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BOOK OF ABSTRACTS

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1 3D Printed Models to Study Vascular Pathologies

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Additive manufacturing also called 3D printing is used in many different professions including medicine and pharmacology. Its application is raising and diversifying every year. The foundation for our 3D models was derived from CT scans of patients with arterial stenosis at the bifurcation of the internal carotid artery and brain aneurysms of the middle cerebral artery or internal carotid. We successfully tried two different 3D printing methods to create the models one using silicone casting and 3D printing with fused deposition modeling another direct printing using stereolithography. One of the goals was to study hemodynamic around carotid stenosis (atherosclerotic plaques) and rupture points of aneurysm as well as potential deposition of pharmaceutics. Further, we successfully grew in vitro vessels using a microfluidic approach.

The work has been supported by the Ministry of Health of the Czech Republic (grant No. NW24-08-00064 and grant No. NU22-08-00124).

2 In Vitro Models of Ischemic Stroke

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Stroke, the second leading cause of global mortality and morbidity, imposes substantial socioeconomic burdens. Ischemic stroke, accounting for about 87% of cases, primarily results from a brain artery occlusion by thromboembolic clots. Ischemic stroke management prioritizes recanalization through either intravenous thrombolysis or mechanical thrombectomy. The development of both approaches relies heavily on preclinical in vitro models. These models not only aid in catheter design and personnel training for mechanical thrombectomy but also serve as indispensable research tools for thrombolysis studies. A diverse range of in vitro models exists, from simple test tubes to advanced 3D structures mimicking patient vasculature, each offering unique insights into the complex dynamics between thrombolytics and occlusive clot structures.

This work has been supported by the Ministry of Health of the Czech Republic (grant No. NW24-08-00064).

3 New Approach for Preparation of Complex Hydroxyapatite Bioceramics

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The inverse precipitation route was adapted for the preparation of three hydroxyapatite powders with multi-cationic chemical composition. For the synthesis inorganic salt of Ca2+, Sr2+ and Ba2+ were used to obtain chemically pure substances. The phase composition of prepared powders was evaluated by X-ray powder diffraction analysis as well as Raman spectroscopy. Powders were used for preparation of composite bioceramics with predefined composition by mixing of individual powders followed by cold pressing and pressure-less sintering at 1200 °C for 1 hour. The microstructure of sintered multi-phase Ca,Sr,Ba-HP bioceramics was studied by Scanning Electron Microscopy and Energy Dispersive X-Ray Analysis. The cytotoxicity of samples was evaluated after 48 h of cultivation by lactate dehydrogenase (LDH) release assay. The 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay was used to analyze cell viability and the effect of material on cell growth. The results of cytotoxicity revealed no negative effect of the examined materials to the cells and their surroundings. Selected materials were investigated by cone beam computer tomography (CBCT) and revealed suitable radioopacity for both Sr and Ba containing multimaterials.

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4 Material Development for Bioceompatible Personalized Scaffolds Produced by Fused Deposition of Ceramics

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The practical implementation of additive manufacturing technology for ceramic and/or composite bone replacements requires thorough research into key components of the production process, material availability, and their impact on the quality of the final bone scaffolds or augmentations. Research activities at Department of Inorganic Materials Slovak University of Technology encompass the following: 1) Investigation of hydroxyapatite sintering behavior to achieve a microporous structure based on the composition of sintering ingredients. 2) Evaluation of cellular toxicity of prepared materials. 3) Assessment of biocolonization potential by specific cell types. 4) Design optimization of final bone replacements or augmentations suitable for dentistry. 5) Validation of replacement behavior in vitro and in vivo under biologically relevant conditions. Various sintering additives were incorporated during the blending process of hydroxyapatite into the composite. Addition of silicon dioxide as a sin-

tering additive minimally altered the mechanical properties of the filament, enabling the preparation of filaments with hydroxyapatite replacement at levels of 1% and 5% by weight. Scaffold shrinkage, observed under an optical microscope for one of the tested hydroxyapatite materials after sintering at 1300°C for one hour, revealed a linear shrinkage of 32.8%. However, the inclusion of silicon dioxide negatively impacted the proliferation of dental pulp stem cells, as determined by the MTT (3-(4,5-dimethylthyazole-2-yl)-2,5-diphenyltetrazolium bromide) test. Interestingly, the lactate dehydrogenase test did not indicate cell membrane deterioration, suggesting that the adverse effect of silicon dioxide must be considered in future material formulations.

Authors would like to thank Dr. Katarína Tomanová for SEM / EDX analysis. This work was supported by the Slovak Grant Agency for Science VEGA grant No. 1/0342/21, 1/0070/22 and Slovak Research and Development Agency under Contracts no. APVV-21-0173, APVV-16-0341 and PP-COVID-20-0025. This work was also created thanks to the support of the Operational Program Integrated infrastructure for the project: Advancing University Capacity and Competence in Research, Development and Innovation ("ACCORD") ITMS2014 +: 313021X329, co-financed by resources of the European Regional Development Fund.

