RESEARCH STRATEGY

FACULTY OF SCIENCE

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Translated from Croatian by doc.dr.sc. Ani Grubišić and collaborators.

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1 Introduction

The Faculty of Science of the University of Split is a scientific-research higher education institution. With the excellence of its scientific-research work, our Faculty is actively present in the European research field, which is emphasized by our participation in international scientific-research and technologic projects and organization of scientific and expert congresses. The research areas include: natural, technical, biotechnical, biomedical and social sciences.

2 Mission

The mission of the Faculty of Science is to contribute to society by performing cutting-edge research in both basic as well as in applied sciences, taking into account the leading high standards of excellence, creativity, integrity, ethics and morals. The Faculty of Science preserves knowledge as a public good, and constantly creates and improves it by research and innovation. The key activity of the Faculty of Science is to promote science and to emphasize the importance of the social role of knowledge and science, thus encouraging students to research, innovation, creative challenges, and especially to take leadership in the profession and society.

3 Vision

Faculty of Science should become an institution known for its world-class multidisciplinary research in basic and applied sciences with a strong and sustainable cooperation with all parts of the community, especially the industry. Faculty will make available all of its scientific infrastructure to other scientists from other research institutions at home and abroad, for maximum efficiency, and in order to achieve top results of research and their transfer. The Faculty will stimulate the mobility of students and their staff for the purpose of expanding and updating knowledge and providing opportunities for the better development of professional staff.

4 Analysis of current state

Indicators of the current state of research activity relate to the period of the last 5 years, with data on structure of employed scientists, scientific productivity, projects, international cooperation, organization scientific conferences, publishing, and doctoral studies.

4.1 SCIENTIFIC STAFF

Faculty of Science employs 74 scientists with PhD:

- 7 full professors – permanent position
- 11 full professors
- 14 associate professors
- 27 assistant professors
- 15 research assistants
- 3 lecturers

4.2 SCIENTIFIC PRODUCTIVITY

Several types of scientific research are conducted at our faculty: theoretical research, experimental research, mixed research, fundamental research and applied research. For experimental and mixed research, it is essential to set up and set up new research laboratories in our new building at the university campus and to collaborate with the scientific centers of excellence (STIM, one of the seven Croatian scientific centers of excellence).

Our Faculty is specific in that the research takes place in four areas of science (natural, technical, biotechnical and social) and a number of different scientific fields (mathematics, physics, geophysics, biology, chemistry, biotechnology, nutrition, computing, electrical engineering, mechanical engineering , pedagogy, kinesiology, psychology, information and communication sciences), and all with a relatively small number of scientists, which is why as a bad phenomenon there is a breakdown of research, but also good coverage of a

large number of branches of science, as well as a markedly diversified co-operation with other institutions at home and abroad.

Scientists from the Faculty of Science have published so far 1273 original scientific work in journals indexed in the WOS (Web of Science) database, and have been cited 25044 times. Of the mentioned 1273, 642 of them were published in the last 5 years (2012-2016). Total scientific productivity over the last five years is shown in the following table:

<table>
<tr><td rowspan="2"></td><td rowspan="2">Total</td><td colspan="3">Name of department and number of PhD</td></tr>
<tr><td>Biology 14</td><td>Phisycs 17</td><td>Informatics 8</td></tr>
<tr><td rowspan="2">Scientific papers in WoS-based journals (SSCI, SCI-expanded and A & HCI)</td><td>230</td><td rowspan="2">80</td><td>68</td><td rowspan="2">8</td></tr>
<tr><td>Collaboration papers: 412</td><td>Collaboration papers: 412</td></tr>
<tr><td>Scientific papers in other journals</td><td>88</td><td>26</td><td>9</td><td>19</td></tr>
<tr><td>Scientific conference papers with international review</td><td>41</td><td>2</td><td>3</td><td>26</td></tr>
<tr><td>Authors of published books</td><td>2</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Chapters in published books</td><td>13</td><td>1</td><td>4</td><td>1</td></tr>
</table>

<table>
<tr><td rowspan="2">Vrsta radova</td><td colspan="4">Name of department and number of PhD</td></tr>
<tr><td>Chemistry 10</td><td>Mathematics 16</td><td>Polytechnics 6</td><td>Social science 4</td></tr>
<tr><td>Scientific papers in WoS-based journals (SSCI, SCI-expanded and A & HCI)</td><td>34</td><td>47</td><td>8</td><td>4</td></tr>
<tr><td>Znanstveni radovi u drugim časopisima</td><td>2</td><td>22</td><td>9</td><td>5</td></tr>
<tr><td>Scientific papers in other journals</td><td>1</td><td>0</td><td>9</td><td>4</td></tr>
<tr><td>Scientific conference papers with international review</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>Authors of published books</td><td>0</td><td>5</td><td>3</td><td>0</td></tr>
</table>

4.3 RESEARCH PROJECTS

The research at the Faculty of Science was based, by the end of 2013, on a scientific projects approved by the Ministry of Science, Education and Sports, that are listed in the table:

List of scientific and development projects awarded by the Ministry of Science, Education and Sports with the names of active leaders in the last 5 years
1. Transitional Groups and Related Discrete Structures (177-0000000-0882) Anka Golemac 2. Discrete Mathematical Models in Chemistry (177-0000000-0884) Damir Vukičević 3. Oligomeric Enzyme Systems in the Synthesis of Bioactive Secondary Metabolites (177-0000000-2962) Maja Pavela-Vrančić 4. Indicators of fecal contamination and possible pathogenic bacteria in the coastal sea (177-0000000-3182) Mirjana Skočibušić 5. High Energy Reaction Systems and Grid Application (177-0000000-3193) 6. Mile Dželalija (closed in 2012) 7. TITIUS: The river Krke - heritage and sociocultural development (177-1300855-3326) Šime Pilić 8. Significance of succession to preserve the biodiversity of the Mediterranean vegetation region (177-0680722 -3581) Juraj Kamenjarin 9. Computer vision in identifying kinematics of sports activities (177-0232006-1662) Vladan Papić (transferred to FESB in 2011) 10. Transport and Magnetic Properties of Nanostructured Complex Metal Compounds (177-0352826-0478) Ante Bilušić 11. Design and Evaluation of Intelligent E-Learning Systems (177-0361994-1996) Slavomir Stankov 12. Usability and Adaptability of Intelligent Scripts Interface (177-0361994-1998) Andrina Granić 13. Modeling of molecules and materials by methods of mathematical and computer chemistry (177-0982929-2940) Ante Graovac (transferred to University of Zagreb, 2013) 14. Rough Form and Classification of Coverings (177-0372791-0886) Vlasta Matijević 15. Mild Groups, Integrative Systems and Symmetries (177-0372794-2816) Saša Krešić-Jurić 16. Convex functions and applications (177-1170889-1287) Marko Matić 17. Inequalities and Numerical Analysis (177-1170889-3039) Nenad Ujevic (Associated with Project 177-1170889-1287 in 2011) 18. Xerofites and Their Secondary Metabolites (177-1191192-0830) Nada Bezić 19. Mechanisms for the preservation of genome stability in higher plants (177-1191196-0829) Jasna Puizina 20. Development and application of the principle of maximum production of entropy (177-1770495-0476) Davor Juretić 21. Structure, Interaction and Transmission in Appropriate Water Solutions (177-1770508-0480) Franjo Sokolić 22. Survey of Multiplex Systems with Monte Carlo Simulations (177-1770508-0493) Leandra Vranješ

