IMCB 30

30th anniversary of the Institute of Molecular and Cell Biology

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IMCB 30

30th anniversary of the Institute of Molecular and Cell Biology

UNIVERSITY OF TARTU
Institute of Molecular and
Cell Biology

FOREWORD

Dear Reader,

This year, the Institute of Molecular and Cell Biology (IMCB) celebrates its 30th anniversary. Looking back over these three decades, I can acknowledge that although we have undergone several major changes, divisions and mergers, we have been able to fulfil our main aims and realise the original ideas for establishing the Institute. Through the firm connection of top-level scientific research and higher education at all three academic levels – Bachelor's, Master's and doctoral – we have contributed stability and reliability to the overall operation of the University of Tartu.

The Institute covers a range of competences from microbiology and eukaryotic models to bioinformatics. Our research groups study new developments in bioinformatics, epigenetics, cell biology and enzymology. It is important for us to support collaboration and synergy between research groups (molecular biology and genetics; biochemistry and cell biology). We have strong research infrastructure (microscopy, incl. transmission electron microscopy and confocal microscopy, FACS, equipment for proteomics, metabolomics and transcriptomics). We also have a lab animal facility, incl. for transgenic mice.

The research programmes at the Institute are covered with various research grants and contracts (currently 27), both national and international, from the public and private sectors.

Our research programmes are closely connected with the teaching of Master's and PhD students. The number of PhD degrees awarded in 2019 was seven (10 in 2018) and 25 students received their MSc degrees (21 in 2018).

Our teaching curricula (five across all academic levels) are fully accredited by national authorities. However, we constantly work to improve them in close collaboration with our students, future employers and academic staff. Recently, we fully upgraded our MSc curriculum Molecular Biosciences, which replaced our previous MSc curriculum Gene Technology. Currently, we are working on our Bachelor's curriculum to increase its flexibility and meet the needs of the stakeholders.

The total number of our research publications has somewhat decreased over the years. However, since 2015 the number of publications per academic researcher has increased from 14.1 to 15.2, and the number of citations for the same period from 413 to 560. This positive trend towards a higher quality of published papers will hopefully continue.

The Institute of Molecular and Cell Biology is a leading partner in the Doctoral School of Biomedicine and Biotechnology. This connects us with our partners and offers more opportunities to our PhD students to receive training at home and abroad.

The Institute is also active in the popularisation of science: we have a Traveling Bioclass programme for gymnasiums and active collaborations with Science Centre AHHAA and the University of Tartu Youth Academy (training gifted learners from gymnasiums). With the Biology Students' Association (BSA), we organise Genetics Workshops, where students from gymnasiums and elementary schools get their first experience of benchwork. Active collaboration with biotech companies (Icosagen, Solis Biodyne, University Clinics, Thermo Fisher Scientific Baltics, BiotaTec, BioAtlas, Centre of Competence for Health) creates additional opportunities for our students to train in these businesses, but also gives us valuable input for further curriculum development. For the Genetics Workshops, the Institute received the Estonian Research Council 2019 Grand Prix for the Best Popularizer of Research and Technology, the Traveling Bioclass received this award in 2017. Our researchers are socially active and motivated to run several other projects for young learners: microbial workshops and project '101 yeast strains from Estonian nature'.

The members of the Institute have actively contributed to fundamental textbooks in the Estonian language. Textbook Cell Biology, written by 26 authors (T. Maimets and S. Kuuse, eds.), received the 'Best Estonian-language Textbook Award 2019' from the Ministry of Education and Research. This book, published electronically in 2018, adds to the Estonian-language textbooks published earlier by our professors: Genetics by Prof. Ain Heinaru (2012) and Bioinformatics by Prof. Maido Remm (2015).

The 'stability' of the Institute mentioned above is by no means a form of stagnation. On the contrary – we are as dynamically stable as any living organism, which is to say, in good health. This means a well-tuned balance between the constant flow of incoming and outgoing information, resources and ideas. The decisive basis for this dynamic balance is built up every day by our people – students, academic staff, technical support colleagues and numerous partners. Thank you all and happy 30th birthday!

Professor Toivo Maimets,
Director

HISTORICAL REMARKS

THE QUEST FOR CHANGE (1970-1990)

A. **Molecular biology and genetics as a new specialisation for students**
   1. Development of a new specialisation for chemistry students – bioorganic chemistry (cell biology, genetics, developmental biology, etc. were added to the chemistry curricula) – starting from 1977
   2. Biology students from the Department of Biochemistry and Plant Physiology and the Department of Genetics and Cytology specialised on the basis of individual study programmes in the field of molecular biology (scientific supervisors from research laboratories outside the departments) starting from 1977

B. **Attempt to develop the Department of Molecular Biology at the Faculty of Biology and Geography**
   1. Professors from the Faculty of Biology did not support this activity (1980-1990)

C. **Development of Estonian Biocentre**
   1. Programmes on biotechnology in the Soviet Union (Research equipment)
   2. Development of Estonian Biocentre at the Academy of Sciences (1986)
   3. Cooperation between the university and the Academy of Sciences (Agreements)
   4. Buildings (Riia 23 etc.). Renovations, research laboratories, lecture rooms in various locations in Tartu (Vanemuise 46, Tähetorn, etc.)

