



LATVIAN ACADEMY OF SCIENCES ACHIEVEMENTS IN SCIENCE 2021

DIPLOMA OF THE LATVIAN ACADEMY OF SCIENCES

I A cross-disciplinary study on how to transform traditional e-learning technology into a real digital-era learning ecosystem.

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The Rīga Technical University Distance Education Study Centre has been developing cross-disciplinary studies since 2000 to create knowledge how traditional e-learning technology would be transformed into a real learning ecosystem of the Digital Age. Participating in EU FP6 project ELU an interactive television technology was created in 2009, which inspired the development, research and widespread deployment of multi-screen e-learning technology eBig3. eBig3 e-course user was transferred from computer to e-Ecosystem with the Internet, television and mobile phone. EBig3 received The BOLDIC2013 Award for the best e-learning innovations in Scandinavia and the Baltic in 2013. The next technology created is the monitoring of knowledge acquisition in the e-learning environment ARTS/TELECI, which created a new metric for e-learning and enabled e-content to be evaluated and updated in the learning process. This opens up the possibility of transforming e-learning from a burden on a distinguished assistant to teachers with opportunities far beyond traditional information storage-type e-learning environments. At the International Conference on Computer Supported Education CSEDU2020 with participation of e-learning researchers from 46 countries, the article on the new technology was rewarded by the Best Poster.

II Recommendations for medical practitioners, health policy makers and organisers of clinical treatment and care about the epidemiology, diagnosis, clinical course, and complications of COVID-19 infections.

Project of the National Research Programme to mitigate the effects of COVID-19: “Clinical, biochemical, immunogenetic paradigms of Covid-19 infection and their correlation with socio-demographic, etiological, pathogenetic, diagnostic, therapeutically and prognostically important factors to be included in guidelines”. Project manager: LAS Full member Ludmila Vīksna, Professor at Rīga Stradiņš University. Team: Rīga Stradiņš University, in cooperation with the University of Latvia and the Latvian Biomedical Research and Study Centre.

The recommendations “SARS-CoV-2 infections and the epidemiology, diagnosis, clinical course, and complications of COVID-19” are intended for physicians of all disciplines, senior medical students, as well as for health policy makers, care organisers, and a wide range of medical practitioners. Scientific publications, technologies, data sets, students’ career growth and public information services in the circumstances of the emergency situation.

III The spatial regulation of the genome by its repressive network can change cell fate.

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Some malignant tumors are able to undergo return to normality by the differentiating agents. It is important to understand how thousands of genes are simultaneously changing their expression which leads to irreversible change of cell fate. A hypothesis that in such cases the genome can be regulated spatially, by physical self-organisation and use for it the dynamic network constructed by knots of its repressive part (pericentric heterochromatin domains), was put forth. The experiments showed that after cancer cell treatment with the differentiation inducer, within 15 min the splitting of this network knots occurred, along with unfolding of the genome DNA and release of the genome expression avalanche lead by stress-response genes. At the summit of this bi-phasic wave the new cell fate pathway becomes stabilized during 3h towards irreversible differentiation. The ‘powerlaw’ splitting/fusing behavior of hetero-chromatin clusters was proved by microscopic, biophysical, and molecular methods. The following experiments and the review revealed the concentric-radial structure of the heterochromatin network supported by actomyosin cytoskeleton which provides the ability to adapt genome expression to the changing environment.

IV Integration of reliable technologies for protection against Covid-19 in healthcare and high-risk areas.

LAS Full member Tālis Juhna, *Dr.sc.ing.* Linda Mežule, LAS Full member Ivars Kalviņš, LAS Full member Juris Purāns, LAS Full member Andris Šutka, *Dr.sc.ing.* Inga Dāboliņa, *Dr.sc.ing.* Inese Fiļipova, *Dr.biol.* Ilze Irbe, *Dr.med.* Ivars Vanadzīņš, LAS Corresponding member Atis Elsts, *Mg.iur.* Andreta Slavinska, *Dr.biol.* Anna Zajakina, *Dr.sc.ing.* Andris Martinovs, *Dr.phys.* Atis Skudra, LAS Corresponding member Gita Rēvalde, *Dr.sc.ing.* Agris Ņikitenko, *Dr.chem.* Kārlis Pajuste, *Mg.sc.ing.* Aleksandrs Ļevinskis. Rīga Technical University, Latvian Institute of Organic Synthesis, Institute of Solid State Physics, University of Latvia, Latvian Biomedical Research and Study Centre, Rīga Stradiņš University, Institute of Atomic Physics and Spectroscopy, University of Latvia, Rēzekne Academy of Technologies, Latvian State Institute of Wood Chemistry, Institute of Electronics and Computer Science.

