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Authors	UNEW/COVU (Djordje Jakovljevic)
Contributors	UKG (Nenad Filipovic, Smiljana Djorovic, Aleksandra Vulovic, Jelena Jevtovic, Katarina Basaric, Neda Vidanovic Miletic, Milena Djordjevic)
Reviewers	UKG (Marko Lukic, Milica Kaplarevic), UOI (Themis Exarchos)

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0.2	State-of-the-art of BME capacities at UKG completed	15/01/2021
0.3	The examples of good EU practices gathered	25/01/2021
0.4	First draft consolidation	05/02/2021
0.5	Revision of document – Comments & Refinements	10/02/2021
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Executive summary

The document is the result of the task 3.3 Identification of best practices for building the innovation capacity at the University of Kragujevac (UKG).

Its main objective is to draw lessons from existing good and innovative modes of assistance to capacity development in low-income countries and to highlight the ways for efficient absorption of EU funds that will lead to the opportunity to better align UKG and regional priorities according to Smart Specialization Strategy.

At the beginning of the document, a state-of-the-art in the area of biomedical engineering at the University of Kragujevac is presented covering the several aspects of Biomedical Engineering (BME) development. It gives a short presentation of the establishment and development of the BME as a discipline at the University, its major research results/projects, infrastructure, research activities and educational mechanisms.

This deliverable is intended to provide an insight into existing BME capacities in order to identify the gaps and define strategies to overcome these by application and implementation of the activities and initiatives used by worldwide renowned universities in the BME field.

The remainder of the document gives a list of examples of good practices in the area of BME capacity building that can be translated to the UKG practices and applied in the following period. The objective of the report is to provide and describe the potential applications and opportunities available at the EU universities that can be adopted and implemented at the UKG to achieve excellence in the field of BME.

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List of Abbreviations

Abbreviation	Explanation
BME	Biomedical Engineering
CAD	Coronary artery disease
CE	Continuing Education
CEFR	Common European Framework of Reference
ECTS	European Credit Transfer and Accumulation System
IMWS	Institute for Mechanics of Materials and Structures
FFR	Fraction Flow Reserve
KUL	Katholieke Universiteit Leuven
TM	Third Mission
TUW	Vienna University of Technology
UKG	University of Kragujevac
UMIB	Unit for Multidisciplinary Research in Biomedicine
UNEW	Newcastle University, Faculty of Medical Sciences
UOI	University of Ioannina

1. Introduction

Innovation capacity building in research is a dynamic process that is a part of the larger process of improvement and development in a specific research area or generally at an institution. Building the capacity of individuals or a research organization in a specific sector is a comprehensive and complex task and most of the time it cannot be implemented as a linear procedure but as a network of activities spread over the different aspects of research activities.

Innovation capacity building at the *individual level* refers to building and improving the skills of researchers to conduct research, apply for funding, and communicate research results to different target groups through training and scholarship programs. Activities like these will increase the skills and knowledge of university researchers to conduct quality research and contribute to the organization to reach excellence in the specific research area.

Innovation capacity building at the *institutional level* includes changes at the level of the university that will lead to reaching excellence and visibility of the university within the international and global research circles. This may include the incentives to encourage research, establishing networks of policymakers and researchers, improving quality and standard raising process, etc.

Additionally, there is no single model that can simply be applied at any institution but the process of building capacities largely depends on the specificities of the institution, its type, its level of progress in a specific area, strategic plan for the future development, priorities in the area, etc.

2. Mapping the existing capacities at UKG

The first step in identifying the applicable capacity building model is to **map the already existing capacities** in the research institution including the development of a research discipline, human resources, available infrastructure, research activities and achievements (research results, projects and papers) and educational aspects.

BME is a discipline in which the principles and tools of traditional engineering disciplines are applied to the analysis and solution of problems in biology and medicine. This is done particularly throughout healthcare, from diagnosis and analysis to treatment and recovery, and has entered the public conscience through the design and development of active and passive medical devices, orthopedic implants, medical imaging, biomedical signal processing, tissue and stem cell engineering, and clinical engineering, and many other applications.

BME is a growing field around the world and the University of Kragujevac and the rest of the consortium partners have recognized enormous RDI opportunities in this field. The long-term mission of SGABU is to create a sustainable fusion of engineering and life sciences that promote scientific discovery and the development of new biomedical technologies through research and education, especially at UKG, as growing demands of the targeted science field in the area of public health.

Moreover, the aspirations in the biomedical engineering area align well with the Serbian government's ambitions to lead in high-impact technologies and align with the provisions and objectives of the Smart Specialization Strategy in the Republic of Serbia for the period of 2020-2027. The Smart Specialization Strategy of the Republic of Serbia (4S)[1] is part of an innovation policy paradigm, which brings together decision-makers, academia and civil society to raise the competitiveness of the economy, economic growth and progress of society by connecting research, industrial and innovation forces and resources in priority economic areas. By directing resources to areas with the greatest competitive and innovative potential, 4S helps the domestic economy to use its potentials more efficiently and to better position itself in global markets and international value chains. In the field of Information and Communication Technologies, i.e. subfields of custom software development and development of own products, new solutions will be supported which include the application of big data, cloud computing, Internet of Things, embedded systems, artificial intelligence and blockchain technology in various fields. As biomedical engineering presents the combination of several research disciplines based on the application of these ICT solutions, its development can make a significant contribution to the achievements and goals set within the 4S Strategy.

2.1 Research capacities

Early development of BME at the University of Kragujevac started in the '90s of the 20th century in the laboratories for applied mechanics at the Faculty of Engineering with the main goal to integrate different scientific fields including mechanical engineering, informatics, medicine, biology and pharmacy and to enable support of computer methods for more reliable medical diagnosis, prevention and patient treatments.

Led by this idea, the Center for bioengineering was founded in 2006 as a result of numerous international and domestic scientific projects and research initiatives in the field of bioengineering, which enabled the

[1] Smart Specialization Strategy of the Republic of Serbia

development of computational infrastructure and BME at the University of Kragujevac. Some of the most important projects are the following:

- **2003-2009**: Particles in Developing Lung: Bioengineering Approach, NHLBI Prime Grant 5 R01 HL070542-03. Harvard University and the University of Kragujevac.

  In the project, it is hypothesized that age-associated changes in lung anatomy, such as progressive alveolation, lead to major changes in particle mixing and deposition, predicting that deposition peaks in very young children with lungs that have become largely alveolated already but are still small. To test this hypothesis, it was proposed to perform a study combining theoretical and experimental approaches. The project provided a comprehensive view of the relationship between alveolar geometry and the appearance of chaotic mixing mechanisms in the lung that may result in a sudden change in the extent of particle deposition. The findings of the project aimed to lay down the foundation for realistic and rationally based inhalation dosimetry in children.

- **2008-2013**: ARTreat, Multi-level patient-specific artery and atherogenesis model for outcome prediction, decision support treatment, and virtual hand-on training, ICT-FP7-224297.

  The main aim of the project was to provide a patient-specific computational model of the cardiovascular system in order to improve the quality of prediction for the atherosclerosis progression and propagation into life-threatening events that need to be treated accordingly. ARTreat used advanced clinical support tools for plaque characterization and discovery of new knowledge; it supported programming the accumulated knowledge into the existing model and generating an adaptive patient-specific computational tool.