5 The Use and Limitations of 3D Scaffolds in Tissue Engineering

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One of the key components in tissue engineering are scaffolds, which provide a structural support for the cells to grow and differentiate into functional tissues. 3D scaffolds provide a more realistic environment for the cells to grow and differentiate, as they can be designed to resemble the native tissue structure. This allows for better cell-cell and cell-matrix interactions, which are crucial for tissue regeneration. Although 3D scaffolds have shown great potential in tissue engineering, they also have some limitations. Among other things, the greatest danger is cell apoptosis inside the material, as the diffusion rate decreases with increasing material thickness and normal static cultivation is not sufficient to nourish the cells inside the material. This paper summarizes the possibilities of modifying the culture method or modifying the hydrogel itself based on our previous experience. Included are methods of dynamic culturing with application of physical stress to the cells, active perfusion, or modification of scaffolds with formation of channels for nutrient distribution.

6 Additive Manufacturing of Barium Titanate Ceramic Scaffolds

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Although hydroxyapatite ceramic is a topic very frequently studied for its potential applications in medicine, it is not the only viable alternative for ceramic implants. Multiple studies have been conducted to investigate the viability of Barium Titanate (BaTiO3) as a potential ceramic biomaterial with added value – the piezoelectric properties of barium titanate, used frequently in the field of electronics, can possibly also be used for enhancing the healing process in the human body. The concept of piezoelectricity induced osteogenesis has been investigated in multiple papers [1-3]. The use of additive manufacturing brings another

intriguing idea into the mix – the possible modification of the required shape for the implants in a way, that would allow the piezoelectric properties to be efficiently used, while at the same time to be able to tailor the desired shape of the implant for the individual need of a specific patient. In this study we investigate whether this approach can be efficiently used while not using specialized additive manufacturing devices worth multiple thousands of euros – instead our approach employs widely available commercial filament printers, which can be used to produce barium titanate scaffolds.

Authors would like to thank Dr. Katarína Tomanová for SEM / EDX analysis. This work was supported by the Slovak Grant Agency for Science VEGA grant No. 1/0342/21, 1/0070/22 and Slovak Research and Development Agency under Contracts no. APVV-21-0173, APVV-16-0341 and PP-COVID-20-0025. This work was also created thanks to the support of the Operational Program Integrated infrastructure for the project: Advancing University Capacity and Competence in Research, Development and Innovation ("ACCORD") ITMS2014 +: 313021X329, co-financed by resources of the European Regional Development Fund.

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7 Tissue Engineered Vascular Grafts – New Approach Utilizing Decellularized Tissues Modified with 3D Collagen and Stem Cell Bioprinting

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lacks suitable biomaterials especially for whole vessel bypass surgery and patch repair. Currently available grafts for bypass surgery possess many shortcomings – limited patency for small calibers, limited remodelation, risk of thrombosis. In this study we are aiming to prepare tissue engineered vascular grafts and patches based on decellularized and lyophilized matrices (pericardium and vessels) followed by recolonization with adipose derived stromal or Wharton's jelly stem cells. Acellular cadaveric donors or animal tissues serve as an abundant source of promising biomaterials. However, theses tissues need to be decellularized to minimize immunogenic response and then processed for minimize thrombogenicity and improve healing and remodelation process. Decellularization was held in our custom build automated system. This system allows cyclic change of decellularization agents (SDS, sodium deoxycholate, DNAse and benzoase), and cleaning water maintaining reproducible process. This process including agents concentrations, time of cycles and their repetitions was optimized based on residual DNA in tissue and structural and biomechanical properties. Depending on tissue (tubular and planar) special chambers were used to maintain homogenous contact with agents and complete decellularization [1]. Recellularization with stromal and stem cells has been adopted to improve vascular remodeling in vivo. The seeded cells attract the ingrowing host cells through a paracrine mechanism. Then they tend to suppress the formation of intimal hyperplasia facilitating remodeleation of the seeded graft into a neo-vessel. To ensure homogenous recolonization of prepared substrates the 3D bioprinting and microextrusion method was utilized. Planar tissues were recolonized using 3D bioprinting method using porcine collagen

with incorporated cells. For coating inner lumen of tubular tissue microextrusion method was created utilizing special microcanulas. These microcanulas contains evenly spaced microchanels where collagen with cells was extruded, leaving inner lumen homogenously coated. Prepared substrates were then cultivated in perfusion bioreactors with pressure stimulation promoting cell proliferation and ingrowing into decellularized tissues [2, 3]. Prepared planar patches and tubular graft were then implanted into pigs for one month observation. Cell recolonized replacements accelerated remodelation and substrate resorption. WJCs also have immunomodulatory properties [1].