D. **Post doc positions abroad – the development of highly qualified research staff** R. Villems, A. Heinaru, M. Ustav, A. Metspalu, A. Karis, J. Kärner, M. Saarma, T. Maimets J. Sedman, J. Remme, P. Palumaa became key persons in the development of molecular biology and genetics in Estonia (professors of departments)

NEW PARADIGM TO UT-1990

IMCB as a project of Tartu University with a new paradigm involved (seven principles)

1. To complete the merging of teaching and research, teachers and researchers. To have a new renovated building for the new institute.
2. To have the same academic performance requirement for academic staff (teachers, researchers). To generate up to 200 graduates with PhD degrees during next 20 years.
3. To elect all academic staff members for a given period. Instead of the 24 existing ones, 12 new elected positions were opened to the best specialists from the university faculties and research laboratories as well as the Institutes of the Academy of Sciences.
4. To publish scientific papers in high-level international journals. International research cooperation.
5. To have a financially self-sufficient institute, operating as a legal entity.
6. To conclude a cooperation agreement with the Estonian Biocentre (of the Academy of Sciences at that time). International projects, Repatriation Funds, PPP projects (Citrina Foundation).
7. To have a consensus principle at decisions (a variety of opinions but acceptance of the majority opinion).

IMCB AND RESEARCH (37 PROFESSORS)

1. General and Microbial Biochemistry (1992–1999 Prof **Peep Palumaa**, 2000–present Prof **Juhan Sedman**)
2. Biotechnology (Prof **Andres Metspalu**, 2008–present Prof **Ants Kurg**, 2009–2016 Prof **Maris Laan**)
3. Cell Biology (1992–present Prof **Toivo Maimets**, 2016–present Prof **Arnold Kristjuhan**)
4. Evolutionary Biology (Prof **Henni Kallak**, 1996–present Prof **Richard Villems**, Prof **Toomas Kivisild**, 2006–present (University of Cambridge) and 2010–2018)
5. Genetics (1992–2020 Prof **Ain Heinaru**, 2008–present Prof **Maia Kivisaar**, 2019–present Prof **Jaak Truu**, 2020–present Prof **Angela Ivask**)
6. Microbiology and Virology (1992–2001 Prof **Mart Ustav**, 2003–2007 Prof **Andres Merits**)
7. Molecular Biology (1988–present Prof **Mart Saarma** (University of Helsinki), 1992–1996 Prof **Richard Villems**, 1996–2019 Prof **Jaanus Remme**, 2019–present Prof **Tiina Tamm**)
8. Plant Physiology (1992–2006 Prof **Agu Laisk**), renamed Biophysics and Plant Physiology (2007–present Prof **Arvi Freiberg**)
9. Science Didactics, founded 1994, until 2001 (2003, 2016–present Prof **Miia Rannikmäe**, Centre of Science Education, 1999–present Prof **Jack Holbrook**)
10. Bioinformatics, founded 2003 (2003–present Prof **Maido Remm**)
11. Developmental Biology, founded 2008 (2008–2010 Prof **Jüri Kärner**, 2008–2015 Prof **Alar Karis**, 2008–2016 Prof **Margus Pooga**, 2019–present Prof **Osamu Shimmi**)
12. Professors arising from the IMCB: Prof **Erkki Truve** (TalTech), **Andres Salumets** (UT), **Pärt Peterson** (UT), **Ana Rebane** (UT), **Hannes Kollist** (UT), **Tanel Tenson** (UT), **Ülo Niinemets** (EULS), **Andres Merits** (UT)

IMCB AND EDUCATION (CURRICULA)

A. **Bachelor's Programmes**
   1. Biology and Biodiversity Conservation
   2. Gene Technology
   3. Environmental Technology
   4. Science and Technology (English)
   5. Basic School Teachers for Natural Sciences and Exact Sciences

B. **Master's Programmes**
   1. Biomedicine, starting from 2006
   2. Environmental Technology
   3. Molecular Biosciences, starting from 2019 (2002–2019 Gene Technology)
   4. Teacher of Biology
   5. Secondary School Science Teacher

C. **Doctoral Programmes**
   1. Gene Technology
   2. Environmental Technology
   3. Molecular and Cell Biology

D. **General Study Subjects (IMCB responsibility)**
   1. Behavioural Genetics
   2. Biochemistry
   3. Bioinformatics
   4. Biophysics
   5. Biotechnology
   6. Cell Biology
   7. Developmental Biology
   8. Evolutionary Biology
   9. General Biology
   10. Genetics
   11. Microbiology
   12. Molecular Biology
   13. Plant Physiology
   14. Virology

OUR PARTNERS AND COLLABORATORS

- Estonian Biocentre (EBC) (1986–2018)
- Institute of Technology (2001)
- Estonian Genome Foundation 2000
  - Estonian Genome Project 2000
- Institute of Genomics 2018
  - EBC stops being a legal entity
  - Estonian Genome Project inside the Institute of Genomics
- Institute of Gene Technology (TalTech) 2002
- University of Life Sciences
- Estonian Crop Research Institute
- Institute of Biomedicine and Translational Medicine, UT
- Institute of Clinical Medicine, UT
- Bioscience Students' Association (2013)
- Contact with schools and Youth Academy of UT (Genetic Workshops, Olympiads, Traveling Bioclass, etc.)
- SMEs and industrial partners (Tartu Biotechnology Park, Asper Biotech, Quattromed, Icosagen, Solis BioDyne, etc.)
- Professional Societies in the field (Estonian Society for Microbiology, Estonian Society of Human Genetics, etc.)