- **2014-2017**: SCOPES Joint Research Project, Role of blood flow and sdf-1/cxcr4–induced recruitment of mononuclear cells in intussusceptive angiogenesis.
  The aim of the project was to study the role of blood flow and SDF-1/CXCR4-induced recruitment of mononuclear cells in intussusceptive angiogenesis using both experimental models and numerical simulations. The focus was on the following fundamental aspects: (i) the role of SDF-1/CXCR4 signaling in intussusceptive angiogenesis, (ii) the role of the bone marrow derived/peripheral blood mononuclear cells in IA during tissue regeneration and their contribution to the "escape" mechanism after anti VEGF therapy and irradiation in cancer, iii) SDF-1/CXCR4 interactions with blood flow/shear stress in the process of intussusception. Different models and approaches were used: (i) in vivo pharmacological studies on chicken area vasculosa, (ii) in vivo genetic studies in zebrafish embryo, (iii) mouse model of liver intussusceptive microvascular growth, (iv) mouse tumor xenografts, switching to intussusceptive angiogenesis after irradiation and anti-angiogenic treatment, (v) detailed morphological and computer modeling, molecular, immunological and cellular analyses for different types of cells (macrophages, neutrophils, eosinophils, mast cells, dendritic cells, NK cells, T- and B-cells). The main outcome of the project was to provide important information regarding intussusceptive angiogenesis and role of bone marrow derived/peripheral blood cells in order to help medical experts design more effective pro- and anti-angiogenic treatment strategies.

- **2015-2018:** Enabling Web-based Remote Laboratory Community and Infrastructure - SCOPES Joint Research Project.

  This project aimed at developing institutional partnerships between Switzerland, Serbia and Slovakia to develop the next generation infrastructure integrating Web-based remote laboratories (Labs) and supporting online engineering education in Europe. Targeted applications were STEM (Science, technology, Engineering and Math) Education in Secondary Schools, Higher Education, and future Massive Open Online Courses (MOOCs) integrating hands-on activities.

- **2016-2019**: SMARTool, Simulation Modeling of coronary ARTery disease: a tool for clinical decision support, Call for proposal: H2020-PHC-2015 single-stage, Project reference: 689068.

  SMARTool focused on developing a platform based on cloud technology, for the management of patients with coronary artery disease (CAD) by standardizing and integrating heterogeneous health data, including those from key enabling technologies. SMARTool cloud-based platform, through Human Computer Interaction techniques, 3D visual representation and artery models, used heterogeneous data in a standardized format as input, providing as output a CDSS - assisted by a microfluidic device as a point of care testing of inflammatory markers – for:

  i) Patient specific CAD stratification - existing models, based on clinical risk factors, will be implemented by patient genotyping and phenotyping to stratify patients with non-obstructive CAD, obstructive CAD and those without CAD, ii) site specific plaque progression prediction - existing multiscale and multilevel ARTreat tools of CAD progression prediction will be refined by genotyping and phenotyping parameters and tested by baseline and follow CCTA and integrated by non-imaging patient-specific data, iii) patient-specific CAD diagnosis and treatment - life style changes, standard or high intensity medical therapy and a virtual angioplasty tool to provide the optimal stent type(s) and site(s) for appropriate deployment.

- **2019 – 2020: Introducing innovation into laboratory exercises and experiments as part of the courses taught within the Master's Program in Bioengineering (BIOLAB)**; **Ministry of Education, Science and Technological Development of the Republic of Serbia.**

  The main aim of the project was to improve and innovate the teaching process within the Master's Program in Bioengineering so that the students can acquire necessary competences that will enable them to work in research institutions and bioengineering and software companies. Specific aims of the project were: 1) Improvement of four key courses taught within the Master's Program in Bioengineering, 2) Upgrading of laboratory equipment, 3) Increase of general and subject-specific competencies and competitiveness of students for performing various projects in the field of bioengineering, 4) Enhancing student employability.

- **August, 2020 – December, 2020: Production of medical ventilators by using 3D printers and lasers, with lower production cost and in shorter production time compared to the standard industry approach, this solution enables the production of affordable medical ventilators in Serbia, for the fight against COVID-19 virus; United Nations Development Programme**

  The number of available mechanical ventilators in many countries in the world, including Serbia, was assessed as insufficient, which led to high demand on the world market, which also raised the price of fans and made their import even more difficult. Given the risk of the second wave of coronavirus and the use of ventilators in patients with other serious respiratory problems, this remedy is important for building the resilience of the health system.

  The overall objective of the project was to contribute to building Serbia's long-term capacity to produce affordable mechanical ventilators in-house using the existing equipment and available expertise.

The specific objectives of the project were:

- to provide the consumables necessary for the production of 3D printed mechanical ventilators parts;
- to produce 30 mechanical ventilators using 3D printing and laser techniques.

- **July, 2020 – December, 2020: Use of Regressive Artificial Intelligence (AI) and Machine Learning (ML) Methods in Modelling of COVID-19 spread (COVIDAI), Central-European Initiative (CEI)**

  The aim of this research was to find an optimal regression model for the estimation of COVID-19 infection spreading in three dimensions: number of COVID-19 infection cases, number of deceased patients and number of recovered patients. For these reasons, three different approaches were utilized: Multilayer Perceptron, Recurrent Neural Network, and Symbolic Regression (Genetic Programming). The grid-search procedure was utilized in order to determine the optimal configurations of these algorithms. Each of the used regression models is expected to give the number of cases in each of the three dimensions as an output.

- **2020 - 2021: Development of MOBile APP for VIRtual FFR (Fraction Flow Reserve), MOBVIRFFR, Project ID: 5928; The Innovation Fund of the Republic of Serbia**

  Software for virtual estimation of FFR was developed within a recently finished H2020 project SMARTOOL (www.smartool.eu) on the cloud-based solution. This software is still in initial pilot phase for using in everyday clinical practice. The software was developed at Faculty of Engineering (FIN), which was the main developer inside SMARTOOL project for virtual FFR and stent deployment. In this project, the aim is to develop a mobile phone application that can be easily used, in the first place, by medical and bioengineering students, and by researchers and medical doctors. Additionally, some Machine learning techniques will be applied to achieve fast calculations in real time. App MOBVIRFFR will be tested with retrospective clinical data obtained from SMARTOOL project and from prospective data inside Clinical Center Kragujevac, which represents a clinical base of the Faculty of Medical Science of the University of Kragujevac.

- **2020 – 2023: Increasing scientific, technological and innovation capacity of Serbia as a Widening country in the domain of multiscale modelling and medical informatics in biomedical engineering – SGABU, WIDESPREAD-05-2020 - Twinning**

  The EU-funded SGABU project aims to enhance the research capacity and capabilities of the University of Kragujevac (UKG) in Serbia in the sector of biomedical engineering. In this scope, the UKG collaborates with four EU leading research institutions (the University of Ioannina in Greece, the Vienna University of Technology in Austria, the Katholieke Universiteit Leuven in Belgium and the Newcastle University in the United Kingdom). Cooperation is being established through project activities, meetings, study visits, summer schools and workshops. Eventually, the project will help to create a computational platform for multiscale modelling in biomedical engineering, which will be tested and validated on patients suffering from cardiovascular and bone disease or cancer.

The Centre has been very active ever since in the realization of scientific and research work encompassing some specific activities such as:

- cardiovascular system simulation

- plaque growth simulation
- respiratory system simulation
- simulation of mouse function
- sports biomechanics
- simulation transport medicine
- optimal stent design and application of nanotechnology in medicine
- predicting the growth of a tumor
- medical images, and
- development tools used in biomedicines.

The Center has also provided significant research infrastructure which enables and contributes to the implementation of the above-mentioned activities, especially having in mind the multidisciplinary approach of the BME.

1. **Dynatek intravascular stent-graft tester**

Large vascular prosthesis tester, designed to create accelerated cyclic pulsatile loading on synthetic or biological vessels. They can test up to 24 samples – radial strain testing – physiologically tuned test method (method A*). Large vascular prosthesis operates by setting the baseline pressure, simulating the diastolic pressure, then pulsing the samples to simulate the systolic pressure using a precision bellows drive system. This tester is designed to test samples of 6mm ID to any custom shape desired. The number of samples is determined by the shape and volume needed to achieve the target deflection. System DC7000 controls speed, pressure and temperature while recording the number of cycles count and enabling graphing of the pressure signal by use of highly precise pressure transducers.