Healthcare area is a vital resource and support for every country during various crisis situations, including the latest global Covid-19 pandemic. As part of an interdisciplinary study, new technological solutions to reduce the risk of infection in hospitals and other high-risk areas were developed and demonstrated. Seven prototypes were developed (air disinfection device, disinfection gate, surface cleaning robot with the possibility to recognize specific objects, hand disinfection control device, anti-viral transparent coating, self-degrading mask filter material, disinfectant liquid with long-lasting anti-viral effect). Further guidelines to produce protective clothing and a number of international scientific publications have been made. All technologies are scalable to products in a short time, and their implementation in hospitals, schools, transport can reduce the risk of infection during COVID-19 as well as on a daily basis.

V Development of a novel DNA bacteriophage isolation and characterization research direction in Latvia.

Mg.biol. Ņikita Zrelavs, *Mg.biol.* Elīna Černooka, *Dr.biol.* Jānis Rūmnieks, *Dr.biol.* Andris Kazāks, *Dr.biol.* Andris Dišlers. Latvian Biomedical Research and Study Center.

Bacterial viruses – bacteriophages, are the most abundant and diverse biological entities on Earth. Since their discovery in the early 20th century bacteriophages or their gene products have been applied in various fields, most prominently in molecular biology, medicine, food industry and agriculture. However, it is worth to note that the majority of the broadly used phage-derived products originate from a strikingly small number of different phages. The creation of DNA bacteriophage collection at the Latvian Biomedical Research and Study Centre (BMC) dates back to the year 2006. Today this collection consists of more than 50 different bacteriophage isolates from various environmental sources that are already described to a different degree throughout the years of investigation at BMC. The majority of the isolates in the collection have already been sequenced, and their annotated genomes are being systematically deposited to the publicly available biological sequence repositories. The most interesting isolates are being profoundly characterized with the results being published in highly regarded scientific journals of the field. A plethora of unique bacteriophages



that represent novel phage genera were isolated during these studies and have aided in the expansion of the globally-known phage diversity. The importance of phages is hidden in the fact that their genomes represent a “vault” of hypothetical proteins with a yet unknown function. Thus, in addition to genomic studies of phages and their diversity, we have also begun the structural-functional elucidation of the biological role for the selected proteins found in this “vault” to gain a better understanding of their role in phage and their host lifecycles. That way we were able to determine the structure and function for several interesting phage proteins, with the findings being expandable to their conserved counterparts from other biological objects. In addition to the fundamental research on bacteriophage biology, attempts to evaluate the potential of the practical application of studied phages or their genome-derived products have been started. In total, in the years 2020 and 2021 the results of the DNA bacteriophage research at BMC have been published in five peer-reviewed scientific articles. We consider the development of a novel DNA bacteriophage isolation and characterization research direction in Latvia as our most important achievement.

VI A modern reference grammar of Latvian written in English published for the first time in the history of Latvian science.

Dr.philol. Andra Kalnača, *Dr.philol.* Ilze Lokmane. Latvian Grammar. Rīga: The University of Latvia Press, 2021, pp. 560. <https://doi.org/10.22364/latgram.2021> . Department of Latvian and Baltic Studies, Faculty of Humanities, University of Latvia.