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8 Collagen Applications: Focusing on The Mechanical and Structural Constraints

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Collagen, a unique natural polymer with a complex hierarchical structure and outstanding properties, is widely used in the field of clinical medicine in connection with both hard and soft tissue applications, but also in other fields such as the food and cosmetic industries. The presentation summarizes examples of several specific applications of collagen in various fields, especially medicine, but also in the food industry, namely the development of a biomimetic vascular replacement for low flow allowing physiological pulse wave transmission, the development of a biodegradable nanostructured electrospun composite layer for the treatment of implant-associated infections and improvements with respect to the rate of osseointegration, the development of tissue engineering scaffolds for the treatment of bone injuries, and finally the evaluation of collagen gels for co-extrusion of sausage casing. The presentation focuses particularly on the processing and modification of collagen type I with respect to its biological character and mechanical properties. It suggests several ways in which the most common problems related to the isolation, handling, electrospinning, and crosslinking of collagen can be overcome while maintaining its native character.

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9 Modelling Adverse Effects After Radiotherapy in the Head and Neck Region – A Case Study

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Linear-quadratic and Lyman-Kutcher-Burman models represent mathematical models that can be employed to predict dose-dependent adverse effects after radiation therapy. The aim of this case study was to calculate values of Normal Tissue Complication Probability for a patient with head and neck squamous cell carcinoma after radiation therapy and retrospectively compare the predictions with late adverse effects that had developed in the patient. The radiation treatment was delivered on a linear accelerator with use of volumetric modulated arc therapy using 6 MeV photon beams. Late adverse effects in parotid glands, thyroid gland and spinal cord were evaluated. The results showed that radiation therapy for the head and neck carcinoma can cause serious late adverse effects. Recognising and treatment of these late side effects can improve the patients' quality of life. Calculated mathematical predictions can be helpful in assessing the treatment plan regarding potential late complications. However, because of their statistical value, these predictions should be used with caution.

10 Dimensional Stability and Printing Precision of 3D Bioprinted Non-methacrylated Collagen Based Scaffolds

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High-concentrated collagen hydrogels have shown great potential in tissue engineering applications due to their natural abundance in the extracellular matrix of many tissues and their biocompatibility. Collagen modified with methacrylate groups achieves better mechanical stability. Also, they allow better control over the crosslinking process and precise printing. Limitation is increased phototoxicity caused by the addition of photoactivators. The alternative can be a lyophilized type I collagen reconstituted in acetic acid. The gelation process can be activated by changing pH and temperature. However, more control over the process is needed to achieve a stable and precise substrate. The quality of the printed bioink shape and resulting structure is affected by various parameters. First, it is a composition of collagen, its concentration, the state of neutralization, and the temperature of processing and printing. However, these parameters can be utilized prior to printing but cannot be altered. Secondly, parameters such as nozzle diameter, feedrate, Z-axis height between layers, and amount of extruded ink affect the resulting process and can be modified even between layers with a multi-extruder setup. Also, these parameters affect incorporated cell culture and can promote cell proliferation or differentiation. The correct printer setup for printing different shapes from the bioink should ideally be such that the resulting printout is of high quality, according to the prepared model. The bioink should be extruded accurately in all parts and should not spill too much sideways with optimal overlapping of layers. Due to the nature of collagen gel and its viscosity, it is complicated to utilize methods used in a filament-based printers like retraction, bridging etc. and must be utilized with modified extrusion volume or speeds in pathways [1]. In this study, we used 3 types of nozzles for printing bioink, each with different diameters (0,6 mm, 1,0 mm, and 1,3 mm), and tried to print different geometric shapes (U-shapes and grids with different gap sizes 1, 2, and 3 mm). For each nozzle, we set the Z height and the amount of ink printed, then gradually reduced both variables to 75%, 50% and

25% of the original size, and at the same time, we tested how much the feedrate affects the print quality. Prints were made with 30 mg/ml collagen optimally neutralized with and without porcine stromal cells. Modified Cellink Inkredible+ bioprinted with a custom screw-driven extruder was used [2]. To visualize and evaluate printed paths of bioink, a 10 µM fluorescein disodium salt was added to the bioink, and printed patterns were scanned using fluorescence microscopy with optical density evaluation. A lower initial Z level tends to create precise prints with minimal overspill; however, it has limitations with the possibility of drying up and changing the properties of the gel. In this case, faster feedrates and a humidified atmosphere should be utilized. Higher Z levels are more prone to spilling and overlapping layers, resulting in worse overall quality. Also, larger extruded volumes generate artifacts due to the nature of the screw-driven extruder and need an adjusted dosing rate over the pathway caused by expanding volume due to the high viscosity of the gel. Grid-based patterns in crossing layers were spilling, creating rounded corners. These can be affected by lowering the dosing volume over the pathway with a combination of screw-driven extruders.