Markić

Our scientists were principal investigators/co- principal investigators in a number of international projects listed in the following table:

ist of bilateral and other international projects with names of active leaders in the last 5 years
1. Modeling of anomalous properties of liquids and solutions of alcohol and water by integral equation method, Project of co-financing of scientific research projects as part of joint Croatian-Slovenian cooperation 2016/2017, Larisa Zoranić
2. Energy and entropy fluctuations in complex solutions, Croatian-French program "Cogito - partnership Hubert Curien" for 2015/2015, Larisa Zoranić
3. Strengthening Capacity for Application and Transfer of Micro-Electromechanical Systems Technology at the University of Split, Call for Capacity Building for Research, Development and Innovation, Structural Project 2014-2016, Ante Bilušić
4. Strengthening Capacities of the University of Split for Research, Development and Innovation in Medical Neuroselectronics (STRIPMED), Call for Capacity Building for Research, Development and Innovation, Structural Project 2014-2016, Damir Kovačić
5. Adaptive Courseware based on Natural Language Processing (AC & NL Tutor), Office of Naval Research (ONR), 2015-2018, Ani Grubišić and Branko Žitko
6. Development of modern curricula for the education of IT teachers, technics, biology, chemistry, physics and mathematics on the basis of the Croatian Qualifications Framework, Priority 3 Improvement of Human Capital in Education, Research and Development, Measure 3.1 Improvement of the Human Resources Development Operational Program Education System, 2015 -2016, Tea Dragičević
7. Bosnia and Herzegovina qualifications framework for higher education - BHQFHE, TEMPUS, 2013-2016, Mile Dželalija
8. Competitive Higher Education for better Employment, IPA projekt, 2013-2015, Mile Dželalija
9. A European Network For Mitigating Bacterial Colonisation and Persistence On Foods and Food Processing Environments, COST Action FA1202, 2012-2016., Juraj Simunić
10. "V-ALERT: Virtual World for Awareness and Learning on Information Security"; Lifelong Learning Programme, Sub-programme Development of Innovative ICT-based Content, Services, Pedagogies and Practice for Lifelong Learning, Action: KA3 Multilateral networks, 2013-2015, Andrina Granić
11. "DigiSkills: Network for the enhancement of digital competence skills"; Lifelong Learning Programme, Sub-programme Development of Innovative ICT-based Content, Services, Pedagogies and Practice for Lifelong Learning (Key Activity 3), Action: KA3 Multilateral networks, 2012-2015, Andrina Granić
12. Earth system Model Bias Reduction and assessing Abrupt Climate change - EMBRACE, FP7 projekt, 2011-2015, Željka Fuchs
13. EU COST ES0905 Basic Concepts for Convection Parameterization in Weather Forecast and Climate

Models, Convection Action, 2010-2014, Željka Fuchs 14. The LSST investigation of GPU computing technology, bilateral research project (Croatia-USA) 2012-2013, Dejan Vinković 15. Studying In-medium properties of strange particles, bilateral research project (Croatia-Austria), 2012-2013, Mile Dželalija 16. Quantum Adsorption on Graphene, bilateral research project (Croatia-Austria), 2012-2013, Leandra Vranješ Markić 17. Genetics of brown algae, *Cystoseira* spp. (Phaeophyceae, Fucales) from the Adriatic Sea, bilateral research project (Croatia-Austria), 2012-2013, Jasna Puizina 18. Recognition and Development of Vocational Educational and Training Competencies – PEIRA, LLP project, 2010-2012, Mile Dželalija

There are currently three scientific projects funded by the Croatian Science Foundation and one funded by the Ministry of Science and Education.

List of active structural, scientific and development projects from national sources (UKF, NZZ, other state institutions or domestic industry) with headline names
1. High-frequency ultrasonic diagnostic probe for advanced intamological applications, HAMAG-BICRO, 2016-2017, Ante Bilušić 2. Youth Career Development Project - Training of New Doctor of Science, HRZZ, 2016-2019, Leandra Vranješ Markic, Larisa Zoranić, Davor Juretić, Darko Koračin 3. Exploration of Materials with Strong Electronic Correlations, MZOS, 2016-2020, Ante Bilušić 4. Universal properties of the cold basin and fermion atoms system, HRZZ, IP, 2015-2018, Leandra Vranješ Markić **5.** Formation and destruction of domains in aqueous solutions, HRZZ, UIP, 2014-2017, Larisa Zoranić **6.** Biophysical Design of Antimicrobial Peptides and Innovative Molecular Descriptors, HRZZ, IP, 2014-2017, Davor Juretić / Damir Vukičević

Currently, the infrastructure project "Functional Integration of the University of Split, PMF-ST, PFST and KTF-ST through the Development of Scientific and Research Infrastructure in the Three Faculties Building" has been approved for funding from the European Regional Development Fund prospects 2014-2020. The development of project documentation is co-financed by the European Regional Development Fund under the 2007-2013 program.

The Ministry of Economy, Entrepreneurship and Craft has selected the project "STem Cekom - Center of Competence in the STEM Area" for financing as part of the grant award "Support to the Development of Centers of Competence". The STEM component of the

University of Split, in particular the Faculty of Civil Engineering, Architecture and Geodesy, the Faculty of Electrical Engineering of Mechanical Engineering and Naval Architecture, and the Faculty of Science, participate in this project. In addition to the university research group, 12 partners from the industry are involved in the project.

Scientists from the Faculty of Science also participate in the work of the Center for Excellence for Science and Technology - Integration of the Mediterranean Region STIM. The Center proclaimed the Ministry of Science and Education on the proposal of the National Council for Science, Higher Education and Technological Development.

