TÜBİTAK

KOCAELİ UNIVERSITY 1992

BIOMATERIALS AND TISSUE ENGINEERING SOCIETY

BIOMED 2024

28TH INTERNATIONAL BIOMEDICAL SCIENCE & TECHNOLOGY SYMPOSIUM

1-3 NOVEMBER 2024

Kocaeli University Kartepe Park Hotel
Kartepe-Kocaeli- TURKEY

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Recent Developments in
Biomedical Science and Technology

BIOMED 2024
PROCEEDINGS BOOK

The Abstracts of the 28th International Biomedical Science and Technology Symposium

Editor

Nermin DEMİRKOL

Biomaterials and Tissue Engineering Society Publications: 03
Biyomalzeme ve Doku Mühendisliği Derneği Yayınları: 03 Ankara, Türkiye

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The Abstracts of the 28th International Biomedical Science and Technology Symposium

01-03 November 2024, Kocaeli University Kartepe Park Otel, Kocaeli, Türkiye

Edited by

Nermin DEMİRKOL

Kocaeli University, Kocaeli, Türkiye

Biomaterials and Tissue Engineering Society

(Biyomalzeme ve Doku Mühendisliği Derneği) Ankara, Türkiye 2024

BİYOMALZEME VE DOKU MÜHENDİSLİĞİ DERNEĞİ YAYINLARI: **03**

Biomaterials and Tissue Engineering Society (Türkiye) Publications: 03

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BİYOMALZEME VE DOKU MÜHENDİSLİĞİ DERNEĞİ

(Biomaterials and Tissue Engineering Society)

Ankara, Türkiye

https://www.biyomalzeme.org.tr/

PREFACE

Dear Colleagues,

The 28th International Biomedical Science and Technology Symposium (BIOMED 2024) was held at Kocaeli University Kartepe Park Hotel on 01-03 November. The symposium, which was chaired by me and honorary chairman of Kocaeli University Rector Prof.Dr. Nuh Zafer Cantürk, was successfully completed in cooperation with Kocaeli University and Biomaterials and Tissue Engineering Society. In the symposium, there were 5 plenary speakers and 9 invited speakers with worldwide competence in the biomedical field, and a total of 92 presentations were made with 36 oral presentations and 42 poster presentations. At the symposium, scientists conducting both basic and applied research in the fields of biomaterials, tissue engineering and regenerative medicine, medical device sector representatives and biomedical material company representatives exchanged ideas and established new collaborations. Within the scope of the event, the top three poster presenters of our participants who made poster presentations were awarded. I would like to express my sincere thanks to all our sponsors, participants and everyone who contributed to the successful realisation of this event. Hope to see you again at the next Biomed Symposiums.

Kind Regards.

Nermin Demirkol, Editor
Chair, BIOMED 2024
Assoc.Prof.Dr., Kocaeli University, Kocaeli, Türkiye.
Board Member, Biomaterials and Tissue Engineering Society, Ankara, Türkiye.

BIOMED's			Date	Place	Organizer	Chair
28	BIOMED 2024	International	01-03 Nov.2024	Kartepe,Kocaeli	Kocaeli U.	Nermin DEMİRKOL
27	BIOMED 2023	National	20-22 Oct. 2023	Aliağa, İzmir	Ege U. Bioengineering	Aylin ŞENDEMİR
26	BIOMED 2022	International	25-27 Nov. 2022	Ankara (online)	Elcinlab / Ankara U.	Y. Murat ELÇİN
25	BIOMED 2021	National	18-19 Dec. 2021	Ankara (online)	BTES	BTES Board
24	BIOMED 2019	International	17-20 Oct. 2019	Çeşme, İzmir	Hacettepe U. Pharrnacy	Kezban ULUBAYRAM
23	BIOMED 2018	National	15-16 Dec. 2018	İstanbul	Acıbadem U. / METU Biomaten	Vasıf HASIRCI, Nesrin HASIRCI
22	BIOMED 2017	International	12-14 May. 2017	Ankara	ElcinLab / Biovalda	Y. Murat ELÇİN
21	BIOMED 2015	International	22-24 Oct. 2015	Kemer, Antalya	METU Biomaten	Vasıf HASIRCI
20	BIOMED 2014	International	24-27 Aug. 2014	Köyceğiz, Muğla	Biyomedtek / Hacettepe U.	Erhan PİŞKİN
19	BIOMED 2013	International	12-15 Nov. 2013	Kuşadası, Aydın	Ege U. Bioengineering	İsmet DELİLOĞLU-GÜRHAN
18	BIOMED 2012	National	10-13 Sep. 2012	Tokat	GOP U. / Hacettepe U.	Erhan PİŞKİN (LO: S. EĞRİ)
17	BIOMED 2011	International	23-25 Nov. 2011	Ankara	ElcinLab / Ankara U.	Y. Murat ELÇİN
16	BIOMED 2010	International	29 Sep.–2 Oct. 2010	İstanbul	Hacettepe U.	Erhan PİŞKİN
15	BIOMED 2009	International	16-19 Aug. 2009	Güzelyurt, KKTC	METU / METU KKK	Vasıf HASIRCI (LO: E. ONURHAN)
14	BIOMED 2008	International	3-5 May 2008	Ortaca, Muğla	Muğla U. / Hacettepe U.	Hakan AYHAN
13	BIOMED 2007	International	26-28 Aug. 2007	İstanbul	Yeditepe U. / METU	Vasıf HASIRCI (LO: G. KÖSE)
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5	BIOMED 1998	National	16-18 Dec. 1998	Ankara	METU	Nesrin HASIRCI
4	BIOMED 1997	International	15-17 Sep. 1997	İstanbul	Hacettepe U. Pharmacy	Atilla HINCAL, Süheyla KAŞ
3	BIOMED 1996	National	11-14 Dec. 1996	Uludağ, Bursa	Uludağ U./Hacettepe U.	Erhan PİŞKİN (LO: Y. ULCAY)
2	BIOMED 1995	National	21-23 Sep. 1995	Ankara	METU	Vasıf HASIRCI
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SCIENTIFIC PROGRAM

Oral Presentations

BIOMED-2024 PROGRAM

FRIDAY: November 1, 2024	
OPENING CEREMONY	
09:30-10:30	**Kocaeli University State Conservatory Turkish Music Department Concert** **Assoc. Prof. Dr. Nermin Demirkol** *(Symposium Chair)* **Prof. Dr. Y. Murat Elçin** *(BTES President)* **Prof. Dr. Nuh Zafer Cantürk** *(Rector of Kocaeli University)*
OPENING SESSION	
10:30-11:00	**Chair:** Prof. Dr. Vasıf Hasırcı
	Plenary Speaker **Prof. Dr. Pavol Sajgalik** *(President of Slovak Academy of Sciences, Slovakia)* "**Are Silicon Nitride Based Ceramic Suitable for Drug Delivery**"
11:00-11:30	*Coffee Break*
11:30-12:00	**Chair:** Prof. Dr. Gilson Khang
	Plenary Speaker **Prof. Dr. Y. Murat Elçin** *(Ankara University, Türkiye)* "**ECM as the Key to Regeneration and 3D Tissue Modeling**"
12:00-13:15	Family Picture (Hotel Entrance) & Lunch

SESSION 1	
Chairs: Prof. Dr. Pavol Sajgalik, Prof. Dr. Nesrin Hasırcı	
13:15-13:45	*Plenary Speaker* **Prof. Dr. Vasıf Hasırcı** *(Acıbadem University, Türkiye)* "**Cell-Instructive Biomaterials for Tissue Engineering**"
13:45-14:05	*Invited Speaker* **Prof. Dr. Gültekin Göller** *(Istanbul Technical University, Türkiye)* "**Research Studies on Bioceramics, Composites and Glass Ceramics**"
14:05-14:25	*Invited Speaker* **Dr. S. Yamini Sudha Lakshmi** *(University of Madras, India)* "**Evaluation and Comparison of Potentised Drug Against Cancer**"
14:25-14:35	**OP-01-** Mesoporous Silica Nanoparticles Mediated Gene Delivery to Target MUC-1 Inhibition in Breast Cancer Micro-Tissues, Ayşenur Pamukçu, Özlem Yıldız , Gülşah Erel Akbaba, **Didem Şen Karaman** (İzmir Katip Çelebi University)

14:35-14:45	**OP-02-** Manufacturing of PHBV/Modified TPS Films as Wound Dressing **Serap Mert**, Candan Altuntaş, Rumeysa Yıldırım, Gamze Liman, Zehra Seda Halbutoğulları, Gökhan Duruksu, Mehmet Kodal, Yusufhan Yazır *(Kocaeli University)*
14:45-14:55	**OP-03-** Therapeutic Potential of Stem Cell-Derived Extracellular Vesicles Loaded Hydrogels for Testicular Torsion **Şükrü Özturk**, Merve Gultekinoglu, Elif Conger Onder, Karim Shirinli, Beyza Sima Tatar, N. Dilara Zeybek, Naside Mangır, Kezban Ulubayram *(Hacettepe University)*
14:55-15:15	*Coffee Break*

SESSION 2	
Chairs: Prof. Dr. Anton Ficai, Prof.Dr.Gamze Köse	
15:15-15:35	*Invited Speaker* **Prof. Dr. Sinan Akgöl** *(Ege University, Türkiye)* "**Natural-based Chemical Sensors**"
15:35-15:55	*Invited Speaker* **Prof. Dr. Anton Ficai** *(Politehnica University of Bucharest, Romania)* "**Smart Drug Delivery Systems and Personalized Therapies**"
15:55-16:15	*Invited Speaker* **Assoc. Prof. Dr. Mahmut Parmaksız** *(Ankara University, Türkiye)* "**Cell-Derived Extracellular Matrix Based 3D Biohybrid Angiogenic Tissue Scaffolds: In-vitro, Ex-ovo and In-vivo Evaluations**"
16:15-16:25	**OP-04-** Development and Characterization of Drug Loaded Chitosan/Silk Fibroin Electrospun Nanofibers For Wound Dressing Material **Özlem Ayşe Tosyalı,** Okşan Karal-Yılmaz, İmren Esentürk Güzel, Ayça Bal Öztürk *(Beykent University)*
16:25-16:35	**OP-05-** Point-of-Care Test Platform for the Diagnosis of Fabry Disease **Ebru Yılmaz**, Aslı Erol, Dilan Çelebi Birand, Elif Nur Yükselen, Nihat Serkan Karayalçın, Memed Duman *(Hacettepe University)*
16:35-16:45	**OP-06-** Small Intestinal Submucosa Decellularization with Supercritical Carbon Dioxide, **Zeynep Caglar**, Busra Kılıç, Halil Murat Aydin *(Hacettepe University)*
16:45-16:55	**OP-07-** Wearable Antennas in the ISM Band for Biomedical Applications **Adem Koçyiğit**, Burak Çelik, M.Burak Karadeniz, Ebru Efeoğlu, Bahattin Türetken *(Bilecik Şeyh Edebali University)*

SATURDAY: November 2, 2024	
SESSION 3	
Chairs: Assoc. Prof. Dr. Nermin Demirkol, Dr. S. Yamini Sudha Lakshmi	
09:00-09:30	*Plenary Speaker* **Prof. Dr. Nesrin Hasırcı** *(Middle East Technical University, Türkiye)* "**Biomaterials and Medical Devices: Development and Regulations**"
09:30-10:00	*Plenary Speaker* **Prof. Dr. Gilson Khang** *(Chonbuk National University, South Korea)* "**Current Issues of Biocompatibility for Tissue Engineering & Regenerative Medicine**"
10:00-10:25	*Invited Speaker* **Prof. Dr. Wojciech Swieszkowski** *(Warsaw University of Technology, Poland)* "**Advancing Musculoskeletal Tissue Engineering through Microfluidic-Assisted Biofabrication**"
10:25-10:45	*Invited Speaker* **Assoc. Prof. Dr. Yavuz Nuri Ertaş** *(Erciyes University, Türkiye)* "**Nanoparticle and Implantable 3D-printed Scaffold-based Approaches for Enhanced Cancer Treatment via Radiotherapy**"
10:45-11:15	**POSTER SESSION - I** *Coffee Break*

SESSION 4	
Chairs: Prof. Dr. Kezban Ulubayram, Prof. Dr. Sinan Akgöl	
11.15-11.25	**OP-08-** Green Synthesis and Characterization of Citric Acid-PEG Modified Alginate Hydrogels for Biomedical Applications **Faustin Hategekimana,** Yaşar Murat Elçin *(Ankara University)*
11:25-11:35	**OP-09-** Thermosensitive Polysaccharide-based Hydrogels: Gelation Mechanisms, and Biomedical Applications **Serap Durkut** *(Ankara University)*
11:35-11:45	**OP-10-** The Design of a Glutathione-Based Injectable Hydrogel from Natural Sources **Fatmanur Bostan**, Ufuk Koca Çalışkan *(Düzce University)*
11:45-11:55	**OP-11-** Development of Nature-Inspired Electroconductive, Modified Hydrogel Cardiac Tissue Sealants and Evaluation of Their Adhesiveness and Biocompatibility Properties **Gülşah Torkay,** Yağmur Kalender , Ayça Bal Öztürk *(İstinye University)*
11:55-12:05	**OP-12-** Angiogenic Effects and In Vivo Response of Chitosan/Poly(vinyl alcohol) Microneedle Patches Soghrat Salamati, **Elif Conger-Onder,** Sukru Ozturk, Karim Shirinli, Beyza Sima Tatar, Naciye Dilara Zeybek ,Naside Mangır , Kezban Ulubayram *(Hacettepe University)*
12:05-12:15	**OP-13-** Development and Characterization of a Self-Healing Nanocomposite Hydrogel against Bacterial Infections **Ayşenur Pamukçu,** Didem Şen Karaman *(İzmir Katip Çelebi University)*
12:15-12:25	**OP-14-** Anti-inflamatory Effects of Exosomes on In-Vitro 3D Spinal Cord Injury Model Ecenaz Merve Namlı**, Pelin Ilhan**, Sinem Ezgi Turunç Özoğlu, Aylin Şendemir *(Ege University)*
12:25-12:35	**OP-15-** Synergistic effect of GO-Ag NP additives on biological properties of an electrospun potential wound dressing material

	Hatice Bilge İşgen, Sema Samatya Yılmaz, Ayşe Aytaç *(Kocaeli University)*
12:35-13:30	Lunch