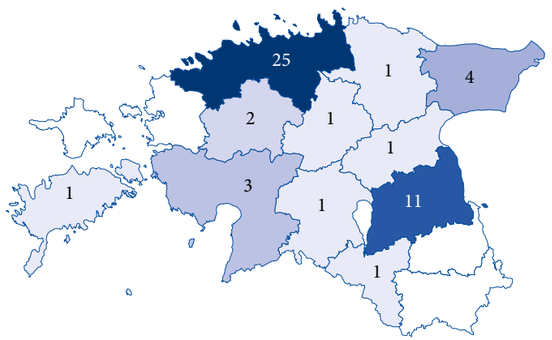
IMCB AND ESTONIAN SOCIETY

1. Minister of Education
   1. Toivo Maimets
2. President of the Academy of Sciences
   1. Richard Villems
3. Audit General, National Audit Office of Estonia
   1. Alar Karis
4. Rectors
   1. Jüri Kärner
   2. Alar Karis (UT, ULS)
5. Vice rectors for Research
   1. Toivo Maimets
   2. Ain Heinaru
   3. Erkki Truve (TalTech)
6. Head of the Department of Research (Ministry of Education)
   1. Ain Heinaru
7. Deans
   1. Toivo Maimets
   2. Ain Heinaru
8. Academicians
   1. Arvi Freiberg
   2. Agu Laisk
   3. Andres Metspalu
   4. Mart Saarma
   5. Mart Ustav
   6. Richard Villems
9. Directors
   1. Richard Villems (Estonian Biocentre, IMCB)
   2. Mart Ustav (Institute of Technology, IMCB)
   3. Alar Karis (Estonian National Museum, IMCB)
   4. Arvi Freiberg (Institute of Physics)
   5. Andres Metspalu (Estonian Genome Project)
   6. Ain Heinaru (IMCB)
   7. Jaanus Remme (IMCB)
   8. Juhan Sedman (IMCB)
   9. Toivo Maimets (IMCB)
   10. Mart Saarma (University of Helsinki)
   11. Toomas Kivisild (University of Cambridge)

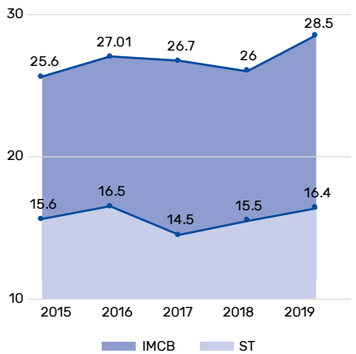
STATISTICS: EDUCATION

239 students are studying at the Institute of Molecular and Cell Biology. The total number of students in the Faculty of Science and Technology is 3174. We are coordinating five curricula. The Gene Technology undergraduate curriculum is the biggest, with 121 students. We have two Master's level curricula: Molecular Biosciences (formerly Gene Technology) and Biomedicine. Biomedicine is a shared curriculum with the Faculty of Medicine. Two doctoral curricula, Molecular and Cell Biology and Gene Technology, are also coordinated by us. In 2019, seven PhD students successfully defended their theses making 184 successful doctoral graduates since 1991. Students are welcomed to our curricula from all over Estonia and abroad. Around 4% of our students are foreign. There are 12.2 students per lecturer and 12,447 credits (ECTS) were issued from our institute in 2019.

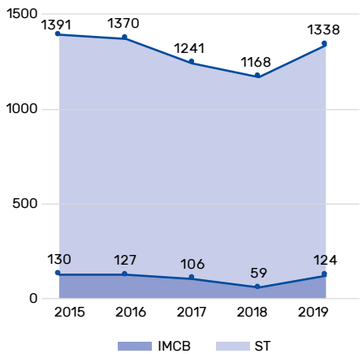
Distribution of students admitted to first study level by county of location of upper secondary school in 2019



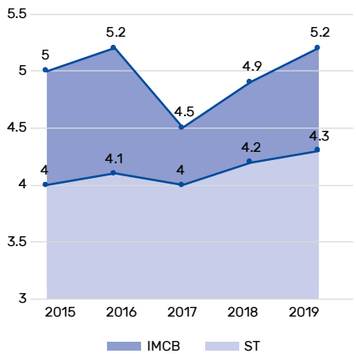
Percentage among 10% most cited publications



