foreign and international scientific conferences (AFA, AFC, AFBA, AFDA)	13.0	0.147	0.011	0.0	0.000	0.000	9.0	0.099	0.008	4.0	0.041	0.003	26.0	6.5	0.071	0.006
Published papers (full text) from domestic scientific conferences (AFB, AFD, AFBB, AFDB)	10.0	0.113	0.009	0.0	0.000	0.000	5.0	0.055	0.004	7.0	0.072	0.006	22.0	5.5	0.060	0.005

- **Supplementary information and/or comments on the scientific outputs of the Institute**

In this assessment period, the Impact Factor (IF) of scientific journals registered in WOS and Scopus in which research articles were published, ranges from 0.196 to 46.568 and its average value is 2.895. This value evidently exceeds the values of Median Impact Factor (MIF) for Subject Categories in which the scientific research and PhD study at the Institute predominates (average values of MIF adapted from JCR Science Edition for the years 2011–2014: 2.152 for Organic Chemistry; 2.802 for Biochemistry & Molecular Biology; 2.083 for Biotechnology and Applied Microbiology; 1.445 for Polymer Science; 2.434 for Microbiology; 2.113 for Chemistry Physical). From the total 283 impacted publications, there were 44 publications with IF higher than 4.000 and 72 publications with IF exceeding the value of 3.000. These data indicate the orientation of the Institute on high quality research output.

In total, 434 contributions (oral and poster presentations) at international scientific conferences/symposia and 86 such contributions at domestic conferences/symposia were presented during this assessment period.

Excessive administrative works associated with management of several projects of EU Structural Funds negatively influenced scientific outputs of the Institute because several employees with university degrees engaged in research projects are also engaged in administration of these "non-scientific" projects. However, beneficial effect is expected in the near future in connection with application of top-level sophisticated instrumental equipments obtained thanks to Structural Funds.

2.2. Responses to the research outputs (citations, etc.)

2.2.1. Table with citations per annum

Citations of papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) have to be listed separately.

Citations, reviews	2011		2012		2013		2014		total		
	number	No. / FTE	number	averaged number per year	av. No. / FTE						
Citations in Web of Science Core Collection (1.1, 2.1)	1722.0	19.449	2047.0	22.745	1999.0	22.032	2251.0	23.004	8019.0	2004.8	21.843
Citations in SCOPUS (1.2, 2.2) if not listed above	129.0	1.457	190.0	2.111	482.0	5.312	403.0	4.118	1204.0	301.0	3.280
Citations in other citation indexes and databases (not listed above) (3.2,4.2,9,10)	1.0	0.011	0.0	0.000	0.0	0.000	6.0	0.061	7.0	1.8	0.019
Other citations (not listed above) (3, 4, 3.1, 4.1)	38.0	0.429	29.0	0.322	34.0	0.375	52.0	0.531	153.0	38.3	0.417
Reviews (5,6)	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.0	0.000

2.2.2. List of 10 most-cited publications, including number of citations, in the assessment period (2011 – 2014)

- [1] BAILEY, M.J. - BIELY, P. - POUTANEN, K. Interlaboratory testing of methods for assay of xylanase activity. In *Journal of Biotechnology*, 1992, vol. 23, p. 257-270. (404 citations in WOS, Scopus)
- [2] BROADLEY, M.R. - WHITE, P.J. - HAMMOND, J.P. - ZELKO, I. - LUX, A. Zinc in plants. In *New Phytologist*, 2007, vol. 173, p. 677-702. (316 citations in WOS, Scopus)
- [3] KAČURÁKOVÁ, M. - CAPEK, P. - SASINKOVÁ, V. - WELLNER, N. - EBRINGEROVÁ, A. FT-IR study of plant cell wall model compounds: pectic polysaccharides and hemicelluloses. In *Carbohydrate Polymers*, 2000, vol. 43, p. 195-203. (232 citations in WOS, Scopus)
- [4] EBRINGEROVÁ, A. - HEINZE, T. Xylan and xylan derivatives - biopolymers with valuable properties, 1 - Naturally occurring xylans structures, procedures and properties. In *Macromolecular Rapid Communications*, 2000, vol. 21, p. 542-556. (180 citations in WOS, Scopus)
- [5] KOGAN, G. - ŠOLTÉS, L. - STERN, R. - GEMEINER, P. Hyaluronic acid: A natural biopolymer with a broad range of biomedical and industrial applications. In *Biotechnology Letters*, 2007, vol. 29, p. 17-25. (164 citations)
- [6] EBRINGEROVÁ, A. - HROMÁDKOVÁ, Z. - HEINZE, T. Hemicellulose. In *Advances in Polymer Science*, 2005, vol. 186, p. 1-67. (158 citations in WOS, Scopus)
- [7] SHLEEV, S. - TKÁČ, J. - CHRISTENSON, A. - RUZGAS, T. - YAROLOPOV, A.I. - WHITTAKER, J.W. - GORTON, L. Direct electron transfer between copper-containing proteins and electrodes. In *Biosensors and Bioelectronics*, 2005, vol. 20, p. 2517-2554. (143 citations in WOS, Scopus)
- [8] BIELY, P. Microbial xylanolytic systems. In *Trends in Biotechnology*, 1985, vol. 3, p. 286-290. (116 citations in WOS, Scopus)
- [9] BIELY, P. - VRŠANSKÁ, M. - TENKANEN, M. - KLUEPFEL, D. Endo- β -1,4- xylanase families: differences in catalytic properties. In *Journal of Biotechnology*, 1997, vol. 57, p. 151-166. (99 citations in WOS, Scopus)
- [10] de VOS, P. - BUČKO, M. - GEMEINER, P. - NAVRÁTIL, M. - ŠVITEL, J. - FAAS, M. - STRAND, B.L. - SKJAK-BRAEK, G. - MORCH, Y.A. - VIKARTOVSKÁ, A. - LACÍK, I. - HLOUŠKOVÁ, G. - ORIVE, G. - PONCELET, D. - PEDRAZ, J.L. - ANSORGE-SCHUMACHER, M.B. Multiscale requirements for bioencapsulation in medicine and biotechnology. In *Biomaterials*, 2009, vol. 30, p. 2559-2570. (72 citations in WOS, Scopus)

2.2.3. List of most-cited authors from the Institute (at most 10 % of the research employees with university degree engaged in research projects) and their number of citations in the assessment period (2011 – 2014)

Name	2011		2012		2013		2014		Total
	WOS	Scopus	WOS	Scopus	WOS	Scopus	WOS	Scopus	
Ebringerová	316	32	313	41	368	68	355	91	1584
Biely	269	11	306	19	259	42	374	54	1334
Gemeiner	150	11	154	11	199	58	204	60	850
Hromádková	153	18	147	25	186	30	178	47	784
Tkáč	115	0	114	9	118	25	168	19	568
Capek	80	13	100	9	118	30	118	35	503
Vršanská	109	7	108	5	76	24	121	24	474
Sasinková	74	3	73	7	92	17	95	12	373
Tvaroška	74	3	70	2	87	8	75	18	337

- **Supplementary information and/or comments on responses to the scientific output of the Institute**

List of ten employees with highest Hirsch index (h-index, according to Scopus):

BIELY, Peter	<i>h</i> = 37
EBRINGEROVÁ, Anna	<i>h</i> = 33
GEMEINER, Peter	<i>h</i> = 29
HROMÁDKOVÁ, Zdenka	<i>h</i> = 27
TVAROŠKA, Igor	<i>h</i> = 26
TKÁČ, Ján	<i>h</i> = 26
VRŠANSKÁ, Mária	<i>h</i> = 25
FARKAŠ, Vladimír	<i>h</i> = 22
HRICOVÍNI, Miloš	<i>h</i> = 22
MACHOVÁ, Eva	<i>h</i> = 18
CAPEK, Peter	<i>h</i> = 18
KLAUDINY, Jaroslav	<i>h</i> = 18

2.3. Research status of the Institute in international and national contexts

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

2.3.1. List of the most important research activities demonstrating the international relevance of the research performed by the Institute, incl. major projects (selected 10 items; details of projects are supplied under Indicator 2.4)

- [1] 283 scientific papers published in journals registered in Current Contents Connect, Web of Science and Scopus (average value of Impact Factor = 2.895; one paper with IF = 46.568; 44 papers with IF higher than 4.000). In addition, 13 chapters in scientific monographs published abroad.
- [2] 9223 citations in Web of Science and Scopus, and 160 other citations.
- [3] 434 contributions at international conferences/symposia (among them 45 invited lectures).
- [4] EU project FP7-IDEAS-ERC (ERC Starting Grant) - till now, the only one ERC project in Slovakia).
- [5] International cooperation within 6 multilateral projects of EU FP7, 2 projects of ESF, 10 multilateral projects of EU COST program, 1 bilateral project of Qatar National Research Funds (QNRF) with Qatar University, 1 bilateral project of National Science Council of Taiwan (NSC) with Institute of Biological Chemistry, Academia Sinica, and 7 projects within intergovernmental and interacademy agreements about international scientific and technical cooperation (2 SK-France, 2 SK-Poland, 1 SK-Portugal, 2 SK-Serbia). In addition, a lot of informal cooperations with many foreign institutions was realised.
- [6] Many employees served as officers or national delegates of several significant foreign associations and international organisations like International Carbohydrate Organisation, European Carbohydrate Organisation, International Glycoconjugate Organisation, International Society for Mass Spectrometry, International Academy of Wood Science, COST Chemistry and Molecular Sciences and Technologies Domain Committee. The Culture Collection of Yeasts is a corporate member of the European Culture Collections' Organisation and the World Federation for Culture Collections. Individual employees are members of following societies/organisations: American Chemical Society, International Society of Heterocyclic Chemistry, Federation of European Societies of Plant Biology, International Association of Plant Tissue Cultures-Biotechnology, European Peptide Society.

- [7] 15 employees served as members (among them 2 editors, 1 managing editor, 1 associate editor) of editorial/editorial advisory boards of reputable foreign scientific journals (Carbohydrate Research, Molecules, Artificial Cells, Blood Substitutes and Biotechnology, Biotechnology and Applied Biochemistry, Biotechnology Letters, Open Chemistry, Arkivoc, Plant Growth Regulation, Plant Root, Environmental Experimental Botany, Journal of Glycomics & Lipidomics, International Journal of Carbohydrate Chemistry, Trends in Carbohydrate Research, Open Glycoscience, Central European Journal of Chemistry, Frontiers in Plant Sciences, Yeast Newsletter).
- [8] 24 researchers served as members of the organising and/or programme committees of international conferences.
- [9] Ownship and management of the Editorial Office of *Chemical Papers*, the only scientific periodical journal in Slovakia publishing original scientific articles in the field of chemistry in English language.
- [10] More than 30 researchers served as reviewers of scientific papers, submitted to reputed international journals, and foreign project proposals, as well.

2.3.2. List of international conferences (co)organised by the Institute

- [1] 40th Annual Conference on Yeasts, May 8-11, 2012, Smolenice, Slovakia.
- [2] EAST-NMR Meeting of Young Researchers, May 16-18, 2012, Bratislava, Slovakia.
- [3] 30th ISSY: Cell Surface & Organelles in Yeasts, June 18-22, 2013, Stará Lesná, Slovakia.
- [4] 41th Annual Conference on Yeasts, May 20-23, 2014, Smolenice, Slovakia.
- [5] 13th Bratislava Symposium on Saccharides, June 22-26, 2014, Smolenice, Slovakia.
- [6] PROSENSE Workshop "Application of Lectins in Various Format of Analysis for Glycoprofiling", January 23-24, 2014, Bratislava.
- [7] 42nd Annual Conference on Yeasts, May 19-22, 2015, Smolenice, Slovakia.

2.3.3. List of edited proceedings from international scientific conferences

- [1] Programme and Abstracts: 40th Annual Conference on Yeasts, May 8-11, 2012, Smolenice, Slovakia. Bratislava: Institute of Chemistry SAS, 2012, 91 p. ISSN 1336-4839.
- [2] POLČIC, P. (Ed.). Proceedings: 30th ISSY: Cell Surface & Organelles in Yeasts, June 18-22, 2013, Stará Lesná, Slovakia. Bratislava: ICY, Institute of Animal Biochemistry and Genetics SAS, Institute of Chemistry SAS, Institute of Molecular Biology SAS, 2013, 108 p. ISSN 1336-4839.
- [3] HAPALA, I. - BREIEROVÁ, E. (Eds.). Programme and Abstracts: 41th Annual Conference on Yeasts, May 20-23, 2014, Smolenice, Slovakia. Bratislava: Institute of Chemistry SAS, Institute of Animal Biochemistry and Genetics SAS, 2014, 79 p. ISSN 1336-4839.
- [4] KATRLÍK, J. - BARÁTH, M. (Eds.). Proceedings: 13th Bratislava Symposium on Saccharides, June 22-26, 2014, Smolenice, Slovakia. Bratislava: Institute of Chemistry SAS, 2014. 141 p. ISSN 1339-7036. ISBN 078-80-971665-0-2.
- [5] HAPALA, I. - BREIEROVÁ, E. (Eds.). Programme and Abstracts: 42nd Annual Conference on Yeasts, May 19-22, 2015, Smolenice, Slovakia. Bratislava: Institute of Chemistry SAS, Institute of Animal Biochemistry and Genetics SAS, 2015, 86 p. ISSN 1336-4839.

