

## Baltic Biomaterials Centre of Excellence

The Baltic Biomaterials Centre of Excellence (BBCE) project's main objective is to establish a joint Centre for development of advanced biomaterials based on the long-term strategic cooperation between AO Research Institute Davos, Switzerland (ARI) and Friedrich-Alexander University of Erlangen-Nuremberg, Germany (FAU) on the one hand and Riga Technical University Rudolfs Cimdinis Riga Biomaterials Innovations and Development Centre (RTU RBIDC), Latvian Institute of Organic Synthesis (LIOS), Riga Stradins University (RSU) and Riga Stradins University Institute of Stomatology (RSU IS) on the other hand.

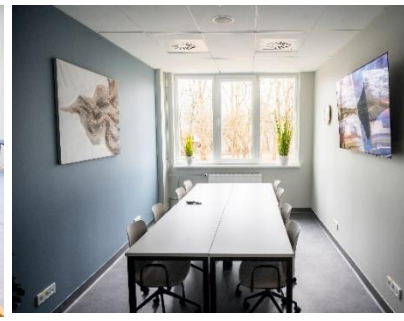
### Development of BBCE

BBCE had a successful 2022! We had seven internal consortium meetings for planning the visits and events, for discussing the research directions, upcoming articles and overall cooperation. During this year, BBCE members submitted 25 research grant applications. We were also very active in disseminating project goals and results towards industry members, mainly through participating in exhibitions and meetings with enterprises. In total 24 onsite/ online visits were carried out. We could hear and see BBCE members on the TV and radio interviews six times, which opened new possibilities for further cooperation with other organizations in Latvia. Main events during the 2022 were:

- twelve short-term outgoing visits to FAU and ARI and three short-term incoming visits to Riga,
- summer school, which provided a lot of new knowledge for Early Stage Researchers and
- six long-term visits to ARI and FAU.

### New premises for BBCE

On the 7<sup>th</sup> of April, 2022, BBCE premises in RSU SI were officially opened. It was a colorful event with the participation of the RSU Rector and translation on TV and radio.



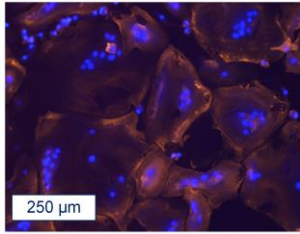
# Most meaningful moments for each SFG in 2022

## Group 1 - Calcium phosphates and composites

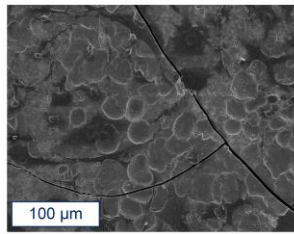
Our PostDoc Jana Vecstaudza spent six months in AO Research Institute, ARI (Davos, Switzerland), within the BBCE long-term training visits across 2021 and 2022.

In 2021 Jana learned how to 3D-print soft biomaterials (e.g., hydrogels) mixed with living cells, also known as bio-inks. Development of the new bio-inks and 3D-printing protocols, requires knowledge of the bio-ink's viscoelastic properties, therefore training on rheological property characterization was done as well.

Further in 2022 the training continued on the topic of cell and biomaterial interaction. More specifically, the *in vitro* model for evaluation of osteoclast cell interaction with calcium phosphate materials was developed. There are different calcium phosphates available for bone regeneration, therefore studying the osteoclast-calcium phosphate interaction helps to understand how to develop better biomaterials. Overall, the new and expanded knowledge gained in the long-term training visits will advance the development of innovative biomaterials for bone and cartilage regeneration within BBCE.



Stained osteoclast cells on the surface of calcium phosphate disc imaged with epifluorescence microscope (in blue – cell nuclei, in orange – actin).



The surface of calcium phosphate disc with resorption pits created by osteoclast cells. Scanning electron microscopy image.



GelMA/nHAp



THA

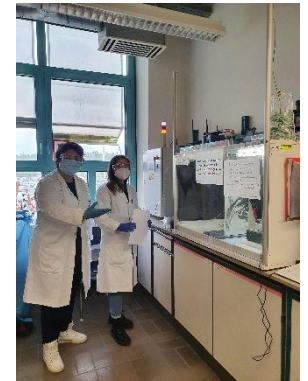


GelMA/nHAp-THA

Examples of 3D-printed hydrogel inks.