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11 Innovative Teaching Methods

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Innovative teaching methods are the main factors in modernizing medical education and training of medical students for a successful career in the dynamic environment of modern medicine. The implementation of these methods will have many advantages for students, such as increased involvement, the development of critical thinking, better preparation for clinical practice, and the flexibility of education. Thus, investment in innovative teaching methods is an investment in the future of medicine and quality patient care. The search, adaptation and use of motivation strategies, forms and means to promote the teaching of the theoretical and practical courses in natural sciences at the medical faculties, a requisite for the improved application of the knowledge gained by graduates in medical practice and the effectiveness of the connections between theory and practice by coordinating the horizontal and vertical content of the course of science with pre-clinical and clinical courses. We try to modernize the compulsory subject "Medical Biophysics" and the compulsory and optional courses at the first and second levels of university education related to medical biophysics and medical physics.

• Implementation of innovative teaching methods such as TBL (Team-Based Learning) and PBL (Problem-Based Learning) in the subject of medical biophysics. These courses should focus on key topics such as the biological principles of ultrasound diagnosis, the function of the cardiovascular system, the activity of the heart, and the effects of electromagnetic radiation on the human body. Creation of online brochures of innovative methods for teachers and students.

• Use the MOODLE platform for testing and evaluating students' ongoing readiness for TBL and PBL lessons. This will enable effective monitoring of their knowledge and understanding of the subject.

• To implement a comprehensive evaluation of the contribution of TBL and PBL methods based on the analysis of the study results of Slovak and foreign students. The obtained data will serve to optimize the teaching process and make the teaching

of the medical biophysics subject more efficient.
• Design and implement the so-called "escape rooms" as an interactive educational activity focusing on the key topics of the medical biophysics subject. These "escape rooms" should allow students to deepen their knowledge and practice solving problems in a fun and interactive way.
• To support the active participation of students in teaching by assigning the task of creating the so-called mental (memory) maps from individual thematic units of the subject with an emphasis on applications in medicine. Creating mind maps will help students better structure information and make it easier for them to remember key concepts.
We believe that a comprehensive modernization of the teaching of the subjects "Medical Biophysics" and related disciplines will increase the quality and efficiency of the teaching, improve the knowledge and skills of students in the fields of medical biophysics and medical physics, strengthen their critical thinking, problem solving and teamwork, increase the attractiveness of these subjects to students, and improve the preparation of students for medical practice.

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12 Cybersecurity in Healthcare – Challenges Hospitals Are Facing not only in The Czech Republic

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The paper focuses on specific problems of IT protection in healthcare facilities. Today's healthcare facilities of all sizes depend to varying degree on the use of IT. Especially large hospitals, where there are tens or hundreds of different medical devices, instruments, etc., have to protect these devices as well. Often the supplier will supply the equipment as a 'black box', the maintenance is handled by the company that manufactured the equipment, and it is not clearly documented how the device behaves in the hospital's IT system. Another specificity is that some equipment cannot be switched off, repaired, etc., because health and human lives depend on its operation, for example after a transplant. Furthermore, there is of course a lot of not only personal, but also very sensitive data in any hospital (and even more so in a larger one). Thus, one can say, that the (not) security of a hospital is close to the (not) security of an industrial facility. These have received a lot of attention lately, but the healthcare still stands somewhat out of interest.

13 Electric Stimulation of Non-excitable Cells

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This paper presents our experimental setup for the electric stimulation of cells. First, the electrophysiology of non-excitable cells and its importance is explained. Then we summarize the currently used approaches in cell electrostimulation. Later we describe our currently used setup, the results of preliminary experiments and the reasons, why we find this setup inadequate. We also point out the issues with cell stimulation research as a whole. This leads to the presentation of the next generation of the experimental setup, based on the PCB (printed circuit board) technology. In the end, we support our development and experiments with FEM models of the electric field.

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14 Wireless Monitoring of Basic Vital Signs Using IP Camera

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The necessity of non-contact monitoring of vital functions is increasingly recognized in the field of medical technology. Recent studies have demonstrated the importance of such methodologies and advocate for continued research into non-contact monitoring systems Within this work, three systems for wireless monitoring of respiratory and heart rates were designed. The best solution selected utilizes Eulerian Video Magnification (EVM) and an IP camera to capture subtle physiological changes from a distance. A block diagram of the system architecture was constructed, and the algorithm was programmed in Python, effectively implementing the design. The system's accuracy was tested on a group of volunteers, with results confirming decent accuracy and a promising outlook for the system. Although further development is crucial for improving its performance and usability, the results suggest that non-contact monitoring is a viable and valuable approach for the future of patient care and medical surveillance. This system represents a significant step forward and lays the groundwork for potential enhancements that could expand its use in clinical settings and home care.

