N°50 - JULY 2019

European Polysaccharide Network Of Excellence



"Nature makes polysaccharides, EPNOE turns them into products"

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editorial

Dear Readers of the EPNOE Newsletter,

We have had two exciting months since the new executive team took office. We have been active in creating new initiatives to support our members and to enhance collaborative joint ventures involving polysaccharides in Europe and around the world. Please find below a summary of these initiatives.

EPNOE Connect: We are joining high level events with policy makers to offer our expertise in challenging issues such as microplastics, human health and climate change. The first event will be in Ljubljana on October 4th (more info on page 4).

EPNOE Science Award 2019: This award will be presented to recognize life achievement contributions of polysaccharide scientists and technologists. The award is international and open to all scientists in the field. Only EPNOE members can nominate the candidates.

EPNOE Ambassadors: We are inviting distinguished scientists around the world to be our Ambassadors and to join us in building bridges to advance polysaccharide science and technology.

EPNOE Industrial Advisory Board: We are creating an advisory board of company members to support us in building innovative ways to collaborate with industry

Support to joint collaborative proposals: We are launching internal calls to build competitive consortia for EU calls with professional support of EPNOE

EPNOE Erasmus databases: We are creating a database of contacts to facilitate exchange of students using current programs in EU

New EPNOE Linked In and webpage: We have created the EPNOE Linked In page and we are redesigning the EPNOE website.

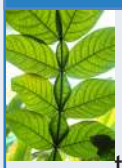
EPNOE2019 and EPNOEJunior2020: We have changed the format of EPNOE conference to cover comprehensively different fields of research and we are planning the Junior Conference as a disruptive and innovative forum for young researchers.

This is only the start. We are having plenty of new ideas and we are motivated to make EPNOE inspiring and vibrant. We hope you enjoy reading this 50th Edition of EPNOE newsletter and you join us on Linked In and in our events. By the way, we are inviting new members. Let us work together!

Pedro Fardim
President of EPNOE
Professor
Faculty of Engineering Science
Department of Chemical Engineering
KU Leuven (Belgium)

news

Member's info



Masters & PhD defenses:

• At Armines-CEMEF, France:

- **Lucile Druel** defended her PhD thesis "Cellulose based aerogels: properties and shaping as beads" on the 10th of May 2019

- **Sophie Goult** defended her PhD thesis "Pectin-based aerogels: Advanced materials for thermal insulation and drug delivery applications" on the 28th of May 2019

• At Jena University, Germany:

- **Nicole Slesiona** defended her Master Thesis entitled "Nanoparticle decorated DNA-origami for future biosensor applications"

New staff:

• At Jena University, Germany:

- **Katja Geitel** joined the group as master student working in the field of alpha-1,3-glucan derivatives (supervised by Prof. Thomas Heinze)

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EPNOE Newsletter: 50th issue

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In 1999–2001, there was a dense informal network around cellulose involving EU academia and industry. In 2002, the European Commission launched a manifestation of interest for creating networks in Europe. Several academic and industrial partners built a first consortium and submitted a network on cellulose called Cellnet. Considered too narrow by the European Commission, it was extended to polysaccharides. In 2003, the "Polysaccharides" proposal was submitted as a Network of Excellence. A Network of Excellence was a novel type of virtual research organisation at the level of the European Union. According to its definition, its purpose was to strengthen excellence on a particular research topic by assembling together the critical mass of resources and expertise needed to be world force in that topic.

"Polysaccharides", very quickly called EPNOE for European Polysaccharide Network of Excellence, was very well ranked and thus accepted.

This European Commission EPNOE project started in May 2005 for 4 years and a half. EPNOE associated 16 European laboratories from 9 countries. In 2007, the EPNOE network became a non-profit organisation called EPNOE Association, in order to ensure that this network will continue after the end of the EC project. EPNOE Association is the current independent structure organising all the EPNOE activities. It is only funded by membership fees. EPNOE grew over years and it has now 41 collective members (academic institutions, research organisations and companies) from 15 countries. EPNOE went through several stages of organization, until its present structure which was decided beginning of 2019. EPNOE is composed of collective and individual members, with one major annual meeting.

EPNOE activities are numerous: university education, fundamental and applied research, student visits, project building, conference and workshop organisation, involvement in the academic world, …

The first EPNOE Newsletter was published in November 2006. The next issues appeared with a periodicity of 3-4 issues per year. Since 2016, EPNOE Newsletter is published every two months, giving news of EPNOE members to more than 1100 subscribers all over the World. It is strong link between scientists involved in polysaccharide research.