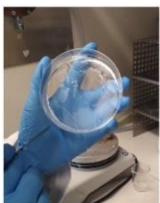
## Group 2- Drug ion cell delivery

Postdoctoral researcher Ozgur Demir spent six months at FAU from September 2021 until March 2022. During this tenure, calcium phosphate/bioactive glass bone cement, with dual drug/ion delivery capability was developed. In addition, a comprehensive characterization of the new bioceramic composites were carried out, including the assessment of osteoconductivity and bioactivity. This long-term training has answered the question of how injectable calcium phosphate cement's properties could be improved or affected by the addition of bioactive glass as a secondary powder phase.

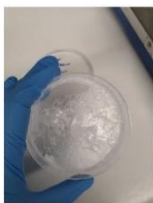


Ph.D. candidate Athanasia Pylostomou had a three-month training visit at ARI in Switzerland. The training focused on the application of 3D bioprinting and polymers as biomaterials for bone regeneration. This extended visit aimed to utilize thermoresponsive hydrogels and human mesenchymal stem cells derived from bone marrow to develop a preliminary endochondral ossification system. The fabrication of the thermoresponsive hydrogels and the cell cultures for cell growth and proliferation were conducted. The cells were printed within the hydrogels in specific shapes. This extensive training program has enhanced the fabrication knowledge and experience brought back to Riga, providing new opportunities for future collaborative experiments and Ph.D. thesis topics.

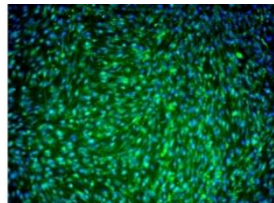
Overall, acquired skills during both of these trainings have opened up future possibilities for project proposals and publications.



Synthesis of bioactive glass powder



Mechanical analysis of CPC/BG composite



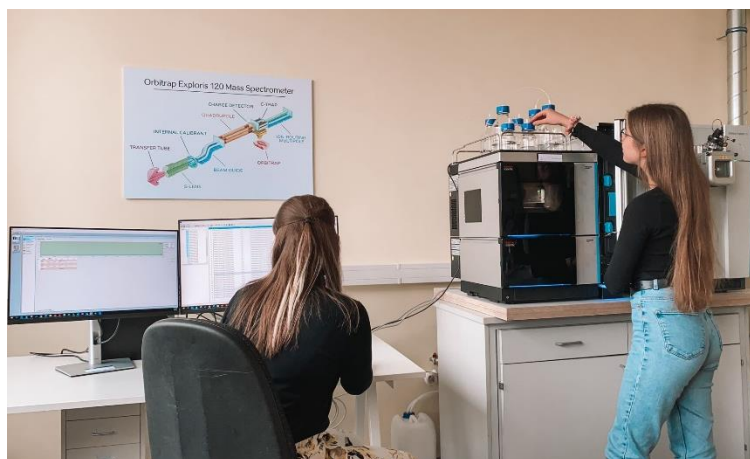
Calcein/DAPI staining of MC3T3-E1 cells cultured with CPC/BG composite



# Most meaningful moments for each SFG in year 2022

## Group 3 - Materials *In vitro*

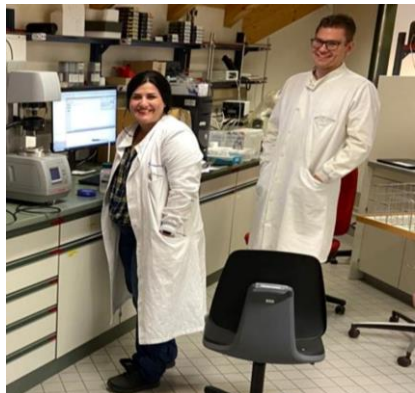
In 2022, SFG3 continued its infrastructure upgrades, culminating in the successful delivery and installation of a high-resolution mass spectrometer system coupled with a UHPLC system by the end of the year. The **Orbitrap Exploris 120 mass spectrometer** will enable the team to expand their LC-MS measurement capabilities for small molecules and delve even deeper into the realm of biology. SFG3 aims to use the instrument to advance their research on cell metabolism and its interaction with biomaterials, as well as to collaborate with both internal BBCE teams and external partners, to provide customized measurements of various biomolecules. In addition to the acquisition of the new equipment, the team has also seen growth in the form of several new members who joined SFG3 in 2022. To further develop their skills and knowledge, SFG3 members have attended various trainings at partner institutions, including ARI and the University of Erlangen-Nuremberg. Their efforts have not gone unnoticed in the scientific community, as they have presented their findings at various conferences and have multiple research papers in preparation.