Number of publications

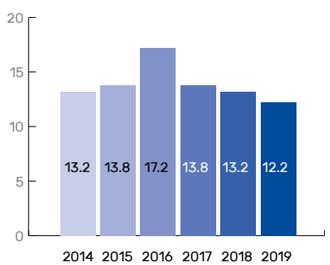


Average h-index impact

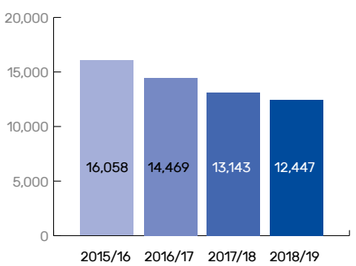


ST - Faculty of Science and Technology

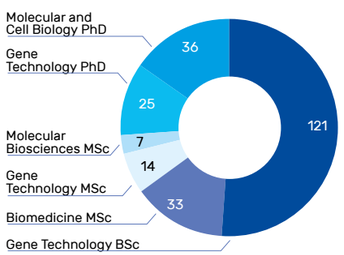
Number of students per teaching staff



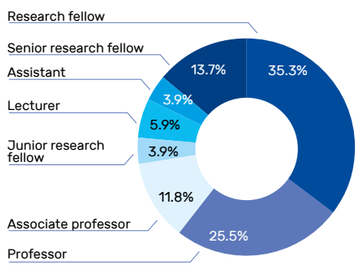
Credits issued in IMCB



Students by curricula 2019



Academic staff member

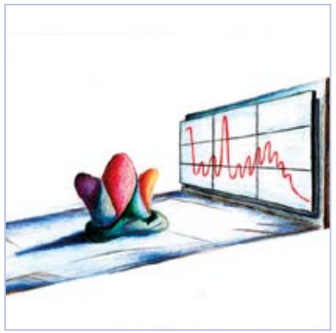


STATISTICS: RESEARCH

In 2018, there were ca 47 publications and approximately 30% of publications by IMCB researchers among 10% of the world's most cited publications. Our research has a great impact, with a 4.9 average h-index. Our researchers Triinu Kõressaar, Andres Metspalu, Maido Remm and Richard Villems are among the top 1% of the world's most cited scientists. Academic staff make up 59% of our employees, 90% of academic staff members hold a PhD and we have 13 professors.

CHAIR OF MOLECULAR BIOLOGY

The Chair of Molecular Biology continues the long standing tradition of studying molecules involved in protein synthesis, initiated in the 1960s by a research group led by Prof. Artur Lind. The following staff members are included in the Chair: professor Tiina Tamm; senior research fellows Jaanus Remme and Aivar Liiv; research fellow Margus Leppik; specialist Ivan Kisly; and doctoral students Silva Lilleorg, Kaspar Reier, Pavel Volõnkin and Ermo Leuska. The Chair is responsible for teaching the Molecular Biology course at the Bachelor's level and several special courses (Molecular Biology of Eukaryotes, Yeasts – from model organisms to pathogens, Nucleic Acids) at the Master's level.



The pulse of protein synthesis is the pulse of life

WHAT IS OUR MOST SIGNIFICANT DISCOVERY? (LAST 10 YEARS)

The most important scientific achievement during the last decade is the elucidation of the modification and biological role of the bacterial translation elongation factor P (EF-P). The pathway responsible for the post-translational modification of EF-P was described. EF-P targeted mRNA sequences were defined.

WHAT IS OUR CURRENT RESEARCH FOCUS?

We are focused on the structure-function relationship of the ribosome in two model organisms – bacteria *E. coli* and budding yeast. The role of ribosomal components in ribosome biogenesis and translation, the role and effect of modified nucleosides of rRNA and mRNA and the biological importance of ribosome heterogeneity are our research directions.

WHAT ARE OUR GOALS FOR THE FUTURE? (FOR THE NEXT 10 YEARS)

Future studies will focus on factors affecting the functions of the bacterial and eukaryotic ribosomes and ribosome dysfunction in disease. The role of rRNA and mRNA modifications in protein synthesis, implementing the higher eukaryotic model, will be a key goal of our future studies.

CHAIR OF GENETICS

The Chair of Genetics consists of three professors, two associate professors, two senior research fellows, six research fellows, two specialists and one project manager. Ain Heinaru recently acquired the status of Professor Emeritus and Tiina Alamäe the status of Associate Professor Emeritus. Ten doctoral students and several Master's and Bachelor's students are engaged in various research projects.

The Chair is responsible for research-based teaching in genetics and microbiology at Bachelor's, Master's and doctoral levels. Research is performed mostly in the fields of microbial genetics and molecular, environmental and applied microbiology.

The Chair has eight research groups: microbial genetics (professor Maia Kivisaar); bacterial stress tolerance (senior research fellow Rita Hõrak); bacterial lifestyles (associated professor Riho Teras); microbial ecology and biodegradation (professor Ain Heinaru/research fellow Signe Viggor); the study of bacterial and yeast proteins (associated professor Tiina Alamäe/Triinu Visnapuu); environmental microbiology (professor Jaak Truu); metals bioleaching (research fellow Anne Menert) and the recently established research group focusing on applications of nanomaterial-based antimicrobial coatings (professor Angela Ivask).

Pseudomonas putida (Photo: Sergei Vlassov)

WHAT IS OUR MOST SIGNIFICANT DISCOVERY? (LAST 10 YEARS)

We have elucidated molecular mechanisms involved in the genetic and physiological adaptation of microorganisms under changing environmental conditions, identified the response of microbial communities to environmental pollutants, isolated and characterised bacterial strains able to degrade a wide range of environmental pollutants for bioaugmentation performances. We have also obtained new information on the evolution and structure of microbial sugar-acting enzymes.

WHAT IS OUR CURRENT RESEARCH FOCUS?

1. The study of mechanisms affecting mutagenic processes in bacteria and the evolution of bacteria under stressful conditions; 2. The study of stress tolerance mechanisms in bacteria; 3. The study of bacterial biofilm development and regulation by global regulators; 4. Microbial biodegradation; 5. Determination of the key microbial species and metabolic pathways responsible for the degradation of different oil fractions in different marine compartments of the Baltic Sea and Arctic marine environments; 6. The biochemical, structural and phylogenetic study of microbial glycoside hydrolases and application of levansucrase and endo-levanase to produce potentially prebiotic oligosaccharides; 7. The bioleaching of metals from Estonian graptolite argillite and e-wastes using a consortia of laboratory-evolved indigenous microorganisms.