4.4 INTERNATIONAL COOPERATION

The scientific cooperation of our teachers with foreign scientists is exceptionally good. If WoS data is analyzed (excluding works of large groups such as those in CERN, which are by their very nature the most developed form of international cooperation, all of which are mentioned in the bibliography, the works are the result of collaboration between scientists from a large number of international institutions) then it can be seen that only about 20% of WoS's work came as a result of the work of teachers exclusively from our institution, so about 80% of them are working with other institutions. A large number of them have also emerged as a result of cooperation with scientists from overseas, i.e. over 430 co-authors in the mentioned works are from other institutions, and over 160 are from abroad.

Teachers also have numerous contacts with universities and other scientific institutions abroad. Prominent scientists from other universities stayed at our faculty, where numerous lectures were held within our doctoral studies and as part of the scientific seminars that are regularly held in our departments.

Our faculty currently has ERASMUS + contracts with 20 foreign higher education institutions (Czech Republic, Greece, France, Italy, Lithuania, Macedonia, Germany, Poland, Slovenia, Sweden, Turkey).

Collaborators on projects led by our scientists are also researchers from foreign higher education institutions, e.g. from Austria, USA, Spain, France.

4.5 ORGANIZATION OF SCIENTIFIC CONFERENCES

1. Mathematical Inequalities and Applications 2008
2. Mathematical Inequalities and Applications 2014
3. Mathematical Inequalities and Applications 2015
4. LHC days in Split, 2006
5. LHC days in Split, 2008
6. Physics at LHC, 2010
7. LHC days in Split, 2012
8. LHC days in Split, 2014
9. 1st Physics and Philosophy, 2012
10. 2nd Physics and Philosophy, 2013
11. 3rd Physics and Philosophy, 2014
12. 4th Physics and Philosophy, 2015
13. 5th Physics and Philosophy, 2016
14. 1st Croatian Conference on Chemical Education, 2012
15. 2nd Croatian Conference on Chemical Education, 2014
16. 3rd Croatian Conference on Chemical Education, 2016
17. International Academy of Mathematical Chemistry, 2014
18. Adriatic Conference on Graph Theory and Complexity, 2014
19. Australia-Croatia workshop on antimicrobial peptides and Summer school in biophysics Phd programme, 2010
20. First Adriatic Symposium on Biophysical Approaches in Biomedical Studies, 2014

In addition to organizing conferences, our teachers were members of a large number of scientific and organizing committees of international scientific conferences organized by other institutions.

4.6 PUBLISHING

In the year 2016, an international scientific journal "Acta Mathematica Spalatensia" has been launched jointly by the Split Mathematical Society and the Department of Mathematics at the Faculty of Science. The journal will be published annually in two lectures: Acta Mathematica Spalatensia (PhD) and Acta Mathematica Spalatensia Series didactica (Professional Methodology).

5 SWOT analysis

The Faculty of Science has a large number of high quality potential mentors, scientists and researchers, and relatively modern scientific equipment. Nevertheless, the research at the Faculty of Science is not sufficiently focused on cooperation between other faculties of the University of Split and cooperation with the industry. In doing so, the Faculty should also promote applied research that translate scientific ideas into practice and bring benefits to society. In order to promote creativity and innovation and critical thinking among the scientists of the Faculty of Science, from those already proven to young people who are just at the beginning of their research career, systemic mechanisms need to be provided in order to promote their top achievements.

5.1 STRENGHTS

- Performing research in an attractive and market-intensive STEM field (science, technology, engineering and mathematics)
- The recent moving into the new building at the University Campus, provided much better working conditions, and finally in one place all the people and research equipment of the PMF were teamed up, which were previously scattered at several locations
- The increased area of scientific research laboratories and the appropriate working conditions allow for the introduction of different types of projects and cooperation with the industry and the procurement of new scientific equipment
- The immediate proximity of other faculties operating in the STEM area enables the collaboration
- Potentials for interdisciplinary and multidisciplinary research in the field of education and natural, technical, biotechnical and biomedical sciences
- Developed international cooperation
- Scientific projects from different scientific fields
- The diversity of scientific groups
- Recognizability and international affirmation of some scientific groups
- A large number of high-quality employees

- High scientific productivity of most employees
- Good mobility of a large number of scientists
- Activities of popularizing science
- Two postgraduate doctoral studies have been established, unique in Croatia
- Possibility of student participation in scientific work during the study

5.2 WEEKNESES

- Excessive orientation to state aid for scientific research
- Insufficient involvement in international projects
- Insufficient involvement in professional projects
- Great inequalities in the distribution of scientific, teaching and professional activities among scientists and departments, and unequal involvement in the popularization of science
- Insufficient motivation and orientation of scientists to apply to the EU and other international competitive projects
- Low visibility in the European Research Area (ERA)
- Insufficient cooperation with the industry
- Insufficient laboratory equipment for achieving competitive scientific research
- Low linkage of research groups at the Faculty level
- Inadequate financial resources for research and development of young scientists
- Lack of scientific staff, overload of teaching and administrative jobs
- Lack of rewards for scientific excellence
- The possibility of promotion, even to the highest scientific job positions, without enough recognizable international research component
- Insufficient outgoing and incoming mobility of scientists

5.3 OPPORTUNITIES

- Active inclusion in international projects (e.g. H2020, Structural Funds and others)
- More intensive cooperation with industry
- More intensive scientific connection with other domestic and foreign academic

institutions
- Interdisciplinary and STEM areas are recognized in national and strategic documents
- Linking with successful scientists, former students of the Faculty of Science (Association Alumni PMF)
- Maximum administrative and teaching unloading of the most productive faculty studies in accordance with applicable regulations and laws

5.4 THRETS

- Poor general economic situation and systematic reduction of state budget funds intended for science and higher education
- An unstable legislative framework with regulations that change frequently
- Unclear way of financing science in the future
- Insufficient stimulation of young scientists
- The absence of a system of awarding the best applicants to international tenders
- The Ministry of Science and Education does not approve new development jobs
- Decreasing and stopping scientific advancement, especially of younger employees
- Unfavorable demographic trends

6 STRATEGIC GOALS AND TASKS

6.1 RECOGNIZE AND AWARD SCIENTIFIC EXCELANCE

Task 1: The Faculty will develop a system of annual rewarding of the best scientists and the best young scientist based on number of publications, projects, participation in activities of popularization of science in the last calendar year.

Task 2: Establish a financial fund for excellent young scientists.

Task 3: Evaluate scientific research work as one of the key activities at the faculty.

6.2 STRENGTHENING THE STATUS OF FACULTY OF SCIENCE AS ONE OF THE LEADING SCIENTIFIC AND RESEARCH INSTITUTIONS

Task 4: Increase the number of scientific conferences held at the Faculty.

Task 5: Organize visiting scientists' workshops and lectures.