SESSION 5	
Chairs: Prof.Dr.Gültekin Göller, Prof. Dr. Iulian Antoniac	
13:30-13:55	*Invited Speaker* **Prof. Iulian Antoniac** *(Politehnica University of Bucharest, Romania)* "**Biodegradable Magnesium Alloys: from Implant Material Concept to Clinical Applications**"
13:55-14:20	*Invited Speaker* **Prof. Stefan Ioan Voicu** *(Politehnica University of Bucharest, Romania)* "**Functional Polymeric Membranes for Osseointegration and Hemodialysis**"
14:20-14:30	**OP-16-** Shaping the future of medicine: Clinical and translational research through 3D bioprinting and biodispensing **Anik Islam** *(TERRALAB)*
14:30-14:40	**OP-17-** Ti Alloys Coated with CaP-doped Varying Amounts of Zn via Micro-Arc Oxidation (MAO) Technique: Physical and Biological Effectiveness **Senem Büyüksungur** , Jürgen Schmidt , Tugba Endogan Tanir, Vasif Hasirci, Alina Vladescu (Dragomir), Nesrin Hasırcı *(Middle East Technical University)*
14:40-14:50	**OP-18-** A Novel Composite Scaffold Design: Cu2+-Doped Borosilicate Glass Integrated with Silk Fibroin and Methacrylated κ-Carrageenan for Bone Tissue Engineering **Saliha İldem Demirer,** Seyithan Kansız, Yaşar Murat Elçin *(Ankara University)*
14:50-15:00	**OP-19-** Production and Characterization of Co-Cr Alloy for Dental Applications by Hot Press and Additive Manufacturing **Hasan İsmail Yavuz,** Mertcan Kıraç, Enes Furkan Sevinç , Fırat Güleç , Ahmet Sever, Egemen Avcu, Rıdvan Yamanoğlu *(Kocaeli University)*
15:00-15:10	**OP-20-** Optimizing Injectable Magneto-Responsive Hydrogels for Biomedical Applications: Dynamic Crosslinking and Amino Functionalization **Aslı Nur Güler,** Seyithan Kansız, Yaşar Murat Elçin *(Ankara University)*
15:10-15:40	**POSTER SESSION - II** *Coffee Break*

SESSION 6	
Chairs: Prof. Dr. Eser Elçin, Prof. Dr. Stefan Ioan Voicu	
15:40-15:50	**OP-21-** The Effect of Methacrylation Degree on the Printability and Physicochemical Properties of κ-Carrageenan Bioinks **Seyithan Kansız**, Murat Taner Vurat, Mahmut Parmaksiz, Ayşe Eser Elçin, Yaşar Murat Elçin *(Ankara University)*
15:50-16:00	**OP-22-** Synthesis and Modification of Ti_3C_2 MXene (Titanium Carbide) for Biomedical Applications **Özge Lalegül- Ülker** *(Ankara University)*
16:00-16:10	**OP-23-** Hierarchical TiO_2 Nanotube Arrays Enhance Mesenchymal Stem Cell Adhesion and Regenerative Potential Through Surface Nanotopograph Nur Kubra Tasdemir, **Bogac Kilicarslan,**, Gozde Imren, Beren Karaosmanoglu, Ekim Z. Taskiran, Cem Bayram *(Hacettepe University)*
16:10-16:20	**OP-24-** Cost-Effective Technique for the Preparation of Novel Si_3N_4 Based Functionally Graded Biomaterials with Improved Bioactivity **Yasemin Tabak**, Şeyda Polat, Ayşen Kılıç, Arzu Taş Ekiz, Monika Tatarkova, Peter Tatarko, Miroslav Hnatko, Hakan Ünsal, Pavol Šajgalík (Tübitak)
16:20-16:30	**OP-25-** Preliminary Investigation of the Usability of Brown Meagre Otoliths in Biomaterial Development **Nihal Derin Çoşkun,** Nermin Demirkol *(Ordu University)*
16:30-16:40	**OP-26-** Mussel-Inspired Breakthrough in Lung Tissue Adhesives: Antibacterial and Highly Adhesive DOPA-Modified GelMA/ Silk Fibroin for Enhanced Healing and Air Leakage Prevention **Burçin İzbudak**, Erkan Rayaman, Emine Alarçin, Gökçen Yaşayan, Ayça Bal-Öztürk *(İstinye University)*
16:40-16:50	**OP-27-** Highly Specific and Sensitive Detection of West Nile Virus via CRISPR-CAS Mechanism **Aslı Erol**, Dilan Çelebi Birand , Ebru Yılmaz, Memed Duman *(Hacettepe University)*
16:50-17:00	**OP-28-** Development of a Magnetically Actuated Drug Delivery System through Hollow Microneedles **Buğra Kağan Ünal,** Soner Çakmak, Fatih Şentürk, Lokman Uzun, İsmail Cengiz Koçum *(Hacettepe University)*
17:00-17:10	**OP-29-** Altering Culture Conditions of A549 Cell Line for Improved In Vitro Alveolar Barrier Models **Neval Sevinc Ozdemir**, Halime Kenar, Vasif Hasırcı *(Acıbadem Mehmet Ali Aydınlar University)*

17:10-18:00	TERRALAB Bioprinting Workshop**, Dr. Flore-Anne Poujade**

19:30-22:30	Gala Dinner

SUNDAY: November 3, 2024	
SESSION 7	
Chairs: Assoc. Prof. Dr. Yavuz Nuri Ertaş, Assoc.Prof.Dr.Cem Bayram	
09:30-09:40	**OP-30-** From Laboratory to Clinic: Regulatory Requirements for Tissue Engineering Products **Umut Doğu Seçkin,** Aylin Şendemir *(Ege University)*
09:40-09:50	**OP-31-** A New Arthrodesis Nail Design Yasin Doğu**, İbrahim Mutlu** *(Kocaeli University)*
09:50-10:00	**OP-32-** Tribological Characterization of Alumina Ceramic for Dental Applications Against Tungsten Carbide **Zeynep Taşlıçukur Öztürk**, Mustafa Alper Yılmaz, Yasemin Tabak *(National Defense University)*
10:00-10:10	**OP-33-** Sensitive Cell Line for the Detection of Botulinum Neurotoxin A **Deniz Simsek**, Ceyda Caliskan, Charlotte Leese, Ciara Doran, Andrew Peden, Liz Seward, Bazbek Davletov *(Sheffield University)*
10:10-10:20	**OP-34-** Development and Characterization of Naturally Derived Scaffolds for Bone Tissue Engineering **Miray Yıldırım,** Aysel Koç Demir, Ayşe Eser Elçin *(Ankara University)*
10:20-10:30	**OP-35-** Synthesis and Biological Activity of Functionalized Graphene Oxide Nanolayers with Schiff Bases via Non-covalent Interactions **Gunel Aliyeva,** Boğac Kılıçarslan, Merve Gültekinoğlu Bayram, Cem Bayram, Ulviyya Hasanova, Zarema Gahramanova, *(Hacettepe University)*
10:30-10:40	**OP-36-** Engineering naturally based composite hydrogel as flexible bioadhesivefor wound healing of internal organs **Ahmet Erdem**, Dilara Küçük, Feyzanur Şentürk, Aygün Iseyeva, Gökhan Duruksu (Kocaeli University)
10.40-11:00	**ANNOUNCEMENT OF BEST POSTER AWARDS & CLOSING**
13:30-16:30	**SOCIAL-CULTURAL TRIP**

Poster Presentations

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P2	Fabrication and Characterization of Decellularized Extracellular Matrix-based Composite Scaffolds for Hard Tissue Repair	**Aysel Koç Demir**, Nuray Emin, Yaşar Murat Elçin
P3	Development of ADA-Gel Based Electroconductive Nanocomposite Hydrogel Bioinks	**Ayşenur Acuner**, M. Zahid Doğan, Dinçer Gökcen, Cem Bayram
P4	Design and Characterization of GelMA-Bioactive Glass Composite Bioinks for Tissue Engineering Applications	**Elif Yüce**, Burçin İzbudak, Banu Kocaağa , F. Seniha Güner, Aldo R. Boccaccini, Ayça Bal Öztürk
P5	Optimization of PLA Composites with GLYMO-Modified Hydroxyapatite: Effects on Mechanical Properties, Thermal Behavior, and Cytocompatibility	**Eylül Odabaş**, Esin Akarsu
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P7	Controlled Protein Release from Hydrolytically Degradable 'Click' Chemistry-based Interpenetrating Polymer Network Hydrogels	**Farouk Segujja**, Gökhan Duruksu, Elif Beyza Eren, Aygün İsayeva and Ahmet Erdem
P8	Development of a Therapeutic Injectable Hydrogel for Spinal Cord Injury	İrem Evfa Küçük, Zehra Gül Morçimen , Fatmanur Kutlu , Elif Esin Hameş, **Aylin Şendemir**
P9	Evaluating the Antimicrobial Potential of Hydrogel Membranes Incorporating Plant-Derived Essential Oils	Temitayo Margaret Omoyeni, **Doğa Kavaz**
P10	Development of Hydrogel-Based Microneedle Patches for The Transdermal Delivery of Tetracycline and Retinoic Acid in Acne Vulgaris Treatment	Basak Erdogdu, **Elif Conger-Onder**, Sukru Ozturk, İpek Eroglu, Kezban Ulubayram
P11	Optimization of Hydrogel Composition to Mimic Brain Tissue of Neurovascular Unit	**Gozde E. Kole**, Vasif Hasirci, Deniz Yucel
P12	Quercetin-Conjugated Self-Healing PectaGel: A Novel Hydrogel for Enhanced Angiogenesis and Tissue Regeneration	**Somaye Hormaty**, Radiye Akyüz, Gülşah Torkay, Ayça Bal Öztürk, Banu Kocaağa
P13	UV-B-induced extracellular vesicles in 3D wound models	**Elif Hatice Ayten**, Esin Akbay Çetin
P14	Injectable Adhesive and Transparent Wound Dressing Based on PRF-Integrated, Glycidyl Methacrylate-Functionalized Silk Fibroin for Corneal Ulcer Treatment	**Şevval Melis Özyürek** , Zarife Nigâr Özdemir Kumral, Ayça Bal Öztürk
P15	Comparison of Extracellular Matrix Components for Biofabrication of Bone Tissue Engineered 3D-Printed Models	**Sibel Çınar Asa**, Safa Şenaysoy, İpek Aydın, Elif Ertürk, Ferda Arı, Hüseyin Lekesiz
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P18	Innovative Wound Dressings Fabricated with Snail Mucus Extract Using a 3D Handheld Bioprinter for Diabetic Foot Ulcer Applications	**Nazlı Ecem Tağrısever**, Erkan Rayaman , Ayça Bal Öztürk
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PLENARY AND INVITED SPEAKERS

PLENARY SPEAKERS

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Ankara University, Türkiye

Nesrin HASIRCI
Middle East Technical University, Türkiye

Vasıf HASIRCI
Middle East Technical University, Türkiye

Gilson KHANG
Jeonbuk National University, Jeonju, South Korea

Pavol ŠAJGALİK
President Slovak Academy of Sciences, Bratislava, Slovakia

INVITED SPEAKERS

Sinan AKGÖL
Ege University, İzmir,Türkiye

Iulian ANTONIAC
National University of Science and Technology Politehnica, Bucharest,Romania

Yavuz Nuri ERTAŞ
Erciyes University, Türkiye

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Gültekin GÖLLER
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S.Yamini Sudha LAKSHMI
Universty Of Madras, Chennai, India

Mahmut PARMAKSIZ
Ankara University, Ankara, Türkiye

Wojciech ŚWIESZKOWSKI
Warsaw University of Technology, Warsaw, Poland

Stefan Loan VOICU
National University of Science and Technology Politehnica, Bucharest,Romania

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SHORT BIOS AND ABSTRACTS OF PLENARY SPEAKERS

Y.Murat ELÇİN

Professor, PhD, Ankara University Faculty of Science, Chemistry Department, Biochemistry Division, Ankara, Türkiye
President, Biomaterials and Tissue Engineering Society (Türkiye)
Founder, Biovalda Health Technologies, Inc.

Yaşar Murat ELÇİN, Professor at Ankara University Faculty of Science, Department of Chemistry Biochemistry Division since 1996. He is Listed in Stanford-Elsevier World Top 2% Scientists & quot; Career Impact List in 2020, 2021, 2022, 2023 and amCp; 2024" (Biomedical Engineering / Biotechnology or Biochemistry & Molecular Biology fields). President of the Biomaterials and amp; Tissue Engineering Society (Türkiye). Founder of the Tissue Engineering, Biomaterials and amp; Nanobiotechnology Research Laboratory (ElçinLab, 1993) (www.elcinlab.org). Founding Deputy Director of the Ankara University Stem Cell Institute (2010-2016). Head of Ankara University Faculty of Science, Dept. Biochemistry (2005-2017). Supervisor of 28 PhD and 32 MSc Theses. Founder of Biovalda Health Technologies, Inc. Professor Elçin has 7 registered patents and amp; 2 prototypes (Matrisis® and Hemagraft®). Chairman of previous BIOMED symposia: 2002, 2011, 2017 and amp; 2022. He has received various awards for his scientific and R&D achievements, including Ankara University Science Award (2008), Middle East Technical University Science Award (2018), Doktorclub 2019 Biotechnology & Genome Technology Award (2019). Prof. Elçin is the Section Editor (Musculoskeletal Regeneration and amp; Tissue Engineering) of Stem Cell Reviews and amp; Reports (Springer-Nature). Editorial Board member of Genes and amp; Diseases (Elsevier), Molecular Biotechnology (Springer), and Cell Biology and amp; Translational Medicine (Springer Nature), etc. Editor of the book "Tissue Engineering, Stem Cells and amp; Gene Therapies" (Kluwer-Plenum, NY, 2003), TEP Editor of the book "Lehninger Principles of Biochemistry, 5th Ed." (Palme, 2013). Bioethics Committee Member, UNESCO-Türkiye (2014-2018).Google Scholar (https://scholar.google.com/citations?user=RQeKK4AAAAAJ&hl=tr&oi=ao) (4600citations +;h-index= 40). International Athlete (Track & Field; 1980-1994).