WHAT ARE OUR GOALS FOR THE FUTURE? (FOR THE NEXT 10 YEARS)

The main goals of our research will focus on gaining a deeper understanding of molecular mechanisms affecting the evolution of bacteria under stressful conditions, deciphering mechanisms of bacterial stress tolerance and the utilisation of those mechanisms for the design of antimicrobial coatings. Future studies will also be dedicated to several biotechnological applications (polluted soil and waste water treatment technologies, biosynthesis of added-value chemicals, bioleaching of metals) and the application of biotechnology-related enzymes.

THE CHAIR OF BIOCHEMISTRY

The Chair of Biochemistry consists of eight staff members and three doctoral students working in three groups with research interest in the heterophasic catalysis of biological systems, nucleic acid metabolism in mitochondria and the plasticity of metabolic reaction networks, respectively. We teach Biochemistry for BSc students and Protein Chemistry, Enzymology and Applied Biochemistry for Master's students.

Biochemistry tips

WHAT IS OUR MOST SIGNIFICANT DISCOVERY? (LAST 10 YEARS)

We have demonstrated that DNA replication is a recombination dependent process in yeast mitochondria.

WHAT IS OUR CURRENT RESEARCH FOCUS?

Currently, we characterise the functions of different protein factors in mitochondrial DNA metabolism, analyse the redox-chemistry of enzymatic reactions in heterophasic systems and study the malleability of metabolic networks under mitochondrial stress conditions.

WHAT ARE OUR GOALS FOR THE FUTURE? (FOR THE NEXT 10 YEARS)

We hope to continue our biochemical research in 3–5 groups with independent PIs and recruit at least 1–2 graduate students every year. In an ideal world, we would like to continue and significantly expand our ties with the biotechnology sector and biomedical industry with a specific focus on protein engineering.

CHAIR OF EVOLUTIONARY BIOLOGY

The Chair of Evolutionary Biology currently includes three staff members and three PhD students. Thanks to extensive collaboration with the Institute of Genomics, we cover much of the teaching of evolutionary biology and the related subjects, such as population genetics, genomics as well as molecular immunology.

From left to right: Tartu, Haifa, Stanford, Cambridge, Tartu

WHAT IS OUR MOST SIGNIFICANT DISCOVERY? (LAST 10 YEARS)

This is complicated. Perhaps, we might mention a *Nature* paper from 2016 about the peopling of Eurasia by humans. The main work was carried out in Prof. T. Kivisild's group in Cambridge and by us in Tartu. It was selected by *Nature* as one of the ten most significant discoveries of the year in all sciences and also received the Estonian Science Prize in 2017.

WHAT IS OUR CURRENT RESEARCH FOCUS?

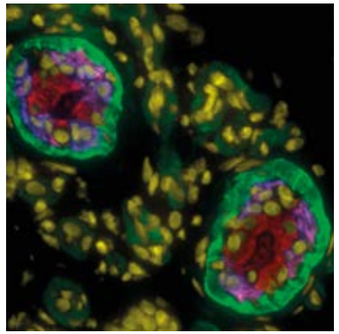
There are a few foci, but to summarise, we could most broadly define it as transdisciplinary research in the field of human genetic variation, archaeology and linguistics.

WHAT ARE OUR GOALS FOR THE FUTURE? (FOR THE NEXT 10 YEARS)

They remain as they have been in the past: try to do good science and teach the next generations of researchers.

CHAIR OF CELL BIOLOGY

The Chair of Cell Biology consists of 10 people (plus MSc and PhD students) belonging to three working groups – Somatic cell biology (Sen. res. Viljar Jaks), Chromatin research (Prof. Arnold Kristjuhan) and the Group of embryonic stem cells and cancer biology (Prof. Toivo Maimets). We teach basic courses in Cell Biology (both lectures and practical lab courses), tissue culture methods and development of biological thought, research methodology and bioethics.



Sweat glands in human palm skin.

WHAT IS OUR MOST SIGNIFICANT DISCOVERY? (LAST 10 YEARS)

We uncovered the molecular mechanisms that regulate early-firing DNA replication origins in the beginning of DNA synthesis. We showed that Forkhead family transcription factors are needed for efficient activation of these origins and the precise arrangement of Forkhead binding sites is required for recruitment of Forkhead proteins to the origins.

WHAT IS OUR CURRENT RESEARCH FOCUS?

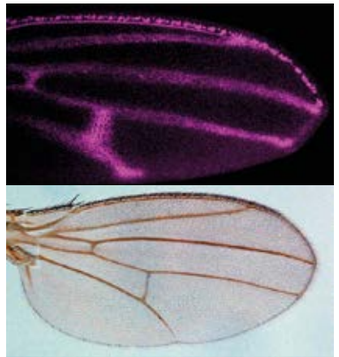
We will continue to study the regulation of cell division at multiple levels: mechanisms of replication initiation at the level of chromatin modification, the interplay between developmental potency and tumorigenesis as well as the regulation of tissue-specific stem cell activity during normal tissue maintenance and regeneration.