Task 6: Provide conditions for regular scientific colloquia and seminars.

Task 7: Increase the activities of popularizing science

Task 8: Establish a system for gathering information about Faculty's scientific activity.

Task 9: Establish a structured reporting system on the scientific activities and achievements of faculty groups and individuals.

Task 10: Present the faculty science on the Faculty's web site.

Task 11: Establish scientific research laboratories.

Task 12: Hire of the best quality young scientists.

6.3 RAISING THE LEVEL OF RESEARCH ACTIVITIES AND INTENZIVATION OF INTERNATIONAL SCIENTIFIC ACTIVITIES

Task 13: Increase the number of published scientific papers.

Task 14: Increase the quality of published works.

Task 15: Increase the number of scholars participating in international scientific conferences.

Task 16: Increase activity in editorials of international and domestic scientific journals.

Task 17: Increase the number of scientists involved in the program and organizational committees of international scientific conferences.

Task 18: Increase the number and amount of funding for national scientific projects, which are led by Faculty employees.

Task 19: Increase the number and amount of funding for international scientific projects, which are led by Faculty employees.

Task 20: Encourage scientific and research collaboration within the Faculty with the aim of establishing major projects or consolidating scientific-research capacities at the Faculty, for promoting interdisciplinary and multidisciplinary research.

Task 21: Establish a financial fund that would serve as a support for shorter international travel, for the purpose of arranging co-operation, preparing and writing projects with foreign partners.

Task 22: Encourage international cooperation.

Task 23: Encourage incoming / outgoing mobility of scientists.

Task 24: Encourage incoming / outgoing student mobility.

6.4 INCREASING PROFESSIONAL ACTIVITIES FOR THE NEEDS OF INDUSTRY

Task 25: Increase the number and amount of scientific-research projects with the public sector and industry, led by staff members of the Faculty.

Task 26: Provide faculty scientific research equipment to the local economy to raise the technological capacities of small and medium-sized companies and develop joint projects.

Task 27: Develop a Rulebook on the use of the Faculty's scientific-research equipment and give services to industry.

Task 28: Improve the regulation and processes related to the protection and commercialization of research results.

Task 29: Encourage all forms of lifelong learning with special emphasis on adult education.

6.5 ASSURING THE HIGH QUALITY OF DOCTORAL STUDIES

Task 30: Provide conditions for conducting doctoral studies.

Task 31: Establish a protocol for monitoring PhD student progress during the study.

Task 32: Enabling conditions for the involvement of foreign scientists as much as possible in the teaching process of doctoral studies and mentoring.

Task 33: Integrating research and teaching activity.

7 RESEARCH GROUPS

7.1 BIOLOGY

7.1.1 Group for histology and electron microscopy

Group for histology and electron microscopy includes scientists who are investigating the histological features of animal, human and plant tissues at the level of a light microscope and ultrastructural structure of tissues at the level of transmission electron microscopy (TEM). Light microscopy techniques include classical histochemistry, immunohistochemistry and immunofluorescence. Electron microscopy includes standard tissue preparation for TEM and immunogold technique. Research in collaboration with the Laboratory for Early Human Development, Faculty of Medicine, University of Split as well as with Department of Pathology, Clinical Hospital Dubrava Zagreb, is based on the histological features of early embryonic development of human tissues and organs. The collaboration with the Laboratory of Aquaculture, Institute of Oceanography and Fisheries is based on diseases of marine organisms, with emphasis on parasitic diseases of fish and shellfish in aquaculture. Plant tissues are studied in collaboration with the Institute for Adriatic Crops and Karst Reclamation.

7.1.2 Group for dynamic population of fish

Investigation of dynamic of population of fish including analysis of biometric properties (morphometric and meristic characteristics), age, growth and mortality, length-weight relationships, diet composition and feeding habits of Adriatic fish. Scientific collaboration we realise with laboratory of ichthyology and coastal fishing (Institute of Oceanography and Fisheries) which investigate biology and ecology of Adriatic fishes. The main object of research are connect with investigations dynamic of population certain species that belong fish families of Carangidae, Sparidae, Gadidae, Scopthalamidae, Trachinidae, Triakidae and Rajidae. Special target was investigation of diet and feeding habits of fish species such as horse mackerel (Trachurus trachurus), Mediterranean horse mackerel (Trachurus mediterraneus), striped bream (Litognathus mormyrus), saddled bream

(Oblada melanura), megrim (Lepidorhombus whiffiagonis), common panndora (Paghellus erythrinus), poor cod (Trisopterus minutus), eagle ray (Myliobatis aquila), smooth-hound (Mustelus mustelus), blackspotted smooth-hound (Mustelus punctulatus), thornback ray (Raja clavata) and brown ray (Raja miraletus).

7.1.3 Group for plant secondary metabolites and their biological role

Investigations of our researh group include the isolation, identification and quantification of volatile secondary metabolites, essential oils and glycosides of aromatic Mediterranean plants with s special focus on endemic and unexplored Mediterranean species. We investigate their morphological-anatomic characteristics as well as the chemical composition and biological effects of secondary plant metabolites. We investigate antiphytoviral activity of the essential oils, components of oil and other bioactive plant compounds. Aside from Croatian plant species, in cooperation with other scientific research institutions, our group also study other aromatic species of the Mediterranean area. Above anable us comparision of phytochemical caracteristics of investigated plant species collected at different localities and determination of their chemotypes. Results of our research are important for conservation of biodiversity, for the protection of certain plant species, for pharmacobotanical application and education, and also contribute to the preservation of Croatian flora and heritages.

7.1.4 Group for genetics and molecular biology

This group investigates the biological activity of natural phytochemicals and phytonutrients or/and their metabolites, as well as the complex plant matrices on regulation of gene expression and the prevention of damage to DNA and other biological macromolecules, as well as their possible anti-aging potential. We investigate the genetic and epigenetic changes that occur after spontaneous and induced polyploidization and hybridization in plants, and their importance to the physiology, ecology, and evolution of polyploids. Particular emphasis is given to the most dynamic regions of the plant genome: the repeat (repetitive) DNA sequences, particularly satellite DNAs, mobile genetic elements, transposons and retrotransposons and genes for ribosomal RNA. By using modern biotechnological methods, in vitro plant tissue culture, we work on induction of

polyploidization of the selected plant species, to create new genotypes, which will be analyzed and the selected ones will be further develop for commercial purposes.
Functional genetics model species Arabidopsis thaliana: meiosis, telomere biology, DNA repair and recombination, cell cycle control. Molecular genetics of gram-negative bacteria with special emphasis on their mechanisms of antibiotic resistance: identification and characterization of genes responsible for antibiotic resistance and their transfer in bacterial communities.