European Polysaccharide Network of Excellence

Nature produces polysaccharides, EPNOE turns them into materials

November 2006 - N°1

NEWS

Prospects for Cellulose

New Book

New Workshops

EDITORIAL

Network of Excellence

First EPNOE Newsletter issue, November 2006

Some figures since 2007

90 = number of project collaborations between two or more institutions members of EPNOE

70 = number of exchanges / visits between institutes of PhD students and Postdocs

40 = number of papers where authors were from two or more institutions members of EPNOE

15 = number of international conferences and workshops organized by EPNOE, with a total of about 4500 participants

This article was proposed by Patrick Navard, Armines-CEMEF, France

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EPNOE 2019 Conference

We are inviting submissions for posters

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Preliminary Agenda for One-day Meeting:

A SCIENTIFIC PERSPECTIVE ON MICROPLASTICS IN NATURE AND SOCIETY

including

PLASTIC RECYCLING and BIO POLYMERS IN ADVANCED TECHNOLOGIES OF THE FUTURE

organised by

- **Slovenian Engineering Academy,**
- **SAPEA (Science Advice for Policy by European Academies) and**
- **University of Ljubljana, Faculty of Chemistry and Chemical Technology**

Ljubljana, 4. 10. 2019
University of Ljubljana, Faculty of Chemistry and Chemical Technology (UL FCCT)
Večna pot 113, 1000 Ljubljana, Slovenia

Preliminary Agenda of the Meeting

9.00 – 9.30 Coffee and information for journalist: SAPEA representatives and organizers will present the content and purpose of the conference.

Morning section: Chair: Prof. dr. Karin Stana Kleinschek

9.30 - 10.00 Welcome
Dr. Mark Pleško, IAS President
Prof. Dr. Jurij Svete, Dean UL FCCT
Mr. Marjan Šarec, Prime Minister of Slovenia (TBC)

10.15 - 10.30 Zoran Stančič, Ambassador EU to Slovenia:
Presentation of EU general view about the environmental challenges in nature and society

10.30 -11.00 Dr. Gabriela Kalcikova, SAPEA:
The presentation of the SAPEA Evidence Review Report on micro- and nanoplastic pollution, published in January 2019.
www.sapea.info/microplastics

11.00 - 11.30 Prof. Wouter Poortinga, SAPEA: Plastics in society: on people, policies and behaviour

(continued overleaf)



Preliminary Agenda of the Meeting

(continued)

11.30 - 12.30 Panel discussion moderated by: Prof. dr. Karin Stana Kleinschek

Topics to be discussed:

- Prof. Dr. Aleksandra Lobnik; University of Maribor: Challenges of plastic recycling
- Prof. Dr. Pedro Fardim, President of the European Polysaccharides network of excellence (EPNOE)/University of Leuven: Bio polymers pro and contra
- Dr. Ivana Vinković Vrček, Institute for Medical Research and Occupational Health: Safety and risk assessment of micro/nanoplastics
- Dr. Branka Viltužnik, Director for Research and Innovation of the Company Plastika Skaza: Industrial view on environment issues and usability of the new technologies
- Mateja Mešl; Director of the Institute for the Cellulose and Paper, Ljubljana: Cellulose and other biopolymers in paper industry
- dr. Marko Maver, State Secretary at Ministry for Environment and Spatial Planning

12.30 – 13.30 Light Lunch

<u>Afternoon section:</u> Chair: Prof. Dr. Andreja Žgajner Gotvajn

13.30 - 14.00 Prof. Dr. Pedro Fardim, EPNOE: Engineering biomass and biopolymers for advanced applications

14.00 – 14.30 *Prof. Dr. Wolfgang Bauer, TU Graz: Application of biopolymers to improve the barrier properties of paper and board*

14.30 – 15.00 Dr. Joel Wallecan, Cargill; Nature-derived alternatives to plastics – an industry viewpoint

15.00 – 15:30 Dr. Suvi Arola, VTT; A Modern Menace: Microplastics

15.30 – 15.45 Coffee break

15.45 – 16.15 Dr. Andrej Kržan, NIC: The future of microplastic

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Announcement

2nd - 6th Sep. 2019 at LCPP Maribor – Slovenia
http://lcpp.fs.um.si

The 3rd Network wide training event on surface functionalization of bio-based fibre products is held within the Marie Skłodowska-Curie Innovative Training Network (MSC-ITN)

FibreNet

www.fibrenet.eu

Among other training activities 15 Early Stage Researcher (ESRs) will present their work to the general public with free admission and buffet for visitors on Tuesday 3rd of Sep. 2019 at Slomškov Trg 15, Maribor, Slovenija. If you are interested in participating at this science to public event as a visitor, please register until 15th of August 2019 per email to rupert.kargl@um.si.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Marie Sklodowska-Curie grant agreement No 764713



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1st CIRCULAR PACKAGING CONFERENCE, 26 - 27. SEPTEMBER (LJUBLJANA, SLOVENIA)

The 1. Circular packaging conference aims to highlight and connect professional, scientist, academics and R&D professional around the topic of circular and sustainable packaging from all recyclable materials (bioplastic, biocomposites, paper, cardboard, steel, glass).