ECM as the Key to Regeneration and 3D Tissue Modeling

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Tissue engineering is a technology of regenerative medicine that aims to regenerate or replace biological equivalents of living tissues/organs using a combination of cells, scaffolds, appropriate biochemical and physicochemical factors. In this context, scaffolds are expected to act as a temporary extracellular matrix (ECM) for the tissue targeted for regeneration. Histotypic-, organotypic cultures, or multicellular spheroids have been developed in the past to mimic tissue structures in vitro with limited success. Many types of bioscaffolds using biocompatible synthetic or natural polymers have been evaluated to mimic native ECM by various methods. The findings revealed that the ECM can be structurally mimicked to some extent, however, fully constructing native ECM without incorporating native bioactive components has always been a distant goal. This is mainly due to obstacles in the formation of the highly rich and intricate bioactive content of the ECM. The main components of the ECM are collagen, non-collagenous glycoproteins, proteoglycans and glycosaminoglycans. The structural diversity of ECMs can be evaluated within the context of the composition, structure, histological localization of basement membranes and interstitial ECM. The matrisome is a collection of genes encoding ECM and ECM-related proteins, and its relationship with more than 1000 genes has been revealed. Matrisome-associated proteins carry a signal peptide required for their extracellular secretion. This talk focuses on our work on biomimetic customizable ECM-like scaffolds created from sources such as blood (platelet-rich plasma/platelet lysate), proteins (albumin), and decellularized tissues/cultures, which have become platform technologies. These technologies can also be used to create 3D tissue models to study diseases, human biology, and test new drugs.

Keywords: Extracellular matrix, tissue regeneration, tissue modeling, tissue engineering, blood-derived materials, decellularized matrices, 3D-bioprinting

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Professor Nesrin Hasirci is actively working at METU- BIOMATEN Center of Excellence in Biomaterials and Tissue Engineering as Advisory Board member. She has more than 250 scientific publications, has 7 patent applications (3 was approved), 22 chapters in scientific books, 4 edited books (2 Scientific about Biomaterials.She presented more 500 talks on international and national congresses, conferences and symposia on which to many of them she was invited and in some been the plenary lecturer. She supervised or co-supervised more than 50 M.Sc. and 20 Ph.D. theses all related to biomaterials for the diagnosis and treatment of soft and hard tissues and organs. Prof. Hasirci worked as Head of newly established Graduate Departments at METU. She is the establisher and the first Head of the Graduate Department of Biomedical Engineering, and have been the Head of the Graduate Department of Biotechnology two times at different periods. She also administered as Vice Chairman of the Chemistry Department in 1990s. In the years of 1994-1995, she had been at Massachusetts Institute of Technology (MIT), Department of Chemical Engineering, Cambridge, USA, as Fulbright Visiting Professor granted by Fulbright Commission and worked in Prof. Robert Langers' Lab. She is 'Honorary Member of European Society of Biomaterials'. She is also 'Fellow of the Science Academy' (Turkey). She is the owner of 'Science Award' given by M. Parlar Foundation and 'Technology Award' given by Elginkan Foundation. She also received the University Awards (given in every year to the successful scientists of the previous year) since 2001 in every year. Prof. Hasirci is a member of the ESF Pool of Reviewers, and has been as reviewer in Horizon, FP-6 and FP-7 EU, COST and ERA-EuroNanoMed projects, as well as many National and International projects and manuscripts submitted to National and International Journals

Biomaterials and Medical Devices: Development and Regulations

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Abstract

Since ancient times, humanity has sought to achieve longer and healthier lives, using various materials to support nonfunctioning organs. Natural materials, such as wood and crystals, were once employed to replace broken bones or lost teeth. As human capabilities advanced, new technologies emerged, leading to the synthesis of novel biomaterials with specific sizes, properties, and responsiveness. Tissue engineering took this a step further, aiming to create living tissues or organs in the laboratory. Additionally, 3D printing technology has enabled the production of small organoids with complex structures by combining cells with hydrogels (bioinks) and arranging different types of cells in an organized manner.As interest in biomaterials and medical devices has grown, the number of organizations manufacturing these products has also increased. However, some of these products have led to negative outcomes, including disorders, injuries, and even fatalities. This has prompted countries to establish regulations with strict guidelines. These regulations assist and guide manufacturers throughout the entire process-from design and production to characterization and post-sale monitoring. Consequently, facilities have established control units to oversee the materials entering and leaving the production line, the testing protocols, the equipment used in laboratories, hygiene conditions, and the personnel across all departments (1). All operations must comply with the rules to ensure safety and efficacy. Medical Device is defined as an instrument, apparatus, device, software, implant, reagent, material or any other article used in the diagnosis, prevention, monitoring, treatment and alleviation of disease, disability or injury or the investigation, and modification of an anatomical, physiological and pathological process or in vitro examination of specimens obtained from the human body. As stated by the International Organization for Standardization (ISO13485), the process of determining the biological compatibility of any medical device consists of several stages. The first stage is checking the compatibility of the materials existing in the device. Next, in vitro testing (for device components). Finally, in vivo testing (first in animals, then in pilot clinical applications). It is important to ensure that the finished device will not have any harmful effects on humans and has no deficiencies.Many laws, regulations and guidelines have been put into practice. Good Laboratory Practices (GLP) specifies every process related to the planning and execution of studies to be carried out in laboratories. Good Manufacturing Practices (GMP) states that the production, packaging, labeling and distribution conditions of medical products should be made in accordance with quality standards. The Medical Device Directive (MDD) contains directives that must be followed for a manufacturer to legally place a medical device on the European market. Today, companies producing medical products must comply with 'The European Union Medical Device Regulation (EU MDR)' directives, which is effective since 2021. EU MDR categorizes medical devices into four classes: Class I, Class IIa, Class IIb, and Class III (2). This medical device classification is based on the device's potential risk of harm to users. As outlined in the EU MDR guidance, producers must establish, document, implement and maintain a quality system throughout the entire medical device life cycle. There is also a strong emphasis on the importance of the QMS of the organization for saving the documents, post-market surveillance, risk assessments of new and existing devices, and necessary procedures.

Keywords: Medical device; Hydrogel; Bioink; 3D-Printed tissue; MDR.

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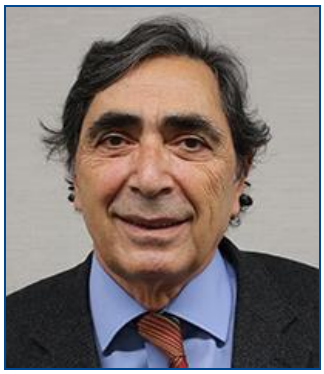

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Vasıf Hasırcı PhD, is Professor at Acibadem Mehmet Ali Aydinlar University (ACU), Biomedical Engineering Department, Istanbul, Turkey. Previously, he was Professor at the Department of Biological Sciences of the Middle East Technical University (METU), Ankara, Türkiye. He is the Founder of the Center of Excellence in Biomaterials and Tissue Engineering (BIOMATEN) at METU. He is also the Founder of the Biomaterials Application and Research Center at ACU and Founding President of the Biomaterials and Tissue Engineering Society (Türkiye).

Cell-instructive Biomaterials for Tissue Engineering

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Cells in the tissues are elastic enough to undergo mechanical deformation when subjected to any force. In addition, the nuclei also have similar properties. It is reported that stiffness of the nucleus varies from cell type to cell type and also with the state of the cell. This provides the researchers in the biomaterials field significant opportunities in designing and producing their engineered tissues. One can guide cells to orient to mimic the properties of a specific tissue, elasticity enables researchers to create tissue sections or 2D or 3D models to perform tests related with their research into fundamental properties or mechanisms. Measurement of certain mechanical properties can be used for diagnostic purposes such as metastatic properties in case of cancer. Research using a variety of cell types enabled researchers to mimic in vitro the organisation of tissues for tissue engineering purposes, especially subjected to constraints to study the tendency towards cancer. One recent study involved creation of a model system to study the healing process. In order to be able to achieve these results nano-micro level processing of biomaterials needs to be highly advanced. Several examples will be presented on cell guidance, cancer detection and regeneration process using microengineered biomaterials (Fig 1).

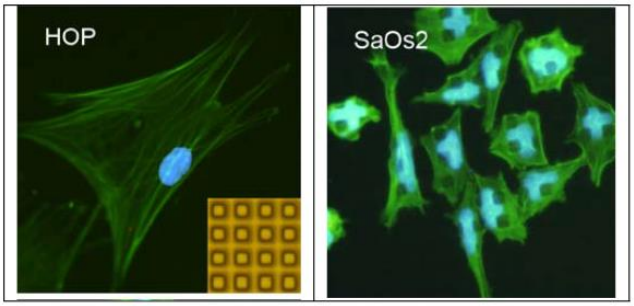

Fig. 1 Immortalized and healthy cells are not affected to the same extent by the pillars on the same PLGA surface. P.M.Davidson.... V. Hasirci..., J Mater Sci: Mater Med (2009)

Keywords: Cell Guidance, Interaction, Plasticity, Tissue Engineering

Gilson KHANG

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Current Issues of Biocompatibility for Tissue Engineering & Regenerative Medicine

Dr. Gilson Khang was born in 1960 in South Korea (57 years old), where he obtained his degrees at the Inha Univ (B.S. and M.S.). In 1987, he joined the Dr Hai Bang Lee's Biomaterials Lab at Korea Research Institute of Chemical Technology (KRICT, Deajeon, Korea). He was studying for Ph.D. degree at the Department of Biomedical Engineering, The Univ of Iowa (Iowa City, IA, USA) from 1991~1995 under the guidance of Prof Joon B. Park. For 11 years (1987~1998) at KRICT, he worked on the development of drug delivery systems, the contact lens, blood bag, blood-compatible vascular graft, urinary catheter and tissue engineered cartilage, bone and spinal cord. His academic career started at the Department of PolymerNano Science and Technology at Chonbuk National University (CBNU, Assistant Professor, 1998-2004; Associate Professor, 2004-2009) and then tenured by Full Professor in 2009. He was planning and steering over 10 big grants from 1998 to present for the Korean Government, for example, Development of Drug Delivery System for Anticancer Drug (2MUSD/yr for 5 years, Korean Ministry of Intellectual and Economy), Stem Cell Research Center (10MUSD/yr for 10 years, Korea Ministry of Education, Science & Technology), Muscloskeletal Bioorgan Center (1MUSD/yr for 9 years, Korea Ministry of Health & Welfare) and so on. From 2006 to 2011, he was the PI of BK-21 (Brain Korea 21 Project) and WCU (World Class University, 3MUD/yr for 5 years) Program at CBNU supported by KMEST. He was Chair Professor in the Department of BIN Fusion Technology of WCU program of CBNU. Dr. Khang is member of Tissue Engineering and Regenerative Medicine International Society (TERMIS), Society for Biomaterials and American Association of Pharmaceutical Science and so on. He was the one of Founder Members of Asian Tissue Engineering Society (ATES) and one of Founder Members of TERMIS-AP Chapter. Prof. Khang was General Secretary and Treasurer for 2005~2009 of TERMIS-AP Chapter and now served as a council member for TERMIS-AP. Recently, he serves TERMIS-AP Continental Chair as 2015~2017, TERMIS Global President-Elect (2016~2108) & executive board member for TERMIS Global. Very recently, he is trying to expand TERMIS-AP chapter to West/Middle East Asia and established iTERMS (Iran TERMS) and gulfTERMS. Also, he elected the Founding Fellow for Tissue Engineering and Regenerative Medicine (FTERM) on 2012 (0.5% of total member of TERMIS). From 2004 to 2009, he was the Editor-in-Chief of the Tissue Engineering and Regenerative Medicine (IF: 1.0) as well as serves the Co-Editor-in-Chief of the International Journal of Tissue Regeneration. He is or has been member of the Editorial Board of many scientific journals (e.g. J Tissue Eng Regen Med, Stem Cell & Development, Inter J Stem Cell, Tissue Eng, Therapeutic Delivery, World J Stem Cell, Regenerative Research, Macromolecular Research, Regenerative Therapy, Frontiers of Bioengineering and Biotechnology and Biomaterials Research).

Pavol ŠAJGALİK

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Pavol Šajgalík is the President of the Slovak Academy of Sciences in Bratislava, Slovak Republic (since 2015), and simultaneously senior research scientist at the Ceramic Department, Institute of Inorganic Chemistry SAS (since 1979). He received his MSc at the Department of Experimental Physics, Comenius University, Bratislava in 1979; his PhD at the Institute of Physics SAS in 1987; DSc at the Institute of Inorganic Chemistry SAS in 1996; and he became Full Professor in 2004.Primarily his research is focused on the research and development of oxide and non-oxide high performance ceramics. Main interest of his research is the relationship between microstructure and mechanical properties of these materials. He is the author of more than 240 scientific papers, co-editor of 8 proceedings, guest editor of 5 special issues of the professional journals, co-author of 5 monographs. He has registered in WOS more than 240 scientific papers, more than 3300 citations and H-index of 32.He regularly organizes workshops on Engineering Ceramics. He has been a leader of many international projects. He is the member of the European, American and Japan Ceramic Societies, the president of the Slovak Silicate Society, the member elect of the World Academy of Ceramics and the Fellow of the American Ceramic Society and Fellow of the European Ceramic Society. He obtained a large number of domestic and international recognitions and awards. In 2015 he was awarded the Slovak State decoration: Order of the Ľudovít Štúr of III. Class.In 2013 he was awarded the Stuijts Award of ECerS and Bridge Building Award of ACerS. He is Fellow of ECerS and ACerS. In 2015-2018 he was the president of ECerS.

Are Silicon Nitride Based Ceramics Suitable for the Drug Delivery?