7.1.5 Group for the study of population dynamics of invertebrates

Studies include a detailed research of the reproductive strategies of invertebrates, including the determination of the relationship between the sexes, morphometric parameters of individuals, the annual development stages of the gonads, research of the species first maturity, fecundity and mortality. For the purposes of this research we apply histological techniques. To determine the longevity and growth of the species we use acetate peels techniques, embedding hard body parts of animals in the epoxy resin. To obtain data on the ecology of species, we compare and relate the results of the longevity and growth of the species and the results of reproductive strategies. The results of the population dynamics of species have their application in conservation biology and research of endemic invertebrate species and relationships between species.

7.2 PHYSICS

7.2.1 Group for hadron physics

The research is related to experimental and theoretical investigations of nuclear matter under extreme conditions of pressure and temperature. Such conditions are obtained in reactions of heavy ions at high energies of the incident ions. The research include analysis of the collected experimental data and computer simulations of such events by using complex software packages. Hadrons are complex systems made up of quark and gluons. Their interactions are described by Quantum Chromo Dynamics, which is the theory of strong force. Under extreme conditions of pressure and temperature, hadrons may loose their identity and dissolve into a new state of matter similar to the primordial matter of

the early Universe. In addition to these basic research, the group works on the application of physics in various areas, the philosophy of physics and physics education research.

7.2.2 Group for condensed matter theory

The research has been centered on dielectric and spectral properties of novel materials, particularly of low-dimensional conducting materials. The research is conducted on two-dimensional and three-dimensional Dirac materials such as graphene, molybdenum disulfide (MoS2), cadmium arsenide (Cd3As2) and sodium bismuthide (Na3Bi), and the collective and one-particle properties of many Dirac electron systems are investigated theoretically. Collective excitations such as plasmons and plasmarons are analysed in detail and the role of the Coulomb interactions in their formation is investigated. The experimental realization of three-dimensional Weyl materials has motivated the theoretical investigation of the collective behavior of many Weyl electron systems. Additionally, the reseach related to application of the maximum entropy production (MaxEP) principle is conducted, and particularly the optimization of the catalytic activity of enzyme triosephosphate isomerase (TIM) is investigated based on this principle.

7.2.3 Group for experimental elementary particle physics

The Standard Model (SM) of elementary particles and their interactions is one of the most complete theories in the history of physics which has gradually taken shape over many years. The SM has withstood tests of unprecedented precision but still, we know that this model cannot be complete. Participation in the CMS experiment at the LHC is the focal point of the group's long-term research vision. The discovery of a Higgs boson by the ATLAS and CMS experiments at the Large Hadron Collider (LHC) has opened a new era for particle physics, namely precision consistency tests of the SM Higgs boson. Two main goals of the research are measurement of the SM Higgs boson properties, as the window for the search for new physics beyond the Standard model, and a direct search for new physical phenomena looking for hypothetical particles called leptoquarks.

7.2.4 Group for magnetic and heat effects in fuel cell

PEM (proton exchange membrane) is the most important part of the fuel cell. It conducts protons from the anode to the cathode. Membrane function is characterized by dynamic parameters that describe the movement of protons. These are: concentration protons, drift speed protons, proton mobility, the capacity of the dipole layer, membrane resistance, temperature on the anode and cathode, heat resistance. The study of these properties is performed by a magnetic field using the Hall effect, temperature measurements and heat flow between electrodes. Experimental data will be used for a construction of the membrane the electro-thermal model. Theoretical basis makes linear thermodynamics of non-equilibrium processes.

7.2.5 Group for computational quantum matter

Quantum matter, from few to many-body systems is studied with special emphasis on their universal properties and phenomena like superfluidity and Bose-Einstein condensation. In studies at zero temperature we use diffusion Monte Carlo, while path integral Monte Carlo is used for finite temperatures. Quantum halo states, self-bound systems spreading far into the classically forbidden region, are one research direction. We predicted the existence of several molecules with characteristics of quantum halo states. The universal scaling of size and energy of dimers and trimers was demonstrated, which we are extending to systems of more particles. Through adsorption of atoms on surfaces or by trapping using magnetic fields and lasers, one achieves novel quantum systems. Our goal is to predict and understand their properties. We are particularly interested in influence of dimensionality and disorder, for example how superfluid-insulator transition is changed. In addition, we investigate the spin-orbit coupled systems of ultracold atoms.

7.2.6 Group for molecular simulation

The physics of associated liquids, amphiphilic solutions and lipids in water is determined by competing hydrophobic and hydrophilic interactions between various molecular groups. By exploring assemblies ranging from molecular to cellular sizes we are aiming at building a unified view of the principal mechanisms responsible for domain formation

and destruction. The used methods will be simulations and integral equation theory. In parallel with the molecular scale studies, the cellular membranes will be probed by means of experimental measurements and simulations. The aim will be to describe the mechanism of destruction of lipid bilayers induced by antimicrobial peptides.

7.2.7 Center of excellence for science and technology integrating Mediterranean region (STIM)

Vision of STIM is to create the network of high level research groups in Croatia on topics essential for sustainable development and integration of the Mediterranean area by matching our scientific quality to international challenges where STIM can make a difference. Mission of STIM is to integrate uniquely the triangle – research, innovation and education – by adding a new dimension to the existing organizations. Through this strategy we will advance our scientific excellence by enhancing the interplay between academia, industry and society. The Areas of Advance remove boundaries and provide the basis for the new interdisciplinary research and networks within Croatia and Mediterranean countries, which adds to the research performed at individual institutions. Organization of research in excellence profiles allows to address urgent issues within areas such as energy, environment, health and sustainability by involving the right mix of disciplines needed to meet the demands and to integrate education programs. The innovation system will join all dimensions of the Areas of Advance including long term collaborations with members from academia, research institutes, industry and society, providing unique opportunity to put research results in effective use.

7.2.8 Group for biophysics and medical neuroelectronic

The group carries out fundamental and applied research in the field of biophysics of hearing and speech, as well as in medical neuroelectronics. Fundamental research is about understanding of the neural correlates of hearing in cochlear implant users. The cochlear implant is the most successful neuroprosthetic functional device that allows the sound to be heard in deaf and hard-hearing persons. We are using an advanced 128-channel high-density evoked potential system located in a laboratory/audiometric chamber that meets the ISO-8253.2. standard. On the other hand, the applied research is related to the

development of innovative neuro-electronic interfaces. Our approach is based on the morphological and neurophysiological analyses of neuronal cultures from the auditory nerve and cochlear nucleus cultured in-vitro on the surfaces of silicon-based substrates with needle-like structures. We are testing the idea that these structures may be used as miniature electrodes providing neurons a unique electrical stimulation with a closed-loop option.