The conference is a great opportunity to have a holistic approach regarding circular and sustainable packaging. With interesting presentations, real life case studies and workshops we expect to create new partnerships between and among academia and industry stakeholders.

Conference topics include, but are not limited to:

- Circular economy
- New innovative bio-based materials
- Sustainable and optimized packaging design
- Packaging printing and converting
- Life cycle analysis
- Packaging waste recycling, reusing and composting

The presentations will be in a form of classic research papers aimed at academics and research organizations and as up to date case studies from the R&D departments and various companies. The expected audience is a mix of academia and industry people.

The conference will also have 2 masterclasses with renowned researchers with a vast industry experience. Silvester Bolka from the Faculty of Polymer Technology will present biocomposites from basic types to industry prototyped examples, while the second one will be on Innovative cellulose materials and additives presented by Dr. David Ravnjak from the Vevče Paper Mill. Other interesting workshops, company presentations and case studies will also be included in the program.

Final paper submissions are expected by **15th July 2019**. All papers will be reviewed and will be published in the Conference proceedings. Other forms of submissions and presentations are possible (case studies, design concepts) but will not be included in the Conference proceedings as a reviewed article.

Kindly invited on a road to more sustainable and circular packaging world.

More info at http://icp-lj.si/international-circular-packaging-conference/

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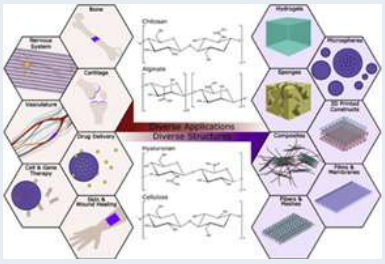
EPNOE-ENBA Workshop



ENBA European Network of BioAdhesion Expertise

NEW FRONTIERS IN BIOFABRICATION: FROM BIOMOLECULES TO TISSUES AND ORGANS

September 17th & 18th, 2019
Workshop in Leuven, Belgium
European Network of Bioadhesion Expertise (ENBA)
Cost Action CA 15216 and EPNOE

Biofabrication is a rapidly growing multidisciplinary field combining engineering, chemistry, physics, medicine, life sciences and including regenerative medicine and tissue engineering. In this workshop we will share presentations of experts working with tissue engineering, mechanobiology, biomaterials, scaffolds, biocarriers, organs on a chip and cell-surface interactions. It is a unique opportunity to discover and exploit the new frontiers of this exciting field and highlight the relevance of bioadhesion expertise of ENBA partners in collaboration with polysaccharide expertise of EPNOE members to advance the state of the art of biomaterials.

Deadline for registration and abstract submission: 31st July 2019

Registration fee: 160 euros for non ENBA members

More information at: https://cit.kuleuven.be/creas/Chemenghealth/bioadhesion/home

KU LEUVEN



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TRAINING SCHOOL IN BRAZIL

ENGINEERING BIOMATERIALS FOR HUMAN HEALTH

July 10th - July 23th, 2019

Collaborative Course Unicamp, Brazil and KU Leuven, Belgium

School of Chemical Engineering, University of Campinas, Campinas, SP, Brazil

The design and development of advanced biomaterials are essential to tackle numerous challenges in regenerative medicine and pharmaceuticals. The field of biomaterials is highly multidisciplinary involving complex biological interactions with designed interfaces and nanoenvironments. This international course is a joint effort of the School of Chemical Engineering at Unicamp in Brazil and the Department of Chemical Engineering at KU Leuven in Belgium in collaboration with Departments of Materials Engineering, Materials Technology and Mechanical Engineering at KU Leuven. The target audience are graduate students and researchers of engineering, chemistry, physics, biology, biotechnology, medicine, odontology, pharmaceutic and related areas.