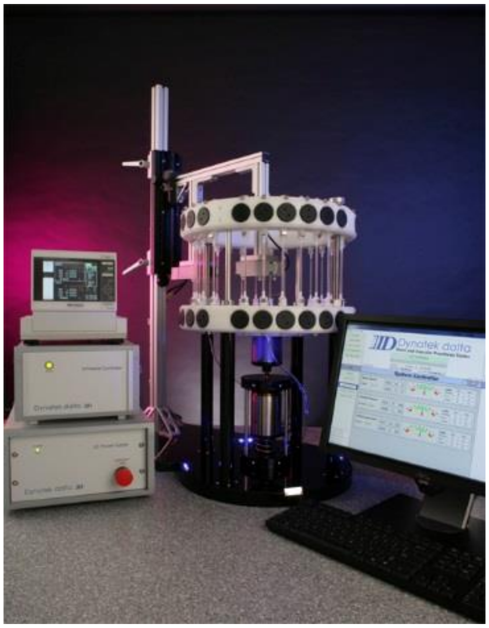

Figure 1. Dynatek intravascular stent-graft tester

2. **Bose Electroforce Stent Tester with 8 test tubes, model 9120-8 SGT**

Life cycle test and radial fatigue test – a test method based on radial bending (method B*). This electrical device for stent/graft testing verifies the fatigue life of intravascular prostheses such as stents, grafts, occluders and shunts under simulated physiological displacements. The instruments are designed to provide automated control for long-term, 400-600 million cycle tests.

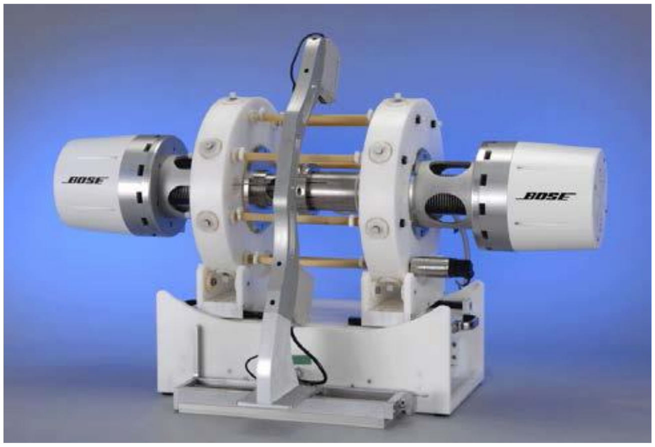

Figure 2. Bose Electroforce Stent Tester with 8 test tubes, model 9120-8 SGT

3. **Bose ElectroForce dynamic tester up to 22N for stent testing, model 3100**

Life cycle testing and fatigue testing for other types of loads for different stents. Highly versatile and robust, the system performs a wide range of simple and advanced materials tests, including: tightening/pressure, axial fatigue test, axial/torsional fatigue test, friction fatigue, determination of viscoelastic properties, product endurance testing. Its flexible hardware and software platform enables the use of multiple axes, sensors and test chambers while designing a test application.

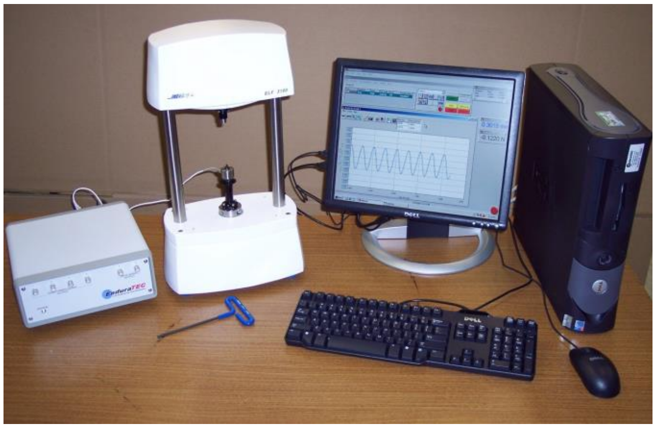

Figure 3. Bose ElectroForce dynamic tester up to 22N for stent testing, model 310

4. Tissue engineering equipment

Development of scaffolds for artificial blood vessels. Electrospinning methods, bioreactor and design of new tissue scaffolds. Computational design of tissue engineering.

Figure 4. Tissue engineering equipment

5. Cell biology Unit

The use of modern methods of cell and molecular biology in the examination of human cancer. Testing of new substances, potential preparations for cancer treatment - *in vitro* tests. The cell biology Unit of the Center for Bioengineering is a specially equipped system, in which human cell lines of cancer and healthy tissue are grown in optimized conditions. Methods of cytotoxicity tests, the redox status of cells, gene and protein expression, micro-RNA profiling, migration, etc. are the basis for any preclinical study, as well as monitoring the molecular mechanisms of cells to better understand the nature of cancer. The most current project in Cell Biology Unit is detecting various single nucleotide polymorphisms in human COVID-19 patient samples.

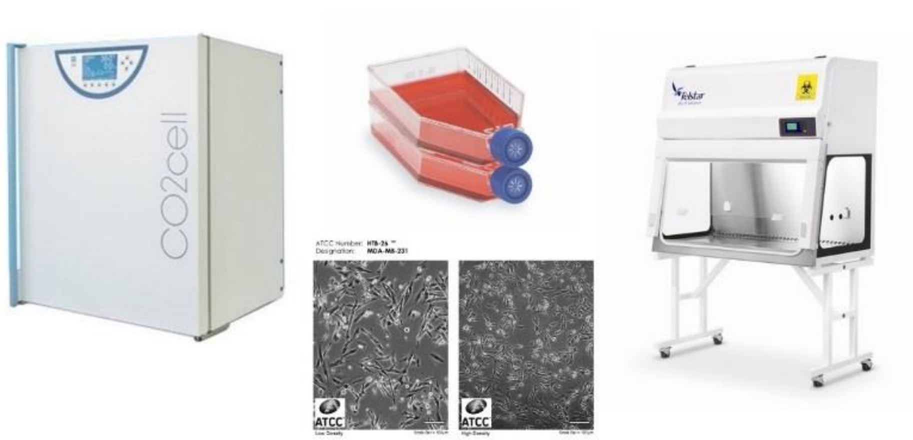

Figure 5. Cell biology Unit

6. 3D bioprint

Applying new 3D bioprinting techniques enables us to create tissue-like structures that could be used in regenerative medicine. Such tissue-like or organ-like structures could be used for replacing the parts of affected organs, or for replacing organs in whole. There are many successful in vivo experiments with 3D bioprinted skin, bone, or bladder. Personalization of therapy indicates the need for establishing a completely new approach in healthcare. The precision of new tissue engineering techniques and devices, such as 3D bioprinters enable us more success in this multidisciplinary scientific approach.

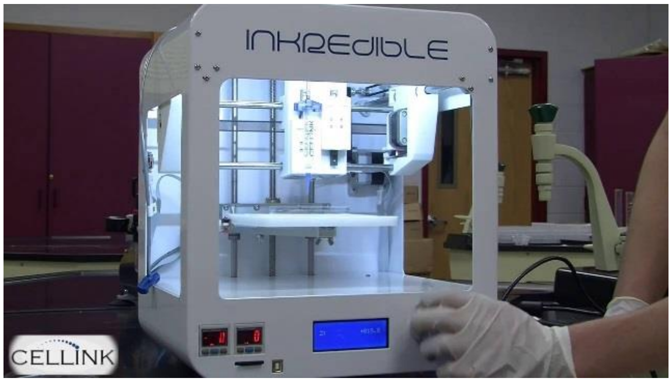

Figure 6. 3D bioprint

7. Organ-on-a-Chip

The use of *in vitro* techniques and animal models has significantly contributed to a better understanding of the molecular mechanisms of various human pathological conditions. However, the scope of such studies is limited. Such studies are mainly based on static testing. The Laboratory for bioengineering creates and optimizes a real-time dynamic system with a clinically relevant assessment based on a mathematical model with and without therapy - *Organ-on-a-Chip*. This approach could significantly help in the early stages of clinical trials of new drugs in a complex human tissue system. One of the current projects is the creation of a *Colon-on-a-Chip* microfluidic system, which would mimic the affected part of the organ in the most realistic fashion possible.