7.2.9 Group for experimental solid state physics

Research is taking place in two directions: the first one is the research of transport and thermal properties of strongly correlated electron systems with emphasis on photovoltaics and thermoelectric, and the other is the study of physical properties of piezoelectric films and micro-mechanical systems based on them. Studies transport properties of strongly correlated systems are within two NSF projects aimed at the study of the electrical and thermal properties of strongly correlated electronic materials that undergo the metal-insulator transition suitable for ultrafast electronic switches, and determination of figure-of-merit and power factor of inhomogeneous thermoelectric materials beyond the linear regime. Research of piezoelectric films started with the structural EU project and the successive one funded by the HAMAG-BICRO agency. The goal of the research is the technological development of phased array micro-network of ultrasonic sources with potential application in medicine, in particular in ophthalmology and dermatology.
Part of our research we focused on the interplay between biophysics and condensed matter physics. In cooperation with the Biophysics PhD program we explore the physical properties of the colloidal solution of nanoparticles obtained by laser ablation, and interaction of bacteria and metal nanoparticles.

7.3 INFORMATICS

7.3.1 Group for intelligent tutoring systems and advanced learning technologies

Research includes a creation of almost fully automated intelligent tutoring system which will be able to tutor any declarative domain knowledge and to communicate in natural

language. Automation will be reflected by adaption and generation of knowledge about the learner who is being taught and knowledge of methods for tutoring learners. The design of the domain knowledge in the expert module will also be automated (computer expert uses computer knowledge extraction), instead of manual (live expert designs domain knowledge). Moreover, the creation, selection, sequencing and presentation of courseware elements will be completely automated. Natural language processing will be applied during two-way communication in all learning, teaching and knowledge testing phases. Instruction design in this system will offer several scenarios of learning, teaching and testing learner's knowledge."

7.3.2 Group for computational intelligence

Deep and complex analysis od signal and systems, identifying the key parameters and features and enhancing communication and data exchange in the world of internet of things grows more and more important and extends to the field of security, energy and healthcare (medicine and bioinformatics). This group works on developing systems (or part of systems) which enhance intelligence, data understanding and interpretation in real-time. Main research vectors for computational intelligence laboratory are: (i) extreme environment sensing (climate, ocean, space...) including operational systems, with accent in energy efficiency, and (ii) development of intelligent solutions in data gathering, pattern recognition and machine learning in wide spectrum of applications like neural networks, biomedicine and security.

7.3.3 Group for artificial intelligence

This research group seeks to understand intelligent behavior in biological and artificial systems during problem-solving and learning. It studies the basis of human learning and reasoning. Through a combination of computer simulations and behavioral experiments, we try to uncover the logic behind our common cognitive processes: constructing perceptual representations, learning concepts, concluding on similarity, inferring on relations between concepts, and making decisions while solving problems. We approach these topics with a range of scientific methods including testing of adults, children, and machines. Our goal is to achieve a better understanding of human learning in

computational terms and apply it to design and build AI systems based on a human learning model."

7.4 CHEMISTRY

7.4.1 Group for the synthesis and biological research of organic compounds

One of the biggest challenges of today mankind is the incidence of a bacterial antibiotic resistance, which is continually growing. The antibiotic resistance is posing a global threat not only for the health system, but also in the process of food production and safety. Therefore, in our laboratory we aim to design and synthesize the heterocyclic compounds, with a special interest in quaternary ammonium salts which display a wide biological potential and biomedical application (antidotes, acetylcholinesterase inhibitors, surfactants, therapeutics etc.). The synthesized compounds are further characterized by fundamental physical-chemical methods FTIR, NMR and MS, after which antimicrobial activities on different strains of fungi and bacteria (Gram positive and Gram negative pathogen species) are determined. Antioxidative activity of compounds is assessed on healthy cell lines but also by using several in vitro methods (DPPH and ORAC). Cytotoxicity of compounds is measured on healthy and tumor cell lines by MTT method.

7.4.2 Group for chemistry education

Chemistry education research group is planned to be focused on improving the teaching and learning of chemistry at the primary, secondary and tertiary level, primarily in the area of the PCK of fundamental chemistry themes and in the area of language of chemistry instruction. Various qualitative and quantitative methods and techniques will be used in order to examine the way that students learn chemistry. Also, the specific teaching methods and approaches will be employed and explored in the aim of increasing PCK of specific chemistry topics. Special research and teaching attention will be given to the pre-service chemistry teachers during their preparation for professional service.

7.4.3 Group for biochemistry

The research interest of our laboratory are nonribosomal peptide synthetizes, with focus on protein conformational changes upon substrate binding. Knowledge about this process is important in designing proteins with new properties, directed toward synthesis of new biologically active peptides. In collaboration with researchers from other institutions, we also investigate molecular mechanisms of urinary bladder cancer development; autophagy, with emphasis on different pathways of damaged mitochondria removal; and the role of SPARTAN protein in DNA replication.

7.4.4 Group for analytical chemistry

Group for Analytical Chemistry carry out testing of food biologically active compounds. We are performing testing of olive oil quality (free acidity, peroxide number, K-number, the fatty acid composition and content of sterols, the triglyceride composition). Antioxidant properties, in particular polyphenol olive oil and wine / varenik, are measured by ORAC method. Determination of the contents of glucosinolate in various types of plants are carried out through two NSF projects. Testing are carried out by UV / VIS, IR, fluorescence spectroscopy and by GC technique with FID detection and HPLC chromatography with UV / VIS and fluorescence detection. Synthesis and testing of nanomaterials made of hydroxide and iron oxide, are carried out in order to obtain materials that could serve as drug carriers, adsorbents in purification of waste water and to improve the magnetic properties of the material. Synthesis is performed by microwave technique. Testing is done by spectroscopic techniques.

7.4.5 Group for the research of biologically active contaminants in biota and environment

The focus of the first part of research is on biologically active substances of anthropogenic origin. In the previous research HPLC (High Performance Liquid Chromatography) instrument was used to measure preliminary concentration of BPA in samples of sediment and suspended matter from the eastern side of the Adriatic. Continued research of sediment will include also nonylphenol (NP), oktylphenol (OP) and t-oktylphenol (t-OP). Presence of all compounds will be determined in the biological material too. The second

part of the research relates to the continuation of the study of heavy metals in the Adriatic. By using AAS (Atomic Absorption Spectroscopy) heavy metals in mussels from the Mali Ston Bay were quantified. The concentrations of heavy metals were correlated with the concentration of DSP toxins continuing the previous research of the presence of algal toxins in shellfish.