Pavol ŠAJGALÍK

Michal Hičák[1] , Ľubomír Medvecký[2], Miroslav Hnatko[1,3], Radoslava Stulajterová[2], Mária Giretová[2] , Monika Tatarková[1], Zoltán Lenčéš[1], Pavol Šajgalík[1]

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The silicon nitride-based porous silicon nitride/α-tricalcium phosphate (α-TCP) microgranules containing 50% α-TCP prepared in present study showed good in vitro simulated body fluid bioactivity with precipitation of hydroxyapatite particles. Usually used tetracalcium phosphate/monetite biocement was modified by the addition of 30 wt.% these highly porous microgranules. Granules prepared by the freeze granulation of starting mixture of silicon nitride and calcium phosphate and subsequent sintering at 1100 °C have a suitable pore structure for the foreseen use. The pore volume was almost 1000 mm3 /g with the open porosity of 77 vol%. This porosity and the biocompatible composition of silicon nitride-based granules gave a chance to fabricate a suitable composite cement for a dexamethasone (DMZ) drug release to the human body. An accelerated release of dexamethasone from composite cement was observed and the full amount of DMZ was released from the composite biocement after 10 days. The presented results are a good base to adjust the total drug release time by mixing an appropriate amount of drug infiltrated ceramic granules with the tetracalcium phosphate/monetite cement

SHORT BIOS AND ABSTRACTS OF INVITED SPEAKERS

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Sinan AKGÖL was born in Izmir in 1970. He graduated from Hacettepe University in 2003 with a Ph.D. degree.Between 2006 and 2021, he held many administrative positions such as head of department and vice dean.Dr. Sinan AKGÖL has 8 national/international patents, over 140 SCI publications, over 3900 citations, 8 national and international editors/chapter authors, 25 science magazine articles, 55 international and 12 invited talks. Dr. Akgöl's h-index is 39.Dr. Sinan AKGÖL, who has trained 20 Master's and 12 PhD students and 3 post-doctoral researchers, is still the advisor of 3 PhD and 3 Master's students.He currently works at Ege University Faculty of Science, Department of Biochemistry, and part-time at Sabanci University Nanotechnology Research and Application Center

Nature Based Chemical Sensors

Sinan AKGÖL

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Abstract

The material science community has recently become very interested in nature-inspired designs, which are thought to be promising materials for the creation of high-performance chemical sensors. Their extremely dynamic interfacial interactions have opened up new possibilities for the creation of environmentally friendly, fast, sensitive, and low-cost sensing technologies. The abundance of precise hierarchical designs found in nature at the nano/microscales serve as limitless sources of inspiration for the creation of a wide variety of sophisticated materials with distinctive features. Natural chemical sensing organs with distinctive capabilities for the detection of environmental chemical signals include biological olfactory and taste systems and their transduction mechanisms. Biological functional components for chemical sensing, which are frequently taken from sensing components of biological olfactory or taste systems at the tissue level, cellular level, or molecular level, are used as a unique resource by biomimetic chemical sensors qualitatively and quantitatively. In this talk, the most recent advances in nature-based and biomimetic chemical sensors will be summarized.

Keywords: nature-based materials, chemical sensors, detection, bioinspired, biomimetics, biosensors.

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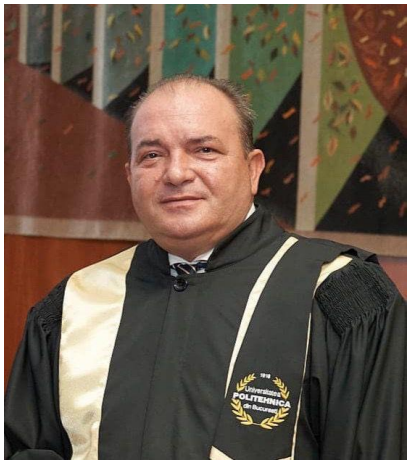

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Iulian Antoniac is Full Professor in Materials Engineering and Biomaterials, Habil in Materials Engineering, Head of Department Metallic Materials Science and Physical Metallurgy, Member of the Senate of the National University of Science and Technology POLITEHNICA Bucharest, Romania. He received his B.Sc., M.Sc., Ph.D., and Postdoc degrees in Materials Science at University POLITEHNICA of Bucharest. Professor Iulian Antoniac research interests include metallic materials obtaining, characterization and testing; advanced techniques for surface characterization; microscopy techniques; functional materials; biomaterials; bioceramics; coatings; biodegradable metals; biocomposites; implants for orthopedics and dentistry; advanced materials for smart industrial applications; physical and chemical characterization of nano- and micro- particles for biomedical applications. Professor Iulian Antoniac act as Fellow, Biomaterials Science and Engineering (FBSE), Corresponding Member of the Academy of Romanian Scientist, Past President of the International Society for Ceramics in Medicine (ISCM) and President of the Romanian Society for Biomaterials. He is the author of numerous scientific international papers, publications and proceedings on materials engineering and biomaterials. He is Editor in Chief for the journal Materials Science Forum, editorial board member for other journals and reviewer for more than 50 journals. In 2005, he received the Daniel Bunea Award from the Romanian Society for Biomaterials. Also, he receives many awards for their patents at various international fairs and exhibitions dedicated to patents.

Biodegradable Magnesium Alloys: from Implant Material Concept to Clinical Applications

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Abstract

Magnesium-based alloys are at this moment the most studied implant materials in the research for developing potential new implants for hard tissue and for bone tissue engineering. They are characterized by numerous advantages such as biodegradability, high biocompatibility and mechanical properties with values close to the human bone. Unfortunately, the implant surface must be adequately tuned, or Mg-based alloys must be alloyed with other chemical elements due to their increased corrosion effect in physiological media. The main advantages of the Mg-based alloys can be easily summarized as follows: osteogenesis and high biocompatibility, biodegradability and possibility to avoid implant removal surgery, and good mechanical properties. The major drawback of Mg alloys is their low corrosion resistance in physiological media, which promotes a fast decrease of the mechanical properties resulting in the early failure of implants before the completion of the tissue-healing process. Also, the hydrogen evolution that represents the main cathodic reaction, which occurs simultaneously with the Mg-based alloy corrosion process, may significantly impair hard tissue healing. The implant interface challenges are related to new bone formation and fracture healing, implant degradation and hydrogen release. A detailed analysis of mechanical properties during implant degradation is extensively described based on different literature studies that included in vitro and in vivo tests correlated with material properties. Some Mg-based implants and regenerative scaffolds are presented, taking into consideration their manufacturing technology, the implant geometrical dimensions and shape, the type of in vivo or in vitro studies. Modern technologies that modify or adapt the Mg-based implant interfaces are described by presenting the main surface microstructural modifications, physical deposition and chemical conversion coatings. The aim of this study is to show the current status in the field of biodegradable magnesium alloys, and potential applications in orthopedics and dentistry. An evolution of the potential of various Mg alloys by focusing on their in vitro properties, biocompatibility, and preliminary in vivo performance. The last part of the lecture provides some recommendations from a translational perspective, identifies the challenges associated with Mg-based implants and presents some future opportunities. Also, the presentation outlines the available literature on potential application in dentistry for Mg-based implants or magnesium matrix composites. The potential for new clinical application of the Mg-based alloys in orthopedic and dentistry are very high due to their major advantages and innovative techniques for processing and surface modification. Future studies will be focused on clinical studies to further validate these findings and optimize the clinical use of Mg alloys.

Keywords: Magnesium alloys, dental applications, tissue engineering, regeneration, biodegradability

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Yavuz Nuri Ertaş is an Associate Professor at the department of Biomedical Engineering in Erciyes University. He received the B.S. degree in Biomedical Engineering from Başkent University and the M.S. degree in Materials Science and Nanotechnology from Bilkent University. He later moved to USA for the doctoral studies and received the Ph.D. degree in Biomedical Engineering from University of California, Los Angeles (UCLA) in 2017. From 2018 to 2020, he was a Postdoctoral Researcher in the department of Chemistry at UCLA. Since 2020, he has been working at the Biomedical Engineering department in Erciyes University and directing an interdisciplinary laboratory (www.ertaslab.com) at Erciyes University Nanotechnology Research and Application Center (ERNAM). He is a recipient of the International Fellowship for Outstanding Researchers Program (TÜBİTAK 2232) in 2020. He was awarded with the 2023 Health Institutes of Türkiye (TÜSEB) Incentive Award for contributions to the fields of nanomedicine and biomaterials, and 2023 Turkish Academy of Sciences Outstanding Young Scientist Award (TÜBA-GEBİP) in 2023. Recently, he also received the 2024 Scientific and Technological Research Council of Türkiye (TÜBİTAK) Incentive Award, the highest level of recognition for a young scientist in Türkiye. Prof. Ertaş conducts research on nanomedicine and biomaterials. His research interests include the development of nanoparticles as contrast agents for magnetic resonance imaging, the production of innovative nanomaterials with antibacterial activity, the development of biomaterials for wound dressing and tissue regeneration applications, and the use of nanotechnology in cancer therapies such as chemotherapy, photothermal, photodynamic, chemodynamic, magnetic hyperthermia and radiotherapy.Prof. Ertaş has authored close to 100 scientific international papers, some of which are published in top-tier journals such as ACS Nano, Small, Advanced Healthcare Materials, ACS Applied Materials & Interfaces, Angewandte Chemie, Chemical Engineering Journal, Chemistry of Materials, ACS Applied Nano Materials, ACS Biomaterials Science & Engineering, Journal of Controlled Release, ACS Applied Polymer Materials, Cancer Letters, Biomaterials Advances and Bioengineering & Translational Medicine. As of December of 2024, he has close to 3000 citations with an h-index of 28.

Nanoparticle and Implantable 3D-printed Scaffold-Based Approaches for Enhanced Cancer Treatment via Radiotherapy

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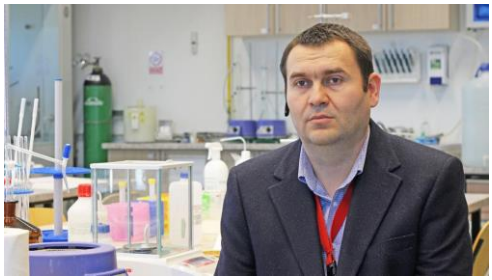
Abstract

Radiotherapy is a common cancer treatment in medical practice that utilizes high-energy X-rays to administer radiation doses to cancerous tissues. However, the therapeutic use of radiotherapy is constrained by its low radiosensitivity, inaccurate tumor localization and poor differentiation between lesions, and the adverse effects of irradiation in healthy tissues. Hence, it is crucial to develop methods to enhance the radiosensitivity of malignancies while reducing their systemic side effects. Combining nanotechnology with radiation improves therapeutic results. Using high-atomic-number (high-Z) nanoparticles as radiosensitizers can greatly enhance the effectiveness of breast cancer treatment when exposed to X-ray radiation, as evidenced by studies evaluating cell viability, proliferation, reactive oxygen species production, and in vivo antitumor effects. Implementation of chemotherapy along with radiotherapy, known as synchronous chemoradiotherapy, can further augment the treatment efficacy. Tumor targeted and anticancer drug loaded nanoparticles will be discussed within this concept. Finally, this talk will focus on improving local cancer therapy via surgical implantation of 3D-printed nanoparticle-containing scaffolds to address the chronic problem of metastasis after surgical removal of tumors. Biocompatible and biodegradable scaffolds may potentially lower the recurrence and metastasis rates in breast cancer patients by inhibiting residual tumor cells following post-surgery, as well as exhibit anticancer properties in other solid tumors.

Keywords: radiotherapy, cancer, nanoparticle, scaffold, 3D printing.



Anton FICAI

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Anton FICAI (born 1981) is full professor and PhD advisor in the Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA Bucharest being actively involved in both academic and scientific life of the university. His major academic interests are related to Composite Materials for Medicine, NanoBioMaterials for Tissue Engineering and Drug Delivery Systems. The research interests are much broader, having the chemical approaches in the center, and cover the following topics: tissue engineering; drug delivery systems; multifunctional materials; composite materials; coatings, antimicrobial / antitumoral materials; nanoparticles synthesis and characterization; surface modification; etc. Till now, over 350 scientific papers, from which over 300 ISI papers and 22 books or chapters (including 2 edited books) were published along with 28 patent applications (10 of them being already released). The international recognition of the R&D activity can be highlighted by the multiple invitations for participate as speaker at international conferences, the positions of guest editors, member of the editorial boards of different national and international journals as well as Section Editor in Chief of Coatings. Valedictorian of UPB, former participant and laureate of the National Chemistry Olympiads he was awarded with over 150 Gold Medals, Special Awards or Best Paper Awards and recently, he was awarded with the Special Award for Transfer of the Research Results into Economy by the Ministry of Resort during the First edition of the “Gala Cercetării Româneşti”. He is also full member of The Academy of Romanian Scientists and several professional societies.

Smart Drug Delivery Systems and Personalized Therapies

Anton FICAI

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Abstract

The grafting materials are of great importance in the medical market because, many times, for an efficient and proper healing, grafting materials are needed and, the existent available grafts (auto-, alo- and xenografts) cannot cover all these needs. Among these grafts, the need of the bone grafts is the highest, ~49% followed by blood vessel, nerve and skin grafts, each of them ranging between 11 and 9%. Considering the causality, pure regenerative but also drug delivery systems with specific properties are required. The use of drug delivery systems is mainly needed when some specific diseases are associated such as osteoporosis, diabetes, infections, cancers, etc. Stimuli responsive drug delivery systems can be efficient to assure improved healing and lower (systemic) toxicity. External and internal stimuli such as electromagnetic fields, light, pH, temperature, enzyme, ionic strength and concentration of specific ions are increasingly used.
This presentation will be mainly focused on presenting some relevant examples related to the smart drug-delivery systems for soft and hard tissue engineering highlighting the advances in the field and the potential associated with the personalized therapy.

Keywords: grafting materials; composite materials; smart drug delivery; personalized medicine.

Acknowledgments: The authors are acknowledging the support of the project 29ROMD/20.05.2024: “Nanostructured bone grafts with predetermined properties”.

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Gultekin Goller is a Material Science Professor in the Department of Metallurgical and Material Engineering at the Istanbul Technical University, Turkey. He supervised 10 PhD thesis and 40 master thesis. Presently he is supervising 3 PhD and 3 master thesis. He is Co-author of 130 scientific articles, 5 book chapters with over 2388 citations reported by WoS (H-index 27) as a date of May, 28 st , 2024. In addition, he is member of the scientific committee of different meetings, head of the organizing committee for different international conferences, member of the International Editorial Board of some journals, and reviewer for different journals. He is honoured with the “Doctor Honoris Causa” title in material science from Politehnica University of Bucharest in 2022. He is awarded to “Pro Scientia et Innovatio” Honorary Order of Romania Inventory Forum in 2023. His research interests are in the field of metallurgical & material engineering especially concentrated on ceramic based composite materials, high entropy alloys, biomaterials and refractory materials. His main activities relating to these topics are focused on the spark plasma sintering, plasma coating and materials characterization by X-ray diffraction and electron microscopic techniques.

Research Studies on Bioceramics, Composites and Glass Ceramics

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Abstract

This talk will provide a detailed overview of the processing techniques and properties of bioceramics, with special emphasis on nearly inert ceramics, bioactive ceramics and composites. Talk also covers powder synthesis, processing methods for porous and dense bulk bioceramics using conventional pressureless sintering and spark plasma sintering. Further physical, microstructural and mechanical characterization techniques will be discussed. Biological behavior and bioactivity measurements of bioactive composites and zirconia toughened alumina composites in in-vitro environments such as cell viability assays are also elucidated.

Keywords: Bioceramics; Composites; Glass Ceramics; Spark Plasma Sintering.