Figure 7. Organ-on-a-Chip

8. Electrospinning system

Development of scaffolds for tissue engineering. Computer-aided tissue engineering design. Scaffolds produced in this way serve as carriers on which cells are grown in special conditions, which could be transformed into mimic tissues in the bioreactor.

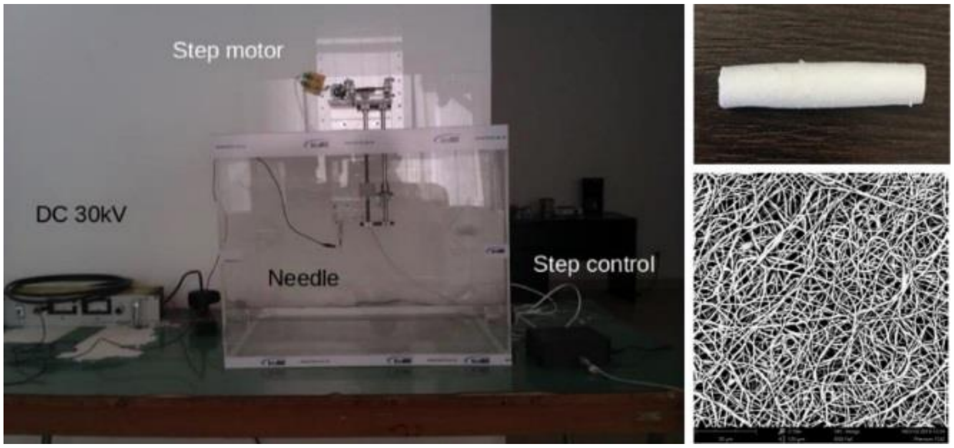

Figure 8. Electrospinning system

9. Bioelectrochemistry and biosensing

The use of electrochemistry and biosensors in the creation of devices for early detection of cancer. The goal of the development of this diagnostic device is precise and cheap detection of microRNA from blood serum or tissue without prior PCR amplification. microRNAs are considered precise markers of any pathological and healthy cell condition. Cancer cells produce different microRNAs in concentrations and ratios specific to each type of cancer. The methodology is based on the hybridization of PNA with detectable microRNAs on specially created electrodes. Precise determination of microRNA content and concentration is achieved by using modern methods of electrochemistry and biosensors.

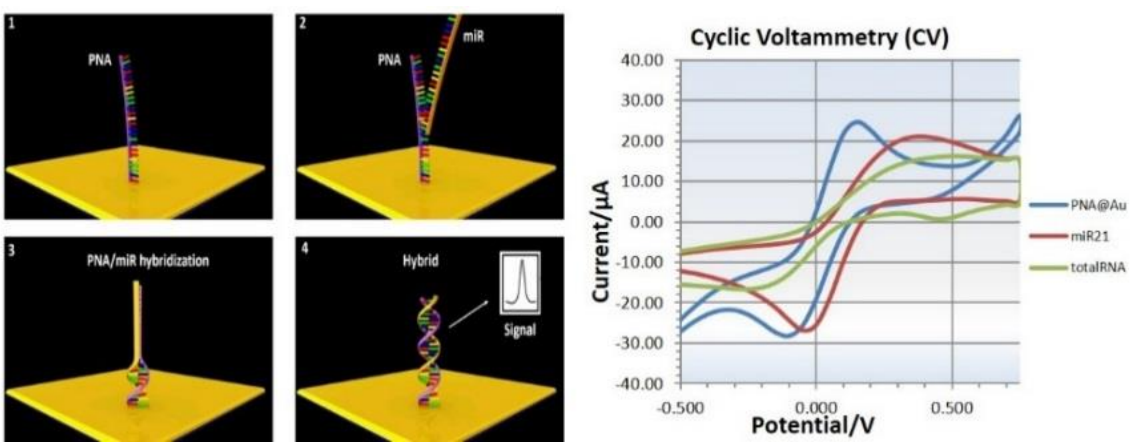

Figure 9. Bioelectrochemistry and biosensing

10. Stent technology development

Development of stent production technology. For this purpose, various materials of nitinol wires, their physical and electrochemical processing are examined. The characteristics of the produced stent must meet the strictest long-term patient protection regulations. Thermal and surface treatment of nitinol is extremely important, primarily due to the preparation of materials for stent production that will reduce adverse reactions in the body to a minimum.

11. PAK program

The Main Features of the Program:

- PAK-G Program for graphical pre-and post-processing
- PAK-S Program for linear and geometrically and materially
- nonlinear structural analysis
- PAK-T Program for linear and nonlinear heat conduction
- PAK-F Program for laminar flow of incompressible fluid and heat transfer
- PAK-P Program for analysis of groundwater seepage
- PAK-CT Program for coupled problems, multiphase fluid flow with heat transfer through a porous deformable medium
- PAK-B Program for biomechanics, modelling of muscles and connective tissue, blood flow through deformable arteries (solid-fluid interaction), cartilage electromechanics.

Today, a very active group in biomedical engineering counts more than 30 young people who have large experience in lecturing and research activities, but have also participated in FP7, ERASMUS+, TEMPUS, SCOPES, COST, H2020 and other research and bilateral projects. It brings together a large number of university professors, doctors, researchers, engineers in the field of medical, biological, electrical, mechanical engineering and other related scientific fields.

They are devoted to computational modelling, data mining, cardiovascular smart device measurements and software development for various problems in engineering and bioengineering (cardiovascular and respiratory system, muscle system, sports biomechanics, drug transport, nanotechnology, prediction of tumor growth).

The research is largely based on the finite element method applied to solids, fluids, modelling of physical fields, multiphysics, and various coupled problems. Also, discrete particle methods, such as dissipative particle dynamics, are developed and coupled with continuum models in multiscale schemes. The solvers are accompanied by state-of-the-art computer graphics as well as image processing methods and 3D medical image reconstructions.

Center achieves results in the field of bioengineering at both national and international level. A large number of scientific publications and results have been generated as the result of collaboration with different national and international partners, spanning from blood flow modelling, drug transport, cartilage muscle and tissue mechanics, thrombosis and plaque development, ECG and EEG simulation, to big data analytics, data mining and multiscale modelling.

2.2 Education in the field of Biomedical engineering

With the world's population ageing and a low birth rate in developed countries, bioengineers are best equipped to meet these rising demands. Bioengineers are needed to drive rapid innovations in medical technologies, such as 3-D printing and micro-electro-mechanical systems (MEMS). Also, many countries are seeing an increase in the demand for bioengineers.

To further develop the field of bioengineering, the University of Kragujevac created the master course at the Faculty of Engineering and enrolled students in the school year 2019/2020, in the **Bioengineering master academic studies**. The purpose of the study program is to educate students in the area of bioengineering which provides the acquisition of knowledge and skills necessary for the successful performance of professional engineering tasks within the framework of the world education area and labor market.

Bioengineering study plan is designed following the needs of modernization and expansion of modules on master academic studies at the Faculty of Engineering, as well as the research needs of this extremely multidisciplinary field.

The study program offers high-quality education for performing professional and academic jobs, following the quality standards of the educational system in Serbia and the requirements for integration into the European educational system.