WHAT ARE OUR GOALS FOR THE FUTURE? (FOR THE NEXT 10 YEARS)

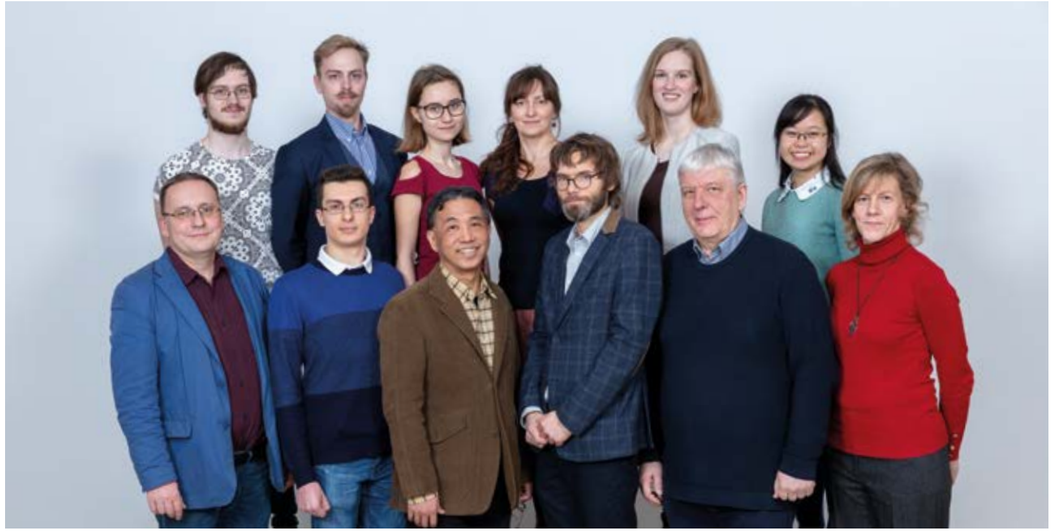
We will continue the high quality research of fundamental eukaryotic cell biology and the mechanisms of different human diseases. These results will form a platform for the development of new drugs and diagnostics. Teaching Cell Biology courses at Bachelor's, Master's and PhD levels will be continuously based on and further developed using our scientific expertise.

CHAIR OF DEVELOPMENTAL BIOLOGY

The Chair of Developmental Biology currently employs four people directly involved in teaching (professor, associate professor, lector, assistant), one researcher and laboratory assistant. In addition, two doctoral and three Master's students and one undergraduate student are involved in the projects. Today's research focus is on the morphogenesis of tissues using the developing wing of *Drosophila* as a model. The group is chaired by Prof. O. Shimmi. The Chair of Developmental Biology teaches at all postgraduate levels (Developmental Biology, Molecular Developmental Biology, General Histology, Microscopy, Microscopic Anatomy, Human Anatomy and Physiology, Developmental Neurobiology, Molecular Cell Biology).



Pupal wing vein patterning of fruit fly Drosophila melanogaster stained by anti-phosphoSmad antibody (above) and wing of adult Drosophila melanogaster (below)



WHAT IS OUR MOST SIGNIFICANT DISCOVERY? (LAST 10 YEARS)

We contributed to the development of cell-penetrating peptides to powerful transport vehicles that deliver various macromolecular drugs into target cells and the elucidation of respective mechanisms. We also showed that conserved guanine nucleotide exchange factor RIC8A is irreplaceable in gastrulation and the development of the nervous system in mammals.

WHAT IS OUR CURRENT RESEARCH FOCUS?

Despite the increasing knowledge of the molecular basis of tissue morphogenesis, the effect of morphological changes on developmental signalling (mechano-chemical feedback) remains poorly understood. Using a *Drosophila* wing as a model, we investigate how the dynamics of tissue/cell shape and the spatiotemporal regulation of signalling molecules are coordinated.

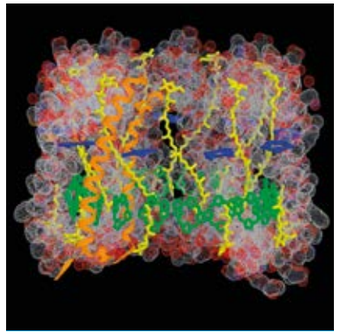
WHAT ARE OUR GOALS FOR THE FUTURE? (FOR THE NEXT 10 YEARS)

With *Drosophila* as a model, we will unveil novel mechanisms involved in forming the 3D organ from 2D precursors. Using multi-coloured time-lapse imaging (5D imaging), we will address how the dynamics of cell-cell communication lead to 3D organ formation and anticipate that our findings will have implications for understanding and treating human disease.

CHAIR OF BIOPHYSICS AND PLANT PHYSIOLOGY

We are investigating fundamental photosynthesis processes at various integration levels, from individual antenna and reaction centre complexes through intact leaves and whole plants. Our highly interdisciplinary enterprise involves close collaboration between research groups from the Institute of Physics and Institute of Technology of the University of Tartu.

We have been responsible for several lectures and practical courses such as Basic Physics (BSc), Biological Physics (BSc), Plant Physiology (BSc, MSc), and Plant Molecular Biology (MSc).



Bacterial light-harvesting 2 (LH2) complex is one of our favorite model playgrounds.