The new SFG3 team members Dr.nat.techn. Kristaps Klavins, Annija Vaska and Nikola Gabriela Matuseviča **working with the new mass spectrometer.**

## Group 4 - Kinetics and stability of the drug delivery systems

2022 has been a busy year for Group 4 with three high-impact publications, ten grant applications, and visits to both FAU and ARI. The group reached its full strength in 2022 with the addition of our new PhD Researcher Ance Bārzdīņa. Our Post-doc Jhaleh Amirian spent five months on her long-term visit to ARI, Davos working on the methacrylation of silk fibroins for a novel bio-ink. The group has widened their skillsets and knowledge as they participated in courses on Clinical Research, Cell line studies, Project management, as well as Scientific writing, and other. The unique backgrounds of members, which include chemistry, pharmacy, and microbiology, have allowed us to start new research projects on topics ranging from phytochemistry to lipid-based nanocarriers for drug delivery. Thanks to the top-level project proposals written by our group, three Rīga Stradiņš University grants were acquired to advance the laboratory setup and availability of reagents. All members of the group have also actively been working with students from the RSU Faculty of Pharmacy supervising their research projects and helping to take their first steps in science. The biggest news from 2022 is our new home – the Study and Research Center at Konsula Street 21, which was finished in late 2022. While the moving process is still in progress, this great, modern, and state-of-the-art center and equipment will offer great possibilities and scientific breakthroughs for the group in 2023.



## Group 5 - Preclinical biomaterial evaluation

In 2022, members of SFG 5 were active in participating and presenting their research at various conferences. Their research covered two major areas of focus, fracture healing and development of nanoparticles for cancer therapy. Rinalds Serzants, now a PhD student in SFG 5, won Gran Prix of RSU International Student Conference '22 for his oral presentation on nanoparticles. Additionally, members of SFG 5 had the opportunity to receive several months of training in the laboratories of the advanced partner ARI. The training focused on developing skills in histology, team management, and observing surgeries. The experience provided group members with a deeper understanding of the field and equipped them for future research. New equipment was installed in LIOS-FFL, home of SFG 5. The equipment included a size exclusion chromatography system with static light scattering detector (SEC-SLS) to characterize macromolecules and newly synthesized polymers, and a diamond band saw that enables the slicing of hard tissues into 30  $\mu\text{m}$  thick sections for histological evaluation. With these new tools and training, SFG 5 is now able to perform material biocompatibility evaluations on novel materials. The group also received a grant from The Latvian Council of Science, to continue their work on nanoparticles for cancer research, expanding their research scope and opening up more possibilities for future publications.



## Group 6 - Clinical evaluation of the materials and personalized implant development

In April incoming visit on «Training and implementation of patient data safety regulations, implementation of digital medical records» was held in RSU SI. Followed by Quality Management event in Riga, when ARI representative, Nora Goudsouzian visited all partner institutions in Latvia and discussed topics related to QMS in each institution. During the year, SFG 6 members were taught different topics at on-site courses, and they visited both advanced partners.

PhD student Lana Micko implemented six-month long-term visit at AO Research Institute, where she learned about platelet rich fibrin characterization with biochemical assay ELISA and immune profile characterization. Leading researcher Sergio Uribe spent four months in Cardiff. He worked on a collaboration project with Cardiff University and BBCE, and prepared publications together with PhD students from SFG 6.

Members of SFG 6 presented their research studies at eleven international conferences in Spain, France, Czech Republic, Poland, and in Riga.



# BBCE erudition competition «BIO-GO-Higher»

It is a real pleasure to see how Latvian schoolchildren compete at the erudition game. The most successful team of 2022 – “Skābais atoms”, from Sigulda State Gymnasium, visited the Institute of Biomaterials at the Department of Materials Science and Engineering of the University of Erlangen-Nuremberg, Germany. All members of the winning team were very satisfied with the experience they had on this visit. It was a great adventure!



## Who will win this year?

The new and exciting competition for the third year in a row – started on September 23, 2022 and will end on April 17, 2023. Also this year, BBCE Latvian partners have prepared interesting tasks. The main prize in year 2023, is a trip to BBCE partner AO Research Institute in Davos, Switzerland!

**May the most erudite win!**



### What are we looking for:

- Cooperation with other institutions
- Cooperation with the industry
- New project applications
- Staff mobility and training

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