The emphasis of this study program is on individual and teamwork, both in the field of engineering and in the field of cooperation with medical doctors in research and at the clinics. Work in modern equipped computer classrooms, the use of last generation computer resources, as well as constant cooperation with medical doctors, enables successful scientific research in the field of bioengineering.

Curriculum

Master's academic studies Bioengineering last one year (2 semesters) and contains 60 ECTS in total. The curriculum of this study program contains 4 elective courses so that the individual interests of students are fulfilled. An integral part of the curriculum is a 180-hour technical practice, which is performed in appropriate institutions, organizations, companies, clinics, and public institutions. The student completes the studies by defending the master's thesis. Upon completion of this study program, the academic title "master engineer of biomedical engineering" is awarded. Persons with completed bachelor academic studies and a minimum of 240 ECTS may be enrolled in the study program. Studies are conducted in Serbian and English. Exercises can be auditory, computer or laboratory. Lectures and auditory exercises are conducted in classrooms with a group of up to 16 students, while laboratory exercises are conducted in laboratories with 8 students maximum.

Study program objectives

The main objective for master engineers of bioengineering is to master all necessary knowledge to join the work in hospitals, scientific-research organizations, private bioengineering companies, as well as software companies.

Course-specific competencies of students include:

- the ability to apply knowledge from the foundations of anatomy and physiology in analyzing and solving specific problems in the field of bioengineering, on several levels;
- the application of acquired knowledge in modelling and analysis of the cardio-vascular and muscular-skeletal system;

- detailed knowledge of the use of biomaterials and nanomaterials in bioengineering;
- the use of new methodologies and technologies in tissue engineering, the design of biomedical devices and biomedical images processing;
- knowledge and handling of instrumentation used in biomedical research;
- ability to create, develop and apply contemporary software to the analysis and computer simulation of various systems in the field of bioengineering.

Expected knowledge outcomes, defined through the appropriate knowledge and skills of students are the following:

- mastering knowledge and skills in the field of bioengineering at the level of master's academic studies prescribed by EU countries documents;
- mastering computer tools, programming skills and the use of information and communication technologies and available modern research equipment;
- monitoring and application of novelties in the field, as well as successful and equitable cooperation with colleagues from educational, scientific, research, business, or clinical organizations from the country and the world;
- mastering wider context of perceiving engineering and research problems, which implies taking into account economic, organizational and social relations.

Mandatory courses:

Course name: Fundamentals of Anatomy and Physiology

Upon completion of the course entitled Fundamentals of Anatomy and Physiology, the students are expected to acquire knowledge about:

- General anatomical features of organ systems
- General characteristics of the structural organization of cells, tissues, organs and organ systems
- Fundamentals of the physiology of organ systems
- The way tissues are organized into organs and organ systems
- Histological and physiological characteristics of tissues and organs
- Basic rules of the relationship between the structure of tissues and organs and their function and dysfunction

Course name: Bioengineering and Bioinformatics

After they have mastered the program and passed the exam within the course entitled Bioengineering and Bioinformatics, the candidates will be able to engage in scientific research in this very popular and interdisciplinary field. The candidates will acquire knowledge of basic concepts in cardiovascular biomechanics, mechanism of circulation, biomechanics of muscles, biomechanics of bones and spine, basics of bioinformatics, parallel systems and the use of bioinformatics databases and artificial intelligence methods in modelling and simulating coupling problems in the cardiovascular system.

Course name: Technical practice 2

Acquiring practical experience about methods of organization and functioning of environments in which student expects the application of the gained knowledge in his/her future professional career.

- Mastering ways of communication with colleagues and getting to know business information flow.
- Recognition of basic processes in the development and design of products and technologies, production, testing and maintenance, according to expectations of future professional competence.
- Making personal connections and acquaintances that may be used during the study period or in the future employment process.

Course name: Study research work on the theoretical basis of Master's thesis

Students are qualified to independently apply previously acquired knowledge from different fields studied earlier, to analyze the structure of the given problem and to systematically analyze it to reach conclusions on possible directions for its solving. Through independent use of literature, students expand their knowledge from the selected field and study different methods and papers related to similar problems. Thus, students develop abilities to conduct analyses and to identify problems within the given subject. By application of acquired knowledge from different fields, students develop the ability to recognize the place and role of an engineer in the selected field, the need for cooperation with other professions and teamwork.

Elective courses are the following:

1. Computational Mechanics of Fracture and Damage

Acquiring basic knowledge about fracture and damage mechanics; Within the course, the basic principles of continuum mechanics in the stress analysis of structural components with initial cracks will be presented, using a finite element method. Structural analysis will be performed by implementing the finite element method.

2. Computational Fluid Dynamics

After they have mastered the program and passed the exam within the course named Computational fluid mechanics, the candidates will be able to successfully follow the contents of the courses that relate to the area of calculation of physical fields, as well as to engage in research and scientific work in this new field. The knowledge that the candidates will acquire is related to the basic methods of numerical solving of fluid flow fields, coupled solving of the problem of solid-fluid interaction as well as parallel solving of large problems in fluid flow.

3. Biomedical Image Processing

After they have mastered the program and passed the exam within the course entitled Biomedical Image Processing, the candidates will be able to engage in scientific research in this interdisciplinary field. The knowledge acquired will allow them to familiarize themselves with the basic principles of biomedical image formation by applying ionizing and non-ionizing modalities, methods of transformation, principles of segmentation and registration, as well as by using software packages for this purpose. This will enable students to independently perform a real task in the field of application of the principles of creating and processing biomedical images.

4. Biomaterials

Students will learn how to recognize and select an appropriate material according to a clinical application of a medical implant or device. To understand the relationship between the composition, structure and properties of biomaterials as well as the primary physical, chemical and biological processes that occur in contact with tissue and biomaterial during its application. To understand the role and importance of certain biomaterials in tissue regeneration.

5. Tissue Engineering

Acquiring basic skills and competencies for further specialization in the field of tissue engineering and regenerative medicine. Students will develop a research approach, analytical and communication skills necessary for their further professional development in the area of tissue engineering.

6. Biomedical Instrumentation and Measurement

Students are trained to independently design and form simple measuring chains for biomedical research, conduct measurements, collect and process data. In this way, they will be able to conceptualize and perform laboratory and clinical biomedical research.

7. Design of Biomedical Devices

A student who passes this course acquires the ability to creatively harmonize the factors from idea to innovative solution within the development of medical devices. They acquire the ability to search, collect and integrate knowledge, as well as the skills of a holistic, critical and systematic approach to the problem of design and development of a medical device. The students will be trained, in teamwork or independently, to design medical devices, with the integration of appropriate legal regulations (FDA regulations, ISO 13485 Directive, etc.).

8. Ergonomics in Bioengineering

After the module is completed, a student has the ability to:

- Identify basic parameters defining work position and work task
- Set basic parameters necessary for solving ergonomic issues
- Verify the suggested solution.

9. Communication Protocols Programming

After the course completion, students will be able to:

- Realize communication protocols, USART, RS422/485, USB, CAN, ModBus, Bluetooth, ZigBee
- Design and implement solutions on contemporary micro controlling systems
- Demonstrate understanding of program concepts, methods and approaches
- Demonstrate understanding of advanced concepts of data exchange and storage.

10. Artificial Intelligence

Students are introduced to the basic concepts of intelligent systems. Experience is gained in the area of knowledge presentation, reasoning methods, system phase, neural networks and genetic algorithms. Areas of application are being studied in technics, medicine, economics and others. During exercises, examples will be analyzed, by use of appropriate programs, from different areas of artificial intelligence application.

11. Advanced Analysis and Computer Simulation of Systems

Upon passing the exam, students will be able to:

- understand theoretical basics of nonlinear continuum mechanics;
- understand basics of static and dynamic nonlinear analysis using finite element methods;

- apply gained knowledge on modelling and nonlinear analysis of real engineering problems.