2.3.4. List of journals edited/published by the Institute:

2.3.4.1. WOS (IF of journals in each year of the assessment period)

2.3.4.2. SCOPUS

2.3.4.3. Other databases

Journal title: **Chemical Papers**

It is the only one scientific periodical journal (12 issues per year) in Slovakia publishing original scientific articles in the field of chemistry in English language.

ISSN: 0336-6352 (Print); 1336-9075 (Online); Ownership, Copyright and Editorial Office: Institute of Chemistry, Slovak Academy of Sciences; Co-published with Versita and Springer-Verlag GmbH (De Gruyter Open Ltd., since 2015).

Abstracted/indexed in: Thompson Reuters databases - WOS, Science Citation Index, Science Citation Index Expanded, Journal Citation Reports/Science Edition, Current Contents/Physical, Chemical and Earth Sciences; SCOPUS, Chemical Abstracts Service (CAS); Google Scholar; ProQuest; Index Copernicus and many other abstracting/indexing databases.

Impact Factors: IF2011 - 1.096, IF2012 - 0.879, IF2013 - 1.193, IF2014 - 1.468.

- **National position of the Institute**

2.3.5. List of selected projects of national importance

- [1] Immobilisation techniques for preparation of biocatalysts for industrial production of natural flavours (APVV project)
- [2] Preparation of nanostructured interfaces, their integration with bioelements and subsequent use (APVV project)
- [3] Chemoenzymatic synthesis and evaluation of biological activities of natural glycophenolics and their analogues (APVV project)
- [4] Structural design, synthesis and evaluation of selective inhibitors of glycoside hydrolases from the family 38 (APVV project)
- [5] Structure, properties and biotechnological potential of novel microbial enzymes degrading plant biomass (APVV project)
- [6] Biochips and biosensors for glycorecognition, their development, preparation and application in cancer research (APVV project)
- [7] Bioactive polysaccharides from non-utilised plants and plant wastes: structural and functional diversity (VEGA project)
- [8] Preparation of subcellular vaccines from oligomannoside epitopes of *Candida albicans* yeast and their immunomodulation properties (VEGA project)
- [9] Biologically active saccharides: Synthesis, 3D structure and intermolecular interactions (VEGA project)
- [10] Novel, more efficient immobilisation technologies for biocatalysts of oxo-reductive reactions and construction of biosensors and biobatteries (VEGA project)
- [11] Mimetics of glycosyltransferase inhibitors - rational design, synthesis and applications (VEGA project)
- [12] Structural analysis of N-linked oligosaccharides in special diagnostics of congenital metabolic disorders of glycosylation (VEGA project)

2.3.6. Selected projects of the Slovak Research and Development Agency (APVV)

- [1] Immobilisation techniques for preparation of biocatalysts for industrial production of natural flavours (Bučko, M.)

- [2] Plant ionome modification by silicon for improvement of the crop nutrition quality (Lišková, D.)
- [3] Alteration in cell metabolism associated with drug transporter – P-glycoprotein overexpression in leukemia cells (Katrлік, J.)
- [4] Preparation of nanostructured interfaces, their integration with bioelements and subsequent use (Tkáč, J.)
- [5] Chemoenzymatic synthesis and evaluation of biological activities of natural glycophenolics and their analogues (Mastihubová, M.)
- [6] Structural design, synthesis and evaluation of selective inhibitors of glycoside hydrolases from the family 38 (Poláková, M.)
- [7] Structure, properties and biotechnological potential of novel microbial enzymes degrading plant biomass (Puchart, V.)
- [8] Possible dual function of P-glycoprotein in leukemia cells: efflux pump and regulatory protein (Katrлік, J.)
- [9] New opinions on pharmacological modulation of allergic asthma (Capek, P.)
- [10] Biochips and biosensors for glycorecognition, their development, preparation and application in cancer research (Katrлік, J.)

(See Table 2.4.4. for full list and more details on the APVV projects)

2.3.7. Projects of the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA)

(Only 12 representative of total 35 projects are selected; following data for each project are given and arranged sequentially: project: title; principal investigator; duration: month/year; registration number; funding for the IC SAS for individual years 2012–2015; role of the IC SAS)

- [1] Microbial enzymes for bioconversion of plant hemicelluloses (Biely, P.; 01/2010–12/2013; 2/0001/10; 7128 €, 9959 €; coordinator)
- [2] Plant mucilages, structure and bioactivity (Capek, P.; 01/2011–12/2014; 2/0017/11; 8180 €, 7377 €, 4955 €; coordinator)
- [3] Mimetics of glycosyltransferase inhibitors - rational design, synthesis and applications (Hirsch, J.; 01/2011-12/2014; 2/0101/11; 12153 €, 8975 €, 12325 €; coordinator)
- [4] Novel, more efficient immobilisation technologies for biocatalysts of oxo-reductive reactions and construction of biosensors and biobatteries (Gemeiner, P.; 01/2012–12/2015; 1/0229/12; 12204 €, 13501 €, 14337 €, 14918 €; coordinator)
- [5] Chemoenzymatic synthesis of key glycosynthons of natural substances (Mastihubová, M.; 01/2012–12/2015; 2/0138/12; 9349 €, 9836 €, 12387 €, 15143 €; coordinator)
- [6] Bioactive polysaccharides from non-utilised plants and plant wastes: structural and functional diversity (Hromádková, Z.; 01/2013–12/2016; 2/0085/13; 11803 €, 9352 €, 9528 €; coordinator)
- [7] Preparation of subcellular vaccines from oligomannoside epitopes of *Candida albicans* yeast and their immunomodulation properties (Machová, E.; 01/2013–12/2016; 2/0026/13; 18602 €, 18531 €, 15875 €; coordinator)
- [8] Study of structure and properties of biologically active saccharides using methods of NMR spectroscopy and theoretical chemistry (Hricovíni, M.; 01/2014–12/2017; 2/0100/14; 6318 €, 6436 €; coordinator)
- [9] Development of lectin, protein and glycan biochips using modern technologies and nanotechnologies for applications in biology, biomedicine and for biomarkers detection (Katrлік, J.; 01/2014–12/2017; 2/0162/14; 14073 €, 17519 €; coordinator)
- [10] Galactoglucomannan oligosaccharides signaling in plant growth processes and their protective potential against toxic metals (Lišková, D.; 01/2014–12/2017; 2/0083/14; 6361 €, 7150 €; coordinator)

- [11] Structural analysis of *N*-linked oligosaccharides in special diagnostics of congenital metabolic disorders of glycosylation (Mucha, J.; 01/2014–12/2016; 2/0188/14; 9181 €, 9751 €; coordinator)
- [12] The diversity, properties and activities of soil yeasts (Vadkertiová, R.; 01/2014–12/2017; 2/0023/14; 8104 €, 6912 €; coordinator)

2.3.8. Projects of SAS Centres of Excellence

Title: *Research on medicinally significant saccharide derivatives*

Acronym: GLYCOMED

Principal investigator from IC SAS: Ing. Slavomír Bystrický, DrSc.

Duration: 01/2009-02/2013

Funding: 81688 € (from State budget)

2.3.9. National projects supported by EU Structural Funds

- [1] Centre for materials, layers and systems for applications and chemical processes under extreme conditions (2010–2012; IC SAS as a partner)
- [2] Completion of Excellence centre for methods and processes of green chemistry (2010–2013; IC SAS as a partner)
- [3] Excellence centre for Glycomics (2010–2014; IC SAS as a coordinator)
- [4] Excellence centre for white-green biotechnology (2010–2014; IC SAS as a coordinator)
- [5] Applied research in the field of industrial biocatalysis (2012–2014; IC SAS as a partner)
- [6] Completion of technical infrastructure for research in the field of new biotechnologies (2013–2015; IC SAS as a coordinator)
- [7] Upgrading of infrastructure for biomedical research (2015; IC SAS as a coordinator and sole recipient)
- [8] Technical infrastructure of research unit (2015; IC SAS as a coordinator and sole recipient)

2.3.10. List of journals (published only in the Slovak language) edited/published by the Institute:

2.3.10.1. WOS (IF of journals in each year of the assessment period)

2.3.10.2. SCOPUS

2.3.10.3. Other databases

2.3.10.4. Not included in databases

none

- **Position of individual researchers in an international context**

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

- [1] BERTÓK, Tomáš - GEMEINER, Peter - TKÁČ, Ján. Highly sensitive biorecognition using lectin biosensors and their biomedical applications. In ACP 2012 - XII. Conference with international participation: Recent Status and Perspectives of Analytical Chemistry in Praxis, May 8-11,

- 2012, Bratislava, Slovakia. (invited lecture - Dr. Tkáč); Abstract published: In *Chemické listy*, 2012, vol. 106(S), p. s152. ISSN 0009-2770.
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2.3.12. List of researchers who served as members of the organising and/or programme committees of international conferences

BARÁTH, Marek (organising committee)

- 13th Bratislava Symposium on Saccharides "Recent Advances in Glycomics", Smolenice, Slovakia, June 22-26, 2014

BIELY, Peter

- 30th International Specialised Symposium on Yeast (30th ISSY) "Cell Surface and Organelles in Yeasts: from Basics to Applications", Stará Lesná, Slovakia, June 18-22, 2013.

BREIEROVÁ, Emília (organising committee)

- 40th Annual Conference on Yeasts, Smolenice, Slovakia, May 8-11, 2012
- 30th International Specialised Symposium on Yeast (30th ISSY) "Cell Surface and Organelles in Yeasts: from Basics to Applications", Stará Lesná, Slovakia, June 18-22, 2013.
- 41th Annual Conference on Yeasts, Smolenice, Slovakia, May 20-23, 2014
- 42nd Annual Conference on Yeasts, Smolenice, Slovakia, May 19-22, 2015

BUČKO, Marek (programme committee)

- European Biotechnology Congress 2013, Bratislava, Slovakia, May 16-18, 2013

FARKAŠ, Vladimír (programme committee)

- 30th International Specialised Symposium on Yeast (30th ISSY) "Cell Surface and Organelles in Yeasts: from Basics to Applications", Stará Lesná, Slovakia, June 18-22, 2013.

GAJDOŠ, Ján (organising committee)

- 13th Bratislava Symposium on Saccharides "Recent Advances in Glycomics", Smolenice, Slovakia, June 22-26, 2014

GEMEINER, Peter (programme committee)

- European Biotechnology Congress 2013, Bratislava, Slovakia, May 16-18, 2013

GUTHOVÁ, Jana (organising committee)

- 40th Annual Conference on Yeasts, Smolenice, Slovakia, May 8-11, 2012
- 41th Annual Conference on Yeasts, Smolenice, Slovakia, May 20-23, 2014
- 42nd Annual Conference on Yeasts, Smolenice, Slovakia, May 19-22, 2015

HIRSCH, Ján (programme committee)

- 11th International Conference on Polysaccharides-Glycoscience, Prague, Czech Republic, October 7-9, 2015

HRICOVÍNI, Miloš (organising and programme committee)

- 2nd EAST-NMR Young Investigators' Meeting, Bratislava, Slovakia, May 16-18, 2012

KATRLÍK, Jaroslav (programme committee)

- European Biotechnology Congress 2013, Bratislava, Slovakia, May 16-18, 2013

KATRLÍK, Jaroslav (organising committee)

- 13th Bratislava Symposium on Saccharides "Recent Advances in Glycomics", Smolenice, Slovakia, June 22-26, 2014

KOLLÁROVÁ, Karin (organising committee)

- 13th Bratislava Symposium on Saccharides "Recent Advances in Glycomics", Smolenice, Slovakia, June 22-26, 2014

KUČEROVÁ, Danica (organising committee)

- 13th Bratislava Symposium on Saccharides "Recent Advances in Glycomics", Smolenice, Slovakia, June 22-26, 2014

MATULOVÁ, Mária (organising and programme committee)

- 2nd EAST-NMR Young Investigators' Meeting, Bratislava, Slovakia, May 16-18, 2012

MOLNÁROVÁ, Jana (organising committee)

- 40th Annual Conference on Yeasts, Smolenice, Slovakia, May 8-11, 2012
- 41th Annual Conference on Yeasts, Smolenice, Slovakia, May 20-23, 2014
- 42nd Annual Conference on Yeasts, Smolenice, Slovakia, May 19-22, 2015

PAULOVÍČOVÁ, Ema (programme committee)

- 40th Annual Conference on Yeasts, Smolenice, Slovakia, May 8-11, 2012
- 41th Annual Conference on Yeasts, Smolenice, Slovakia, May 20-23, 2014
- 42nd Annual Conference on Yeasts, Smolenice, Slovakia, May 19-22, 2015

PETRUŠ, Ladislav (International Steering Committee)

- 7th Central Europe Conference "Chemistry towards Biology", Katowice, Poland, September 9-12, 2014