A comprehensive synchronic reference grammar of Latvian written in English has been published for the first time in the history of Latvian science. The monograph is based on theoretical, methodological, and typological research carried out by A. Kalnača and I. Lokmane over the course of several years. “Latvian Grammar” was written to make information about the Latvian language and its grammatical system more easily available not only within Latvia, but also beyond its borders. A modern grammar of Latvian written in English is as important for native speakers of Latvian as for those who have learned Latvian as a second language and is of great value for anyone interested in the culture and history of Latvia or the Latvian language itself. The need for a reference grammar of Latvian written in English is especially important right now due to the existence of a large Latvian diaspora community abroad, particularly in English-speaking countries where children and young people are educated in the language of their home countries rather than in Latvian. A Latvian grammar written in English will also be useful for those who are learning Latvian as a foreign language and wish to learn more about its grammatical system and unique features. Likewise, “Latvian grammar” will be a useful reference and source of examples for teachers of Latvian – both those who teach it to speakers as a school or university subject and those who teach it as a foreign language. There is also considerable demand among linguists abroad for a systematic and dependable description of Latvian written by native speakers of Latvian. Latvian is a rather unique combination of ancient as well as relatively new features, which are of interest to researchers abroad and are important for the typological, cognitive, pragmatic, functional, and contrastive analysis of language.

VII This research is a novelty in Latvian scientific language study, and it can be used as the monograph, the open-access digital database, and the mobile app in a complementary manner.

Agnese Dubova (project leader), team of authors. Language of Science: Style, Text, Context. Rīga: Zinātne, 2021, pp. 280, ISBN 978-9934-599-11-8, digital database and mobile app “Zinātnes valoda” (“Language of Science”), 2020: <https://zinatnesvaloda.lv/>.

Researchers from Ventspils University of Applied Sciences and Liepāja University have published a collective monograph, “Language of Science: Style, Text, Context”, a result of analysis carried out over a period of two years. The monograph was developed within the Latvian Council of Science Fundamental and Applied Research Project “Intra-lingual Aspects of the Latvian Scientific Language” NR. Izp-2018/2–0131. The monograph deals with the link between scientific and common language, scientists’ strategy and tactics in choosing the language, multilingualism in science, and Latvian scientific language research history. The monograph also deals with possibilities of scientific text classification development and offers a



classification of texts used in scientific communication. The monograph focuses on the macrostructure of Latvian scientific text in various research fields and the results of analysis of its microstructure, as well as aggregates unwelcome deviations from the scientific language style. A bibliography of research on English, Russian, Latvian, Lithuanian, and German scientific languages and scientific communication has been added to the monograph. The publication will be useful to pupils and teachers, students and university lecturers, scientists, and others. The digital database and a mobile app “Zinātnes valoda”, which provides practical aid to pupils, students, lecturers, and researchers in developing scientific and academic texts, has been created as a result of the project.

VIII The study provides a comprehensive multidisciplinary expertise and future scenarios for maintaining the competitiveness of the Latvian economy in the shadow of a pandemic and in the post-crisis development.

Inna Šteinbuka (scientific editor), team of authors. Latvijas tautsaimniecība pandēmijas ēnā un pēckrīzes izrāviena iespējas = Latvian Economy in the Shadow of Pandemic and Opportunities of the Post-Crisis Recovery. Rīga: The University of Latvia Press, 2021, pp. 360, ISBN 978-9934-18-687-5, <https://doi.org/10.22364/ltpelij>. Productivity Research Institute at the Faculty of Business, Management and Economics, University of Latvia, UL Think Tank LV PEAK.

The monograph was written within the framework of the national research programme “Covid-19 Mitigation” project VPP-COVID-2020 / 1-0010 “Towards the Post-pandemic Recovery: Economic, Political and Legal Framework for Preservation of Latvia's Growth Potential and Increasing Competitiveness (reCOVery-LV)”. A total of 80 economists, lawyers, political scientists and sociologists, including 19 doctoral students, worked on the research project. The study combines the scientific expertise of researchers with the practical experience of the state and local governments and non-governmental organizations in order to find adequate tools for economic breakthrough. The monograph comes at a time when the Covid-19 crisis has shaken not only people's lives but also the economy. Its aim is to predict the future course of the "disease" of the economy and to find strong medicines for a faster economic recovery. An interdisciplinary team of researchers from LU, LAS, LLU, RTU and RSU has been involved in economic diagnostics and developing recommendations for policy makers to mitigate the devastating effects of the crisis and move the economy out of the turbulence zone. The key word of the monograph is Latvia's competitiveness, while the main factor promoting competitiveness is productivity, the renaissance of which is a precondition for a breakthrough after the crisis. Productivity growth is linked to technological modernization, innovation and the skills of the workforce. In order to get involved in knowledge-intensive global value chains, Latvian companies need strong skills, innovation capacity and efficient use of resources.