More information: https://cit.kuleuven.be/creas/Chemenghealth/biomaterials

UNICAMP

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cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Funded by the Horizon 2020 Framework Programme of the European Union

AERoGELS COST ACTION CA18125

LAUNCHING COST ACTION 18125 AERoGELS

"Advanced Engineering and Research of AeroGels for Environment and Life Sciences"

37 countries have confirmed their participation in the Horizon2020-funded COST Action *AERoGels* project.

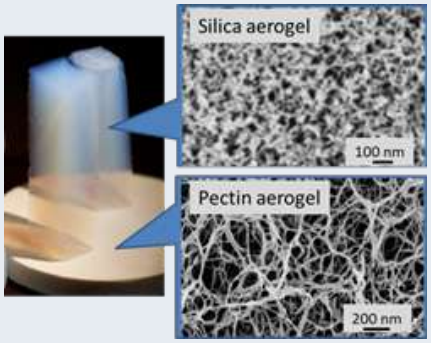
COST Action is a special type of European projects which helps connecting research initiatives on selected topics across Europe and beyond. COST Action is supporting exchanges and visits, allows organizing schools and workshops and is an efficient platform for reinforcing existing and building new collaborations.

Aerogels are a special class of lightweight nanostructured materials with high and open porosity, very high internal pore surface area and tunable physicochemical properties. These properties make aerogels extremely versatile materials for numerous applications. Aerogels can be based on inorganic matter (metal and silica oxides), synthetic polymers and bio-based polymers. Although some types of aerogels have already reached the market in construction materials and aerospace engineering, the full potential of aerogels is still to be discovered.

AERoGELS COST Action will bring together the knowledge on research and technology of aerogels at the European level from academia, industry and regulatory experts. In this Action, the use of aerogels will be focused on environmental (treatment and removal of pollutants, energy management, life cycle analysis) and life sciences (pharma, bio-medical) applications. Structure-properties correlations, regulatory aspects and circular economy approaches will be combined.

CEMEF is world renown leader in bio-aerogels, started working on this topic in early 21st century within the European project AeroCell. In this COST Action, Tatiana Budtova (CEMEF/ MINES ParisTech), together with Francesco Ruiz from Keey Aerogel, are Management Committee members and representatives of France. Tatiana is also Working Group leader on the environmental applications of aerogels.

https://www.cost.eu/actions/CA18125/#tabs|Name:overview



This article was proposed by Tatiana Budtova, Armines-CEMEF, France

"Nature makes polysaccharides, EPNOE turns them into products"

The 3rd International Conference on Bamboo Application – Green Circular Economy and Technology

June 16-18, 2019, Fuzhou University (Qishan Campus), Fuzhou, People's Republic of China

Group photo of the conference attendees (Image courtesy the organizers)

The conference was jointly organized by the College of Environment and Resources (Fuzhou University), the Sino-Europe Food Valley Alliance, the Bamboo Industry (Jian'ou) Department (Fujian), the Fujian Textile Industry Association, Sanming Yuanfu Biomass Technology Co., Ltd. and Fujian Province Boyi Environmental Technology Co., Ltd., Fujian University of Technology, Putian University and Fuqing Branch of Fujian Normal University with support from the International Bamboo and Rattan Organisation (INBAR), the Fujian Association for Science and Technology, Wageningen University & Research (NL) and the Sino-Europe Technology Promotion Center (SETPC).

The conference consisted of a full day of lectures on June 17 with 24 lectures, organized partly in two parallel sessions, from University researchers, International Organizations and Companies. There were about 230 attendees comprised of scientists from academia and industry, students, and others engaged in R&D for commercial ventures on the use of bamboo as a resource for energy, food and materials. From EPNOE the Univ. Leuven, Univ. Innsbruck and Wageningen UR contributed with invited presentations to the programme.

(continued overleaf)



The 3rd International Conference on Bamboo Application – Green Circular Economy and Technology

June 16-18, 2019, Fuzhou University (Qishan Campus), Fuzhou, People's Republic of China

(continued)

The lecture topics ranged from the developmental biology of bamboo, biorefinery methods for obtaining high-value chemicals from raw material and waste products, the extraction of lignin and its conversion into products for use in diverse applications (in dyes, ceramics, etc.), the use of bamboo fibers in textiles and composites, bamboo as a source for cellulose nano-aerogels for environmental remediation, the production of nano-ink, the valorization of industrial and agricultural waste, and international efforts to utilize bamboo as a means of remediating degraded soil, to develop the rural economy, and as a sustainable alternative to plastics or other non-renewable materials in home décor, cutlery and engineering materials. Examples were cited of using bamboo winding pipes for irrigation, cutlery articles and industrial hard hats made of bamboo, and that the ceiling at Barajas International Airport in Madrid (an area of ca. 200,000 m2) is made of bamboo. Outcome of the conference was the establishment of the International Bamboo Application Institute (IBAI) for communication on applied bamboo R&D and innovations.