SCHENKMAYEROVÁ, Andrea (organising committee)

- 13th Bratislava Symposium on Saccharides "Recent Advances in Glycomics", Smolenice, Slovakia, June 22-26, 2014

ŠEFČOVIČOVÁ, Jana (organising committee)

- 13th Bratislava Symposium on Saccharides "Recent Advances in Glycomics", Smolenice, Slovakia, June 22-26, 2014

TKÁČ, Ján (programme committee)

- European Biotechnology Congress 2013, Bratislava, Slovakia, May 16-18, 2013
- European Biotechnology Congress 2015, Bucharest, Romania, May 7-9, 2015

TVAROŠKA, Igor (programme committee)

- 17th European Carbohydrate Symposium (Eurocarb17), Tel Aviv, Israel, July 7-11, 2013

UHĽIARIKOVÁ, Iveta (organising and programme committee)

- 2nd EAST-NMR Young Investigators' Meeting, Bratislava, Slovakia, May 16-18, 2012

VADKERTIOVÁ, Renáta (programme committee)

- 42nd Annual Conference on Yeasts, Smolenice, Slovakia, May 19-22, 2015

VATEHOVÁ, Zuzana (organising committee)

- 13th Bratislava Symposium on Saccharides "Recent Advances in Glycomics", Smolenice, Slovakia, June 22-26, 2014

- **Position of individual researchers in a national context**

- **2.3.13. List of invited/keynote presentations at national conferences, as documented by programme or invitation letter**

- [1] HRICOVÍNI, Miloš. Structure and intermolecular interactions of heparin saccharides with proteins. In III. Seminar of Subbranch Medicinal Chemistry, September 7, 2012, Bratislava, Slovakia.
- [2] KÓŇA, Juraj. The role of QSAR model with DFT descriptors for design of inhibitors of Golgi alfa-manosidase II. In III. Seminar of Subbranch Medicinal Chemistry, September 7, 2012, Bratislava, Slovakia.
- [3] MASTIHUBOVÁ, Mária. Biocatalysis in glycochemistry. In Chemical Horizons, February 29, 2012, Bratislava, Slovakia.
- [4] TKÁČ, Ján. Sugars – fuel for biobatteries and markers of diseases. In Chemical Horizons, March 20, 2013, Bratislava, Slovakia.
- [5] PILIŠIOVÁ, Ružena - PAULOVÍČOVÁ, Ema - PAULOVÍČOVÁ, Lucia - YASHUNSKY, D. V. - KARELIN, A.A. - TSVETKOV, Y.E. - NIFANTIEV, N.E. Immuno-characteristics of synthetic gluco- and manooligosaccharide antigens of pathogenic *Candida* sp. In Miniconference of PhD. Students 2014, June 20, 2014, Bratislava, Slovakia. (invited lecture - Dr. Pilišiová); abstract published: In Abstract Booklet: Miniconference of PhD. Students 2014, June 20, 2014, Bratislava. Bratislava: Institute of Experimental Pharmacology and Toxicology SAS, 2014.
- [6] PAULOVÍČOVÁ, Ema - PAULOVÍČOVÁ, Lucia. Použitie prietokovej cytometrie pre evaluáciu imunofluorescencie in situ. In Beckman Coulter Workshop, June 8-9, 2014, Vyhne, Slovakia. (invited lecture - Dr. Paulovičová E.)
- [7] SUCHÁNKOVÁ, Magda - BUCOVÁ, Mária - PAULOVÍČOVÁ, Ema - PAULOVÍČOVÁ, Lucia - TIBENSKÁ, Elena - MAJER, Ivan - TEDLOVÁ, Eva - NOVOSADOVÁ, Helena. Moulds anr the most recent insights on etiology of sarcoidosis. Analysis of antimycotic Analýza antimykotických antibodies. In XII. Martin's Days of Immunology, April 9-11, 2014, Martin, Slovakia. (invited lecture - Dr. Paulovičová L.); abstract published: In Klinická imunológia a alergológia, 2014, vol. 24, p. 3. ISSN 13350013.

- [8] SUCHÁNKOVÁ, Magda - BUCOVÁ, Mária - TIBENSKÁ, Elena - SZABOOVÁ, K. - MAJER, Ivan - NOVOSADOVÁ, Helena - PAULOVÍČOVÁ, Ema - TEDLOVÁ, Eva - BUC, Milan. TREM receptors in BAL at sarcoidosis and other pulmonary diseases. Is there a possibility to use them in diagnostics of pulmonary sarcoidosis? In XII. Martin's Days of Immunology, April 9-11, 2014, Martin, Slovakia. (invited lecture - Dr. Paulovičová E.); abstract published: In *Klinická imunológia a alergológia*, 2014, vol. 24, p. 3. ISSN 13350013.
- [9] VATEHOVÁ, Zuzana. Separation of monosaccharides using HPAEC-PAD. In Thermo Fisher DIONEX DAY - 2014, November 13, 2014, Bratislava, Slovakia.
- [10] VLČKOVÁ, Silvia. HRMS in selected applications. Thermo Scientific and Pragolab Workshop: News not only in Mass Spectrometry, June 20, 2014, Bratislava, Slovakia.

2.3.14. List of researchers who served as members of organising and programme committees of national conferences

FARKAŠ, Pavol (organising committee)

- IVth Interactive Conference of Young Scientists 2012, April 4-May 5, 2012
- Vth Interactive Conference of Young Scientists 2013, April 4-May 5, 2013
- VIth Interactive Conference of Young Scientists 2014, May 7-June 6, 2014
- VIIth Interactive Conference of Young Scientists 2015, May 5-June 6, 2015

HIRSCH, Ján (programme committee)

- 65th Congress of the Slovak and Czech Chemical Society, High Tatras, Slovakia, September 9-13, 2013
- 67th Congress of the Slovak and Czech Chemical Society, High Tatras, Starý Smokovec, Slovakia, September 7-11, 2015

KATRLÍK, Jaroslav (programme committee)

- IVth Interactive Conference of Young Scientists 2012, April 4-May 5, 2012
- Vth Interactive Conference of Young Scientists 2013, April 4-May 5, 2013
- VIth Interactive Conference of Young Scientists 2014, May 7-June 6, 2014
- VIIth Interactive Conference of Young Scientists 2015, May 5-June 6, 2015

MASTIHUBA, Vladimír (programme committee)

- 65th Congress of the Slovak and Czech Chemical Society, High Tatras, Slovakia, September 9-13, 2013
- 67th Congress of the Slovak and Czech Chemical Society, High Tatras, Starý Smokovec, Slovakia, September 7-11, 2015
- IVth Interactive Conference of Young Scientists 2012, April 4-May 5, 2012
- Vth Interactive Conference of Young Scientists 2013, April 4-May 5, 2013
- VIth Interactive Conference of Young Scientists 2014, May 7-June 6, 2014
- VIIth Interactive Conference of Young Scientists 2015, May 5-June 6, 2015

MUCHA, Ján (organising committee)

- 1st Conference of Centre of Excellence for Glycomics "Recent and incoming functions of the Centre", Bratislava, Slovakia, May 23, 2012

PÄTOPRSTÝ, Vladimír (organising committee)

- 1st Conference of Centre of Excellence for Glycomics "Recent and incoming functions of the Centre", Bratislava, Slovakia, May 23, 2012

TKÁČ, Ján (programme committee)

- IVth Interactive Conference of Young Scientists 2012, April 4-May 5, 2012
- Vth Interactive Conference of Young Scientists 2013, April 4-May 5, 2013

- VIth Interactive Conference of Young Scientists 2014, May 7-June 6, 2014
- VIIth Interactive Conference of Young Scientists 2015, May 5-June 6, 2015

VLČKOVÁ, Silvia (organising committee)

- 1st Conference of Centre of Excellence for Glycomics "Recent and incoming functions of the Centre", Bratislava, Slovakia, May 23, 2012

- **Supplementary information and/or comments documenting the international and national status of the Institute**

List of significant cooperating foreign universities and institutions:

University of Oxford, University of York, University of Bath, University of Leeds, Manchester Intedisciplinary Biocentre (UK); Lund University, Chalmers University of Technology (Sweden); VTT Technical Research Centre of Finland, Åbo Academi University (Finland); Norwegian University of Life Sciences (Norway); University of Copenhagen, Novozymes AS (Denmark); University of Natural Resources and Life Sciences (BOKU) in Vienna, University of Vienna (Austria); University of Nancy, University of Liege, Blaise Pascal University, Grenoble Alpes University, UMR CNRS, INRA (France); Leibnitz Institute DSMZ (Germany), Wroclaw University of Technology (Poland); University of Debrecen (Hungary); Ege University (Turkey); Complutense University of Madrid, University of Cordoba (Spain); University of Bari, University of Milan, University of Pisa, Institute for Macromolecular Studies, Illycaff S.p.a. (Italy); University of Trás-os-Montes and Alto Douro (Portugal); Russian Academy of Sciences; University of Belgrade (Serbia); USDA ARS Western Regional Research Center (USA); Food Research Institute (Japan); Qatar University (Qatar); Stellenbosch University, University of KwaZulu-Natal (South Africa); University of Adelaide (Australia); The Catholic University of Korea; University of Burdwan (India); University of Chemistry and Technology in Prague, Masaryk University, Brno University of Technology (Czech Republic).

List of significant cooperating domestic universities and institutions:

Comenius University (faculties in Bratislava and Martin), Slovak University of Technology in Bratislava, Slovak Medical University, Slovak University of Agriculture in Nitra, Pavol Jozef Šafárik University in Košice, University of Ss. Cyril and Methodius in Trnava, Alexander Dubček University in Trenčín National Agricultural and Food Centre, Institute of Apiculture, International Laser Centre, Axxence Slovakia s.r.o., Tau-Chem s.r.o., HighChem s.r.o., Saneca Pharmaceuticals a.s.

It is a great honour for the Institute of Chemistry (and for Slovak research community too) that the members of the International Carbohydrate Organisation at their meeting held on the 27th International Carbohydrate Symposium in Bangalore, India (2014) decided that the 32nd International Carbohydrate Symposium in 2024 will be organised by the Institute of Chemistry SAS in Bratislava, Slovakia. This decision was undoubtedly influenced by a knowledge about a very successful organisation of the 13th European Carbohydrate Symposium organised by the Institute in 2005 in Bratislava, where more than 500 scientists attended.

2.4. Tables of project structure, research grants and other funding resources

- **International projects and funding**
 - 2.4.1. Major projects within the European Research Area and other important project – Framework Programmes of the EU, ERA-NET, European Science Foundation, NATO, COST, INTAS, etc.**

(here and in items below are specified: type of project, title, grant number, duration, total funding and funding for the Institute, responsible person in the Institute and his/her status in the project, e.g. coordinator “C”, work package leader “W”, investigator “I”)

Year	Project title	Type / Project number	Duration in months	Funding for the Institute (EUR)	Role of the Institute / Responsible person
2012	Nanoparticles for therapy and diagnosis of Alzheimer disease - NAD	FP7/NMP4-LA-2008-212043	09/2008-08/2013	84910	I / Tvaroška
	Cancer diagnosis: Parallel sensing of prostate cancer biomarkers	FP7/317420	10/2012-09/2016	357543	I / Tkáč
	Integrated structural biology infrastructure for Europe (INSTRUCT)	FP7/211252	04/2008-12/2015	13400	I / Hricovíni
	Enhancing access and services to East European users towards an efficient and coordinated Pan-European pool of NMR capacities to enable global collaborative research & boost technological advancements (EAST-NMR)	FP7/228461-EAST-NMR	02/2009-01/2013	41077	I / Hricovíni
	Microbial Resource Research Infrastructure (MIRRI)	FP7-312251	11/2012-10/2015	9833	I / Vadkertiová
	ESF-EuroGlycoforum-Research Networking Program	ESF/RNP-LESC-07-RNP-015	05/2009-04/2014	9333	I / Mucha
	Multidisciplinary frontiers of magnetic resonance	ESF/RNP-PESC-05-PGM-022	04/2007-04/2012	6332	I / Matulová
	Cascade chemoenzymatic processes - new synergies between chemistry and biochemistry	COST Action CM0701	10/2008-04/2012	1333	I / Gemeiner
	Colloidal aspects of nanoscience for innovative processes and materials	COST CMST Action CM1101	06/2011-01/2016	17200	I / Gemeiner
	Analytical techniques for biorefinerie	COST Action FP0901	08/2009-05/2013	8617	I / Hromádková
	Food waste valorisation for sustainable chemicals, materials & fuels (EUBis)	FA COST Action TD1203	11/2012-11/2016	12667	I / Hromádková
	Mineral-improved crop production for healthy food and feed	COST Action FA0905	01/2010-12/2013	9000	I / Lišková
	Chemical approaches to targeting drug resistance in cancer stem cells	COST CMST Action CM1106	03/2012-03/2016	15000	I / Tvaroška
	Multivalent glycosystems for nanoscience - MultiGlycoNano	COST CMST Action CM1102	11/2011-11/2015	16000	I / Tvaroška
2013	Electrochemical LEctin and glycan biochips integrated with NAnostructures	FP7/311532-ERC-SG-LS9	01/2013-12/2017	600179	C / Tkáč
	Systems biocatalysis	CMST COST Action CM1303	11/2013-11/2017	8667	I / Nahálka
2014	Valorisation of lignocellulosic biomass side streams for sustainable production of chemicals, materials & fuels using low environmental impact technologies	FPS COST Action FP1306	05/2014-05/2018	6667	I / Mastihuba
2015	Challenging organic syntheses inspired by nature – from natural products chemistry to drug discovery	CMST COST Action CM1407	03/2015-03/2019	3167	I / Mastihubová
	Study of reaction mechanism of glycosyl transferases using ab initio molecular dynamics as a tool for design of inhibitors	FP7/SASPRO-0005/01/02	07/2015-06/2018	32395	C / Kozmon