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15 Design of a Remote Patient Health Monitoring System Using Arduino with Connection and Data Exchange via Bluetooth

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Remote monitoring of health parameters has become increasingly crucial in modern healthcare. This study explores the integration of Arduino and Bluetooth technology to develop a cost-effective and accessible solution for continuous patient temperature monitoring. The system utilizes an Arduino Nano board, a KY-013 analog temperature sensor, and an HC-06 Bluetooth module to measure and transmit temperature data wirelessly to a mobile device. The Arduino Nano's versatility and Bluetooth's simplicity enable real-time data transmission, facilitating prompt medical interventions. Despite challenges such as limited range and environmental interference, the project demonstrates several advantages, including remote monitoring, early detection of illnesses, user-friendliness, affordability, and customizability. However, concerns regarding data security and dependency on mobile devices need to be addressed. Overall, this study presents a promising solution for remote patient monitoring, with potential for further refinement and adaptation to emerging healthcare trends.

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16 Improved Systolic Peak Detection in Photoplethysmography Signals: Focus on Atrial Fibrillation

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Photoplethysmography (PPG) is widely recog-

nized non-invasive optical technique for monitoring blood volume changes. Recently, PPG signals have gained prominence in healthcare applications, including the detection of cardiac arrhythmias. Cardiac arrhythmias represent a significant global health challenge, with particular focus on identifying atrial fibrillation (AF), the most prevalent type. Accurate detection of systolic peaks in PPG signals is crucial for arrhythmia detection and for other applications such as heart rate estimation and heart rate variability analysis. Despite the high accuracy of existing beat detection methods in healthy subjects, the performance in the presence of cardiac arrhythmias is lower. This study employs a deep learning method to enhance the detection of systolic peaks in PPG signals, even in the presence of AF. The model was trained on a dataset comprising 2,477 10-second PPG segments with over 37,000 annotated PPG peaks, including data from AF patients. Our model achieved an F1 score of 97.3 % on the test dataset and F1 score of 94.8 % on the test dataset when considering only AF patients.

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17 Comparison of Production Technologies of Provisional Dental Replacements

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The aim of the work is to choose the most suitable technology to produce temporary dentures. The selected manufacturing technologies were stereolithography (SLA), Digital Light Processing (DLP) and CNC milling. The temporary dentures produced were in the form of crowns and bridges. The total number of manufactured prostheses was n = 30. Accuracy scanning of the manufactured dental prostheses was performed on a 3D scanner S900 Arti (Zirkonzahn, Italy). Analysis of the accuracy of the fabricated crowns and bridges was performed in the GOM Inspect software (Zeiss, Germany). The results show that the SLA technology has smallest deviations from the compared technologies in terms of the production of bridges and crowns. The worst achieved results in terms of accuracy were recorded with CNC milling technology.

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18 Creation of a Cochlea Model with Implemented Electronics for Cochlear Implantation

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Cochlear implantation is a key treatment method for patients with profound neurosensory hearing loss, enabling them to regain or restore their hearing and significantly improve their quality of life. This work focuses on the creation of a functional cochlea model with integrated electronics to simulate cochlear implantation and verify the correctness of electrode insertion. The model includes reflective optocouplers, LEDs and an LCD display for monitoring and displaying important indicators. The electronic model of the cochlea is equipped with an Arduino Nano development board and a program written in C++ that provides detection and measurement during electrode insertion. Testing of the model confirmed its functionality and contributed to a better understand-

ing of the anatomy of the ear and the hearing process. The developed model will introduce medical students to cochlear implantation in practice, giving them an idea of the difficulty and accuracy of this surgical procedure.

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19 Use of 3D Scanning in Burn Analysis and Identification: Methodology and Case Studies

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This article discusses the use of 3D scanning to determine the area and extent of burns. The study involved a comparison of twelve burns in six subjects using two software. The article deals with the methodology of scanning burns, and subsequently describes in detail the methodology of determining the area of burns from a 3D scan. Methodologies for burn scanning and determining burn area from 3D scans were detailed, emphasizing the innovation's potential in surpassing traditional assessment methods like the Rule of nine and Palm method estimation. Collaboration with clinicians facilitated data collection and patient monitoring. Twelve burns were scanned at least twice, allowing comparison of the burn area before and after a certain period of healing. This approach enables the use of 3D scans to determine individual treatment according to the progression of healing, and at the same time opens up the possibilities of using 3D scans to model burn orthoses.