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Dr.S.Yamini Sudha Lakshmi has completed M.Sc in Biochemistry (1988), in Avinashi Lingam Home Science College, Coimbatore, M.Phil(1992), Ph.D(2003),PGDBI(2004) and CRA(Canada 2022). Has completed 37 years of teaching and research till date .Currently working in Department of Medical Biochemistry, University of Madras, Taramani Campus with the research related to Cancer Biology and nanopreparations, Synthesis and Formulation ofpotentised drugs and compounds.She has headed the Department of Biochemistry in various colleges and has served as Dean of Academics in an University of Madras Affiliated College. Also established the Department of Bioinformatics and Headed the Department. Served as Head of the Department of Basic Medical Sciences in Eritrea, College of Allied Health Sciences, Asmara, North East Africa. Has guided 27 M.Phil students and other project students of Biotech disciplines of Engineering Colleges and currently Guiding the Ph.D research scholars.Visited Countries like France(2016), Germany (2016) Abhudhabi (2010),Srilanka2012&2020),Dubai(2017&2023), Australia (2018) Singapore (2020) , HongKong(2020) and Thailand (2022)for delivering a talk as a keynote speaker as well as to conduct workshop.To her credit has published about 35 papers in national and international Journals.Has Organised first ever International Conference in the Dept of Medical Biochemistry, University of Madras Taramani Campus in the year 2018 since the department establishment (1968).She is also the life time member of various associations.She has been honoured with about 12 Awards till date from various Recognised bodies of the Nation. She has also been honoured as the Vice Chancellor of World Tamil University, USA since 2022 till date. She is one amongst the Indian who has registered for the whole body donation to the welfare of students fraternity.

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Evaluation and Comparison of Potentized Drug against Cancer

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Abstract

Tautopathy is an enhanced tool for the homeopathy to use in different cases coming from the allopathic system. It is science of antidotes and toxicology. It helps to remove bad effect of allopathic drugs. Tautopathy remedies with water and herbal tinctures are used for detoxification process. Tautopathic medicines are prepared by trituration and succession method by using decimal and centesimal scales. Side-effect of drug and its chronic symptoms, psychological and physiological addiction, overdoses of drug, chemical poisoning's are treated by using tautopathic remedies. tautopathic treatment is that which is carried out with a potentized drug made from a substance that caused the respective disorder. Tautopathic drugs have a major role. Either they relieve the patient of the effects of the drug thereby curing the disease or remove the blockage helping the similimum to establish cure. Tautopathic drugs have a major role. Either they relieve the patient of the effects of the drug thereby curing the disease or remove the blockage helping the similimum to establish cure. Tautopathic drugs have a major role. Either they relieve the patient of the effects of the drug thereby curing the disease or remove the blockage helping the similimum to establish cure. Tautopathic drugs relieve the patient of the effects of the drug thereby curing the disease or remove the blockage helping the similimum to establish cure.
In the current study, Tautopathic Medicines are made by potentizing the conventional drugs used for the treatment of cancer. The process of potentization is similar to that used for homeopathic medicines, i.e., trituration and succussion. Both the decimal and centesimal scales are used and evaluated. The comparison of potentized drug against the crude drug. This would also appear to confirm the tautopathic hypothesis that the potentized drug can remove or reverse the action of the crude drug it is prepared from, with regard to the precise symptoms it induces.

Keywords: Tautopathy, potentized drug.

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Mahmut PARMAKSIZ is Associate Professor at Ankara University Stem Cell Institute, Türkiye. He received the B.S. degree in Chemistry from Ankara University, completed his MSc and PhD on regenerative biomaterials at “Tissue Engineering, Biomaterials and Nanobiotechnology Laboratory” at the Department of Chemistry/Biochemistry, Ankara University. Following a one-year postdoctoral position at the Valencia Polytechnic University - Center for Biomaterials and Tissue Engineering, Spain, he started working as a faculty member at Ankara University Stem Cell Institute. His research interests mainly focus on extracellular matrix (ECM) based materials (hydrogels, grafts, cell culture surfaces etc.), in-vitro microtissue models, development & characterization of functional biomaterials for regenerative medicine applications. He has several journal articles, book chapters, patents, conference papers and national/international projects in these fields.

Cell-Derived Extracellular Matrix Based 3D Biohybrid Angiogenic Tissue Scaffolds: In-vitro, Ex-ovo and In-vivo Evaluations

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Abstract

Decellularization is one of the remarkable biomaterial production approaches in recent years. Here, ECM isolated from tissues or organs is used to develop bioscaffolds rather than imitating the native ECM. Frequently used xenogenic or allogeneic tissue sources may face limitations such as the risk of zoonosis, donor shortage, or the formation of a secondary defect during tissue harvesting. The use of in-vitro “cell culture-based ECM” has recently emerged as an alternative approach to overcome the limitations of tissue/organ decellularization. This approach overcomes the limitations associated with organ sources, possesses the ease of unlimited production in 2D culture; thus it seems possible to overcome the limitations faced with bioscaffold productions. A better understanding is possible when considering that the natural ECM is secreted by cells of the related tissues/organs. However, there is a limited number of studies investigating the suitability of cell culture-based ECM as a component in scaffold development. In particular, contribution of cell culture-based ECM to the neovascularization process is an almost untouched research area to be explored. This talk will mainly focus on simultaneously solving two existing problems of tissue engineering by developing a human stem cell derived ECM decorated biohybrid tissue scaffold. Furthermore, the angiogenic and regenerative behaviors of biohybrid scaffolds will be discussed with in-vitro, ex-ovo and in-vivo study findings.

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Advancing Musculoskeletal Tissue Engineering Trough Microfluidic-Assisted Biofabrication

Wojciech ŠWIESZKOWSKI

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Abstract

The development of biomimetic 3D tissue models is a critical advancement in tissue engineering and regenerative medicine. In this work, we present an innovative biofabrication strategy that leverages microfluidic principles to construct highly precise, biomimetic 3D models of human tissues. By integrating a microfluidic extrusion system with high-resolution, computer-controlled 3D deposition, we can fabricate complex, tissue-like structures using hydrogel inks embedded with diverse cell types. This cutting-edge approach allows for the creation of living constructs that closely resemble the architecture and function of natural tissues, such as muscles, blood vessels, and more.

Depending on the target application, the bioinks are composed of modified biopolymers such as gelatin, alginate, fibrinogen, hyaluronic acid, PEG, or polymer-ceramic composites. These hydrogels are loaded with different cell types, including bone marrow-derived human mesenchymal stem cells, muscle precursor cells, and HUVECs. The resulting high-resolution, fiber-based 3D printed living constructs successfully mimic organized tissues, including cartilage [1], muscle [2,3], and muscle-tendon junctions [4].

Keywords: Musculoskeletal Tissue Engineering furanocoumarins, bergaptol, anticancer, anti-angiogenic, 3D microtissues.

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[4] Volpi M, et al. Advanced Healthcare Materials, accepted

Stefan Ioan VOICU

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Stefan Ioan Voicu is Professor at the Faculty of Chemical Engineering and Biotechnologies starting his career in 2009, with a Bachelor in Organic Chemistry (from 2005), Ph.D. in Polymeric Membranes (from 2008), and Habilitation in Chemical Engineering (from 2016). He published 15 books and book chapters (Wiley, Springer Nature, Elsevier), >80 peer reviewed scientific papers with Hirsch index 38, total number of citations 4700+. The main research interests are related to polymeric membranes for biomedical applications with outstanding contributions in the field of surface functionalization methods for hemodialysis and osseointegration and polymeric membranes for water purification (first report in literature for membranes with self-indicating properties, that change the color surface during filtration process). Except academic activity, Prof. Voicu has also experience in the field of industrial research, being for two years Research Scientist at Honeywell Automation and Control Solutions, Sensors Laboratory with 3 granted US Patents (US 7,695,993 B2, US 7,867,552 B2, US 7,913,541 B2) developed in the field of metallic surface functionalization for SAW chemical sensors. He served as editor at different prestigious publishing houses, like Elsevier or Springer Nature.

Functional Polymeric Membranes for Osseointegration and Hemodialysis

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Abstract

The field of membrane materials is one of the most dynamic due to the continuous requirements regarding the selectivity and upgrade of the materials developed with the constantly changing needs. Two membrane processes are essential at present, not for development, but for everyday life – desalination and hemodialysis. Hemodialysis has provided life and increased life expectancy over the past 60-70 years for tens of millions of people with chronic kidney dysfunction. This presentation is focused on the latest developments in the field of membrane materials for biomedical applications. A short introduction to the field of membrane materials will open this fascinating journey, the main subject being the applications of these materials in hemodialysis, osseointegration, artificial lungs, liver and pancreas, controlled drug delivery, proteins separations and other related separations with the biomedical sciences (antibiotics removal from environment or retention of compounds used un clinical imaging techniques). Surface treatment (chemical reactions, plasma or laser treatment) of membranes to increase separation properties, hemocompatibility, reduce toxicity or achieve desired physical properties will be presented and discussed. Some future trends and actual scientific projects will end this presentation.

Keywords: polymeric membranes, hemodialysis, osseointegration

ABSTRACTS OF ORAL PRESENTATIONS

OP-01

Mesoporous Silica Nanoparticles Mediated Gene Delivery to Target MUC-1 Inhibition in Breast Cancer Micro-Tissues

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Abstract

Breast cancer is the most common cancer in women, with a rating of 25.1%. Breast cancer also holds the top spot among women's causes of death, with a rate of 12.9%. Breast cancer has emerged as the most prevalent cancer globally. Researchers have achieved remarkable breakthroughs in the treatment and diagnosis of cancer. There are numerous treatment methods for cancer, including surgery, chemotherapy, radiotherapy, immunotherapy, gene therapy, and hormonal therapy, all of which are still effective today. Although these treatment methods, especially the use of chemotherapeutic drugs, are quite high and allow a positive healing process, there are also serious side effects and disadvantages for patients. Because the disease responds to chemotherapeutic drugs for a long time and becomes resistant to drugs, current treatment methods are less effective. Given these factors, the current approach to treating breast cancer cases involves the use of surgery, chemotherapy, and radiotherapy, either individually or in combination, without the development of a gene therapy protocol. A treatment method that targets the functions and formation of molecular biomarkers specific to breast cancer holds promise for achieving the expected effects in oncology treatments. In this study, we developed an innovative approach to reduce the MUC1 protein expression in breast cancer cells. We do this by combining plasmid DNA (pDNA), which produces MUC1-specific short hairpin RNA (shRNA), with mesoporous silica nanoparticles to develop a nanomedicine-based therapeutic method. The study's additional unique value is to test the efficacy of the planned treatment method in 3-dimensional (3D) micro-tissues, to mimic cancer's real tumor structure by examining the effectiveness of tumor dispersal. The results revealed that the net positively surface charged MSNs were developed to inhibit the MUC1 gene associated with breast cancer, and these nanoparticles were used as a carrier system for the transport of pMUC1-shRNA. It was shown that when complexed, MSN protected pMUC1-shRNA against DNAse and could release it in a suitable environment. Then, the potential of the pMUC1-shRNA:MSN-PPI complex to inhibit the MUC1 gene was evaluated in 3D breast cancer microtissues, which are physiologically more similar to the *in vivo* environment. As a result of the analyses, it was seen that pMUC1-shRNA: MSN-PPI reduced the relative MUC1 mRNA level by 33%. When all the data were considered, it was seen that MSN-PPI could be a plasmid DNA carrier system and provide gene silencing in 3D cancer microtissues. In near future studies, we plan to examine gene silencing at the protein level and evaluate the transfection efficiency of MSN-PPI *in vivo* animal experiments.

Keywords: gene delivery, nanoparticles, microtissue, breast cancer

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OP-02

Manufacturing of PHBV/Modified TPS Films as Wound Dressing

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Abstract

Wounds are a global health problem that can lead to problematic situations from infections to disability and even death. Therefore, it is vital to heal wounds quickly and effectively. In this study, we aimed to develop a low-cost and high-performance wound dressing using natural polymers, starch and polyhydroxybutylvalerate (PHBV). The wound dressing was produced in an extruder by mixing PHBV and thermoplastic starch (TPS) in a ratio of 85/15, and the compatibility of PHBV and TPS was tried to be improved by using citric acid at different ratios as a compatibilizer. FTIR, DSC, TGA and SEM analyses were performed to determine the structural, thermal, and morphological properties of the obtained PHBV/TPS films. After sterilization of the produced films, cell proliferation and toxicology tests, cell adhesion evaluation and in vitro scratch assay tests were performed.

Keywords: PHBV, TPS, extrusion, wound dressing,

Acknowledgment This study was supported by Türkiye Sağlık Enstitüleri Başkanlığı (TÜSEB), Project number: 2022-A2-YL-28773.

OP-03

Therapeutic Potential of Stem Cell-Derived Extracellular Vesicles Loaded into Alginate Dialdehyde-Gelatin Hydrogels for Testicular Torsion

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Abstract

Testicular torsion (TT) is an acute ischemia of the testicle caused by a sudden disruption of blood flow to the organ. TT is a significant cause of male testicular failure and infertility. The standard treatment involves surgical intervention and detorsion [1]. However, surgery alone often fails to prevent ischemia-reperfusion injury, underscoring the need for new strategies to improve outcomes. This study aimed to develop an extracellular vesicle (EV)-loaded alginate dialdehyde-gelatin (ADAgel) injectable hydrogel and evaluate its effectiveness in both *in vitro* and *in vivo* models of testicular torsion.

EVs were isolated from rat bone marrow mesenchymal stem cells (rt-BMSCs) using ultracentrifugation, and their physicochemical properties (size, number), morphology, and markers (CD63, CD81, CD9) were characterized through nanoparticle tracking analysis (NTA), transmission electron microscopy (TEM), and flow cytometry. The dose-dependent effects of EVs (10 and 50 µg/mL) on cellular viability, uptake, and antioxidative properties were assessed using mouse testicular Sertoli cells (TM4, ATCC® CRL-1715™). Additionally, angiogenic effects were tested using aortic ring and chorioallantoic membrane (CAM) assays. Injectable ADAgel hydrogels were synthesized through a Schiff base reaction [2] using various concentrations of ADA and gelatin solutions (2.5-20%, ratio 1:1) and were characterized for morphology, swelling, degradation, rheology, cytotoxicity, and injectability. The angiogenic effects of EV-loaded ADAgel hydrogels were assessed via the CAM assay, followed by *in vivo* testing on rats with 3-hour torsed testes, with therapeutic effects evaluated histologically after 7 days.