2.4.2. Other international projects, incl. total funding and funding for the Institute

Year	Project title	Type / Project number	Duration in months	Funding for the Institute (EUR)	Role of the Institute / Responsible person
2012	Structural analysis of natural compounds from medicinal plants	DK Analityka/Agreement	06/2011-09/2013	11796	I / Capek
2013	Development of potent and selective glycosyltransferase inhibitors	SAS-NSC 2012/8	01/2013-12/2015	66000	C / Tvaroška
	NMR study of biosurfactants produced by bacteria isolated from cloud water and arctic snow	SAS-CNRS/3	01/2013-12/2014	2400	C / Matulová
	Innovative enzyme technology for biomass processing	Research Council of Norway/Agreement	01/2013-12/2014	12500	I / Biely
2014	Preparation, characterisation and application of lectin biochips in cancer diagnosis and in discovery of cancer biomarkers)	QNRN-NPRP 6-381-1-078	01/2014-12/2016	209506	C / Tkáč

2.4.3. Other important, international projects and collaborations without direct funding

(Selected 11 projects; project/collaboration title and cooperating organisation are given in brackets)

- [1] The study of catalytic mechanism of glycosyltransferases
(National Centre for Research of Biomacromolecules, Masaryk University, Brno, Czech Republic)
- [2] The study of plant cell walls
(Australian Centre for Plant Functional Genomics, University of Adelaide, Glen Osmond, Australia)
- [3] Structural analysis of *N*-linked oligosaccharides, glycopeptides and glycoconjugates
(Institute of Chemistry, University of Natural Resources and Life Sciences, Vienna, Austria)
- [4] Macrophages as targets of immunomodulatory effect of β -glucans during tumour and inflammation
(Institute of Physiology and Fundamental Medicine, Siberian Branch of RAMS, Novosibirsk, Russia)
- [5] Structure and biological activity of polysaccharides of various plant materials
(Department of Biotechnology, The Catholic University of Korea, Bucheon, Republic of Korea)
- [6] Immunomodulatory properties of synthetic oligosaccharides in vivo and ex vivo
(N.D. Zelinsky Institute of Organic Chemistry, Russian Academy of Sciences, Moscow, Russia)
- [7] Microbial production of industrially important enzymes
(Institute of Food Chemistry and Biotechnologies, Brno University of Technology, Brno, Czech Republic)
- [8] Immunomodulatory activity of plant polysaccharides
(Department of Pharmacognosy, University of Oslo, Oslo, Norway)
- [9] Influence of soil contamination on structure and function of plant root
(Joint Research Unit for Soils and the Environment, INRA, Vandoeuvre-les-Nancy, France)
- [10] Application of lectin microarray for monitoring of specific expression of glycoconjugates as markers of functional state of system on whole animal cells
(Faculty of Veterinary Medicine, University of Bari "Aldo Moro", Bari, Italy)
- [11] The study of polysaccharide films structure using atomic force microscopy
(Center of Molecular and Macromolecular Studies, Polish Academy of Sciences, Lodz, Poland)

- **National projects and their funding**

2.4.4. Projects supported by the Slovak Research and Development Agency (APVV) [Role of the Institute of Chemistry (IC): coordinator “C”, investigator “I”]

Year	Project title	Type / Project number	Duration in months	Funding for the IC (EUR)	Role of the IC / Responsible person
2012	Biotechnological preparation of new types of functional cereals and cereal products enriched with polyunsaturated fatty acids and pigments	APVV-0662-11	07/2012-12/2015	20190	I / Breierová
	Immobilisation techniques for preparation of biocatalysts for industrial production of natural flavours)	APVV-0302-10	05/2011-10/2014	51679	C / Bučko
	Biodecorated composite magnetic nanoparticles: Preparation, collective properties and applications	APVV-0125-11	07/2012-12/2015	20449	I / Capek
	Undersdanding of plant adaptation in the radioactive Chernobyl area	APVV-0740-11	07/2012-12/2015	0	I / Nahálka
	Plant ionome modification by silicon for improvement of the crop nutrition quality	APVV-0140-10	05/2011-10/2014	34000	I / Lišková
	Alteration in cell metabolism associated with drug transporter – P-glycoprotein overexpression in leukemia cells	APVV-0290-10	05/2011-10/2014	19372	I / Katrlík
	Preparation of nanostructured interfaces, their integration with bioelements and subsequent use	APVV-0282-11	07/2012-12.2015	135088	C / Tkáč
	Nanoparticles for therapy and diagnosis of Alzheimer disease - NAD	APVV-DO7RP-0013-08	09/2008-06/2013	9096	I / Tvaroška
	Lectin biochips for characterisation of glycan structure of the IGF system proteins as a tool for research, diagnostics and therapy of colorectal carcinoma	APVV-SK-SRB-0041-11	01/2012-12/2013	2430	C / Katrlík
	NMR study of the structure of biosurfactants produced by bacteria isolated from cloud water and arctic snow	APVV-SK-FR-0030-11	01/2012-12/2013	3930	C / Matulová
2013	Study of regulation of radical and cellular signaling during hypertension and influence of novel therapies on this signaling	APVV-0348-12	10/2013-09/2017	11000	I / Nahálka
	New opinions on pharmacological modulation of allergic asthma	APVV-0305-12	10/2013-09/2017	23000	I / Capek
	Research and development of silicon carbide thin film technologies for applications in solar cells and thin film devices	APVV-0443-12	10/2013-12/2016	11065	I / Sasinková
	Chemoenzymatic synthesis and evaluation of biological activities of natural glycophenolics and their analogues	APVV-846-12	10/2013-09/2017	51932	C / Mastihubová
	Structural design, synthesis and evaluation of selective inhibitors of glycoside hydrolases from the family 38	APVV-484-12	10/2013-09/2017	93990	C / Poláková
	Structure, properties and biotechnological potential of novel microbial enzymes degrading plant biomass	APVV-0602-12	10/2013-09/2017	56700	C / Puchart
	Polymeric substances from instant coffee powder	APVV-SK-PT-0024-12	01/2013-12/2014	5400	C / Capek
	Polysaccharide-polyphenolic conjugates with anticoagulant and antioxidant activity from selected plants of <i>Asteraceae</i> a <i>Rosaceae</i> families	APVV-SK-PL-0084-12	01/2013-12/2014	4000	C / Capek
2014	– (There was no General call in 2013)				
2015	Biochips and biosensors for glycorecognition, their development, preparation and application in cancer research	APVV-14-0753	07/2015-06/2019	15900	C / Katrlík
	Possible dual function of P-glycoprotein in leukemia cells: efflux pump and regulatory protein	APVV-14-0334	07/2015-10/2018	2850	I / Katrlík

Determination of glycosylation changes of proteins related to colorectal carcinoma using modern sensitive lectin biochips with impact to cancer research, diagnostics and therapy	APVV-SK-SRB-2013-0028	01/2015-12/2016	2101	C / Katrík
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2.4.5. 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	2012	2013	2014	2015
Number	22	20	19	18
Funding in the year (EUR)	176604	179539	174329	178976

Note: Excluding projects for the popularisation of science.

- **Summary of funding from external resources**

2.4.6. List of projects supported by EU Structural Funds

(Project title, duration and the role of the Institute are given)

- [1] Centre for materials, layers and systems for applications and chemical processes under extreme conditions (2010–2012; IC SAS as a partner)
- [2] Completion of Excellence centre for methods and processes of green chemistry (2010–2013; IC SAS as a partner)
- [3] Excellence centre for Glycomics (2010–2013; IC SAS as a coordinator)
- [4] Excellence centre for white-green biotechnology (2010–2013; IC SAS as a coordinator)
- [5] Applied research in the field of industrial biocatalysis (2012–2014; IC SAS as a partner)
- [6] Completion of technical infrastructure for research in the field of new biotechnologies (2013–2015; IC SAS as a coordinator)
- [7] Upgrading of infrastructure for biomedical research (2015; IC SAS as a coordinator and sole recipient)
- [8] Technical infrastructure of research unit (2015; IC SAS as a coordinator and sole recipient)

2.4.7. Summary of external resources of the EU Structural Funds (ERDF/ESF)

Role of the Institute in the project, e.g. coordinator “C”, work package leader “W”, investigator “I”.

Year	Project title	Project number	Duration in months	Funding for the Institute (EUR)	Role of the Institute
2012	Excellence centre for Glycomics	26240120031	09/2010-12/2014	3395560	C
	Excellence centre for white-green biotechnology	26220120054	09/2010-08/2013	3461535	C
	Applied research in the field of industrial biocatalysis	26240220079	02/2012-03/2014	436929	I
	Completion of Excellence centre for methods and processes of green chemistry	26240120025	01/2010-09/2013	21610	I
	Centre for materials, layers and systems for applications and chemical processes under extreme conditions - Stage II	26240120007	04/2010-03/2012	3171	I
2013	Completion of technical infrastructure for research in the field of new biotechnologies	26210120029	12/2013-06/2015	2797200	C
2014	–	–	–	–	–
2015	Upgrading of infrastructure for biomedical research	26230120008	11/2015-12/2015	8317020	C
	Technical infrastructure of research unit	26210120049	11/2015-12/2015	9367000	C

External resources	2012	2013	2014	2015	total	average
External resources (milions of EUR)	7.444	1.243	1.729	21.895	32.311	8.078
External resources transferred to cooperating research institute (milions of EUR)	0.081	0.101	0.380	0.069	0.631	0.158

- **Supplementary information and/or comments on research projects and funding sources**

Within the projects of the EU Structural Funds, the Institute acquired approximately 27.8 mil. € (included in 32.311 mil. € of External resources in Table above). These finances were mainly used for acquisition of top-level research infrastructure for Analytical Department and some laboratories at the Institute as well as for joint research facilities in Nitra and Hlohovec. In addition, a part of building (Pavilion) was completely reconstructed (ca. 180000 €) and some consumables were also provided.

2.5. PhD studies and educational activities

2.5.1. List of accredited programmes of doctoral studies, period of validity

- [1] 4.1.16 Organic chemistry (supervised by: PriF UK and FCHPT STU)
- [2] 4.1.18 Physical chemistry (supervised by: PriF UK and FCHPT STU)
- [3] 4.1.19 Macromolecular chemistry (supervised by: FCHPT STU)
- [4] 4.1.22 Biochemistry (supervised by: PriF UK and FCHPT STU)

[5] 4.2.27 Microbiology (supervised by: PriF UK)

[6] 5.2.25 Biotechnologies (supervised by: PriF UK and FCHPT STU)

Period of validity: Since 2015 (last accreditation of supervising universities) until next complex accreditation of supervising universities) - for all above mentioned programmes (for 4-year internal and for 5-year external studies).

Note: PriF UK = Faculty of Natural Sciences, Comenius University in Bratislava; FCHPT STU = Faculty of Chemical and Food Technology, Slovak University of Technology in Bratislava).

**2.5.2. Summary table on doctoral studies
(number of internal/external PhD students, number of foreign PhD students, number of students who successfully completed their theses, number of PhD students who quit the programme)**

PhD study	12/31/2012			12/31/2013			12/31/2014			12/31/2015		
Number of potential PhD supervisors	38			39			42			47		
PhD students	number	defended thesis	students quitted									
Internal	25.0	6.0	1.0	27.0	6.0	2.0	23.0	6.0	4.0	24.0	6.0	0.0
External	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
Other supervised by the research employees of the institute	2.0	1.0	0.0	3.0	1.0	0.0	3.0	2.0	0.0	2.0	2.0	0.0

2.5.3. Summary table on educational activities

Teaching	2012	2013	2014	2015
Lectures (hours/year) ²	49	75	70	77
Practicum courses (hours/year) ²	128	264	273	374
Supervised bachelor theses (in total)	3	8	9	14
Supervised diploma theses (in total)	2	4	4	7
Supervised PhD theses (in total)	26	34	33	31
Members in PhD committees (in total)	8	7	6	7
Members in DrSc. committees (in total)	3	2	5	4
Members in university/faculty councils (in total)	2	3	3	3
Members in habilitation/inauguration committees (in total)	3	0	1	1

Note: ²Time spent with bachelor, diploma or PhD students during their supervising is not included.