12. Musculoskeletal Systems

Structural design, based on numerical methods, as well as estimation of fatigue and fracture resistance of the complex systems from the area of biomedical engineering. Special attention is dedicated to training in the estimation of damage accumulation, initialization of crack, its widening and uncontrolled development leading to functional failure of the analyzed structure.

13. Nanomaterials in Bioengineering

Students will be able to recognize and select a suitable nanomaterial according to its clinical application. To understand the relations between content, structure and properties of nanomaterials as well as basic physical, chemical and biological processes that occur in their contact with living tissue. To understand the role and significance of individual nanomaterials and their practical application in bioengineering as well as aspects of nanomaterial toxicity.

Other Academic Studies Incorporating Bioengineering Courses at Faculty of Engineering are the following:

Bachelor Academic Studies:

- Mechanical Engineering
  - Module: Applied Mechanics and Automatic Control
    - Course – Bioengineering Fundamentals (3rd year)
- Computer Technology and Software Engineering
    - Course - Bioengineering and Bioinformatics (4th year)

Master Academic Studies:

- Mechanical Engineering
  - Module: Applied Mechanics and Automatic Control
    - Course – Computational Fluid Dynamics (1st year)
  - Module: Informatics in engineering
    - Bioengineering and Bioinformatics (1st year)
    - Course – Computational Fluid Dynamics (1st year)
    - Course - Biologically inspired computing (2nd year)
- Electrical Engineering and Computer Science
    - Course - Biologically inspired computing (1st year)

2.3 Innovation capacity building: monitoring and evaluation

Innovation capacity building is an ongoing process at the University of Kragujevac. Some indicators have been already developed and monitored by different units and departments at the university and its faculties (e.g. Office for international projects, Financial department, etc.).

Some indicators are rather general in nature, but for the purpose of monitoring the development of capacities of BME they can be translated and "localized" to a specific discipline (number of publications, external income from projects, number of students, etc.).

These are indicators/targets/metrics that have already been developed and/or applied as part of several different initiatives:

- **Human Resources Strategy for Researchers** – with the aim to enhance management of human research potential at Western Balkans universities in line with national and EU strategies for researchers. In order to monitor the level of achievement of defined activities, a set of indicators and targets were developed that can provide an insight into the process of building the capacity of researchers at the University of Kragujevac, for example:
    - Developed Rulebook on intellectual property management at the University of Kragujevac;
    - Clearly regulated procedure concerning plagiarism checks at the University of Kragujevac;
    - Organzed activities, such as webinars, presentations, info days, individual consultations, focused on raising the capacity of researchers for project proposal writing and management organized;
    - Defined procedures for financial monitoring of international projects;
    - Adopted open science platform;
    - Lifelong learning and short study programs;
- With the Eramus+ CBHE project „Institutional framework for the development of the third mission of universities in Serbia“ (Contract no 561655-EPP-1-2015-1-RS-EPPKA2-CBHE-SP), the metrics was developed for monitoring research and education activities as part of the Third Mission (TM) of the University:
    - Existence of Continuing Education (CE) in the university strategy and action plan;
    - Number of CE programs as a percentage of the total number of study programs;
    - Number of CE participants as a percentage of the total number of students;
    - Earnings from continuing education per total number teaching staff in FTE;
    - Number of patents per researcher;
    - Number of technical solutions applied on national or international level, per researcher;
    - Number of hours taught by external lecturers as a percentage e equivalent) of teaching hours in regular study programs;

Third mission activities are important since they direct the development of universities towards entrepreneurial mindset, enabling them to become a powerful engine for innovation and economic growth.

- As part of ranking procedures that the University of Kragujevac is actively engaged in, there is additionally a set of indicators monitored and data gathered, such as:
  - Total number of offered study programs;
  - Number of study programs in foreign languages;
  - Number of online study programs;
  - Number of students (against different criteria – gender, study level, etc.);
  - External income from research;
  - Percentage of external income from international sources;
  - Percentage of external income from national sources;
  - Income from copy rights and licencing;
  - Expenditures for research (in per cents);
  - Expenditure for knowledge transfer (in per cents);
  - Number of academic publications;
  - Number of professional publications;
  - Number of art results;
  - And many others.

However, this methodology can be updated following the instructions and recommendations given in the Practice Paper of the UK's Department for International Development[2], particularly in the section *Generic Indicators for monitoring the success of capacity building components of research programmes*. Also, monitoring related to the training and education can be conducted through the collecting of personal testimonials (such is the practice at Lund University[3]) or through questionnaires on given courses modified to fit the needs of particular training sessions (described by the University of Tartu[4]), etc.

Within the SGABU project, we aim to develop a scientific strategy for stimulating and upgrading scientific excellence and innovation capacity in Biomedical engineering. In this regard, the key performance indicators for measuring the outcomes of SGABU are developed. Primary KPI: (i) relative increase of impact factor of jointly published papers in journals, (ii) relative increase in the h-index of bioengineering research group at UKG, (ii) relative increase in research proposal participation (including HORIZON calls for proposals). Secondary KPI: (i) number of staff exchanges during the project, (ii) increase in the number of people trained (balanced number of people form academic and industrial background) (iii) number of jointly organized conferences, workshops and summer schools. Socioeconomic KPIs include but are not limited to: (i) increase of number of users exploiting the SGABU platform on a regular basis during the

[2]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/187568/HTN_Capacity_Building_Final_21_06_10.pdf

[3]https://www.lunduniversity.lu.se/international-admissions/professional-education/testimonials-our-course-participants

[4] https://www.ut.ee/en/studies/study-regulations/evaluation

project lifecycle, (ii) distribution of the users exploiting the SGABU platform on a regular basis: number of countries, number of international organizations, SMEs, and academic institutions.

3. Examples of best practices

Regardless of the complexity of the identified best practices, the aim of this document is to make BME innovation capacities at the University of Kragujevac better and more efficient with fewer problems and obstacles. This can be done either by using the complete methodologies and processes or by translating some aspects of the identified practices and adapting them to the existing environment. Here are some of the activities of SGABU partners and selected EU institutions that can be, to different degrees, applied at the University of Kragujevac.

3.1 Best practices of SGABU consortium members

3.1.1 Vienna University of Technology (TUW)

TUW offers a Master's Programme Biomedical Engineering[5] with specialization in the following areas: Biomaterials and Biodynamics, Biomedical Signals and Instrumentation, Mathematical and Computational Biology, and Medical Physics and Imaging. The program is described as international and research-focused and some of the main aims are to attract international students and to increase the number of women in engineering sciences.

As part of the university, the Institute for Mechanics of Materials and Structures (IMWS) focuses on the synthesis of experimental investigation and numerical modelling of the mechanical behavior of materials at different length scales, thereby bridging engineering mechanics with physics, chemistry and biology; and by the application of the developed constitutive models to structural analysis. In recent years, bioengineering materials and structures have become a major focus of the Institute, which is also associated to the Laboratory for Micro and Nanomechanics of Biological and Biomimetic materials. The institute is well connected to the national and international elite in academic research and industry, and has participated in numerous national and international projects. In the course of the last decade, TUW-IMWS has become a world leading research institution in multiscale mechanics of engineering materials.

TUW has recognized the importance of funding excellent research; therefore, several funding programs have been created to serve the needs of researchers at the university. Some of the examples are:

Innovative Projects[6]- through the Innovative Projects internal competitive funding programme, TUW supports scientifically ambitious project ideas from all faculties. Particular value is placed on inter-faculty collaborations. Depending on the latest call for proposals, pioneering ideas from young researchers are supported with infrastructure or staff. The innovative nature of the project being supported is evaluated under a peer review process and then discussed in a panel meeting.