The conference was followed by a three-day tour around the bamboo forests area of Fujian province to visit the facilities of companies engaged in processing of bamboo. In Jiang Le the Sanmingshi Yuanfu Biomass Technology Co Ltd was visited where bamboo lignins are manufactured along with bamboo cellulose; In Jian Ou the production of bamboo shoots for preprocessed food was shown at Tian Tian Food Co Ltd; The traditional methods of bamboo shoots fermentation were shown; At Chaoyan Cap Industry Co Ltd the production bamboo wickerwork for safety helmets was demonstrated; At Zhixing Activated Carbon Co Ltd the large scale manufacturing of bamboo charcoal and activated carbon was explained; At Shuangy Bamboo & Wood Ltd, the production was shown of bamboo based handicrafts, furniture and gift items for exports.

Reports on the conference and subsequent tour:
INBAR website: https://www.inbar.int/fujian-and-the-future-of-bamboo/
In Chinese: https://mp.weixin.qq.com/s/Ghx-nJ9iYILso0joyZa0Ig

This article was proposed by Jan van Dam (WUR, the Netherlands)
and Avinash Manian (Innsbruck University, Austria)



PhD topics related to polysaccharides

Ana Bratuša

Chemical derivatization of polysaccharides by amino acids

The aim of this thesis is to investigate and develop new and efficient approaches for the functionalization of polysaccharides, mainly dextrans, with natural amino acids and their derivatives. A focus is laid on esterification reactions. Products are tested with respect to biological efficacy and toxicity.

Andreja Dobaj

Three dimensional structures of polysaccharide derivatives: from characterization to application in regenerative medicine

This thesis elaborates the preparation of hydrophilic, porous, water insoluble three-dimensional scaffolds from polysaccharides. Alternative non-toxic methods of cross-linking and the influence on biomechanics and degradability are investigated.

Maša Hren

Chitosan - Graphene oxide based alkaline membranes for the direct ethanol fuel cells

The focus in this thesis will be the development of nano-composite membranes with polysaccharides, mainly cellulose and chitosan. The aim is to introduce cationic moieties onto the polysaccharide and use it to produce a suitable nano-composite membrane for the use in alkaline direct ethanol fuel cells.

Urban Ajdnik

Anti-biofilm multifunctional coating for medical devices

The aim of this thesis is to prepare multifunctional coatings (antimicrobial properties, antifouling, drug delivery etc.) for medical devices using colloid systems based on natural polyelectrolytes and surfactants.

FibreNet

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Marie Sklodowska-Curie grant agreement No 764713

Fazilet Gürer

Functional 3D printed and porous polysaccharide derivative scaffolds for vascular tissue engineering

This thesis in the frame of the Marie Curie ITN project FibreNet elaborates the preparation of composite materials from water soluble polysaccharides, and fibrous biodegradable matter. The aim is to design and print biomaterials that can be used for the regeneration of the vascular system and cartilage tissue.



PhD topics related to polysaccharides

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Marie Sklodowska-Curie grant agreement No 764713

Lucija Jurko

Nano fibrous systems morphology study for advanced biomedical applications—wound healing

This thesis in the frame of the Marie Curie ITN project FibreNet investigates the preparation of nano-fibrous polysaccharide-based materials that are obtained by electro-spinning. Derivatization aims at introducing cationic moieties to combat bacterial growth and promote the healing of wounds.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Marie Sklodowska-Curie grant agreement No 764713

Özkan Japer

Development of Novel Fiber - Based Structures with Far Infrared Activity for Advanced Therapeutic Treatments

In this thesis in the frame of the Marie Curie ITN project FibreNet methods for the functionalization of textile fibers with infrared emitting and reflecting nano-particles are investigated in the laboratory and pilot scale. Textiles fabricated from these materials are investigated with respect to thermal and biological properties. Özkan Japer is a PhD student employed at the company Litia Spinnery, Slovenia.