2.5.4. List of published university textbooks

2.5.5. Number of published academic course books

2.5.6. List of joint research laboratories/facilities with universities

[1] *Joint Laboratory of Fourier Transform Infrared Spectroscopy*

Joint research laboratory of Institute of Inorganic Chemistry SAS, Institute of Chemistry SAS, Faculty of Chemical and Food Technology (Slovak University of Technology), and Faculty of Natural Sciences (Comenius University) situated at Institute of Chemistry SAS. The Laboratory serves for basic service and special measurements for individual research projects and pedagogical purposes, as well. Nicolet 6700 spectrometer with several additional accessories, new IR Nicolet iS50 spectrometer with Raman and GC-IR modules, Infrared Microscopy Nicolet iN10 and DXR Raman microscope are available.

[2] *National NMR Centre*

Established at Faculty of Chemical and Food Technology (Slovak University of Technology). In the framework of the state research and development program, this Center joints NMR laboratories of Faculty of Chemical and Food Technology (Slovak University of Technology in Bratislava), Faculty of Natural Sciences, (Comenius University in Bratislava), Faculty of Natural Sciences (P.J. Šafárik University in Košice) and Institute of Chemistry SAS. The NMR laboratory at the Institute of Chemistry SAS is equipped with two NMR instruments (Bruker Avance III D 600 MHz and 400 MHz) and serves for basic service and special measurements for individual research projects and pedagogical purposes, as well.

[3] *Joint Facility of Metabolics of Plants, Plant Materials and Foods of Plant Origin*

This facility joints Institute of Chemistry SAS and Faculty of Biotechnology and Food Sciences of the Slovak University of Agriculture in Nitra. It was established in 2009 in Nitra with the aim to perform scientific projects of basic and applied research in the field of food sciences and biotechnologies. In addition it should serve as a training base for education of magister, doctorand and postdoctoral students as well as for visiting research and pedagogic scientists. In the framework of implementation of two projects supported by EU Structural Funds (3.23 mil. € and 2.80 mil. €) during 2011–2015, this facility was equipped with unique instrumental technique.

• **Supplementary information and/or comments on doctoral studies and educational activities**

Although the Institute has the capacity for education of more PhD students, the increase of their number is problematic due to existing competences and financing. According to effective legislative, all doctorands are PhD students of corresponding university and therefore finances from Ministry of Education are allocated to the university and the Institute has a status of external educational organisation. Financial support from Presidium of SAS and from institutional budget is limited. The quota for the IC SAS is four maximum five new PhD students per year. Despite this problem, about 25 PhD students in average per year are educated at the Institute. During this assessment period, an increased interest in PhD study was noticed for accredited programmes of Biotechnology and Biochemistry. But there is still deficiency in the field of Organic Chemistry, Macromolecular Chemistry and Physical Chemistry.

During the study, several PhD students realise research fellowships abroad to extend their knowledge. Reciprocally, many PhD students from abroad come to the Institute of Chemistry SAS (see Table below, documenting such longer-term research fellowships during this assessment period).

Foreign PhD students visiting the IC SAS			PhD students from IC SAS hosting abroad		
Name	Period	Country	Name	Period	Country
Accogli G.	6 weeks	Italy	Pakanová Z.	28 weeks	Austria
Muljuš G.	2 weeks	Serbia	Palenčárová K.	3 weeks	Germany
Robajac D.	2 weeks	Serbia	Šedivá A.	2 weeks	Serbia
Ziewiecki R.	18 weeks	Poland	Damborský P.	5 weeks	Portugal
Marková L.	26 weeks	Czech Republic	Damborský P.	4 weeks	England
Zichová M.	22 weeks	Czech Republic	Belický Š.	10 weeks	England
Tobolková B.	13 weeks	Czech Republic	Belický Š.	2 weeks	Portugal
Valicová M.	13 weeks	Czech Republic	Klunda T.	3 weeks	Finland
Horák R.	13 weeks	Czech Republic	–	–	–

Many PhD students, after defending their theses, frequently leave for postdoctoral scholars (2-3 years) at reputable universities abroad. This indicates a high quality of the PhD education at the Institute.

It is beneficial that existing joint laboratories with universities (Joint Laboratory of FTIR Spectroscopy, National NMR Centre, Joint Facility of Metabolics of Plants, Plant Materials and Foods of Plant Origin; see indicator 2.5.6.) serve, in addition to basic research, also as training bases for pedagogic purposes.

2.6. Social impact

2.6.1. List of the most important results of applied research projects

- [1] Identification and structure determination of selected organic compounds (for Saneca Pharmaceuticals, a.s., Hlohovec).
- [2] Testing of software Mass Frontier 4.0 for interpretation of fragmentation of organic compounds (for HighChem, Ltd., Bratislava).
- [3] Identification and structure determination of selected heterocyclic compounds (for Tau-Chem, s.r.o., Bratislava).
- [4] New formulations based on fungus *Trichoderma* for biological protection of plants, especially for thick-sown grain (for Azoter, spol. s r.o., Nové Zámky)
- [5] Expression of antimicrobial peptide defensin-1 in colony of bees (for Institute of Apiculture, Liptovský Hrádok)
- [6] Immobilisation of biocatalysts for industrial production of natural aromas (for Axxence Slovakia, s.r.o., Bratislava).
- [7] Serodiagnosis of inflammatory markers; fungi in etiology and sarcoidosis (for Faculty of Medicine, Comenius University in Bratislava).
- [8] Structural analysis of polysaccharides present in instant coffee produced from fruit of *Coffea arabica* (for Illy-Coffee, S.p.A., Trieste, Italy).

2.6.2. List of the most important studies commissioned for the decision-making authorities, the government and NGOs, international and foreign institutes

BYSTRICKÝ, Slavomír; GEMEINER, Peter; HRICOVÍNI, Miloš; MATULOVÁ, Mária

External members of Commission for decision making in objections at Public Procurement Office (2007–)

BUČKO, Marek

Member of Selection Commission of the National Fellowship Programme for selection of applicants from abroad; SAIA, n.o. (2011–2013)

HROMÁDKOVÁ, Zdenka

Member of Sector Council for Food Processing Industry in the programme of Ministry of Education, Science, Research and Sport and Ministry of Labour, Social Affairs and Family of the Slovak Republic "National System of Professions" (2012–)

MATULOVÁ, Mária

Member of Sector Council for Chemistry and Pharmacy in the programme of Ministry of Education, Science, Research and Sport and Ministry of Labour, Social Affairs and Family of the Slovak Republic "National System of Professions" (2012–)

HRICOVÍNI, Miloš; TVAROŠKA, Igor

Members of Council of National NMR Centre (2008–)

PETRUŠ, Ladislav

Member of the Jury for Administration of the Literary Fund Prices (2015)

Member of the Junior Chamber International Jury for the Student Personality of Slovakia Award (2012–2015)

Member of the jury in project Science Makes the Future (2014)

Expert evaluating the projects of Austrian Science Fund - FWF (2015); COST CMST and TD (2012–2014); KORANET (2012)

KATRLÍK, Jaroslav

Expert evaluating the projects of H2020-MSCA-IF2015 (2015); H2020-Personalising health and care (2014); FP7-PEOPLE-IEF-IIF-IOF (2012–2013); FP7-ICT2011-8 (2012); Croatian Science Foundation (2012)

GEMEINER, Peter; PETRUŠ, Ladislav

Members of the Council of Natural Sciences of Slovak Research and Development Agency (2012–2014)

TKÁČ, Ján

Expert evaluating the projects of South African Medical Research Council.

2.6.3. List of contracts and research projects with industrial and other commercial partners, incl. revenues

- [1] *DK Analytika, Jelenia Gora, Poland*
Structural analysis of natural compounds from medicinal plants
Revenues: 11 796 €
- [2] *Novozymes A/S, Bagsvaerd, Denmark*
Application and characterisation of xylanases: Mode of action of G30 xylanases
Revenues: 15 000 €
- [3] *Annikki GmbH, Graz, Austria*
Bioconversion of wheat straw xylan
Revenues: 7 500 €
- [4] *VP Research, Health Sciences North, Sudbury, Ontario, Canada*
Production of Cholera O1 39 O-specific polysaccharide + core (without toxic Lipid A)
Revenues: 9 000 €
- [5] *Novozymes A/S, Bagsvaerd, Denmark*
Substrate specificity of xylanase GH30 from *Erwinia chrysanthemi*
Revenues: 7 500 €
- [6] *Novozymes A/S, Bagsvaerd, Denmark*

- Diversity of catalytic properties of xylanases family GH30
Revenues: 7 500 €
- [7] *Novozymes A/S, Bagsvaerd, Denmark*
Action of different types of endoxylanases on native plant cell walls
Revenues: 1 000 € (in 2015; 7 500 € for whole contract)
- [8] *Pulp and Paper Research Institute, a.s., Bratislava*
Determination of elemental composition of samples
Revenues: 700 €
- [9] *TAU-CHEM, s r.o., Bratislava*
IR, NMR, elemental and organic analyses and evaluation of results
Revenues: 15 830 €
- [10] *Biotika, a.s., Slovenská Ľupča*
LC-MS analyses and evaluation of results
Revenues: 2 000 €
- [11] *Saneca Pharmaceuticals, a.s., Hlohovec*
LC-MS analyses and evaluation of results
Revenues: 22 710 €
- [12] *HAMELN rds a.s., Modra*
LC-MS analyses and evaluation of results
Revenues: 570 €
- [13] *AQUA Invest Slovakia, s.r.o., Bernolákovo*
Chemical and microbiological analyses and evaluation of results
Revenues: 2 070 €
- [14] *National Drilling Company, s.r.o., Bernolákovo*
Chemical and microbiological analyses and evaluation of results
Revenues: 1 613 €
- [15] *XIMEA s.r.o., Marianka*
Chemical and microbiological analyses and evaluation of results
Revenues: 823 €
- [16] *VermiVital s.r.o., Záhorce*
Determination of enzymatic activity of commercial preparations
Revenues: 810 €

2.6.4. List of licences sold abroad and in Slovakia, incl. revenues

2.6.5. List of most important social discourses under the leadership or with significant participation of the Institute

- [1] Spectral analyses for diagnosis of rare diseases (for 2nd Children Clinic at Faculty of Medicine of Comenius University and Children's Faculty Hospital with Polyclinic in Bratislava and St Michael's Hospital in Bratislava).
- [2] Differential diagnostics of vaginal candidosis in atopic patients (for Department of Clinical Immunology and Allergy, Faculty Hospital of Comenius University and for Department of Clinical Immunology and Allergy, Oncology Institute of St. Elisabeth in Bratislava).
- [4] Creation and upgrading of the Catalog of CCY (database of the yeasts collected by the Culture Collection of Yeasts).
- [5] Editorial activities: fifteen employees served as members (among them one editor, two managing editors, two associate editors, three assistant editors) of

- editorial/editorial advisory boards of fifteen foreign and three domestic scientific journals.
- [6] Membership in the Slovak Academy of Sciences bodies: one member of the Presidium of SAS, seven members of the Scientific Advisory Board of SAS, sixteen memberships (seven employees) in various Commissions of SAS, seven members (among them one vice-chairman) of Commission VEGA.
 - [7] Four employees were members of the Scientific Board of four university's faculties.
 - [8] At average, each year six employees reviewed nine dissertation theses and inaugural dissertations, four employees served as members of Commissions for the defence of DrSc theses, seven employees as members of Commissions for the defence of PhD theses and two employees as members of Commissions for the habilitation and inaugural process at universities.
 - [9] Many employees served as officers or national delegates of several significant foreign and domestic scientific societies, associations and international organisations like Slovak Chemical Society (Hirsch, Mastihuba), Czechoslovak Microbial Society (Biely, Breierová), International Academy of Wood Science (Biely), International Carbohydrate Organisation (Hirsch), European Carbohydrate Organisation (Hirsch, Hricovíni), International Glycoconjugate Organisation (Katrлік), International Society for Mass Spectrometry (Pätoprstý), COST Chemistry and Molecular Sciences and Technologies Domain Committee (Petruš). The Culture Collection of Yeasts is a corporate member of the European Culture Collections' Organisation and the World Federation for Culture Collections. Individual employees are members of following societies/organisations: American Chemical Society, International Society of Heterocyclic Chemistry, Federation of European Societies of Plant Biology, International Association of Plant Tissue Cultures-Biotechnology, European Peptide Society.

2.6.6. Summary of relevant activities, max. 300 words

List of joint research laboratories/facilities with industrial partners and other companies

- [1] *Axxence Slovakia s.r.o., Bratislava*
Joint research facility "Axxence Park-Hall 1 – Applied research in the field of industrial biocatalysis"
It was established in 2013 and it supplies complex infrastructure for effective applied research of isolation of natural aromas and their final purification. As a part, special equipments are available.
- [2] *Saneca Pharmaceuticals a.s., Hlohovec*
Joint research facility "Saneca-Infrastructure-HL – Applied research in the field of biomedicine"
It was established in 2015 to support transfer of results of basic research to the praxis and to afford appropriate infrastructure for effective applied research in the field of identification, isolation and purification of important natural compounds and their precursors.