7.5 MATHEMATICS

7.5.1 Group for mathematical inequalities and applications

We will try to establish some new methods for improvement of the classical inequalities for convex functions, such as the Hermite-Hadamard inequalities, Jensen's inequality and the converse Jensen inequality. As special cases of those improvements we can obtain refinements of the converse Holder inequality and the converse Minkowski inequality. The obtained improvements and of the Jensen inequality and its converse can be used to establish new inequalities related to the Shannon entropy and the Zipf-Mandelbrot law both of which have considerable importance in Information theory. We also investigate various classes of generalized convex functions as well as some classes of functions which produce sharper variants of the classical inequalities for convex functions, for instance superquadratic functions and strongly convex functions. We will try to establish certain integral inequalities which will enable us to obtain better bounds for the reminder of some corrected quadrature formulae.

7.5.2 Group for mathematical physics

Mathematical theories that have an application in formulating a quantum theory of gravity and the structure of space-time at the Planck scale are investigated. The emphasis is given on investigation of noncommutative spaces of the Lie algebra type and the algebraic approach to formulation of differential geometry on such spaces. The standard notions of differential geometry are constructed as deformations of the corresponding classical notions where the deformation parameters are the structure constants of a Lie superalgebra. The research includes: (1) properties of enveloping algebras of finite-dimensional Lie algebras and Lie superalgebras, and their embeddings into the Weyl and

Clifford-Weyl algebras, (2) deformed symmetries of noncommutative spaces, (3) relations between enveloping algebras, Hopf structure and star-product on symmeric algebras, (4) construction of bicovariant differential calculi on quantum spaces and their realizations in the Clifford-Weyl algebras, (5) algebraic methods for integrable systems and their discretizations. Future research will include the formulation of higher-order differential calculi, the Lie derivative, the Hodge operator and other geometric objects within the deformation theory. We will also investigate geometric methods for numerical integration of integrable systems in classical and quantum mechanics.

7.5.3 Group for graph theory and applications

Central focus of the research of this group includes: (1) graph theory with emphasis on extremal graph theory; extremal graph theory analyzes maxima and minima of graph theoretical invariants on selected graph classes, e.g.: graphs with given number of vertices, trees with given number of vertices, chemical graphs with given number of vertices; (2) algorithms with emphasis on graph theory algorithms, complex networks algorithms and combinatorial algorithms that enable better understanding of these graphs; finding optimal graphs and optimization of given graphs; (3) complex networks with emphasis on multiplexes, curriculum networks and network descriptors; (4) mathematical chemistry with emphasis on molecular descriptors, nanotechnology, peptide antibiotics; (5) discrete mathematics. Our goal is to obtain purely mathematical results and multidisciplinary applications.

7.5.4 Group for representations of vertex algebras

This group studies new methods in vertex algebra theory and theory of infinite dimensional Lie algebras. We study certain important classes of vertex algebras like W-algebras and their connection to logarithmic conformal field theory in physics. It uses free field realization and screening operators in order to realize vertex algebras and their modules. Researchers construct intertwining operators and calculate fusion rules in categories of modules over certain algebra of Virasoro type (Heisenberg-Virasoro and W(2,2) algebra). Furthermore, it studies certain irrational C2-cofinite vertex algebras and their connection to the theory of quantum groups.

7.5.5 Group for functional analysis group

This group studies orthonormal and Parseval wavelets and multiwavelets in n dimensions. The resolution levels are defined by an arbitrary expansive matrix with integer coefficients. We developed a construction method of such wavelets by using generalized multiresolution analysis (GMRA) technique. The core space of the underlying GMRA is an arbitrary shift invariant space; i.e. there are no restrictions to the number of its generators. We constructed a suitable high-pass filter matrix that represents a generalization of the well-known high pass filter concept from the classical theory of MRA wavelets with dyadic dilations on the real line. The method is presented in several examples and we are considering a broader group of new examples. We are analyzing the results and working on a general description of certain classes of wavelets and their associated multiresolution structure.

7.5.6 Group for applied mathematics

The interaction of fluid and an elastic plate is studied. For developed models, as well as those proposed in the engineering literature, existence (and uniqueness) of solution is proved. In the case of a thin fluid layer, via asymptotic analysis, a simplified model, i.e. effective equations, is developed. The goal is to justify the obtained model by theorems on convergence in the appropriate normed spaces, and also by error estimates. Parameterizations of dynamic geometries for shape optimization are developed. The initial representation of shape is 3D point cloud and mathematical parameterizations of the point clouds are based on parametric surfaces (NURBS, T-Spline). The optimization process involves solving system of partial differential equations based on the engineering setup. The main goal is developing numerically efficient and dynamically adaptive method.

7.5.7 Group for topology

Research area is the general and algebraic topology, particularly a research where techniques of approximating spaces by limits of ANR and polyhedral inverse systems are applied. Another research area is the shape theory, particularly the coarse shape theory,

which may be considered as its full generalization. Recently, some topological and algebraic coarse shape invariants has been studied which enable applications to topology and homotopy theory, as well. Among others, the most interesting invariants are the coarse shape groups and coarse shape path connectedness. Concerning continuum theory the category CU in which u.s.c. functions are morphisms and compact metric spaces are objects is introduced. Inverse sequences in CU are also considered and it is shown that they form category, denoted with ICU. Results are applied to prove that inverse limits of inverse sequences with inverse limits as terms are homeomorphic. Further, the definition of topological entropy due to Adler, Konheim, and McAndrew is generalized to set-valued functions from a closed subset of the interval to closed subsets of the interval. These set-valued functions are viewed, via their graphs, as closed subsets of [0,1]2. Motivation for observing graphs and their Mahavier products (notion introduced by Greenwood and Kennedy) is that when set-valued functions are iterated in the usual sense, information is lost - and often lost very fast. Mahavier products are a convenient way to study subsets of a generalized inverse limit space. They also make it easier to study “finite” generalized inverse limits – which are not interesting at all in inverse limits, but are interesting in their own right in generalized inverse limits.

7.5.8 Group for combinatorial and discrete mathematics

The research considers combinatorial structures focusing on t-designs, symmetric designs, difference sets, partial difference sets, strongly regular graphs etc. It includes solving the existence problem for these structures, investigating their properties and links, their construction and classification. The classification problem has been approached through imposing different conditions on the action of finite automorphism groups of the structures under observation. One such condition is transitivity of the group action, in particular: point-transitivity, block-transitivity, flag-transitivity or multiple transitivity. A transitive permutation group belongs to either class: primitive or imprimitive; the action of groups from both classes is considered. In addition to theoretical aspect, for computing with permutation groups well-known systems GAP and MAGMA are used. This approach has recently led to developing a new construction method for symmetric designs and difference sets with given parameters. The application

of the method to concrete and specific design families is in progress together with the work on improving the construction algorithms.