NEW RESEARCH FACILITIES AT UNIVERSITY OF MARIBOR

University of Maribor has been actively involved in the Horizon 2020 project **Renewable Materials and Healthy Environments Research and Innovation Centre of Excellence (InnoRenew CoE)** since 2017. Main goal of the project, coordinated by University of Primorska, is a development of a new institute by a consortium of research groups in Slovenia (University of Primorska, University of Maribor Institute for the Protection of Cultural Heritage of Slovenia, Slovenian National Building and Civil Engineering Institute, Pulp and Paper Institute, EuroCloud Slovenia, National Institute of Public Health, and Regional Development Agency of the Ljubljana Urban Region) with the aid of an advanced partner from Germany (Fraunhofer WKI). This partnership brings together expertise on renewable materials in a wide variety of disciplines including health, information technology and computing, engineering, construction, urban deve¬lopment, cultural heritage, material science, and sustainability. The emphasised renewable mate¬rial is wood, its products and derivatives in all forms, ranging from solid timber and wood fibre and, application-wise, to biorefinery, energy and biomedi.

In addition to funding from the European Union which covers the implementation and research work of the project itself, Republic of Slovenia is funding the purchase of research equipment and setting up of the needed infrastructure. Research group of Karin Stana Kleinschek has, in the frame of this infrastructure project, established a new research entity at the Faculty of Electrical Engineering and Computer Science (FERI at University of Maribor) within Institute of Automation and is currently in the process of acquiring new research equipment, which will be housed in a newly equipped lab space (funded by FERI at University of Maribor). Planned equipment will encompass: (i) equipment for **preparation of material building blocks**; (ii) equipment for **fabrication of particles, capsules and porous matrices**; (iii) equipment for analysis of **porosity, surface area and pore size**; (iv) equipment for **analysis of chemical, physical, structural and topographical properties** of materials; (v) equipment for **preparation and structuring of thin films and surfaces** and (vi) equipment for **fabrication of optical fibre-based sensors and spectral signal generation and detection.**

Funding: Horizon 2020 Framework Programme of the European Union; H2020 WIDESPREAD-2-Teaming: #739574 and the Republic of Slovenia; Investment funding of the Republic of Slovenia and the European Union of the European Regional Development Fund

This article was proposed by Silvo Hribernik, University of Maribor, Slovenia

Combination of advanced sensorics and tissue engineering techniques for development of a smart biosensor for simultaneous monitoring of blood glucose and insulin

Tanja Zidaric[1], Lidija Gradisnik[1], Marko Milojevic[1], Tadej Tofant[2], Tina Maver[1,3], Uros Maver[1]

[1]Institute of Biomedical Sciences, Faculty of Medicine, University of Maribor, Taborska 8, 2000 Maribor, Slovenia (tanja.zidaric@um.si, lidija.gradisnik@um.si, marko.milojevic@um.si, uros.maver@um.si)

[2]Strip's, electrotechnique-electronics d.o.o., Kandrse-Del 7, 1252 Vace, Slovenia (tadej@bio-re-cell.com)

[3]Laboratory for characterization and processing of polymers, Faculty of Mechanical Engineering, University of Maribor, Smetanova 17, 2000 Maribor, Slovenia (tina.maver@um.si)

This postdoctoral project combines development of a biosensor for simultaneous measurements of blood glucose and insulin in diabetic patients, and fabrication of an in vitro skin model (so-called artificial skin) to test biocompatibility of sensor components, as well as its performance in vitro. By coupling the most advanced techniques in biomedical science (3D printing of cell-laden biomaterials) and electroanalysis (various approaches for easier synthesis protocols), such interdisciplinary approach will contribute to further improvements in the fields of biosensorics and tissue engineering.

Platforms for detecting both key analytes in glucose metabolism (glucose and insulin) will be based on screen-printed carbon electrodes, modified with bioactive molecules (e.g. enzyme, antibody). During biosensor development, the emphasis will also be placed on formation of protective coatings (membrane, hydrogels) with the intention to minimize or even prevent the biofouling effect, without compromising electroanalytical performance. For this purpose, various natural (alginate, collagen), semi-synthetic (chitin, chitosan) and synthetic (PEG, PCL) polymers will be tested in different combinations and structure configurations. A systematic characterization of formed protective coatings will be performed, using various analytical methods. Additionally, safety and effectiveness of sensor components will be evaluated on human-derived cell lines and serum. Finally, both biocompatibility and biosensor performance will be assessed through a newly developed artificial skin model, constructed by using 3D bio-printing of cell-laden hydrogels (i.e. bioinks). By manipulating external factors (e.g. ambient and skin temperature, pH) better insight into glucose metabolism will be achieved, contributing base knowledge to develop novel algorithms, which will enable prediction of urgent conditions related to either high or low blood sugar (hypo- and hyperglycemia).

In order to replicate crucial physiological and mechanical traits of skins epidermal and dermal layers, scaffolds for the artificial skin model will be fabricated in collaboration with the Laboratory for Characterization and Processing of Polymers, University of Maribor, by 3D bio-printing natural polysaccharides, with in-situ incorporated human skin cells.