To enhance the cooperation between research and industry, several academic and university research units (Institute of Chemistry SAS, Institute of Experimental Pharmacology and Toxicology SAS, Faculty of Chemical and Food Technology of the Slovak University of Technology, Faculty of Natural Sciences of the Comenius University, Faculty of Natural Sciences of the University of Ss. Cyril and Methodius) and private-sector industrial research and production units (HighChem s.r.o, Tau-Chem s.r.o., Saneca Pharmaceuticals a.s.) created in 2015 the O4H (acronym for "Omics for Health") cluster with the aim to integrate mutual research and developmental activities.

2.7. Popularisation of Science (outreach activities)

2.7.1. List of the most important popularisation activities

(selected 20 items)

- [1] BERTÓK, T. - PIHÍKOVÁ, D. - BELICKÝ, Š. - KIRINOVIČ, P. Investigation of biomarkers for diagnosis of some diseases. In *Television TA3, appearance in broadcast: Science within reach, July 2, 2015* (<http://www.ta3.com/clanok/1064973/veda-na-dosah-z-2-jula.html>).
- [2] FILIP, J. - KLUKOVÁ, Ľ. - TKÁČ, J. Beautiful new bioelectronanoworld. In *Quark*, 2015, vol. XXI, no. 2, p. 28-29.
- [3] TKÁČ, J. - FILIP, J. - PETROVIČ, J. Our scientists revealed how to use material of the future. In *Aktuality.sk, Správy (Spotlights.sk, News) (6:00 h), August 10, 2015* (<http://www.aktuality.sk/clanok/301612/nasi-vedci-odhalili-svetu-ako-pouzit-material-buducnosti-elektrobaterka>).
- [4] BIELY, P. Cell walls make decisions. In *Flavor of science*. Martin: Publishing House of Matica slovenská, 2015. p. 45-47.
- [5] PETRUŠ, Ľ. COST experience, lesson and messages. In *COST Info Day*. Lecture at the Slovak Centre of Scientific and Technical Information, Bratislava, March 3, 2015.
- [6] VRŠANSKÁ, M. Honour for Slovak science. In *Bulletin of the Czechoslovak Microbial Society*, 2015, vol. LVI, no. 2, p. 85-86.
- [7] TKÁČ, J. - BERTÓK, T. - JURIKOVÁ, S. How to exist more healthy thanks to biotechnologies. In *Radio and Television Slovakia, Radio Slovensko, interview in broadcast: Night pyramid, September 26, 2014* (<http://www.rtv.slovakia.sk/radio/relacie/detail/nocna-pyramida/archiv?date=26.09.2014>).
- [8] KATRLÍK, J. Institute of Chemistry SAS and the project Prosenec. In *Radio and Television Slovakia, Radio Regina, interview in broadcast: Radio Regina Magazine, February 19, 2014*.
- [9] HUSHEGYI, A. - ŠLOSÁROVÁ, M. - BABINSKÁ, M. The night of researchers. In *Radio and Television Slovakia, Radio Regina, interview in broadcast: Guest of Radio Regina Bratislava, September 19, 2014* (<http://www.rtv.slovakia.sk/radio/relacie/detail/host-radia-reg>).
- [10] BIELY, P. What is a prebiotic? In *Quark*, 2014, vol. XX, no. 4, p. 30-31.
- [11] FARKAŠ, P. - FERKO, M. VII. Annual interactive conference of young scientists continues in the sign of news. In *ChemZi*, 2014, vol. 10, no. 2, p. 62-63.
- [12] BIELY, P. Cradle of the Nobel Prize laureates. In *SAV News*, 2014, vol. 50, no. 9, p.8-9.
- [13] MASTIHUBA, V. - OMASTOVÁ, M. Science in the centre with personalities of chemistry. In *ChemZi*, 2013, vol. 10, no. 1, p. 26.
- [14] TKÁČ, J. Sweet biochips in bioanalysis. In *Pan European Networks: Science & Technology*, June 2013, Issue 07, p. 18.
- [15] BIELY, P. Engine fuels from cellulose. In *Quark*, 2013, vol. XIX, no. 5, p. 34-35.
- [16] TKÁČ, J. Saccharides as markers of diseases. In *Festival of Science - The Night of Researchers 2013*. Lecture at AVION, Bratislava, September 27, 2013.
- [17] KOÓŠ, M. - SHOEBRIDGE, G. Sugars in medicines. In *Radio and Television Slovakia, Radio Slovakia International EN, interview in broadcast: Reports: Society, February 28, 2012*.
- [18] BIELY, P. Saccharides – a key to youth In *Quark*, 2012, vol. XVIII, no. 2, p. 18-19.
- [19] TKÁČ, J. - KOÓŠ, M. - VALOVIČ, P. Research on glycans. In *Radio and Television Slovakia, Slovak Radio, broadcast: News, August 19, 2012*.
- [20] TKÁČ, J. - ČUPKA, M. He investigates sugar which maybe overcome the cancer and viruses. In *Pravda, section of newspaper Pravda: Weekend, September 22, 2012, p. 16-18*.

2.7.2. Table of outreach activities according to Institute annual reports

Outreach activities	2012	2013	2014	2015	Total
Articles in press media/internet popularising results of science, in particular those achieved by the Institute	5	8	11	16	40
Appearance in telecommunication media popularising results of science, in particular those achieved by the Institute	5	1	5	3	14
Public popularisation lectures	9	14	12	12	47

- **Supplementary information and/or comments on popularisation activities**
(max. 300 words)

The Institute organises the Doors Open Day (regularly each year in November). During this day, visitors can see research laboratories and instrumentation and discuss with corresponding scientists and instrument operators. In addition, there are many popularisation lectures and visual exhibitions.

The Institute attends (each year) some exhibitions and trade fairs (International Agricultural and Food Exhibition AGROKOMPLEX, Techforum, Slovmedica) where presents collection of rare saccharides (produced by the Production Department), collection of yeasts, dyed polysaccharides, biotechnological applications of plant cultures in vitro for human health, etc.

The Institute attends periodically the Science and Technology Week in the Slovak Republic, an popularisation event organised by the Ministry of Education, where scientific activities are presented to the public (lectures, practical experiments and exhibitions).

The Institute co-organised (in 2014 and 2015) popularisation excursions for high school students (project "The science for future" - 122 students from four high schools attended and project "Superschool" - seven high schools attended). In addition, a number of lectures was presented directly at the pertinent high schools.

2.8. Background and management. Human resources and implementation of recommendations from previous assessment

2.8.1. Summary table of personnel

Personnel	2012	2013	2014	2015
All personnel	131.0	130.0	138.0	147.0
Research employees from Tab. Research staff	82.0	81.0	87.0	96.0
FTE from Tab. Research staff	67.870	71.330	73.730	79.520
Average age of research employees with university degree	46.6	47.1	47.0	46.3

Note: The data for average age of research employees with university degrees in Table 2.8.1. are not quite correct because full time equivalent work capacities (FTE = 1) of these employees are used for calculation of the average age. But many of them have FTE lower than 1. Actually, there are some employees older than 70 years with FTE of only 0.05. They are very beneficial (experiences, contacts, projects, consulting, ...) for the Institute but the inclusion of their age in calculations deforms average age markedly.

2.8.1.1. Professional qualification structure (as of 31.12. 2015) FEMALE

FEMALE	AGE									
	Number of	< 30	31 - 34	35 - 39	40 - 44	45 - 49	50 - 54	55 - 59	60 - 64	> 65
DrSc. / prof.	0	0	0	0	0	0	0	0	1	1
II.a / Assoc. prof.	0	2	1	2	2	1	6	4	2	
Other researchers PhD./CSc.	7	10	1	1	0	1	1	0	0	
doc. / Assoc. prof.	0	0	0	0	0	0	0	0	0	

2.8.1.2. Professional qualification structure (as of 31.12. 2015) MALE

MALE	AGE								
	Number of	< 30	31 - 34	35 - 39	40 - 44	45 - 49	50 - 54	55 - 59	60 - 64
DrSc. / prof.	0	0	0	1	0	0	0	2	8
II.a / Assoc. prof.	1	1	4	4	2	1	4	3	0
Other researchers PhD./CSc.	1	1	0	1	0	0	0	1	0
doc. / Assoc. prof.	0	0	0	0	0	0	0	0	2

2.8.2. Postdoctoral and mobility scheme

2.8.2.1. Postdoctoral positions supported by national and international resources

none

2.8.2.2. Postdoctoral positions supported by external funding

Jaroslav Filip, PhD. postdoctoral position (2014-2015) supported by FP7/311532-ERC-SG-LS9 grant

Tomáš Bertók, PhD. postdoctoral position (2014-2016) supported by FP7/311532-ERC-SG-LS9 and QNRF-NPRP 6-381-1-078 grants

2.8.2.3. SAS stipends and SASPRO stipends

Stanislav Kozmon, PhD. SASPRO stipend for 07/2015–06/2018

2.8.2.4. Internal funding - the Slovak Academy of Sciences Supporting Fund of Stefan Schwarz

Jana Šefčovičová, PhD. postdoctoral position supported for 05/2011–04/2015

Lucia Paulovičová, PhD. postdoctoral position supported for 05/2012–04/2016

Pavol Farkaš, PhD. postdoctoral position supported for 01/2012–12/2015

Zuzana Košťálová, PhD. postdoctoral position supported for 01/2013–12/2016

Andrea Schenk Mayerová, PhD. postdoctoral position supported for 01/2014–12/2017
Maroš Bella, PhD. postdoctoral position supported for 05/2014–04/2018
Tomáš Bertók, PhD. postdoctoral position supported for 01/2015–12/2018
Jaroslav Filip, PhD. postdoctoral position supported for 05/2015–04/2019

2.8.3. Important research infrastructure (max. 2 pages)

i) Major instrumentation

Bruker Avance III HD 600 MHz NMR spectrometer with CryoPlatform (Bruker).

Bruker Avance III HD 400 MHz NMR spectrometer with CryoPlatform (Bruker).

LTQ Orbitrap Velos (Thermo Scientific); high-resolution mass spectra of low-molecular compounds and their fragments; determination of fragmentation schemes, primary and secondary structure of individual components from complicated mixtures; MSⁿ and ESI, APCI and APPI ionisation.

Orbitrap Elite upgrade with ion mobility and Nanospray Flex Ion Source (Thermo Scientific); structural analysis of protein complexes, peptidoglycans, small molecules.

LTQ Orbitrap XL, Accela 1250 (Thermo Scientific); ultrafast liquid chromatography connected to high-resolution mass spectrometer with ESI, APCI, APPI ionisation; detection of positive and negative ions.

UltrafleXtreme TM, Dionex ultimate 3000RSLC (Bruker); MALDI TOF/TOF measurements and interpretation of high-resolution mass spectra of high-molecular compounds and fragments.

Fusion Orbitrap Tribid mass spectrometer (Thermo Scientific); high-resolution mass spectrometer with MSⁿ fragmentation and ESI ionisation.

QTRAP 4500 Mass Spectrometry System (AB Sciex); monitoring of reactions; characterisation and quantitative analysis of compounds by ESI a APCI using unique "TripleTrap Scanning" and "MRM3" methods.

Thermo GC Quantum Ultra XLS (Thermo Scientific); separation and identification of volatile and non-volatile compounds; quantitative determination; monitoring of reaction progress; checking of products purity on the basis of GC-mass spectra.

EVOQ (Sciex) GC-TQ MS System (Bruker); determination of purity and physico-chemical properties of volatile compounds; characterisation and quantification of impurities and degradation products.

PlasmaQuant MS ICP mass spectrometer (Analytik Jena AG); targeted determination of individual elements in the sample; fast and multielemental analysis (range of 3 – 145 AMU) with sensitivity at 1 – 10 ppb level.

Illumina MiSeq DNA/RNA Sequencing System (Illumina); automatic sequencing of DNA/cDNA fragments - Next Generation Sequencing; high-throughput desk sequenator utilising technology of massive parallel sequencing – enables sequencing of whole genomes to obtain image of gene expression; exome sequencing in mutation status.

Label-free & Microarray Reader bScreen LB991 (Berthold); measurements of label free biomolecular interactions and processing of kinetic analyses for compounds with low-molecular weight.

Cell Sorter (Biorad); separation of cells with acquisition rate of more than 25000 events per second.

IR Spectroscopy System (IR Nicolet iS50 spectrometer with Raman and GC-IR modules) and Infrared Microscopy Nicolet iN10 (Thermo Scientific); DXR Raman microscope (Thermo Scientific); measurements of biochemical interactions.

IR Nicolet iS50 spectrometer, DXR SmartRaman spectrometer, DXR Raman microscope (Thermo Scientific); confirmation of identity and purity of compounds based on IR and Raman spectra.

Atomic Force Microscope BioScope Catalyst (Bruker); surface properties at atomic level with possibility to map proteins in tissues, measurements of interactions of biomolecules, identification of specific components; measurements in all modes, LFM, AC, mapping, nanomanipulations, nanolithography.