The isolated EVs exhibited a cup-shaped morphology (150-200 nm) and expressed CD63, CD9, and CD81. These EVs were taken up by TM4 cells in a time-dependent manner, significantly enhancing cellular proliferation at higher doses ($p<0.05$). Compared to the H_2O_2-treated TM4 group, EV treatment (10 and 50 µg/mL) significantly improved cellular viability, indicating that EVs suppress oxidative stress. Both the aortic ring and CAM assays demonstrated enhanced angiogenic effects with higher EV doses. All ADAgel hydrogel formulations were non-toxic to L-929 and TM4 cells. Encapsulation of EVs into the hydrogels did not alter their angiogenic effect, and blood vessel density significantly increased in the EV-loaded ADAgel group compared to controls ($p<0.05$). *In vivo* experiments demonstrated that

EV-loaded hydrogels reduced the effects of testicular torsion and improved sperm quality compared to the control group. In conclusion, EV-loaded injectable hydrogels represent a promising new treatment option to enhance surgical outcomes for testicular torsion in clinical settings.

Keywords: Extracellular Vesicle, Injectable Hydrogel, Testicular Torsion

Acknowledgments

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OP-04

Development and Characterization of Drug Loaded Chitosan/Silk Fibroin Electrospun Nanofibers for Wound Dressing Material

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Abstract

Wound dressing biomaterials are essential for wound management as they can stop bleeding, protect wound site from external environment, absorb exudates and accelerate the healing process. Among the various dressing materials, nanofibers can simultaneously combine the natural polymers which have different physical characteristics. To enhance the efficiency of electrospun nanofibers, biomolecules and drugs can be applied in the combined polymeric solutions to create structures with improved properties. Electrospun nanofibers have been reported to possess great potential for drug-delivery investigations due to unique properties like simultaneous delivery of diverse therapeutics, high drug loading capacity, modulating drug release profiles[1].

Chitosan (CS) is attractive natural polymer as a wound dressing biomaterial with its biocompatibility, biodegradability, soft adhesive, non-toxic, antibacterial, and hemostatic properties. Silk fibroin (SF) is a protein-based material with good biocompatibility, high water absorption, low immunogenicity, high tensile strength, flexibility, and sustained drug delivery[2]. Vancomycin is a glycopeptide antibiotic agent commonly used in the treatment of several dangerous infections caused by gram-positive microorganisms[3].

In this study, we fabricated and characterized an antibacterial electrospun CS/SF nanofibers containing vancomycin for wound dressing applications. The morphology, chemical structures and thermal properties of the drug free and drug loaded nanofibers were determined by scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), and thermo gravimetric analysis (TGA) respectively. Their swelling, degradation behaviour and drug release kinetics were also investigated. FTIR and SEM results showed the presence of good interaction between the polymers and drug molecule. TGA results revealed that the drug loaded nanofibers increased the thermal stability compared to drug free nanofibers. The drug loaded nanofibers showed desirable swelling behavior at pH 7.4 at 37˚ C, it is expected that the nanofibers would be of great potential for wound healing. The nanofibers are also a prospective material for sustained drug release and the cumulative drug release data were fitted to Korsmeyer–Peppas kinetics. In vitro cytotoxicity evaluation studies confirmed that drug loaded CS/SF electrospun nanofibers demonstrated good biocompatibility.

In conclusion, the results demonstrated that drug loaded CS/SF electrospun nanofibers promising potential in therapeutic wound dressing.

Keywords: wound dressing, nanofiber, drug delivery, chitosan, silk fibroin

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OP-05

A Point-of-Care Test Platform for the Diagnosis of Fabry Disease

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Abstract

Fabry disease (FD) is a rare, X-linked hereditary disorder of glycosphingolipid metabolism, caused by a deficiency of the lysosomal enzyme α-galactosidase A (α-Gal A). This deficiency leads to the accumulation of globotriaosylceramide (Gb3) and globotriaosylsphingosine (lyso-Gb3), resulting in a broad range of clinical symptoms and progressive organ damage. Early diagnosis is crucial, as enzyme replacement therapy (ERT) or dietary modifications can prevent irreversible damage. However, the current diagnostic methods generally require expensive equipment and professional expertise, and the preparation and extraction of the samples can take up to 24 hours. Therefore, it is essential to develop methods that are practical, portable, inexpensive, can be applied to low-volume samples, and provide rapid results for the diagnosis of the disease.In this study, we developed a portable Fluorometric measurement platform designed for the rapid and early diagnosis of Fabry disease. We employed the fluorogenic substrate 4-methylumbelliferone (4-MU) to assess α-Gal A activity. Upon hydrolysis by α-Gal A, 4-MU produces a fluorescent product, the concentration of which correlates with enzyme activity and can be quantified via fluorescence measurements. To ensure optimal system performance, we conducted experiments to test various parameters, including incubation times, lower reaction volumes and pH range of serum plasma, to determine the ideal conditions for detecting enzyme activity. The method we tested enables rapid (<2 hours) and sensitive measurements using low sample volumes (<10 µL). Our results indicate that α-Gal A activity in plasma can be reliably detected at levels as low as <1 nmol/h/mL, which is consistent with reported values for Fabry patients, where activity typically falls below 0.6 nmol/h/mL.This study paves the way for future studies integrating a centrifuge mechanism to further optimize plasma separation from whole blood sample, and develop a prototype of a new Lab-on-Disk-based point-of-care test system for diagnosis of Fabry disease. Single-use, CD-shaped microfluidic chips have been designed and developed to separate whole blood into its cellular components to obtain pure plasma and to measure α-Gal A enzyme activity. The completion of this prototype marks a significant step toward its clinical application and widespread use. In conclusion, the proposed test system presents a promising, low-cost, portable, and alternative for Fabry disease diagnosis, emphasizing the importance of rapid detection in improving patient outcomes.

Keywords: Fabry Disease, Fluorometric measurement, Alpha Galactosidase, Point of Care Testing, Biosensor

Acknowledgements
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OP-06

Small Intestinal Submucosa Decellularization with Supercritical Carbon Dioxide

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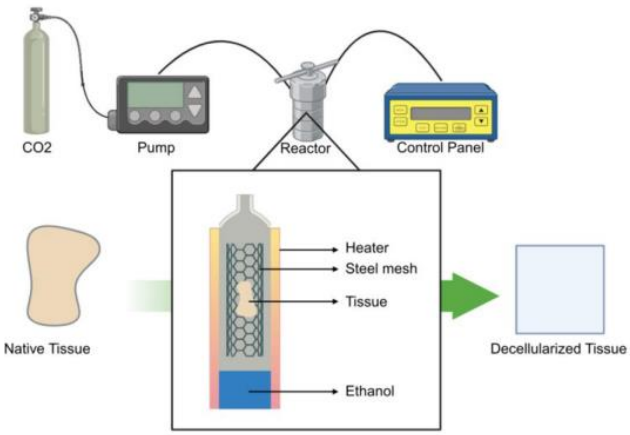
Abstract

Biomaterials are commonly used for treatments and therapeutic applications. In the last years acellular grafts draw attention due to their functional micro-environment for tissue-cell interactions in addition to its structural integrity and bioactive molecules. In this study, a novel supercritical carbon dioxide (scCO2) decellularization method was developed for small intestinal submucosa (SIS) decellularization. The efficiency of the scCO2 protocol was evaluated by comparing with a method which was published by Luo et al (Luo et al., 2011). The removal of genomic DNA was found to be 91.13% after conventional method decellularization on the other hand, scCO2 decellularization yield was 92.77% in terms of genomic DNA removal. Both protocols were characterized and compared by H&E and DAPI histological staining's to investigate the extracellular matrix (ECM) after decellularization. Glycosaminoglycan (GAG) assay showed a 75.47% decrease in the conventional method decellularization group whereas 2.08% GAG amount decrement was observed in the scCO2 decellularization group. In vitro cell culture studies showed high cell viability and proliferation for both protocols. It was shown that the scCO2 technology was an efficient and high-yielding method for the decellularization of SIS as an alternative to conventional methods.

Keywords: Decellularization, SIS, Membrane, Supercritical Fluid



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OP-07

Wearable Antennas in the ISM Band for Biomedical Applications

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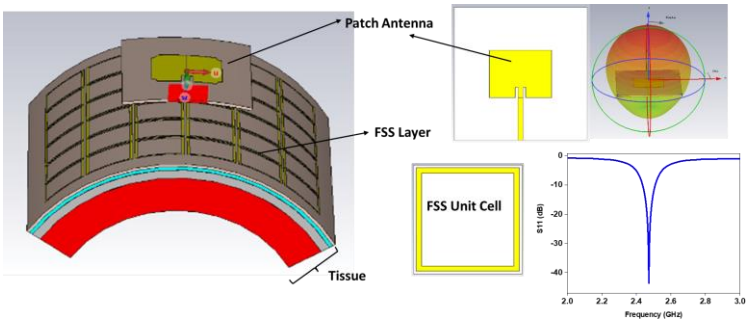
Abstract



Planar antennas gained great attention due to their compactness, lightweight, and low cost. They can use wearable devices for the human body to monitor health conditions. In this study, we designed a planar antenna that operates in a 2.45 GHz industrial, scientific, and medical (ISM) band with a layer (at the bottom of the antenna) both to improve antenna characteristics and to reduce specific absorption rate (SAR) values. The related layer was designed as a frequency-selective surface (FSS). The FSS layer helps to reduce the SAR value at an optimized distance from the antenna. Furthermore, the FSS structures and designed antenna were tested for bending conditions. The FSS structures successfully decreased SAR values at a high rate.

Keywords: Wearable antenna, Patch antenna FSS layer, SAR reducing

Acknowledgment: This study was supported by the Kocaeli University BAP Coordination Unit, project number FDK-2024-3576, and Nokta Engineering Corporation.

OP-08

Green Synthesis and Characterization of Citric Acid-PEG Modified Alginate Hydrogels for Biomedical Applications

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Abstract

Today, with the remarkable evolution of modern and smart technologies related to tissue engineering and regenerative medicine, the use of sustainable and biodegradable materials with biocompatibility and cost-effective advantages is paramount owing to the personalized and specialized requirements from patients and doctors. The successful design of effective biomaterials for serving this purpose is primarily based on the use of biodegradable, biocompatible polymers as scaffolding materials which are either derived from natural polymers such as polysaccharides and polypeptides, or synthetic polymers.

Alginate, a polysaccharide well known to form physical hydrogels in the presence of divalent cations such as Ca^{2+} and Ba^{2+}, is typically used in the form of a hydrogel in the biomedical field, including wound healing, drug delivery, and tissue engineering applications. However, its low *in vivo* biodegradability and mechanical stability in aqueous solutions is a limiting factor. Furthermore, alginates exhibit poor cell adhesion and proliferation due to the lack of specific molecular interaction with mammalian cells. To address this issue and expand their use in various medical fields, developing alternative new low cost and green strategies and techniques to design new alginate-based biomaterials with improved functional properties and performance has become paramount in today's medical technology. Citric acid, an intermediate product of the Krebs cycle, has three carboxyl groups and one hydroxyl group with three possible acid dissociation constants. This makes citric acid an excellent green crosslinking agent, both through physical crosslinking (hydrogen bonding) and covalent crosslinking (ester bonds).

In this study, alginate-based 3D hydrogels were prepared in a completely green synthetic way, using Caffeine-catalyzed citric acid-polyethylene glycol as the cross-linker system. First, the crosslinker was prepared via caffeine-catalyzed ring-opening polymerization of citric acid and polyethylene glycol diglycidyl ether. Sodium alginate was then crosslinked through polycondensation reaction and hydrogen bonding with the crosslinker to form a 3D hydrogel. The obtained hydrogel was characterized by FTIR, Solid state NMR, SEM, TGA and DSCA. Hydrogel's physical properties such as thermal stability, swelling ratio and gel fraction as well as compressive strength were studied and optimized. Interestingly, the developed hydrogel constructs could withstand compressive deformation in both dry and swollen state without significant damage and were able to regain their initial shape after unloading, indicating that the hydrogels had a certain shape-recovery property.

Keywords: Modified alginate, 3D hydrogels, citric acid, green synthesis

OP-09

Thermosensitive Polysaccharide-based Hydrogels: Gelation Mechanisms, and Biomedical Applications

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Abstract

Polysaccharides have gained interest as promising materials for biological applications due to their biocompatibility, biodegradability, non-toxicity, low cost and excellent mechanical properties [1]. Thermosensitive polysaccharide-based hydrogels are an important class of intelligent biomaterials that undergo a reversible phase transition when exposed to temperature stimuli. The thermosensitive property of polysaccharides can be achieved by incorporating or grafting a thermosensitive polymer. A large number of functional groups, such as hydroxyl groups, carboxyl and amino groups on the main chain of polysaccharides, provides opportunities for grafting with thermosensitive polymers.

In this study, we first synthesized a novel and facile synthetic thermoresponsive poly (N-vinylcaprolactam) (PNVCL) via free radical polymerization. This compound was then effectively grafted with several modified polysaccharides (galactosylated chitosan, aminated alginate, and oxidized carboxymethyl cellulose) using different coupling reagents (NHS/EDC, EDC/HOBt etc.) [2 and 3]. In this presentation, the modification strategies and gelation mechanisms of the polysaccharide-based hybrid copolymers used to construct various hydrogels will be briefly explained and the temperature-dependent water uptake and drug release performance will be shown.

The newly formed thermosensitive polysaccharide-based hydrogels displayed novel properties, such as increased mechanical strength and thermal stability. Moreover, our studies demonstrated that these hydrogels underwent a reversible and rapid sol-gel transition at a lower critical solution temperature (LCST) of 32-38 °C in aqueous conditions, making them suitable candidates for controlled drug release. They can be used as delivery systems for drug release, enhancing therapeutic efficacy while minimizing potential side effects.