WHAT IS OUR MOST SIGNIFICANT DISCOVERY? (LAST 10 YEARS)

One of our most prominent findings shows that photosystem II can oxidize plastoquinol in a manner coupled with proton transport and fulfil the ATP gap (A. Laisk, H. Eichelmann, V. Oja (2015) Biochim Biophys Acta 1847, 565-575). We also identified the extreme thermal robustness of photosynthetic excitons, which raised fundamental issues of quantum mechanical concepts in biology (M. Rätsep, R. Muru, A. Freiberg (2018) Nature Commun 9, 99).

WHAT IS OUR CURRENT RESEARCH FOCUS?

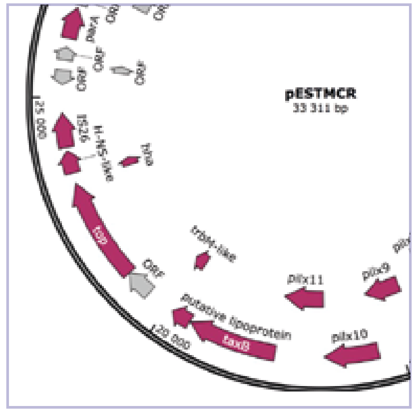
We are focusing on quenching chlorophyll fluorescence by non-radiative recombination of the primary radical pair before stabilisation of charges and the modulation of photosynthetic primary energy and electron transfer processes by physical parameters such as temperature and pressure.

WHAT ARE OUR GOALS FOR THE FUTURE? (FOR THE NEXT 10 YEARS)

We are aiming for a breakthrough in the understanding of chlorophyll excitations in vivo and in vitro by studying an unprecedented wide spectral range of UV-IR which is becoming available via collaboration with the Estonia-operated Max IV EstFin synchrotron radiation and ESS neutron scattering facilities. Our research is expected to be relevant to future energetics and device design.

CHAIR OF BIOINFORMATICS

The Chair of Bioinformatics was established in 2002. Our team currently consists of seven research scientists, five PhD students and one assistant. We are responsible for six lecture courses with an overall volume of 24 EAP. These are Bioinformatics I, Bioinformatics II, Data Analysis in Molecular Biology, Genomics, Genomics and Bioinformatics and Sequence Analysis in Linux Environment.



Map of the E.coli plasmid with a colistin resistance gene mcr-1. We discovered the first appearance of colistin resistance gene in Estonia in 2016. (Brauer et al., Antimicrob. Agents Chemother.)

WHAT IS OUR MOST SIGNIFICANT DISCOVERY? (LAST 10 YEARS)

The people of our workgroup have published nearly 100 publications in genomics over the last 18 years in various journals, including *Nature* and received nearly 10,000 citations. Perhaps the most significant recent discoveries are the new computational methods that allow analysis of the human genome 10–30 times faster than previous methods.

WHAT IS OUR CURRENT RESEARCH FOCUS?

We develop computational methods for the faster and more reliable analysis of genomic sequences. Some examples of such methods are:

- detection of variants in personal human genomes;
- detection of chromosomal aneuploidies of embryos from blood samples of pregnant women;
- prediction of antibiotic resistance of a bacterial strain from its genomic sequence.

WHAT ARE OUR GOALS FOR THE FUTURE? (FOR THE NEXT 10 YEARS)

We plan to develop computational methods for the surveillance of bacterial pathogens (virulence, resistance to drugs or cleaning agents). This will be complemented with an analysis of the transfer routes (when, where and how) of pathogens. We also plan to develop methods for the surveillance of food composition and food origin based on traces of DNA detected in food.

CHAIR OF BIOTECHNOLOGY

The Chair of Biotechnology currently consists of four staff members. We are teaching six courses including lectures and practical sessions in Biotechnology and Molecular Biotechnology. At the Master's level, we teach Omics and Structure and Function of the Genome. We also participate in teaching the Introductory Laboratory Course and science popularization activities of Traveling Bioclass I and II.

Pipet soldiers

WHAT IS OUR MOST SIGNIFICANT DISCOVERY? (LAST 10 YEARS)

Our most significant scientific achievements during the past 10 years have been related to the development, optimisation and introduction of new DNA-based molecular diagnostic methods into clinical practice in Estonia, including the DNA array-based analysis of DNA copy-number changes in patients with intellectual disability and developmental anomalies as well as non-invasive prenatal diagnosis methods based on cell-free foetal DNA analysis.

WHAT IS OUR CURRENT RESEARCH FOCUS?

Our current research includes studying DNA copy-number changes in female reproductive ageing and infertility and chromosomal instability in human (and bovine as a model) early embryos. In addition, we are focusing on the development and implementation of new methods for genome editing and the epigenetic profiling of a limited number of cells to enable functional studies from well-defined cell populations, including embryonic and stem cells.

WHAT ARE OUR GOALS FOR THE FUTURE? (FOR THE NEXT 10 YEARS)

Our goals are to continue providing our students with up-to-date knowledge in the field, foster our existing fruitful collaborations and work towards improving the funding situation to initiate novel collaborative research projects that employ our expertise in cell-free DNA and method development to utilise novel liquid biopsy-based methods for improving diagnosis and treatment of various diseases, including cancer.