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20 In Vitro Analysis of Biocompatibility using Mesenchymal Stem Cells

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In vitro assessment of biocompatibility plays a pivotal role in the development and evaluation of biomedical materials and devices. This study focuses on employing mesenchymal stem cells (MSCs) in conjunction with the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay and Enzyme Linked Immunosorbent Assay (ELISA) kits as a comprehensive approach for biocompatibility analysis. MSCs, with their multilineage differentiation potential and immunomodulatory properties, serve as an ideal model system for mimicking cellular responses to biomaterials. The MTT assay and ELISA provide quantitative data essential for evaluating cytotoxic effects. In this work we describe both MTT and ELISA analysis in regard to biocompatibility assessment of various biomaterials used in regenerative medicine.

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21 Facial Burn Mask Design and Manufacturing Workflows

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Hypertrophic scarring remains a significant concern for burn patients, particularly those with facial injuries, often leading to physical discomfort and psychological distress. Non-surgical interventions such as pressure therapy and silicone application have shown efficacy in scar management. This article reviews the application of innovative methods and technologies, including 3D scanning, CAD modeling, and additive manufacturing, in the development of personalized Pressure Garments (PG) and Transparent Facial Orthoses (TFO) for scar treatment. Three methods of TFO fabrication—traditional, hybrid, and innovative—are explored, highlighting advancements in customization and efficiency. Additionally, finite element analysis (FEA) is discussed as a tool for optimizing TFO design. Case studies demonstrate the effectiveness of these approaches in enhancing scar rehabilitation and patient outcomes. While promising, further research is needed to refine digital manufacturing processes and optimize treatment efficacy.

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22 Comparison of Blood Pressure Measurement Methods and Mean Arterial Pressure Determination Methods

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Blood pressure is an important indicator of overall health and can be affected by a variety of factors. This article describes a commercial module NIBP 2020 UP. Additionally, compares the accuracy and reliability of the different blood pressure measurement methods offered by the module. Furthermore, we use the least-squares approximation method to derive a mathematical formula to calculate mean arterial pressure (MAP). We then compared the accuracy of the linear and quadratic models in predicting the MAP values. We also performed a comparative analysis between our formulas and the widely used formulas in clinical practice.

23 Detecting Robotic Assistant: Analyzing Sensoric Floor Data Patterns

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As smart home systems become increasingly prevalent, the integration of robotic assistants into domestic environments is gaining traction. Smart sensor floor detectors, primarily used for fall detection, offer the potential to monitor movements within the home. However, existing detection algorithms often lack the capability to differentiate between human and non-human activity, necessitating the refinement of large-scale sensor algorithms. In this article, we propose a method to augment robotic assistant data by introducing additional sensitive materials. We conduct experiments to test various detector configurations and demonstrate improved robotic assistant detection. Our work contributes to advancing the role of robotic assistants in smart home environments.

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24 Charting The Waters of Digital Security: Implementing NIS2 Dierctive in Healthcare and its Challenges in The Czech Republic

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Information technology has become an integral part of everyday life and industries over the last twenty years. Massive digitisation and data collection have led to data itself becoming a strategic resource that needs to be protected from misuse. The new NIS Directive2 addresses the issue of cyber security, bringing enhanced specifications and regulations in the field of cyber security for economic operators operating in the EU. The aim of this article is to present the basic requirements for the specific environment of the healthcare sector, which is partly overlooked in the professional debate and not given enough attention, even though it is one of the most important sectors in terms of the functioning of society. The article summarises the requirements that the Directive places on the healthcare sector and the state of preparedness of the Czech healthcare sector for the Directive. The article concludes the directive is a very important step in ensuring good cyber security practice across EU member states and is a good cornerstone for future expansion, while also pointing out the situation in the Czech Republic is currently deficient.

25 Advanced Phase Analysis of Retinal Videos Using ECG

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Spectral analysis is one way to further explore retinal hemodynamics and vascular pulsation. Specifically, for the phase component of the spectrum of retinal videos, the importance in retinal analysis is not yet fully defined. In this work, we discuss a methodology for advanced spectral phase analysis of retinal videos from healthy subjects. Using electrocardiographic signals that were simultaneously recorded, we perform normalization by individual cardiac cycles. We measured the left eye of 13 healthy individuals and determined whether spectral phase analysis is relevant within the cardiac cycle using the principle of photoplethysmography. Possible future applications were also explored, focusing on the detection of pathologies in the vascular system of the head and the potential classification of vessels in the optic nerve head (arteries and veins).