Keywords: Polysaccharide, thermosensitive hydrogels, poly(N-vinylcaprolactam), drug delivery

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OP-10

The Design of a Glutathione-Based Injectable Hydrogel from Natural Sources

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Abstract

Glutathione (GSH) is a tripeptide consist of glutamic acid, cysteine and glycine amino acids synthesized in cells [1]. GSH is a potent antioxidant involved in many basic biological processes, including protein and DNA synthesis, cell proliferation and oxidation/reduction signaling [2]. GSH has potent antioxidant activity, is involved in numerous basic biological processes and has been used for interventions in various degenerative diseases. However, GSH use has been severely restricted by physical and chemical barriers in the gastrointestinal (GI) tract after oral administration, thus resulting in low oral bioavailability [3]. In order to improve appropriate formulations with valuable clinical therapeutic effects, various delivery strategies have been developed, such as hydrogels, encapsulation into nanoparticles, microemulsions and liposomes [4],[5]. Hydrogels, which are three dimensional networks of crosslinked hydrophilic polymers, have a significant role in solving the clinical and pharmacological limitations of present systems because of their biocompatibility, ease of preparation and unique physical properties such as a tunable porous nature [6].The development of an *in situ* forming injectable hydrogel system allows excellent spatial and temporal control, unlike systemically administered therapeutics [6]. To enhance the bioavailability of GSH, the research was focused on strategies with the ultimate goal of developing injectable hydrogel. In this study, first of all, to obtain efficient levels of GSH from natural sources, lyophilized and fresh plant samples from broccoli (*Brassica oleracea*), spinach (*Spinacia oleracea*), cabbage (*Brassica oleracea* var. *capitata* f. *alba*) purslane (*Portulaca oleracea*) were optimized for extraction. Analytical methods using HPLC with both an ultraviolet detector (UV) and HPLC with a fluorescence detector (FLD) was developed in order to determine GSH quantitatively and qualitatively, the results were compared. According to the results of HPLC-UV, the highest level of GSH was obtained with the lyophilized spinach plant, while, no peak was obtained in fresh purslane. The results of HPLC-FLD also revealed the lyophilized spinach plant having the highest level of GSH. Likewise, no peak was obtained in fresh and lyophilized purslane. Then, natural glutathione-based injectable hydrogel and commercial-synthetic glutathione-based injectable hydrogel were designed. While similar results were obtained in terms of chemical structure, a natural-source glutathione-based injectable hydrogel had a better homogeneous distribution. Upon successful completion of the study, it will be possible to increase the application areas of natural-source glutathione-based injectable hydrogel highly improved antioxidant and bioactive properties biomedical purposes such as drug delivery, biomaterials and tissue engineering.

Keywords: Antioxidant, Biomaterial, Glutathione, Injectable hydrogel

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OP-11

Development of Nature-Inspired Electroconductive, Modified Hydrogel Cardiac Tissue Sealants and Evaluation of Their Adhesiveness and Biocompatibility Properties

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Abstract

Hydrogel tissue adhesives are materials designed for tissue or organ regeneration, capable of bonding both inorganic and organic materials, particularly in moist and dynamic environments. These biocompatible and biodegradable polymers are expected to heal tissue damage and subsequently be eliminated from the body. Tissue adhesives offer advantages such as rapid application, facilitation of surgical procedures, and reduced discomfort for patients. They can be multifunctional, incorporating conductive biomaterials, supporting hemostasis, enabling drug delivery, or being designed for less invasive injectable applications [1]. In recent years, tissue adhesives have begun to replace traditional procedures like suturing or stapling wounds and have made significant clinical advances. They are often used to stop bleeding or reinforce sutures. Cardiovascular adhesives face a variety of challenges in the complex, fluid environment of the cardiovascular system, characterized by high pressure. They must withstand strong pulsating stresses, maintain adhesion in wet conditions, and perform well when exposed to blood, which could potentially disrupt the reactive functional groups of the material [2]. In this study, an electroconductive tissue adhesive was developed, specifically targeting the adhesion of electrically excitable cardiac tissue. Initially, alginate polymer was modified through methacrylation and oxidation reactions, followed by conjugation with polypyrrole (PPy) for electroconductivity (OMA-PPy) or grafting with DOPA groups from mussel foot proteins via Schiff base reaction (OMA-DOPA). Structural characterization of the synthesized polymers was performed using Fourier-transform infrared spectroscopy (FTIR), while the DOPA content was quantified using UV-VIS spectroscopy. The conductive or adhesive-modified polymers were blended with gelatin methacryloyl (GelMA). Hydrogel tissue adhesives were prepared by adding lithium phenyl-2,4,6-trimethylbenzoylphosphinate (LAP) as a photoinitiator and cross-linking under visible light. The swelling and degradation behavior of the hydrogels was examined gravimetrically. The mechanical strength of the prepared tissue adhesives was evaluated using compression tests. For GelMA, GelMA/OMA, GelMA/OMA-PPy, and GelMA/OMA-PPy/DOPA hydrogels, the compression strength values (kPa) were 775.89 ± 123.45, 851.01 ± 88.80, 1033.05 ± 157.34, and 1007.35 ± 100.75, respectively. That is, PPy addition increased the mechanical strength. Adhesive properties were assessed through an *in vitro* burst pressure test, conducted according to ASTM F2392-04 standards (Standard Test Method for Burst Strength of Surgical Sealants), alongside lap-shear and T-peeling tests. As a result of the burst pressure test, the mmHg values for GelMA, GelMA/OMA, GelMA/OMA PPy, and GelMA/OMA-PPy/DOPA hydrogel tissue adhesives were 150.39 ± 48.61, 192.23± 66.30, 162.02 ± 48.90, and 254.43 ± 24.98, respectively. This shows that each group withstood more than the blood pressure of 120 mmHg, with the DOPA group reaching the highest value. Hemocompatibility studies have shown that the formulations are also highly compatible with blood. Biocompatibility of the tissue adhesives was evaluated *in vitro* using PrestoBlue, Live/Dead, and

DAPI/Actin assays with L929 fibroblasts as a model cell line. The obtained results suggest that the modified sodium alginate and gelatin-based electroconductive and DOPA-containing visible light-cured hydrogel formulations are promising for application in various tissues, particularly cardiac.

Keywords: Tissue Adhesive, Cardiac Sealant, Conductive Hydrogel, GelMA, DOPA

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OP-12

Angiogenic Effects and *In Vivo* Response of Chitosan/Poly(vinyl alcohol) Microneedle Patches

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Abstract

Angiogenesis plays a crucial role in tissue repair processes, ensuring the continuation of important cellular processes as stem cell differentiation, cell proliferation, and migration during tissue repair. It also plays a significant role in reducing the impact of hypoxia conditions caused by tissue damage by facilitating oxygen transport to the tissue. Estrogen hormones are known to be particularly effective in angiogenesis during mammalian ovulation [1]. In recent years, microneedles (MNs) are considered ideal platforms for transdermal application of various therapeutics due to their penetration-enhancing properties [2,3]. Here, chitosan (CS) and poly(vinyl alcohol) (PVA) were blended to prepare MN patches using different crosslinkers, specifically glutaraldehyde (Glu) and tetraethyl orthosilicate (TEOS). These MN patches were loaded with various estrogen hormones (E1: estrone, E2: β-estradiol, E3: estriol) to stimulate angiogenesis. The angiogenic effects and in vivo responses of the MNs were investigated. Initially, the MNs were characterized in terms of their morphological (SEM), mechanical, and degradation) properties. Results showed that E1- and E2-loaded MNs had a uniform square-based pyramidal needle structure with a needle height of approximately 650 μm, whereas the morphology of E3-loaded MNs was disrupted, and the number of uniform needles decreased. The morphological appearance of E1- and E2-loaded MNs cross-linked with either TEOS or Glu was similar, with needles arranged in a smooth and regular manner. MNs cross-linked with TEOS (MN-T) were more flexible and fractured at a higher force compared to MNs without TEOS. Conversely, MNs cross-linked with Glu vapor exhibited a more brittle structure with increased application time. Estrogens did not significantly affect the mechanical properties of the MNs. Upon investigating the degradation behavior, it was found that MNs cross-linked with TEOS were inadequately cross-linked, dissolved in water, and did not maintain a stable structure. MNs exposed to Glu vapor were stable, with a maximum mass loss of 1% on day 8, and their water retention capacity decreased with prolonged application time.The effects of estrogen-loaded MNs on angiogenesis were analyzed using the in ovo CAM assay. All estrogen-loaded MNs demonstrated statistically significant higher vascularization compared to the non-loaded groups ($p < 0.05$). However, there was no statistically significant difference in vascularization levels among the different estrogen-loaded groups ($p > 0.05$). To assess the *in vivo* response of the developed MNs, E2-loaded MNs cross-linked with Glu vapor were implanted subcutaneously in rats. Macroscopic examination 14 days post-implantation revealed that the MNs had integrated into the connective tissue. Increased presence of inflammatory cells and vascularization were observed in the estrogen-loaded MNs compared to the control group. These findings suggest that estrogen may induce angiogenic and inflammatory responses. Additionally, it was observed that estrogen-containing MNs triggered fibroblast activity and increased collagen fibril accumulation. In conclusion, the estrogen-loaded MNs demonstrated angiogenic effects and show potential for safe use in various therapeutic applications.

Keywords: microneedle, angiogenesis, estrogens, TEOS, glutaraldehyde

Acknowledgments

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OP-13

Development and Characterization of a Self-Healing Nanocomposite Hydrogel against Bacterial Infections

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Abstract

Self-healing hydrogels based on dynamic covalent bond chemistry have shown potential in biomedical applications ranging from tissue engineering scaffolds to drug delivery systems [1]. The self-healing ability attributed to the reversible nature of the polymer network enables structural recovery of the hydrogel upon a mechanical load or physical stress. In this study, a self-healing hydrogel incorporated with mesoporous silica nanoparticles (MSN) was developed as a drug delivery system. The self-healing hydrogel was fabricated by employing dynamic imine bond formation between oxidized alginate (OAlg) and polyethyleneimine-methoxy polyethylene glycol (PEI-mPEG) copolymer. The presence of functional groups required for imine bond formation was confirmed with Fourier transform infrared spectroscopy (FTIR). The OAlg/PEI-mPEG hydrogels were later incorporated with MSNs synthesized by biphase stratification strategy. The morphology, size, and net surface charge of MSNs were characterized by scanning electron microscopy (SEM) and dynamic light scattering (DLS) analyses [2]. The viscoelastic properties and self-healing characteristics of OAlg/PEI-mPEG hydrogels were evaluated by rheological analysis. The effect of increasing concentrations of MSNs on the gelation properties of nanocomposite OAlg/PEI-mPEG@MSN hydrogels was also investigated [3]. The biocompatibility of OAlg/PEI-mPEG@MSN hydrogels was demonstrated on the L929 mouse fibroblast cell line. For the utilization of nanocomposite OAlg/PEI-mPEG@MSN hydrogel as a drug delivery system, a flavonoid with improved antibacterial activity upon loading into MSNs was tested against *Staphylococcus aureus* as a model organism. As a result, a nanocomposite hydrogel with self-healing ability was developed and its potential as a drug delivery system was elucidated for further applications.

Keywords: self-healing hydrogel, imine bond, mesoporous silica, antibacterial, infection

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OP-14

Anti-inflamatory Effects of Exosomes on *in vitro* 3D Spinal Cord Injury Model

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Abstract

Spinal cord injury (SCI) poses a significant problem since it causes high disability rate, serious complications, limited treatment options, and significant medical costs (Lu et al.,2024). Exosomes show promise that allow them to be used in regenerative medicine. Mesenchymal stem cells (MSCs), which are frequently used in regenerative medicine, effectively secrete exosomes (Chianese et al.,2024). To overcome the limitations of cellular therapies, MSC-derived exosomes may help restore survival in SCI.

In this study, neural, oligodendrocyte, and astrocyte cell lines were co-cultured for a 3D *in vitro* SCI model. The cells were seeded in bacterial cellulose – Methyl cellulose (BS-MS) composite hydrogel. One day after seeding, mechanical damage was applied using a 2 mm diameter punch. For chemical damage, lipopolysaccharide (LPS) was applied at a concentration of 10 µg/mL (Anjum et al., 2024; Yang et al.,2024). In the group where mechanical and chemical damage were applied together, mechanical damage was applied two days after chemical damage. One day after mechanical damage, BIII tubulin was shown with immunofluorescence staining, and qPCR analysis was performed. These analyses showed that damage was created. On this 3D SCI model, BMSC-derived exosomes were added (25 µg/mL) to the experimental groups, where cell-loaded hydrogels were mechanically and chemically damaged. At the end of the 3-day culture period, neurite regeneration (BIII tubulin) was examined with immunofluorescence staining and qPCR analysis. In addition, the decrease in proinflammatory cytokines (IL1-beta and IL10) was examined by qPCR analysis. It was shown that exosome applied groups supported neurite regeneration and reduced the proinflammatory response.

Keywords: antiinflamatory, BS-MS (gel), exosome, spinal cord injury model, stem cell

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OP-15

Synergistic Effect of GO-Ag NP Additives on Biological Properties of an Electrospun Potential Wound Dressing Material

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Abstract

With the discovery that materials exhibit different properties at nanoscales, nanotechnology has become an interesting science (Kenry et al., 2017). Electrospinning is frequently used in biomedical applications to create fibers with diameters ranging from nanometers to micrometers (Subtirica et al., 2018; Samatya Yılmaz and Aytac, 2022). Nanofibrous structures can meet all the features expected from a wound dressing material, such as high porosity, cell adhesion ability, and wound moisturizing (Khil, 2003). However, the great increase in the use of petroleum-derived polymeric disposable products leads to environmental pollution (Saratale et al., 2021). Therefore, in this research, a mixture of biodegradable and biobased polybutylene succinate (PBS) polymer and a highly flexible and biocompatible thermoplastic polyurethane (TPU) polymer was used as the matrix to obtain a biodegradable wound dressing material with advanced properties (Bhattarai et al., 2018; Kato et al., 2024). Hollow nanofiber production was carried out by coaxial electrospinning method by adding different ratios of graphene oxide and silver nanoparticle (GO/AgNP, 1/0, 0/0.1, 0/0.2, 0.9/0.1, 0.8/0.2, %) additives to the PBS/TPU (60/40, w/w) mixture. The study aims to prevent agglomeration while ensuring homogeneous distribution of GO in the presence of AgNP and to try to benefit from the superior properties of GO with the highest efficiency at a low GO amount. The liquid absorbency capacity and drying time of the obtained hollow PBS/TPU/GO/AgNP nanofibers, cytotoxicity behavior against L929 fibroblast cells for 24 hours, and antibacterial effect against *S.aureus* bacteria at 24 hours were investigated. While the liquid absorption capacity of GO/Ag NP doped nanofibers decreases, it is predicted that they will accelerate wound healing by keeping the wound environment moist when used as a wound dressing. While no antibacterial activity was observed against S. aureus at 24 hours in 1% GO, 0.1% AgNP, and 0.2% AgNP doped nanofibers, antibacterial activity was revealed against S. aureus owing to the synergistic effect when GO and Ag NP were used together. However, it was observed that cell viability decreased in PBS/TPU/GO/AgNP electrospun mats. Since they have over 70% cell viability according to the ISO 10993–5 standard (Alippilakkotte et al., 2017), it was stated that their use as wound dressing material would be suitable. These results showed that PBS/TPU/GO/AgNP nanofibers have antibacterial effective wound dressing potential especially for high infection risk, cut, diabetic, and exudative wounds after surgical operations.