The model of Innovative Projects support mechanism can be modified to fit the financial and operative capacities of the University of Kragujevac. Using existing units and offices this model can be applied at UKG to support the development of ambitious project ideas from all twelve faculties in terms of assistance

[5] https://www.tuwien.at/en/studies/studies/master-programmes/biomedical-engineering
[6] https://www.tuwien.at/en/research/funding-opportunities/innovative-projects

and support in finding the most appropriate external (national and international) funding schemes for developed ideas.

Collaboration Centres [7]– besides providing a funding channel that was also intended to support current 'bottom-up' development in research, the "Multi-Faculty Collaboration Centre" channel was designed to act as the first level of cross-subject/cross-faculty collaboration among research groups at TUW, also including researchers from other universities where relevant, as a springboard for research collaboration projects.

The Centre for bioengineering at the University of Kragujevac conducts research in the area of biomedical engineering and cooperates with experts and scientists from other faculties within the University of Kragujevac, other national and foreign universities. Using the collaboration model of TUW, these activities can be upgraded and improved in the following period.

3.1.2 Katholieke Universiteit Leuven (KUL)

KUL offers a Master's Programme Biomedical Engineering[8] providing students with knowledge and skills in major areas of biomedical engineering, including biomechanics, biomaterials, medical sensors, biosignal processing, medical imaging and tissue engineering.

In September 2021, the new master's program starts[9]. The aim of this new program is to provide a view of advanced contemporary fields in biomedical engineering, covering biomedical imaging, data processing, bioinstrumentation, multiphysics, biofluid mechanics, bioinformatics as well as medical equipment and regulatory affairs. There are also general interest courses developed to meet the students' needs for transferable skills. The elective courses are:

- Biomechanics
- Tissue Engineering
- Bio-electronics
- Biomedical Data Analytics
- Bio-informatics and AI.

The **Doctoral School of Biomedical Sciences[10]** wants to provide **high-quality doctoral training** that supports PhD researchers in their study of research and equips them for their future career. The aim of doctoral training is to help PhD researchers to think and act more creatively and independently. This will prepare them for a career in frontline research and education or for high-level roles in professional sectors where in-depth and rigorous analysis is required. To achieve this aim, doctoral training focuses on personal development in 4 complementary areas:

- Professional expertise - Knowledge of the discipline, analytical and synthetizing skills, creativity, out-of-the-box thinking
- Research management - Project management and financing, respecting professional and ethical standards

[7] https://www.tuwien.at/en/research/funding-opportunities/collaboration-centres
[8] https://onderwijsaanbod.kuleuven.be/opleidingen/e/CQ_51360389.htm#activetab=diploma_omschrijving
[9] https://www.mech.kuleuven.be/en/education-mech/bme/students/students-bme-1/programme-master-biomedical-engineering
[10] https://gbiomed.kuleuven.be/english/phd

- Personal effectiveness - Self-management, time management, motivation, problem-solving, career planning
- Impact and influence - Collaboration, communication, networking, leadership

Having in mind that the University of Kragujevac has already established Master Academic Studies in bioengineering, the next step in the strategic planning can be in the direction of the establishment of doctoral school/study where apart from the scientific-oriented courses, students can also have access to courses for their professional development.

3.1.3 University of Ioannina (UOI)

At UOI, Biomedical engineering course is taught at the Department of Materials Science and Engineering, School of Engineering[11], within the postgraduate program Advanced Materials. The course covers in depth topics related to biomedical technology such as artificial organs, medical devices, biosensors as well as techniques for obtaining, processing, analyzing and modeling physiological signals.

In addition, the Department of Materials Science and Engineering hosts a self-contained unit called The Unit of Medical Technology and Intelligent Information Systems (MedLab)[12], which is focused on research and innovation in the fields of Biomedical engineering and development of Intelligent Information systems. The unit is characterized by high quality scientific research and development of innovative Information Technology (IT) applications, products and services. MedLab's research activities cover a variety of subjects classified into the following domains: Multiscale modeling of human organs, biomedical engineering, decision support systems, bioinformatics, multi-scale predictive modeling, data mining, and big data, wearable systems for monitoring and management of chronic diseases and intelligent information. Most of the Unit's activities are based on international collaborations in the framework of European and Nationally funded projects (FP5, FP6, FP7, Horizon 2020).

3.1.4 Newcastle University, Faculty of Medical Sciences (UNEW)

The Faculty[13] provides courses for clinicians, healthcare professionals and aspiring academics to support the continuing professional development needs of those working in life science, health and social care.

Among other courses, there are several that can be applied for UKG researchers in order to raise their capacities in grant writing:

Writing in a Research Setting - This module aims to familiarize students with the many different processes involved in medical writing. The module is designed to allow the students to experience medical writing and to enable them to develop a range of key skills that will prepare them for writing research proposals, grant applications, case reports and manuscripts for peer-reviewed journals.

Designing a Research Proposal - This module is part of the Clinical Research programme and is designed to allow students to put into practice the experience that they have acquired. Students are required to design a project and establish approval for their project in collaboration with the supervisory team. The module is designed to provide the first-hand experience of planning, designing and preparing a project by

[11] https://engineering.uoi.gr/en/
[12] http://medlab.cc.uoi.gr/
[13] https://www.ncl.ac.uk/medical-sciences/study/cpd/

allowing students to put into practice specific knowledge gained in the programme to-date helping them to develop a better understanding of clinical research and allowing them to utilize the portfolio of skills accrued so far.

Introduction to Practical Bioinformatics - This intensive two-day course aims to introduce scientists to the command-line interface and the R programming environment. It starts from the basics without assuming any prior knowledge. It introduces the Linux command-line, command-line BLAST and shell scripting and includes data handling in the R statistical programming environment.

3.2 Best practices of the selected EU education and research institutions

3.2.1 University of Cambridge

Biomedical engineering that operates within the **Department of Engineering**[14] organizes the set of seminars and workshops related to biomedical engineering. Some of them are as follows:

Seminars:

- Engineering for Clinical Practice
- Engineering for the Life Sciences
- Life Science Interface Seminars
- Physics of Medicine
- Cambridge Oncology
- Life Sciences

Workshops:

- First joint Engineering / Clinical School workshop - Covering design and planning, soft tissue, bone, elastography, skin and sensors and the heart
- Engineering / Clinical School workshop on Oncology - Covering imaging, the modelling of biological structure, radiotherapy and systems biology
- Joint workshop in Image Processing in Medicine - Covering topics such as morphology & heterogeneity, imaging mechanical properties, analyzing motion/change, and novel/enhanced imaging

3.2.2 Utrecht University

Utrecht University is internationally recognized university that implements fundamental and applied research across a wide range of academic fields. In order to stimulate excellence in research, development and innovation, Utrecht University provides support to its researchers in the area of funding, open science, research data management, IT, events and writing courses[15]. Each faculty has a Research Support Office that provides support in the following areas:

[14] http://www.eng.cam.ac.uk/
[15] https://www.uu.nl/en/research/research-at-utrecht-university

- Project and grant applications
- Contract negotiations
- Legal and financial affairs
- Project management
- Formation of consortiums
- Valorisation of research.

Utrecht University is offering a Master's program in Medical imaging. It is a strongly technology-oriented program in a clinical setting. The researchers have the opportunity to participate in different research projects and collaborate with international research groups and non-academic partners. The program is offered in collaboration between Image Sciences Institute and the Center for Image Sciences at UMC Utrecht and Eindhoven University of Technology[16].

3.2.3 Imperial College London

Research in the field of bioengineering is conducted within the Department of Bioengineering at the Faculty of Engineering. Their work includes the engineering of diagnostic and therapeutic technologies, orthopaedics and the musculoskeletal system more generally, neuroscience and neurotechnology, machine learning, bioelectronics, cancer research, biocompatible materials, regenerative medicine, cell mechanics and the cardiovascular system and synthetic biology. They have collaborated successfully with a range of companies across the world. In order to stimulate innovation, they have created a supportive impact environment. They are creating translation pathways to take devices to market, developing future medical device entrepreneurs through the MRes in Medical Device Design and Entrepreneurship and working in partnership with Imperial Innovations and colleagues across Imperial College London.