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26 Modelling The Long-Term Impacts and Costs of Diabetes Mellitus on Peripherial Artery Disease

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The prevalence of peripheral artery disease (PAD) escalates with age, affecting a notable segment of the population with a high proportion remaining asymptomatic. These asymptomatic patients, particularly those with diabetes mellitus (DM), are at an increased risk for cardiovascular events and related morbidity. The aim of the study was to evaluate the impact of DM on PAD, focusing on the femoral region. The study was structured to modify an existing discrete event simulation (DES) model based on a literature analysis. Utilizing a DES model, this study captures lifetime costs and effects from the healthcare payer's perspective, using quality-adjusted life year (QALY) as the primary outcome measure. The DES approach permits a granular analysis of disease progression, encompassing the development from asymptomatic states through to more severe manifestations such as intermittent claudication, critical limb ischemia, and even limb amputation, which are substantially influenced by the presence of DM. The findings illustrate that while patients without DM demand higher healthcare resources over a lifetime horizon, the pres-

ence of DM accelerates disease progression, leading to earlier onset of severe symptoms and interventions. Despite more annual spending on diabetic patients, the aggregate costs are lower due to earlier mortality.

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27 R-Wave Peak Times Displayed in Body Surface Isochrone Maps of Young Men

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In standard 12-lead electrocardiography, the peak time or intrinsicoid deflection is defined as the activation time of the ventricular muscle lying under the exploratory electrode. It serves as an easy measurable parameter used in the diagnosis of cardiac diseases related to disturbed or delayed ventricular activation. Body surface isochrone maps of R wave peak time were constructed and analysed in 13 healthy young men. The activation was found to start always on the anterior chest surface and mainly in its upper half. It mainly ended in the back chest, mainly in its upper half, and around the right shoulder. This agrees with previously published results of mean maps, also in older controls obtained from different mapping lead systems. The R wave peak times obtained from our maps also agreed with known intrinsicoid deflections for the standard leads V5 and V6, published previously.

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28 Method Comparison for Bone Density in Multiple Myeloma Patients

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This study conducts a comparative analysis of three methodologies for quantifying bone mineral density in the vertebral regions of patients diagnosed with multiple myeloma and exhibiting lytic lesions in the spinal column. Initial observations reveal marginal discrepancies between method 1 and method 2, both demonstrating susceptibility to noise artifacts. Conversely, method 3 showcases smoother outcomes and, on average, registers elevated values in computed BMD. The forthcoming pursuit of objectively assessing algorithmic precision will entail juxtaposing outcomes against a calibration phantom in subsequent investigations.

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29 Unlocking Genetic Prognostication: Cage App – Computer-Aided Approach for Genomics Prediction

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Advanced sequencing techniques have propelled molecular biology research into what is often termed the post-genomic era. Consequently, there's a heightened focus on unraveling the functional connections between individual genes and their ultimate phenotypic expression. This newly

developed app, designed within Matlab2023b App Designer, holds significant promise for opening new and optimal pathways in predictive genomics. We developed user-friendly app for uploading genomics (in form single nucleotide polymorphisms (SNPs)), metabolomics and phenotype data, their visualization and subsequently prediction analysis using different methods such as linear, non-linear and also deep learning for genomic prediction and calculated polygenic risk score and GWAS with visualization which is implemented in Matlab2022b.

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30 Modeling of Ventricular Activation in a PVC Patient Using a Reaction-Diffusion Model

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Premature ventricular contractions (PVCs) represent a form of cardiac arrhythmia characterized by early depolarization of the ventricular myocardium, leading to an interruption in the regular cardiac rhythm. This study focuses on modeling of the ventricular activation and the associated electrocardiographic body surface potentials (BSPs) in a 17-year-old athlete with frequent PVCs. Using the patient-specific model of heart and torso geometry and a bidomain reaction-diffusion (RD) model of the ventricular activation, we simulated the ECG signals in 128 chest leads as well as in standard 12 leads and in 3 standard limb leads during PVC. These simulated data showed a high correlation with measured data in the same 3 lead sets. For data obtained by the bidomain RD model, the correlations were 0.81, 0.89, and 0.90. These results were also compared with data obtained by previously used cellular automaton (CA) model where the correlation with the measured ECG data in the same three lead sets were 0.86, 0.93, and 0.94. The most significant differences between simulated and measured data were observed in the central and right anterior regions on the torso. These differences are likely due to the relative simplicity of the activation model and assumptions of the heart and torso homogeneity. The similarity between measured BSP during PVC and simulated BSP resulting from ventricular activation started near the invasively determined PVC focus supports the idea that non-invasive localization of the ectopic focus could also be feasible using computational modeling.

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31 Optimalization of 3D Bioprinting of Highly Concentrated Collagen Bioinks in Tissue Engineering Applications

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In the field of tissue engineering, collagen hydrogels play a crucial role as they serve as biomimetic scaffolds, closely resembling the natural extracellular matrix and providing an ideal, biocompatible environment for cells and their adhesion. By carefully controlling the properties of the collagen bioink, including factors like pH and rheology across batches, and then cultivation processes, in-

cluding active perfusion, we aim to enhance the overall performance of bioprinted samples. In this study, we have focused on two main fields – an optimized method for neutralizing collagen hydrogel and the impact of active perfusion. The first part formulates a method based on two successive neutralizations of the collagen hydrogel using the 2× enhanced culture medium and an addition of NaOH for pH adjustment. For the preparation of the bioink, an automated custom-built mixing system with colorimetric pH estimation was used [1]. Secondly, we focused on investigating the impact of active media perfusion on cell viability, morphology, and metabolic activity within highly concentrated bioprinted collagen hydrogels in contrast with static cultivation. The results showed that the cell viability has significantly increased in bioprinted samples with active culture media perfusion, as well as their metabolic activity. The findings from this study could pave the way for more effective tissue engineering strategies and regenerative medicine applications [2].