Despite this being at its core a basic scientific project, it will nevertheless be directed towards designing advanced patentable inventions, which could in the future, significantly improve management of various diabetic disorders, and thus the life quality of patients. The basic conclusions will be enriched with biocompatibility studies performed at the Institute of Biomedical Sciences in Maribor, together with electroanalytical validation conducted at Faculty for Chemistry and Chemical Engineering, University of Maribor.

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Edible 3D bioprinted scaffolds for growth of cultured meat

Jernej Vajda[1], Bostjan Vihar[2], Lidija Gradisnik[2], Marko Milojevic[2], Uros Maver[2]

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With globally increasing animal product consumption (especially meat), industrial livestock farming is producing unsustainable greenhouse gas emissions, results in poor animal welfare conditions and drives global antibiotic resistance. Since demand is expected to rise, new approaches to production are required as an alternative to traditional livestock farming. A promising one is in-vitro cultivation of meat, which has been rapidly evolving over the past few years, where we have seen a lot of increasingly complex research in the field of tissue engineering and production of cultured meat. Nevertheless, there are still many obstacles to be overcome before laboratory meat products will hit market readiness, especially when talking about whole cuts (as opposed to minced meat) and profitable mass production.

We propose an experimental set-up to build thick blocks of muscle tissue as a stepping-stone to scaled-up production of cultured meat. At the same time, the proposed approach could serve as an important testing platform for further research and optimization of novel manufacturing strategies, testing of various growth media compositions, influence of different external stimuli on meat growth, *etc*. The proposed project envisions a systematic approach to a scalable scaffold design to cultivate muscle and fat cells without the introduction of "complete" (multi-level) vasculature. Such an approach allows for an easier scale-up and thus presents a more cost-effective procedure for potential future industrialization. Scaffolds will be generated using both core-shell and conventional 3D printing techniques, utilized routinely at the Institute of Biomedical Sciences, to provide well defined geometries and sufficient porosity for nutrient uptake of the incorporated cells. The so-formed "tissue grafts" will be cultivated in a perfusable system, which will enable continuous online and on-site measurement of pH and O2 changes through *in situ* included sensors ("UNISENSE" electrodes with diameters of only 10 µm).

This project's main goal is to build a 10x10x10 mm block of muscle tissue that would closely resemble a cut of meat. Simultaneously, the final construct will be designed in a way to enable incorporation, growth and phenotype preservation of multiple cell types with the goal of creating a piece of meat which would replicate biological muscle tissue as much as possible in both palatability and nutritional value.

The influence of geometry, chemistry and morphology of 3D printed biomaterials on the differentiation of stem cells

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Tissue engineering is a rapidly developing, interdisciplinary field, focused on growing new tissues and organs, by integrating cells into a three-dimensional (3D) scaffold with appropriate physico-(bio) chemical properties and under optimum growth conditions. This has enormous potential for regeneration and replacement of damaged tissues and organs, as well as for development of in-vitro disease and tissue models for advanced research studies in pathophysiology, pharmacology and toxicology. As a supporting technology, 3D biofabrication is quickly progressing, providing researchers with a means to produce geometrically defined structures with increasing efficiency and resolution.

In this project we will investigate the influence of 3D printed biomaterials on stem cell behaviour and differentiation. The project will combine the development of optimal biomaterial scaffolds that simulates extracellular matrix (ECM) like environment, as well as the in-depth analysis of the actions and changes in stem cell behaviour at the molecular level. The purpose is therefore on the understanding how the changes in chemistry, morphology and structure of 3D printed materials influences the phenotype of stem cells, which could lead to many new therapeutic possibilities in the field of regenerative medicine. Furthermore, we aim to investigate the orchestration of stem cell activity through their paracrine and autocrine communication, as well as cell populations within an environment (e.g., a scaffold). Once we design the biomaterials for optimal growth and proliferation of stem cells, we will furthermore study the effect of biomaterial composition on stem cell differentiation. With modifications of physio-chemical properties of biomaterials we will try to control the differentiation of the cells. Thus, we would like to develop several different "bio-inks" that will allow the growth of stem cells and their controlled differentiation into different "simulated tissues".

In view of all of the above, we will focus on controlling stem cells through their environment. The interaction of human mesenchymal stem cells (hMSCs) with 3D printed scaffolds displaying different scaffold architectures will be investigated. Considering the systematic design of the project, we are convinced that such findings can significantly contribute to the development of regenerative medicine and possibly also increase the potential for future products for faster implementation in clinical practice. A schematic depiction of the overall project concept is shown in Figure 1.