RTG D8 Advance diffractometer (Bruker); accessories: vertical theta-theta Bragg-Brentano geometry Si(Li) detector Sol-XE, Cu source of RTG radiation, Göbel mirror; scope: 0D, 1D and 2D mode.

DSC1/700 STARe and TGA/DSC 1 LF STARe System for thermal analysis (Mettler Toledo); monitoring of stability and phase transfers of crystalline compounds and partial determination of specific crystal system.

Organic Elemental Analyser Thermo Flash 2000 CHNS/O (Thermo Scientific); quantitative determination of C, H, N, and S content.

Thermo Scientific iCAP 7000 Series ICP-OES Duo analyser (Thermo Scientific); low cost multi-element analysis for measuring trace elements (detection limit > 1ppb).

RC1 EasyMax calorimeter (Metler Toledo); calorimetric measurements for validated processes of the preparation of compounds and their intermediates.

Dionex UltiMate 3000 (Dionex); qualitative and quantitative determination of organic compounds; separation of components prior to identification. Detection type: refractive index, UV/VIS absorbance, electrochemical, fluorescence, charged aerosol.

CytoFlex flow cytometer (Beckman Coulter); unique detection capabilities for 3 lasers and 13 colour research flow cytometry including nanoparticle research.

Biotechnology Unit for Enzymatic Transformations (Amedis); preparation of enzymatic fractions with required activity on the basis of lysates of microbial cells, plant or animal cell lines.

CR60-K Reactor System (Büchi); validation of quarter-manufacturing chemical productions.

BR60-K-S Crystallisation System (Büchi); validation of quarter-manufacturing chemical productions.

ii) The other instrumentation

HPLC 1200 Series (Agilent Technologies); HPLC Preparative Chromatography System Waters Delta Prep 3000; HPLC System (Shimadzu); HPLC Beckman System Gold (4 individually programmable blocks with integrated refractometer Beckman 156); HPLC with UV/VIS and RI detector (4 instruments); FPLC-Fluid Pressure Liquid Chromatography P-920 (Amersham Bioscience); Dionex ICS 5000 ion chromatograph, Flash chromatograph Isolera One (Biotage); GC-MS ITQ 900 GC-Ion Trap MS, Trace GC Ultra (Thermo Scientific); Gel Electrophoresis BioRad 3 System; Reverse-osmotic Unit SSR050G; Rotatory viscosimeter RHEOTEST 2; Rotatory digital viscosimeter LVDV-II+ Brookfield; Spectrophotometers SPEKOL 11 Beckman (4 instruments); UV/VIS spectrophotometer UV-1800 Shimadzu (3 instruments); Centrifuge Hettich Universal 32; Cooled centrifuge Jouan; Cooled centrifuge Boeco Hettich; Microtube centrifuge Biofuge Pico; Heraeus Inst. (2 instruments); Flow Calorimeter-Enzyme Thermistor Thermal Assay Probe-TAP3300 (AB Technology); Flow Injection Analyser-FIA System (intergrated with Flow Calorimeter and Process Monitoring Cabinet); Supercritical fluid extractor Lizard 2001 (SEKO-K); Encapsular reactor; Microwave reactor Discover (CEM); Ultrasonic homogeniser Person; Potentiostat/galvanostat Autolab PGSTAT 128N; Spin coater POLOS ACD200; Film applicator COATMASTER 509 MC (Erichsen); Two-channel electrochemical SPR Analyser Reichert SR7000DC; Two-channel potentiostat extension Autolab PGSTAT 128N; Microarray spotter Arrayit SpotBot; Microarray scanner InnoScan 710 (Arrayit Corporation); Ultrafiltrations Amicon (3 instruments); Microscopic Workstation (microscope LM 6-3 and stereomicroscope STM 723; digital picture processing, Kapa Optics); Fluorescence microscope Axio Vision Imager A1, Zeiss (with possibility of evaluation using Elispot/Fluorisplot method); Fluorescence microscope ECLIPSE 80i (Nikon); Inverted microscope DMI 3000-B and Digital microscope DMD 108 (Leica Microsystems); Jacomex glovebox gp (concept) T2; Melting point apparatus M-565 Buchi and Stuart SMP3; Laminar flow box machine MSC Advantage (Thermo Scientific); Real time PCRCFX 96 RTPCR; Colony picking robot QP

Expresion, modul QPix2; Microarray spotter and reader, ZeptoREADR; DNA amplifier BioRad C1000; Bioreactor unit, Sartorius Stedim; Homogeniser, Stansted Fluid Power.

iii) Efficient computer technique for theoretical calculations

Linux Workstations with Intel processors on 70 nodes (560 CPUs)

Linux Graphic cards workstations with Cuda processors on 5 nodes (10 thousand GPUs)

Intel Data server (25 TB disk storage)

QNAP Data server (10 TB disk storage)

This research infrastructure (especially modern sophisticated equipments) helps in solution of projects, in particular where separations, exact structural characterisation and determination of properties of studied compounds are required.

Most of the above mentioned top-level instruments are also available to other institutes of SAS as well as to the institutions outside of SAS - either in the form of services providing by the Analytical Department or there is a possibility of measurements by skilled researchers, postdoctoral and PhD students or operators from external domestic and foreign institutions. For example, several such measurements were done by researchers from Czech Republic, Austria, Italy and Serbia (mainly within cooperation in solving joint projects).

2.8.4. Description of how the results and suggestions of the previous assessment were taken into account

Suggestion 1) To organise training courses to teach PhD students and researcher from other institutes in sophisticated methods available at the Institute (MS, AFM, NMR), so that they should be able to operate these instruments under close supervision and to analyse results.

Most of sophisticated instruments are located at Analytical Department. In this respect, all measurements and services are realised by the qualified operators from this department. Each segment of instruments (GC and LC, MS, NMR, IR, ...) is supervised by corresponding operator which presents specialised lectures at institutional seminars or training courses. After relevant learning and training, there is a possibility for researchers and PhD students from the other departments (at least one person per department) and institutes to perform measurements at these instruments individually. Several training courses (like School of Mass Spectrometry, School of NMR Spectroscopy, EAST-NMR Annual User Meeting, ...) are co-organised with co-operating institutions and companies (Thermo Scientific, Beckman Coulter, Pragolab, Bruker, Shimadzu, Labo...). In the framework of Program BiochemNet (Agreement with Masaryk University in Brno, Czech Republic), specialised internships of Czech students are realised to teach them in modern analytical and biochemical methods.

Suggestion 2) It is highly recommended that the leadership of the Institute encourage research staff to obtain DrSc degree. We can identify M. Hricovíni, M. Stratilová and M. Vršanská as possible candidates.

Dr. M. Vršanská received DrSc degree during this assessment period (in 2014). In addition, Dr. M. Matulová received this degree in 2013. Due to dramatically increased specific requirements (number of publications, citations, ...) of the Slovak Commission for Scientific Degrees, Dr. E. Stratilová had to postpone submission of her candidature. M. Hricovíni meets all new requirements, excepting one criterion - participation in PhD education process. It is due to low interest of young people in PhD study in the field of Physical Chemistry. However, there are identified some other candidates and the compilation of further two DrSc theses is in progress.

Suggestion 3) To increase the popularisation activities for general public in order to motivate young people to study chemistry.

The popularisation activities like articles in press media/internet, appearance in telecommunication media and public lectures increased considerably. The Institute organised (each year) the Doors Open Day; it attended at several international and domestic exhibitions and trade fairs and national popularisation events (like Science and Technology Week in the Slovakia, European Researchers' Night, SAVinci). It also co-organised popularisation excursions for high school students and several popularisation lectures were presented directly at corresponding high schools. For details, see Indicator 2.7.

Suggestion 4) The effort to earn EU projects can be reinforced by being more involved in some project coordinations and exploring also other programs (like RMP) to attract foreign students for PhD and postdoctoral training.

As a result of achieved grants from EU projects FP7-PEOPLE and FP7-IDEAS-ERC (ERC Starting Grant - till now the only one in Slovakia), five PhD students were affiliated. Another PhD student was admitted due to FP7-PEOPLE-COFUND-MCA project (SASPRO grant). Several doctoral and postdoctoral trainings were pursued in the framework of FP7-EAST-NMR project, international projects supported by EU (COST, ESF), intergovernmental (SK-Serbia, SK-France, ...) and interacademic (SAS-NSC, Taiwan; SAS-RAMS, Russia) agreements. In this respect, new applications for EU grants (especially HORIZON 2020) are submitted each year.

Suggestion 5) To establish system for long-term maintenance of the sophisticated instruments.

The Institute obtained several grants from EU Structural Funds (see Table 2.4.7.). Some of them (especially projects of technical infrastructure and its upgrade) include partial financial sum for long-term maintenance of provided sophisticated instruments. In addition, a part of finances raised by Analytical Department (income for analyses and measurements) are reserved to cover these expenses. Finally, the Institute is involved in several incoming calls of grant agencies (including EU Structural Funds) to gain extra finances for long-term maintenance of the infrastructure and human resources.

- **Supplementary information and/or comments on management, research infrastructure, and trends in personnel development**

Because of insufficient funding from State budget, most of finances were and will be provided by external resources (scientific project grants - national and from EU, collaborations with funding, commercial activities of the Production Department and Analytical Department).

Due to financial support from EU Structural Funds and APVV projects, the Institute was provided, during last six years, with modern and sophisticated instrumental equipments. Moreover, the building of Production Department, Pavilion and some laboratories (in the main building) were reconstructed and modernised. For the future, it will be necessary to provide additional financial resources for permanently reliable operation and maintenance of this infrastructure.

Management and personnel development will be also dependent on interest of young people in PhD study in organic chemistry and biochemistry (there is no problem with biotechnology). Fortunately, this interest has an increasing tendency during last four years.

The Institute of Chemistry is the administrator of the building where additional five academic institutes reside but janitorial staff (manager, electrician, serviceman, plumber, portresses; in total nine employees) and corresponding budget is incorporated only into the Institute of Chemistry. This fact misrepresents some indicators, especially

when total number of employees and salary budget is taken into account. In addition, great efforts to keep building in operative conditions (frequent breakdowns; the building was constructed in 1953) are on the expense of scientific productivity.

In an effort to rejuvenate the research staff of the Institute, five young peoples (under 35 years) which just finished PhD study at the Institute and five others with PhD degree from other different institutions, were employed during two last years. This trend will continue also in the future.

3. Research strategy and future development of the Institute for the next five years (2016-2020) (Recommended 3 pages, max. 5 pages)

3.1. Present state of the art in both the national and the international contexts

3.2. Research strategy of the Institute in the national and the international contexts, objectives and methods

Department of Enzymology of Carbohydrates

The objective of future research of the group focusing on enzymatic syntheses will be to use systems biocatalysis (an approach consisting of organising enzymes *in vitro* to generate an artificial metabolism) for synthesis of valuable oligosaccharides and alkaloids. The second aim will be to prove theoretical work in the field of protein-RNA and protein-glycan recognition. Polyphosphate kinases will be reprogrammed to change their specificity from one nucleotide to another, and, glycan processing enzymes will be reprogrammed to change their specificity from one monosaccharide to another.

The objective of long-term research of the group studying microbial enzymes will be the elucidation of the structure-catalytic activity-function relationship of the enzymes degrading plant cell wall polysaccharides. The main purpose of the current research in this area may in future result in novel biotechnological applications leading to, for example, a conversion of plant biomass to chemical fuels and other useful products, such as functional food additives. Such a research is increasingly supported all over the developed world. Another research will be aimed at the application of the plant cell wall degrading microbial enzymes for synthetic purposes as biocatalysts. The synthetic potential of these enzymes is enormous and has not been sufficiently investigated. Under specific conditions, the hydrolytic enzymes, such as glycoside hydrolases and carbohydrate esterases, could catalyse reverse reactions that could be exploited for the synthesis of biologically important oligosaccharides, glycosides and other derivatives as well as for a modification of polysaccharides and natural fibres yielding the polymers having required and/or new physico-chemical properties.

Department of Glycobiology

The major goals of the future project will be focused on the structural analysis of glycoconjugates and *N*- and *O*-glycome profiling of human fluids with relation to medical conditions. The work on blood glyco-biomarkers will be performed in collaboration with clinicians, focusing on determination of the patients CDG-subtypes, furthermore in discovering of a new glyco-biomarkers with potentially clinical relevance and prognosis in cells pathophysiology.

Transglycosylases from families GH 16, 36 and 72 will be the objectives of the future study. Application of “omics” and computational chemistry methods will be used: i) to ensure their overproduction; ii) to affect their activity and specificity; iii) to determine the type of emerging bonds; iv) to design the structure of potential inhibitors.

In honeybee research, the continuation in the investigation of the abundant royal jelly antimicrobial substances active against *P. larvae* is planned. The aims are: i) to examine their individual and joint efficacies against the pathogen *in vitro* and also *in vivo* (on larvae reared under laboratory conditions); ii) to compare their contents in royal jellies in bee colonies; iii) to

examine the possibility to increase their production in bee colonies by selective breeding (a cooperation with beekeepers aimed to increase resistance of bee colonies against AFB).