THE ADMINISTRATION AND NON-ACADEMIC PERSONNEL OF THE INSTITUTE

STANDING, FROM LEFT TO RIGHT:

Ingrid Jalak, Accountant
Kristina Mäemets-Allas, Project Manager
Tiiu Rootslane, Specialist
Sirje Kask, Laboratory Assistant
Mart Roos, Engineer
Sulev Kuuse, Vivarium Manager
Janika Vana, Assistant

SITTING, FROM LEFT TO RIGHT:

Annely Kukk, Specialist
Milvi Siniroht, Technician-Laboratory Assistant
Teele Eensaar, Project Manager
Alar Tuubel, Driver-Clerical Assistant
Signe Parts, Communication Coordinator

Estonia's National University 100, Book presentation "Rector Jüri Kärner" and opening of the art exhibition of electron microphotos by Jüri Kärner. Professor Jüri Kärner (1940–2010) was the Rector of the University of Tartu in years 1988–1993. He was also the developer of the field of electron microscopy in Estonia. (21.10.2019)

STUDENT LIFE

THE UNIVERSITY OF TARTU YOUTH ACADEMY

The University of Tartu Youth Academy offers several opportunities to students, including gifted learners, to develop their abilities. Over the years, the Institute of Molecular and Cell Biology and the University of Tartu Youth Academy have developed a close cooperation in the tuition and studying process. The lecturers and students of the Institute of Molecular and Cell Biology are actively engaged in several activities of the Youth Academy. They deliver lectures in schools, conduct training sessions and workshops in the university labs and act as instructors for e-courses. Since 1961, the lecturers and PhD students of the institute have organised the annual Estonian Biology Olympiad. The National Biology Olympiad (NBO) team prepares the best students from Estonian schools for the International Biology Olympiad.

THE BIOSCIENCE STUDENTS' ASSOCIATION

The Bioscience Students' Association (Bioteaduste üliõpilaste selts) supports the personal growth of future bioscientists and promotes science in the community.

The BSA offers lectures to students on a variety of bioscience topics. BSA members support bioscience freshmen by volunteering as mentors for new students to help them adjust to the university. The BSA reaches out to partner universities and works on improving the bioscience curricula in collaboration with the IMCB.

In 2019, the BSA organised 'March for Science' to bring awareness to the underfunding of Estonian science. This event was recognised as the Deed of the Year by the EUL. In the same year, the BSA launched 'Environment Week', which also gained public attention and recognition.

GENETICS WORKSHOP

The Genetics Workshop is a project which offers high school students the opportunity to do practical lab work for an entire day in addition to their theoretical biology studies. The workshops take place once a year and last for two weeks. The participants can either do forensic science or investigate their own DNA. The originator of the project is Mari Järve who started organising the workshops in 2013. Since 2018, IMCB and BSA have been the main organisers. The genetics workshop has been awarded 'Nationally recognized science popularizer' and 'The most interesting lesson' prizes.

RIIKLIKULT TUNNUSTATUD TEADUSE POPULARISEERIJA 2019

TRAVELING BIOCLASS

Rändav bioklass (Traveling Bioclass) is a joint initiative of the University of Tartu and Thermo Fisher Scientific. The project started back in March 2014. It's a mobile laboratory that visits schools to promote biosciences among Estonian high school students, allowing them to conduct hands-on biotechnology experiments with real scientific instruments supervised by students. The programme also includes lectures and discussions designed to foster interest in science. So far, we have made 159 school visits and around 3000 children and 180 students have participated in the programme. In 2017, Rändav bioklass won the Estonian Science Popularisation Award.

RIIKLIKULT TUNNUSTATUD TEADUSE POPULARISEERIJA 2017

IMCB TIMELINE

FROM 1990 TO PRESENT

1990 – IMCB was founded by the decree of rector prof Jüri Kärner

1994 – Moving to freshly renovated building at Riia 23 (on photo: Peeter Tulviste and Ain Heinaru, 30.11.1994)

1996–1997 – As a private donation (Citrina Foundation, U.K.) Riia Street 23b/1 unit was built and opened (on photos: Peeter Tulviste and Nils Otto von Taube; Peeter Tulviste, Lennart Meri, Mart Ustav, 17.12.1997)

1997 – IMCB started to prepare gymnasium students for Estonian and International Biology Olympiad

1999 – Laboratory of medical molecular diagnostics was founded

1999 – Quattromed (Icosagen) was founded

2000 – Estonian Genome Foundation and Estonian Genome Project started

2001 – Institute of Technology was evolved

2002 – Gene Technology (BSc and MSc) curricula were launched

2003 – The chair of bioinformatics was created

2006 – Biomedicine (MSc) curriculum was launched

2007 – As a private donation (Helgi Nirk) the laboratories were renovated

2008 – The chair of developmental biology joined IMCB

2012 – Omicum building was built

2013 - Genetics Workshops for gymnasium students started

2013 – The Bioscience Students' Association was founded

2014 – Start of Traveling Bioclass in Estonia

2018 – Institute of Genomics was established

2019 – Molecular Biosciences (MSc) curriculum was launched

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020

1990-1995 Prof. Ain Heinaru became the first director of the Institute

1996-1999 Director: Prof. Mart Ustav (periodically suspended)

1999–2003 Director: Toivo Maimets

2003–2007 Director: Juhan Sedman

01.01.2008 – ... Director: Prof. Toivo Maimets

1998 Director: Alar Karis

10.04.2003 – 01.06.2003 Director: Prof. Jaanus Remme

02.06.2003 – 31.08.2003 Director: Prof. Richard Villems

1994–... Riia 23

1997–... Citrina Riia 23b/1

2012–... Omicum Riia 23b/2