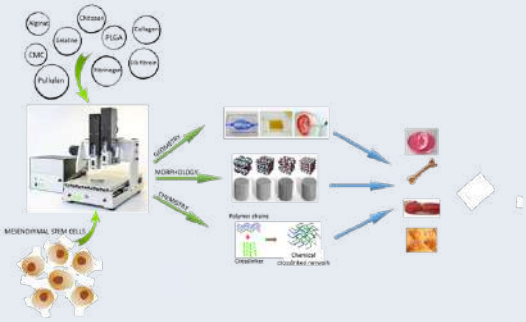

Figure 1: Schematic abstract of the project.

European Polysaccharide Network Of Excellence

Starch+

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Starch, either in the neutral or cationic form, is the most important additive in paper industry. Cationic starch for example is applied at the wet-end of the paper manufacturing process to increase the paper strength and to act as dewatering and retention agent. However, there is still limited understanding on the dissolution behavior of cationic starch, particularly when it comes to industrial environments, where pressure and shear is applied to the starch suspensions.

The Starch+ project is a joint effort coordinated by the Austropapier Association under scientific leadership of Graz University of Technology and in cooperation with four (from August 2019 even five) industrial partners. The objective is to investigate the solubilization process of cationic starches. The main focus of the work is to employ conditions for solubilization close to those used in industry and to investigate how different cooking conditions influence the molecular and supramolecular properties of the resulting starch solutions. Jet-cooking is nowadays the most common form of starch dissolution in an industrial context. It employs water steam at elevated pressures for fast solubilization. For this purpose, a small-scale jet-cooking device was purchased in the frame of this project (capacity ca 50 liters).

Our setup is capable to operate at steam pressures up to 6 bar which translates to temperatures larger than 160°C. Currently, we aim at elucidating differences to other cooking processes and to assess their influence on starch properties such as retention and wet strength on papers.

The project is financially supported by the Austrian Research Promotion Agency (FFG). More information required? Please contact us via mail (stefan.spirk@tugraz.at).



Integration of 3D bioprinting and organ-on-a-chip systems for tissue engineering of the small intestine

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BACKGROUND

Tissue transplantation has become a powerful tool for regenerative medicine in recent years, saving thousands of patients every year. However, demand for transplantable tissues remains far greater than supply (In the EU, approximately 31,000 people received a donor organ, while 63,000 were put on waiting lists in 2013) [1]. The issue seems especially apparent for the gastrointestinal tract (in Europe 600,000 people die annually from colorectal cancer [2] and about 3,000,000 are suffering from chronic inflammatory diseases such as Crohn's disease or ulcerative colitis [3]). Even if a suitable donor is found, risk of rejection remains high and patients are bound to immunosuppressive therapy, which reduces their quality of life and can have adverse effects [4-6]. Tissue engineering and regenerative medicine promise tailor-made tissue constructs in a scale-able process, even from patients own cells, which opens possibilities for personalised treatment using *in-vitro* disease models and production of high-compatibility transplants [7].

AIMS AND IMPLEMENTATION

The aim of this project is integrating 3D bioprinting with lab-on-a-chip devices for reproducible engineering of the small intestine. In-vitro models, which adequately mimic anatomy and function of the tissue, will significantly improve current systems for molecular transport analysis, pharmacological and toxicological experiments. Current research of intestinal physiology is often limited to monolayers of Caco2 cell lines on semipermeable membranes, which have a very limited capacity for research purposes mentioned above. To emulate the intestinal absorption and transport system, human intestinal epithelium cells (HUIEC), isolated and characterised at the Faculty of Medicine will be cultivated on the surface of a vascularised connective tissue, composed of endothelial cells (HUVEC) and fibroblasts in an extracellular matrix (ECM) like environment. Formulations based on polysaccharides such as alginate and cellulose derivatives will be optimised for controlled growth and differentiation of individual cell lines, combined into (bio)inks and deposited into scaffolds for tissue engineering using the 3D bioprinting system Vitaprint [8]. To achieve the required geometrical complexity and resolution with internal gradients, core-shell printing will be integrated with microfluidic preparation of the inks. For well-defined fabrication of freeform structures, printing into support matrices will be explored. Scaffolds will be printed directly into custom-made lab-on-a-chip devices with separate and controlled perfusion of engineered 'intestinal lumen' and inner vasculature. Thus, advanced molecular absorption and transport mechanisms will be explored.

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