IX The study provides a cross-disciplinary research on how it is possible to restructure and strengthen the resilience of local food chains during the crisis and post-crisis in Latvia.

Irina Pilvere (scientific editor), team of authors. Restructuring of Local Agricultural and Food Supply Chains and Strengthening of Resilience in Crisis and Post-Crisis Conditions in Latvia (Vietējo pārtikas ķēžu pārstrukturizēšana un noturības stiprināšana krīzes un pēckrīzes laikā Latvijā), Jelgava: Drukātava, 2021, pp. 465.

The team of authors – 29 scientists and students – food technology engineers, economists, biologists, agronomists, sociologists and chemists from the Latvia University of Life Sciences and Technologies and the Institute of Horticulture and the Editor-in-Chief, LAS Full member Irina Pilvere conducted a study on using the accumulated knowledge in the sustainable use of natural resources on how to make the restructuring of agriculture and food supply chains during a crisis and a post-crisis time. Possibilities for rebuilding food chains were analyzed following the economic constraints caused by Covid-19 in seven agricultural sectors, involving industry experts in the study. Proposals for entrepreneurs and policy makers have been prepared. A detailed analysis of horticulture has been performed, evaluating 46 types of fresh fruits and vegetables grown in Latvia and their availability in stores. The current and necessary supply of local products in the Latvian



retail market has been determined. The monograph presents a scientifically based four-week food model for preparing a warm lunch at home in a time of crisis for pupils from grades 1 to 4. The model is based on a prepared food nutritional analysis to reflect the actual daily needed supply of nutrients, as well as authors suggested environmentally friendly packaging solutions.

X Comprehensive and compelling story about Latvian forest and it's researchers.

Ēriks Hānbergs, Jurgis Jansons. *We – The Silava Insiders. Stories about Latvian forest and forest scientists (Silavieši. Stāsti par Latvijas mežu un meža zinātniekiem)*. Rīga: Latvijas Mediji, 2021, pp. 567, ISBN: 978-9934-15-992-3. Published with support of Latvian State Forest Research Institute “Silava”.

The book has been prepared and published to mark the 75th anniversary since the founding of the Latvian State Forest Research Institute Silava. Through the stories of the Silava insiders and their friends, the book presents an extensive overview of the institute's activities — research directions, institutional, administrative and staff development — and of the key events over the last 25 years, also touching upon the historical events and lessons of experience. An important part of the book is devoted to the interviews with former and existing staff members and friends of the institute. The book is a comprehensive representation of the forest and it's values. The scientists of the institute are developing methods of smart forest management to achieve that they would be beneficial for Latvia's economy while maintaining their recreational role and sustainability. The protagonist of the book are people who have worked or are working at the institute. When reading their stories, one will find out what are the main research directions and topics, as well as learn about the passionate bond between forest and it's researchers.

XI First Latvian author's work on the macro, micro and chemical structure of wood, as well as on the visual recognition of tree species, evaluation and characterization of their physical and mechanical parameters.

Leonards Līpiņš. *The Lesson on Wood (Koksnes mācība)*. Rēzekne: Latgales druka, 2021, pp. 168, ISBN: 978-9934-8576-9-0. Published with the support of JSC “Latvia State Forests”.

“The Lesson on Wood” is the first book by Latvian author on the macro, micro and chemical structure of wood, as well as on the visual detection of tree species, evaluation of physical and mechanical parameters and characterization of tree species. The book describes in detail the variability of wood properties from the site of the trunk, the region of growth, the impact of forestry measures taken, felling time, physical, biological and other factors. The book contains findings from the research of Professor Leonards Līpiņš and other scientists on the moisture, density and quality of economically important tree species. The book will be useful for forestry and production professionals as well as students.