Department of Glycobiotechnology

Plant biotechnology group will focus on: i) determination of Cd effects on the chemical composition of root cell walls; ii) investigation of the role of galactoglucomannan oligosaccharides (GGMOs) in monocot plants; iii) investigation of the role of GGMOs in the metabolism of compounds participating in cell defence (antioxidative enzymes, nitric oxide) in the presence of Cd; iv) findings whether and which lectins could be involved in GGMOs signalling in selected physiological processes in plants; v) comparison of changes in cell wall structure after auxin treatment using biochemical and chemical analytical methods.

Encapsulation group will aim their research towards development of original immobilised biocatalysts from viable recombinant cells with co-expressed non-natural cascade of redox enzymes to produce chiral building blocks for chemistry and pharmaceuticals by “one-pot” strategy. Use of unique techniques (ESEM, CLSM, XPS) and methods of bioreactor engineering is planned in cooperation with national and international project partners for proper characterisation of new cascade whole-cell biocatalysts.

Bionanotechnology/glycomics group will pay attention to continuing research in the area of development of innovative high-throughput optical biochips and biosensor integrating nanotechnology tools for determination of glycomarkers in patients' samples with cancer, autoimmune and neurodegenerative diseases. The developed devices will be designed for their application in both discovery and screening of biomarkers in order helping diagnosis and treatment of diseases, to facilitate detection and biomedical research of infections caused by pathogens, and for glycobiology research.

Department of Glycochemistry

The Laboratory of Sugars and Glycomimetics will continue in the design and synthesis of inhibitors of the GH38 family enzymes, especially those proposed by the 3D QSAR model, in order to obtain selective and potent inhibitors of Golgi II mannosidase. Similar effort will be devoted to development of a next generation of the potential inhibitors of glycosyltransferases with a higher stability and longer half-life time under the standard physiological conditions. The special attention will be paid to the synthesis, structural characterisation and inhibitory properties of new iminosaccharides structurally related to swainsonine. Another approach will cover a chemical synthesis of a possible chromogenic substrate specific for the GH30 family enzymes. Such a successful synthesis of the target trisaccharide (based on branched glucuronoxyllobioside) would enable to measure the activity of this enzyme group which still remains impossible.

The Laboratory of Biocatalysis and Organic Synthesis will focus mainly on introducing the biocatalytic reactions into the procedures of glycochemistry, particularly into the synthesis of important plant glycophenolics and their synthetic analogues.

Department of Glycomaterials

The R&D activities will be aimed at polysaccharides or their conjugates isolated from higher plants (medicinal, agricultural) and from lowest plant organisms - microalgae (cyanobacteria and algae).

The aim of long-term research projects will be the utilisation of cereal and forest waste for the preparation of carbohydrates with potential biological effects on human health: i) different reaction pathways, either with standard chemical and enzymatic methods or unconventional ultrasound-assisted method, will be used to break down polysaccharides into oligosaccharides from lignin–saccharide–protein complex. The objective of the research is a design of an appropriate strategy for the preparation of various oligomers or polymers with well-defined structure, in order to maximize the biological effects and on the other hand, minimize the content of the negative ingredients; ii) for the food industry, interesting materials such as fiber,

prebiotics, etc. can be fractions of the hemicelluloses (xylans, arabinogalactans, β -glucans, etc.) which differ in the degree of branching, molecular weight and in the content of the non-sugar components, and thereby also by physico-chemical properties. A systematic study of structure, physico-chemical properties and methods of preparation of the poly- and oligosaccharides might contribute to better understanding the relationship between their structure and biological activity.

Fresh-water microalgae represent a huge family of microscopic organisms, which colonise all biotopes and territories of our planet. Significant property of microalgae is their capability to excrete into the environment polymeric compounds – viscous mucilage's. High variability in monosaccharide composition as well as in functional groups affords unique physico-chemical properties to these biopolymers with potential applications in the food industry (stabiliser, thickening agent, etc.), pharmaceutical industry (matrix for drug) and in medicine (antiviral, antithrombotic, immunomodulating effects). Microalgae biopolymers are less investigated in term of structure and their potential industrial applications. Missing data from the literature concerning the biological activity of fresh-water microalgae biopolymers led us to search for their pharmacodynamic properties and mechanism of action in order to verify their potential clinical applications. To determine the scientific background for possible applications, detailed structural identification of biopolymers will be required in this research area.

Department of Immunochemistry of Glycoconjugates

The studies will be aimed at conjugate preparation based on surface carbohydrate antigens isolated from microorganisms – pathogenic yeasts and Gram negative bacteria (*Vibrios*). To assess protective effect of the individual conjugate constructs, the immunised animals will be subjected to experimental infection. In addition to survival of experimental animals, the dissemination of *Candida albicans* within internal organs will be monitored. Simultaneously, the immunomodulatory properties of the individual conjugates will be assessed monitoring the humoral and cellular immunity in blood sera and blood organs (spleen) samples of animals. Successful realisation of the project depends on the fulfillment of several stages consisting of antigen selection, preparation of effective glycoconjugates, as well as from results of analyses of their immunomodulation properties. The immune response by broader methodic spectrum (ELISPOT immunocytometry, cell-proliferation and imaging) with focused effort on unknown reactions of the immune system at the cellular level, especially immune memory development, will be monitored. This direction can bring significant advances in the research of highly efficient sub-cellular vaccines against permanently threatening new emerging and old pathogens. All isolated mannans, lipopolysaccharides and other biomolecules will be extensively studied and characterised by modern methods available at the Institute (NMR, MALDI, ESI-MS, GC-MS, FTIR, etc.).

Department of Structure and Function of Saccharides

The activities will continue within the existing government and international grants in the nearest future. In the experimental part, the structures of various synthetic saccharides and polysaccharides isolated from the natural sources will be analysed in solution. The newly-installed NMR spectrometers (Bruker) allow analysis of diluted solutions of biologically active carbohydrates and their derivatives applying various 1D and 2D high-resolution NMR methods. Theoretical approaches will be focused on the development of new glycoconjugates and glycomimetics of commercially available antiviral, antibacterial and anticancer drugs using a rational approach where combination of more accurate DFT computer models and experimental techniques are applied in cooperation with other departments at the Institute. Quantum-chemical methods will be further used in analysis of spin-spin coupling constants in biologically active carbohydrates. New polysaccharide composites prepared from the waste materials obtained during industrial production of cellulose as well as various biologically active glycoconjugates will also be analysed.

Bacterial infections often represent a serious medical problem due to the continuous emergence of antibiotics resistant strains of bacteria. To design novel types of antibacterial agents, one needs to get a deeper understanding of the essential biological processes for

bacteria survivor. Therefore glycosyltransferase GIFT2, which is essential for the survival of *Mycobacterium tuberculosis*, and the TcdA and TcdB toxins, which are the sources of the pathogenic properties of *Clostridium difficile* due to their glycosyltransferase activity, will be studied. The state-of-the-art hybrid QM/MM simulations employing metadynamics and the string method will be used for the description of the reaction mechanisms on the free energy surface. The quality of obtained results will be verified by the nudged elastic band method and high-quality *ab initio* calculations. Thus found reaction pathways will have potential application in the design of transition state mimetics, which could serve as a new generation of potential drugs.

Culture Collection of Yeasts

Yeasts are important members of microbiota in soil, however, a knowledge on their diversity, properties, activities and roles in the managed soils are still very limited. Therefore, further research activities will be aimed at: i) the isolation and identification of yeasts related to the soil adjacent to fruit trees; ii) determination of yeasts typical of soil and those which entered the soil from phyllosphere; iii) investigation of the enzymatic profiles of yeasts which are related to the mineralisation process in soil; iv) examination of the abilities of yeasts to promote plant growth, ascertaining of interactions between yeast strains and determination of yeasts which tolerate different stress factors. Another part of the research will deal with the authentication, a long-time storage and a data set building on the yeast cultures maintained in the Culture Collection of Yeasts (CCY) with the aim to provide a biological material of a high quality to research and industry and to fulfil standards given by: (1) the Convention on Biological Diversity (1992); (2) OECD (OECD best practice guidelines for biological resource centres, 2007); (3) the World Federation for Culture Collections (WFCC), the European Culture Collections' Organisation (ECCO) and the Microbial Resource Research Infrastructure (MIRRI).

Project proposals submitted to 7RP or H2020	2012	2013	2014	2015
Institute as coordinator	irrelevant	irrelevant	0	0
Institute as participant	irrelevant	irrelevant	6	3

Note: Columns for proposals submitted in 2012 and 2013 are irrelevant because Horizon 2020 started since 2014.

The Institute intends to reconstruct the separate old building (former engineering shop) where most of instrumental equipments and corresponding staff of the Analytical Department would be centralised. Moreover, complete reconstruction of computer network in the main building, as well as reconstruction of some laboratories, is intended. But, it depends upon the success of the Institute in new proposals of the EU Structural Funds projects. Due to timeworn sanitary accessories (water piping, central heating and some laboratory hoods) in the main building, their complex reconstruction will be necessary in the near future. In this respect, the Institute applied for finances from central academic resources.

4. Other information relevant for the assessment

The Culture Collection of Yeasts (acronym CCY), as a part of the Institute has the status of the International Depository Authority for the purpose of patent procedure. Approximately 3600 yeast cultures, among them the type strains, yeasts of medical importance (pathogenic yeasts), industrial importance (brewing and wine yeasts) and isolates from various natural sources (water, soil and plant environments, insects) are maintained there. The CCY is a service

collection which offers: isolation of yeast cultures from various environments, deposit of yeast cultures (in an open part of the collection, safe deposit, patent deposit), identification and a long-time storage of yeast cultures. In this respect, only approximately 50% of the CCY staff research capacity is devoted to the research activities while the other 50% involve the maintenance of the yeast cultures and the service works.

Analytical Department provides services connected with physico-chemical characterisation of chemical compounds. Corresponding measurements at sophisticated scientific equipments (see Indicator 2.8.3.) are performed in: Laboratory of Mass Spectrometry, Laboratory of NMR Spectroscopy, Laboratory of IR Spectroscopy, Laboratories of other analytical methods (measurements of optical rotation, elemental analyses, GC and HPLC analyses, as well as chemical and biochemical analyses of water samples). Analytical services and measurements for commercial purposes are also available.

The Production Department, as an integral part of the Institute, provides facilities for a large-scale isolation of natural compounds and preparation of saccharides and their derivatives also for commercial purposes. Currently the Production Department offers many of the less common monosaccharides, some oligosaccharides, a series of 1-deoxy-1-nitroalditols some glycosyl-nitromethanes, and some polysaccharides with covalently bound dyes for use in enzymology. Moreover, the Department is the sole manufacturer of some rare saccharides. In this respect, it cooperates with many prominent foreign and domestic companies (like Sigma-Aldrich, Acros, Biosynth, Microchem, etc.) in the market with saccharides. In addition to products included in List of Products, the Department has also the capacity for the preparation of many other saccharide derivatives on the basis of custom synthesis (either in small package sizes for laboratory use or in bulk quantities). The income from the sales of products made approximately 717 000 € (cca 179 000 € per year) for this assessment period.

Following important prizes and awards (selection) for scientific work were presented during this assessment period:

- Charles D. Scott Award (Biely)
- Medal of SAS for support for science (Koóš, Hirsch)
- Prize of SAS for results in international scientific and technical cooperation (Hricovíni)
- Certificate of Appreciation "Gold INCHEBA" for the product D-Cellobiose (Institute of Chemistry of SAS, at Slovmedica International Exhibition, Bratislava, 2013)
- Medal of Slovak Chemical Society (Koóš)
- Honorary Plaque of SAS for merits in biological sciences (Lišková)
- Honorary Plaque of SAS of Dionýz Ilkovič for merits in physico-chemical sciences (Matulová)
- Minor Medal of Samuel Mikovíni (Tkáč)
- Prize of President of Slovakia, Prize of Rector of Slovak Technical University, Top Student Personality of Slovakia (Bertók)

Partial reconstruction of the building of Production Department resulted in the decrease of income from the sales of produced saccharides in 2013. Complex reconstruction of Pavilion (additional building, where most of new instruments are located) as well as administration of the main building (where additional five academic institutes reside but nine-membered janitorial staff is incorporated only into the Institute of Chemistry) negatively influenced scientific outputs of the Institute and these factors might misrepresent (to a certain extent) some indicators operating with total number of employees and salary budget.

In addition to above mentioned janitorial staff (nine employees), the Economy-technical Section involves nine administrative workers (secretary, personnel clerk, financial officers, accountants, officer for public procurement, supplier, storesman, driver). This staff may seem to be redundant but it is necessary due to a large amount of administrative (and sometimes bureaucratic) works related to management of many projects, personnel agenda, financial controls and reports, infrastructure, etc.)

The institutional Library (two employees) offers usual librarian, recherche and reprographic services as well as scientific informations. There are 25482 book units including more than 30 titles of periodical journals. Access to electronical databases is provided centrally by the Central Library of the Slovak Academy of Sciences and the Slovak Centre of Scientific and Technical Information.

Bratislava, July 2016

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