7.5.9 Group for number theory

We investigate problems related to determining the minimal index and all elements with minimal index in the families of bicycles biquadratic fields. Also, we observe the analog problems for the relative extensions. For a given extension, these problems reduce to the resolution of the corresponding Diophantine equation called index form equation. In some special types of fields, it has been found correspondence between the index form equation and simpler types of Diophantine equations such as Thue equations or systems of Pellian equations. For the solving of these equations we use various tools from Diophantine approximations: Baker's theory, the theory of continued fractions, Bennett's theorem, etc.

7.5.10 Group for theoretical and applied statistics

Main focus of the research group in theoretical and applied statistics is in mathematical and computational models of statistical inference. Development of statistical methodology is mostly conducted for measurement-error models in Omics research, effects of normalization and batch correction methods to statistical inference and statistical learning and modelling of two- and three-dimensional random sets. The motivation behind the development of theoretical models and also the main field of group's applications is in Omics research (genomics, epigenomics, glycomics), biomedicine and in statistical and computational processing of figures representing two-dimensional random sets. Special consideration is given to development of tools for computational statistics (and statistical software) and to collaboration with computer scientists on the design and implementation of such tools.

7.6 POLYTECHNICS

7.6.1 Group for STEM education perspective

Research group analyze the development trends in STEM areas and didactic application class. In our research, we track trends and integrate them into primary, secondary and higher education curricula. We also analyze new technologies and include them in teaching process to achieve competencies in the STEM area.

7.6.2 Group for application and development of numerical methods in electromagnetism

The group is aimed mostly towards the development of the numerical models for simulation of current distribution along the thin-wire structures illuminated by the electromagnetic waves (scattered mode), or excited by a voltage generator (radiator mode). The current distribution is being modeled both in frequency and time domain, with geometries of interest placed in a free space or half-space (above and in the ground). Frequency domain results are obtained via formulation based on the Pocklington type equation, and can be transformed in time domain using Fast Fourier Transform (FFT) algorithm. Time domain results are also obtained directly via equation of the Hallen type, which is numerically solved using Galerkin-Bubnov Indirect Boundary Equation Method (GB-IBEM).

7.6.3 Group for electrical engineering and electrical measurements

Scientific research in theoretical and practical application of the concept of measurement uncertainty in the field of electrical engineering. One part of scientific research is focused to application of this concept in electrical measurements with renewable energy sources (wind power and photovoltaic solar sources), and electrical measurements with electric drives.

7.6.4 Group for robotics and applied science

This research group analyzes the new technologies in the field of robotics, automation, electronics and computer vision in order to apply in everyday life. In this group, we research and develop new applications of IoT (Internet of Things) technology.

7.7 SOCIAL SCIENCES

7.7.1 Group for expert systems in sport and exercise

These studies are conducted to determine and explain the criteria for assessing the actual quality of top athletes, the need and effectiveness of the student population for the exercise, technical and tactical content in sports games with the ball, the effects of integrated teaching physical education with other school subjects. Designed, weighted and empirical expert systems open up new possibilities for scientific research to determine the impact of certain segments of the system of integrated sports training (physical conditioning, technical and tactical, psychosocial ...) and real quality, and allow the coaches to the professional work effectively analyzed and comparing the actual quality of athletes with its potential for achieving more rational and efficient management processes for sports training, guidance and specialization of players to the appropriate position and role in the game. Established knowledge of the students' needs to exercise, of the appropriate age for the learning of technical and tactical knowledge of the sport and of the effects of integrated teaching will be of use for more meaningful and more rational implementation of teaching and training.

7.8 MULTIDISCIPLINARY RESEARCH GROUPS

7.8.1 Group for mechanisms of bacterial resistance to antibiotics

The scientific interests of the group are fundamental and applied research in microbiology. The incidence/prevalence of antibiotic resistance in bacterial communities of marine ecosystems, characterization of resistance mechanisms and modes of

transmission, with particular focus on beta-lactamases in Enterobacteriaceae and genera Acinetobacter, Aeromonas, Vibrio, Pseudomonas, Stenotrophomonas, Burkholderia and Chryseobacterium are being investigated. Research involves isolation of bacterial strains resistant to antibiotics, biochemical and molecular identification of resistant strains, their determination of phenotypic susceptibility to antibiotics, implementation of phenotypic assays for beta-lactamase production, and the characterization of resistance genes. The regulation of outer membrane proteins - porins as hereditary mechanism of antibiotic resistance is also being investigated. In addition, the group is studying the antimicrobial activity of different biologically active compounds from plants of the Mediterranean region, endemic species in particular, against the strains of opportunistic pathogens resistant to commercially available antibiotics, for the purpose of their potential use in pharmacy.

7.8.2 Group for antimicrobial peptide biophysics – construction, synthesis and characterization

The research connects three interdisciplinary and complementary segments Peptide design, Experimental testing and Molecular simulations. Using numerical methods, based on the specific amino acid properties molecular descriptors are constructed. Those descriptors are then used to connect mentioned properties with biological activity, which provides the basis on which we design new peptides ("QSAR" approach). Signal sequences of the peptides, that are evolutionary well preserved, can be used for EST and SRA database survey that also defines new peptide sequences. Sequences with the best biophysical characteristics are synthesized that is followed with biophysical, microbiological and molecular biology characterization. The conformation of peptides is determined, their microbiological activity and toxicity to host cells is measured to distinguish if the new antimicrobial peptide is also potential antibiotic. Mechanism of action of peptides is measured with permeability tests on flow cytometry and with atomic force microscopy. Using molecular dynamic simulations of peptides in various solutions as well as in interaction with model membranes structural and dynamical properties of peptides are examined as well as mechanisms of action.

7.8.3 Group for human-computer interaction

Research interests of Human-Computer Interaction (HCI) group are related to user interfaces and interactions between humans and interactive computer systems, products and services. We conduct research related to design, implementation and evaluation of usable, accessible interactive systems in general and technology-enhanced learning (TEL) systems in particular. Different adaptivity mechanism are developed and engaged in TEL systems to achieve high level of personalization and adaptive behavior tailored to individual user. Various methods for technical and pedagogical usability along with user experience evaluation are intensively explored. Systematic empirical research is conducted to develop comprehensive methodologies for usability evaluation of TEL systems and web portals, paving the way to design of standardized methodology applied to evaluation of different forms of interaction with contemporary technology. Questioning and re-envisioning current interaction modalities has resulted in new forms of communication designed and developed also under an umbrella of related undergraduate/graduate courses due to active student enrolment.