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32 Wavelength and Crosslinker Effects on Gelatin Methacrylate Hydrogel Photopolymerization

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Hydrogels based on gelatin methacrylate (Gel-MA) have garnered significant attention in tissue engineering and regenerative medicine due to their excellent biocompatibility and tunable properties. However, Gel-MA alone does not form a hydrogel, necessitating the use of different crosslinkers. Photopolymerization is one method utilized to create a rigid structure. In this experiment, we investigated the influence of 370 nm and 405 nm wavelengths on hydrogel curing time using various concentrations of 2-Hydroxy-4'-(2-hydroxyethoxy)-2-methylpropiophenone (I2959) and lithiumphenyl-2,4,6-trimethylbenzoylphosphinate (LAP). Different concentrations of I2959 (0.05%, 0.2%, 0.5%, and 1% w/v) and LAP (0.05%, and 1% w/v) were added to the Gel-MA solution to form hydrogels. Curing was carried out using UV light sources emitting at 370 nm and 405 nm, with exposure times ranging from 5 seconds to 15 minutes. All hydrogels prepared with different concentrations of I2959, and LAP successfully cured under 370 nm UV light. The fastest curing time achieved with I2959 was 3 minutes, whereas LAP demonstrated more efficient curing with a shorter exposure time of 5 seconds. In contrast, under 405 nm UV light, I2959 failed to achieve successful curing, while LAP showed poor results. Spectrophotometric analysis of both curing agents supported these findings.

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33 Optimalization on 3D Tissue Scaffold Perfusion

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Dynamic cultivation is the process of growing and cultivating cells or tissues under mechanical forces, fluid flow, electrical stimuli or other physical and chemical stimuli, which mimic conditions in vivo and provide a more realistic environment for the cells to grow and develop. The cultivation occurs within bioreactors, devices or systems that provide a controlled environment for the growth of microorganisms, cells, or tissues, and culture chambers, where cell development takes place. Dynamic cultivation has been found to have beneficial effects on cell modulation, growth, and gene expression, and actually it is widely used in tissue engineering and regenerative medicine research. This study aims to develop and assess a pressure wave-controlled perfusion system that can stimulate both planar and tubular tissues within a culture chamber. The system is able to deliver a range of flow rates. The designed system features two large-volume cartridges that alternately fill with culture medium. The system is controlled by set of pressure-controlled diaphragm valves, phototransistors and Arduino platform. The assembled system was validated in laboratory environment and later was used in a culture experiment with 3D bioprinted tissue carriers.

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34 Decellularization of Tissues of Cadaverous Donors for Cardiovascular Replacements

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Decellularization is essential method used also for tissue replacement and 3D bioprinting, as it allows us to obtain the extracellular matrix (ECM) that can be further used as the scaffold for artificial tissue structures. The decellularization process typically involves the use of detergents, enzymes, or other methods to break down and remove the cells while preserving the structural and functional properties of the ECM. The goal is to eliminate cellular and nuclear material while retaining the tissue's native architecture and bioactive molecules. Various techniques and protocols are used for tissue decellularization, but there is currently no established standard process for evaluating the obtained ECM, The effectiveness of the process is often assessed by evaluating the removal of cellular material, preservation of ECM structure, and the biocompatibility of the resulting acellular matrix. In the our study, we investigated the decellularization of two types of tissues (human saphena magna and porcine vena jugularis) in two different states (native and lyophilized). To verify the physical properties, the tissues were tested for tensile strength and for the quality of residual DNA removal, the tissues were stained with DAPI after decellularization.

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35 Design of Measurement of Cells in a Perfusion Bioreactor Using a Microcomputer

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This article presents a design for a microcomputer-based system to measure cell concentration in real-time within a perfusion bioreactor. The system utilizes an Arduino UNO for data acquisition from various sensors, including temperature, pH, and potentially CO2 and dissolved oxygen. Software modules process the sensor data and interpret cell concentration trends. This automated and cost-effective approach allows for optimal cell culture through real-time monitoring and potential control of perfusion parameters. While theoretical analysis suggests promise, further experimentation is required for comprehensive understanding and optimization, focusing on precise cell concentration measurement, perfusion parameter impact, long-term stability, and validation across diverse bioreactors.

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