The Department has 8 spin-out companies and attracts seed and philanthropic funding. The £40M donation to create the BME research hub at the Imperial White City campus will revolutionise translational research.[17]

3.2.4 Karolinska Institute

The **Biofab**[18] facility offers a diverse range of micro and nanostructuring techniques for a wide scope of applications in the fields of life-science and medicine. The Biofab aims to bridge the gap between engineering and biology at Karolinska Institutet and to provide common grounds with respect to suitable material of use of modular design and tunable structures for biomedical purposes.

[16] https://www.uu.nl/masters/en/medical-imaging
[17] https://www.imperial.ac.uk/bioengineering/
[18] https://ki.se/en/fyfa/biofabrication-and-tissue-engineering-biofab-facility

3.2.5 LMU Munich

The **Faculty of Medicine and the University Hospital**[19] (with the Biomedical Center) and the Faculties of Chemistry and Pharmacy, and Biology are located on the Grosshadern/Martinsried Campus. This dense concentration of know-how in the life sciences is designed to facilitate the translation of new findings in basic research into practical therapies and other applications. The Medical Center in Grosshadern forms part of the Munich University Hospitals system, which includes the hospitals on the Sendlinger Tor Campus in the city center. Thus the Grosshadern Campus not only stands for cutting-edge research, but also for state-of-the-art, all-round medical care.

3.2.6 University of Helsinki

The **research team from Santos' Lab**[20] makes the unique bridge between medical engineering, pharmaceutical nanotechnology and biomedical research by combining unique techniques, such as microfluidic glass technology, to help to build innovative nanomedicines/nanovectors and multidrug loading. To design and test the functionality and efficacy of these nanomedicines, they use state-of-the-art nanotheranostic technologies for personalized medicine, which allow the precise engineering of materials at nanoscale to develop novel therapeutic formulations, including industrial scale-up validation, batch-to-batch reproducibility, and controllability of the nanomaterials' physicochemical properties for translation into the clinic.

3.2.7 Institute for Bioengineering of Catalonia

The Institute for Bioengineering of Catalonia[21] has provided the following courses in complementary skills for researchers:

Effective communication - Workshop focused to improve communication skill according to the different needs in the institution. Effective communication is a key interpersonal skill and the learning how researchers can improve their communication has many benefits.

Leadership and team management - Workshop focused on the heads of units and research groups about how to deal with the challenging situations derived from leading a team of people towards successful results. The content of the course includes: fulfil leadership role, build a productive and inspiring group culture, deal with conflicts constructively, delegate tasks more effectively, build and sustain the motivation of the group.

Writing Style in English - The workshop focused and designed for project managers and experienced researchers, aimed at improving style and effectiveness with the written word, with practical applications for research projects applications and scientific papers for journals.

Conference Presentations Skills Training - Workshop focused to improve competence and confidence in presenting in English at scientific conferences. This skills-based workshop combines presentation planning

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[19] https://www.lmu.de/en/about-lmu/lmu-at-a-glance/lmus-campuses/index.html
[20] https://www.helsinki.fi/en/researchgroups/nanomedicines-and-biomedical-engineering
[21] https://ibecbarcelona.eu/complementary-skills-training-for-researchers-at-all-career-stages/

with many opportunities to practice public speaking. This skills-based workshop combines presentation planning with many opportunities to practice public speaking.

Learning to write clearly - The workshop focused to help participants improve their writing skills through awareness of the elements of clear writing. Participants understand how they make their writing clearer and more effective by following a series of simple guidelines. The course has been designed for scientists who have some experience in science writing but want to take their skills to the next level.

Diversity and Cross-Cultural Awareness in Research - The workshop focused to perform mobility stays in other countries as part of their career, or are welcoming in their labs at people from other cultures, cross-cultural fertilization in research is a reality which requires an understanding of values, beliefs and expressions of people with different age, gender, race, religion, etc. The aim of this workshop is to raise awareness in the daily routine of working in an international research environment which is full of interactions with people from different cultural backgrounds. This working environment implies different perceptions of reality involving stereotypes, unwitting preconceptions or gender bias.

Guidance for women in their research career - Workshops focused on gender issues in research and innovation, the challenges facing women and how gender inequality can impact efficacy and research quality. The workshop includes talks from female researchers and invited talks, describing the challenges facing women research careers and how to improve the representation of women. The aim is to discuss the most appropriate and beneficial actions that can be taken to address the gender imbalance and the strategies that could be adopted.

Depending on the availability of interested researchers at the University of Kragujevac for specific courses, similar courses can be organized within task 8.2.

3.2.8 University of Groningen

MSc Biomedical Engineering[22] at the University of Groningen offers young people the opportunity to gain in-depth knowledge on a broad range of topics within health care and technology while working with state-of-the-art medical facilities.

What makes their MSc unique is the excellent cooperation with the University Medical Center Groningen and it covers three areas:

- Medical Imaging - focuses on the visualization of structures and processes within the human body. It ranges from the visualization of metabolic processes within a cell, up to the measurement of electrical activity in the cortex and radiation therapy.
- Medical Device Design - to restore body functions, research and design are performed on implants, artificial organs and prostheses.
- Biomaterials Science and Engineering - to realize a high-quality implant, the material must be biocompatible, which means that they are accepted by the body and do not evoke a rejection reaction. Interactions between body cells and biomaterials, therefore, are an important field of study.

[22] https://www.rug.nl/masters/biomedical-engineering/

3.2.9 Erasmus University Rotterdam

University College Student Representatives launch **Science of the Human Body**[23] as an online, open-access biomedical research journal and an initiative that links all University Colleges in the Netherlands.

The journal is being organized entirely by students from various colleges.

3.2.10 The University of Porto

The Unit for Multidisciplinary Research in Biomedicine (UMIB)[24] at the University of Porto mission is to conduct research applied to clinical medicine in order to accomplish scientific progress and innovation to improve human health.

UMIB key-resources include:

- Being based in one of the largest tertiary healthcare centres in Northern Portugal with accessibility to a large patient population;
- Having core laboratory facilities appropriate to achieve the research goals, including cell culture, microscopy, flow-cytometers and real-time thermocyclers;
- Having accumulated a broad spectrum of skills and expertise among the research team spanning from basic to clinical medicine that guarantees the use of different approaches to achieve a common objective, thus creating the basis for the establishment of Translational Research programs.

[23] https://www.eur.nl/en/news/launch-university-college-wide-biomedical-journal-science-human-body
[24] https://sigarra.up.pt/icbas/en/uni_geral.unidade_view?pv_unidade=37

4. Deviation from the work plan

The due date for the development of the D3.3 – Best practices for building the innovation capacity was M4 (January 31st, 2021). A number of SGABU project teams' members were affected by COVID 19 in December and January. Due to this situation, we had a delay in compiling the first draft of the deliverable. The responsible EU officers were informed about the situation during January.

5. Conclusions

The D3.3 Best practices for building the innovation capacity provides the base of the best practices identified by the project team both at the universities that constitute the partnership and universities outside the SGABU consortium that have been achieving excellent results in education and RDI activities in the field of Biomedical engineering.

The list of best practices provides only a summary of activities can be, completely or partially, applied at UKG or their methodology can be used to develop a new capacity building modules. The list is not exhaustive but it provides a sufficient number of different examples that UKG can assess and select the most suitable modalities to apply during the lifetime of SGABU project for the purpose of strengthening research capacities, modernization of existing facilities, establishing new BME centers and laboratories, attracting foreign students, as well as providing support to the activities of the International Projects Office.

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7) https://ki.se/en/fyfa/biofabrication-and-tissue-engineering-biofab-facility
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24) Smart Specialization Strategy of the Republic of Serbia