Keywords: Graphene oxide, Synergistic effect, Hollow, Electrospinning, Wound dressing

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OP-16

Shaping the Future of Medicine: Clinical and Translational Research Through 3D Bioprinting and Biodispensing

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Abstract

The rapid advancements in biomedical technology are opening doors to groundbreaking innovations in medicine. At the forefront of these advancements is 3D bioprinting technology, which enables the fabrication of living, functional tissues by layering cells and biomaterials in a controlled manner.

In regenerative medicine, bioprinting offers the potential to repair and restore damaged tissues. By creating scaffolds that mimic the natural environment of cells, bioprinting significantly enhances tissue engineering efforts. This allows lab-grown tissues to integrate more effectively with the human body, improving the success of regenerative treatments.

In personalized medicine, bioprinting plays a transformative role by enabling patient-specific treatment approaches. Tissues or organs developed from a patient's own cells minimize immune rejection risks during transplants, as well as eliminating the possibility of not finding a suitable donor, making treatments safer and more effective. Additionally, bioprinted patient-specific tissue models are revolutionizing drug testing and disease modeling, enabling more accurate and tailored therapeutic strategies.

The capabilities of bioprinting are driving significant advancements in personalized healthcare and regenerative medicine. These technologies not only improve the quality of life for patients but also enhance the efficiency and precision of medical treatments.

In conclusion, 3D bioprinting technology stands as a revolutionary innovation in biomedical science. Its contributions to regenerative medicine and personalized care are paving the way for more effective, safer, and patient-centered healthcare solutions.

Supporting the development of bioprinting technology and expanding its applications will undoubtedly lead to more innovative and successful treatment methods in the future of medicine.

OP-17

Ti Alloys Coated with CaP-doped with Zn via Micro-Arc Oxidation: Physical and Biological Effectiveness

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Abstract

Introduction

Titanium alloys are preferred for implant applications because of their biocompatibility, corrosion resistance, low density and mechanical strength. However, for better osseointegration and to avoid infections, surface characteristics of these implants can be improved[1]. The aim of the present study is to coat Ti6Al4V alloys with calcium phosphate (CaP) doped with varying amounts of zinc (Zn) using the micro-arc oxidation (MAO) technique. Zn was chosen due to its well-known antibacterial and bone-growth properties. The effects of the coat on chemical, physical, mechanical, biological and antimicrobial properties were examined.

Materials and Methods

Ti6Al4V samples were coated with CaP doped different amounts of Zn (25, 50, 75, and 100 g/L Zn) using the MAO. Coated samples were characterized for their surface properties as morphology, elemental composition, mechanical properties (hardness, elastic modulus), corrosion resistance, wettability and surface roughness. *In vitro* cytotoxicity and cell interaction tests were conducted using L929 and Saos-2 cells. Additionally, antimicrobial efficacy of the coatings against *Escherichia coli* (*E.coli*) was assessed.

Results and Discussion

The study revealed that the MAO technique effectively produced uniform coatings of Zn doped CaP on Ti6Al4V. CaP+Zn25 coating had the highest adhesion to the substrate, while CaP+Zn100 samples showed delamination from Ti6Al4V surface (Figure 1). The coatings are biocompatible, as evidenced by high cell viability and enhanced cell proliferation on Zn-doped surfaces regardless of Zn concentration. According to the EDS data, the Zn content of the coating was not in parallel with the zinc content of the electrolyte solutions. This indicates that the zinc content which can be doped to CaP might be limited to a certain amount. The antimicrobial tests showed that Zn-doped coatings, especially at lower concentrations (as 25 and 50%) effectively inhibited bacterial growth. However, an excessive increase in Zn content was not effective as the others, and further increase led to diminished antimicrobial effectiveness (Figure 2). Overall, MAO is an effective technique that can be used to modify metallic implant surfaces.

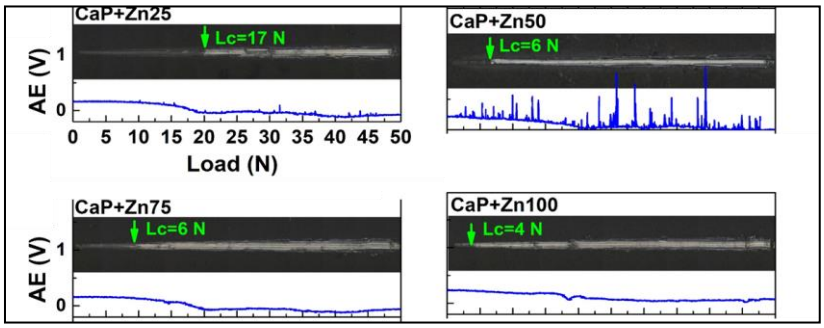

Figure 1. Scratch test results of CaP+Zn coatings on Ti6Al4V alloys.

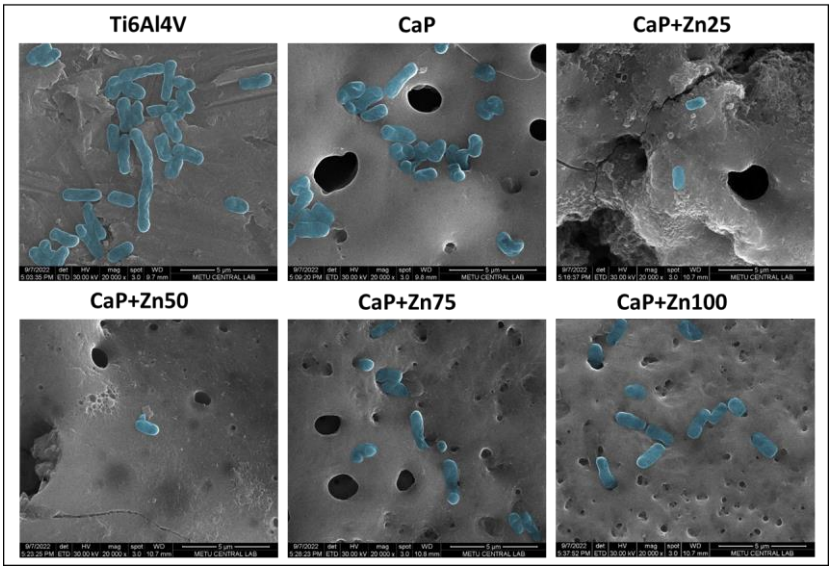

Figure 2. SEM images of *E. coli* incubated for 48 h on uncoated and CaP+Zn coated Ti6Al4V samples.

Conclusion

Overall, the study demonstrates that Zn-doped CaP coatings by MAO technique can significantly improve the surface properties of Ti6Al4V implants, making them more suitable for biomedical applications especially as orthopedic implants, as well as in environments prone to bacterial contamination.

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Keywords: Ti-Based Alloy, Bone, Corrosion, Calcium phosphate, antibacterial activity.

OP-18

A Novel Composite Scaffold Design: Cu^{2+}-Doped Borosilicate Glass Integrated with Silk Fibroin and Methacrylated κ-Carrageenan for Bone Tissue Engineering

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Abstract

Bone is a natural nanocomposite composed of organic proteins, inorganic minerals and multiple cell types. The complex structure of bone consists of a series of layers and various cells that form the bone tissue. Engineered composite scaffolds offer a multifunctional role mimicking the extracellular matrix in terms of supporting cell proliferation and differentiation. In recent years, borosilicate bioactive glass (BAG) based composite scaffolds have attracted significant attention in hard tissue applications. BAG is primarily composed of silicon dioxide (SiO_2), boron oxide (B_2O_3), calcium oxide (CaO), sodium oxide (Na_2O), and phosphorus pentoxide (P_2O_5) and the specific proportions of these components can vary depending on the desired properties and applications. Also, various ions such as Mg^{2+}, Ba^{2+}, Ag^{+}, Fe^{2+}, La^{3+}, and Ti^{4+} have been doped to BAG structures to improve the bioactive properties. Recent studies have shown that Cu^{2+} -doped BAG supports bioactivity and may enhance osteogenesis and angiogenesis of the regenerating bone tissue.

In this study, Cu^{2+}-doped BAG particles were synthesized and incorporated into a polymer matrix composed of silk fibroin (SF) and methacrylated κ-carrageenan (κ-Car-MA) to create a bioactive composite scaffold for prospective bone tissue applications. The aim of this study is to investigate the potential use of this new composite material, which has not been previously studied in the literature, in the field of bone tissue engineering. The developed composite structure mimics bone tissue with its components: SF simulates collagen I, the main protein in bone tissue, while κ-Car-MA has structural similarity to glycosaminoglycans. Additionally, the osteoinductive and osteoconductive properties provided by Cu^{2+}-BAG has the potential to promote bone tissue regeneration. The composite scaffolds were prepared via a photo-crosslinking method, ensuring uniform distribution of the BAG and Cu^{2+}-BAG particles within the polymer matrix. Comprehensive characterization techniques, including Fourier-transform infrared spectroscopy, thermogravimetric analysis, scanning electron microscopy, energy-dispersive X-ray spectroscopy, and atomic absorption spectroscopy were employed to analyze the chemical interactions, morphological features, and elemental composition of the scaffolds. The findings demonstrate that Cu^{2+} was integrated into the BAG structure, and it was observed that the scaffolds formed exhibited a mesoporous structure. As result of mechanical testing, while there was no significant change in terms of mechanical strength, their compressive modulus has been affected by BAG content.

Keywords: silk fibroin; nanocomposite; hydrogel; advanced materials; bioactive glass

OP-19

Production and Characterization of Co-Cr Alloy for Dental Applications by Hot Press and Additive Manufacturing

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Abstract

Cobalt-based alloys are used mainly in biomedical applications due to their high hardness, wear resistance, strength, superior biocompatibility, and corrosion resistance. Powder metallurgy and additive manufacturing are promising methods for producing dental CoCr alloys. In this study, CoCr alloy was produced by hot pressing and selective laser melting (SLM). The samples' density and microstructural, mechanical, and antibacterial properties were analyzed and compared with cast samples. The density values of the materials produced by hot press and SLM methods were higher than those of castings. The mechanical properties increased with increasing final densities of the samples. Although electrochemical and antibacterial properties were improved compared to casting, the results obtained from hot pressing and SLM were similar. Furthermore, antibacterial analysis results showed that CoCr alloy was more resistant to gram-positive Staphylococcus aureus (ATCC 29213) bacteria than gram-negative Escherichia coli (ATCC 25922) bacteria.

Keywords: Biomaterial, dental alloys, CoCr alloys, powder metallurgy, additive manufacturing, antibacterial activity, corrosion

OP-20

Optimizing Injectable Magneto-Responsive Hydrogels for Biomedical Applications: Dynamic Crosslinking and Amino Functionalization

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Abstract

Magneto-responsive hydrogels (MRHs) are typically prepared by incorporating magnetic particles into hydrogels. Their morphology and properties can be controlled remotely by manipulating the amplitude and direction of the applied magnetic field. Therefore, they are considered as a promising platform for a range of applications, including drug delivery, regenerative medicine, and tissue engineering. However, despite the superior characteristics, their practical uses in biomedical applications require the invasive operations. Consequently, injectable MRHs hydrogels have gained prominence due to their advantages in non-invasive applications.

For an ideal injectable hydrogel, it is expected to exhibit shear-thinning property and effective sol-gel/gel-sol transition. Achieving this transition usually requires low concentration of hydrogels, which can result in low mechanical properties post-injection. Therefore, dynamic crosslinking of injectable hydrogels has attracted significant attention for a variety of biomedical applications. Dynamic crosslinking refers to a type of chemical bonding in polymer networks where the crosslinks are reversible and can be broken and reformed under certain conditions, such as changes in temperature, pH, or the presence of specific chemicals or even applied stress. This dynamic nature allows the hydrogels to exhibit self-healing properties, adaptability, and improved processability.

In this study, imine bond-based MRHs featuring dynamic crosslinking were developed to improve the shear thinning property for injection procedures in biomedical applications. MRHs were composed of oxidized-alginate, gelatin and amino-functionalized Fe_3O_4 based-magnetic nanoparticles (MNP-NH_2) in which imine bonds formed at the MNP-NH_2/o-Alginate and gelatin/o-Alginate interface. To characterize these hydrogels and evaluate their physicochemical properties, Fourier transform infrared spectroscopy, vibrating sample magnetometry and thermogravimetric analysis were conducted. The effect of amino functionalization on the rheological properties of the synthesized injectable MRHs were thoroughly investigated through rheological analyses including strain sweep tests and temperature sweep tests. The findings demonstrated that amino functionalization of MNPs affected the yield stress and yield strain of the developed MRHs while maintaining the magnetic property.

Keywords: biopolymer, magnetic field, hydrogel, magneto-gel, advanced materials.

OP-21

The Effect of Methacrylation Degree on the Printability and Physicochemical Properties of κ-Carrageenan Bioinks

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Abstract

3D bioprinting is a cutting-edge additive manufacturing technique that enables the precise fabrication of complex biological structures by layering bioinks composed of living cells, biomaterials, and bioactive molecules. A typical bioink comprises a biocompatible matrix, often in the form of hydrogels. These materials are chosen for their ability to encapsulate cells, maintain a suitable mechanical environment, and promote cell growth and differentiation. The physical properties of bioinks, such as viscosity, shear-thinning behavior, and crosslinking ability, are essential for ensuring the precision and stability of the printed structures.

κ-Carrageenan is a natural sulfated polysaccharide extracted from red seaweeds. Structurally, it consists of alternating units of D-galactose and 3,6-anhydro-D-galactose, which are linked by α-1,3 and β-1,4 glycosidic bonds. One of the most important properties of κ-carrageenan is its ability to form strong, thermally reversible gels when combined with certain cations. It is biocompatible and non-toxic, making it suitable for biomedical applications such as drug delivery systems, wound dressings, and tissue engineering scaffolds. However, ionically crosslinked κ-carrageenan gels usually suffer from low stability for long period applications. Therefore, photocurable groups like methacryl are usually conjugated to κ-carrageenan backbone to improve the stability of κ-carrageenan. However, the effect of methacrylation on the printability of κ-carrageenan is an open question in 3D bioprinting applications.

In this study, the effect of methacrylation degree on the physicochemical properties of κ-carrageenan were evaluated in terms of 3D printing. To this aim, methacrylated κ-carrageenans (κ-Car-MA) having low, medium, and high methacrylation degree were synthesized and characterized through FTIR and ^{13}C-NMR analyses. Semi-quantitative printability tests were conducted on a 3D-printed two-layered grid model to assess the printability of κ-Car-MA hydrogels. Then, rheological properties were evaluated through temperature sweep and amplitude shear sweep tests to reveal the effect of methacrylation degree. It was found that methacrylation degree directly affected the printability of κ-Car-MA hydrogels. Rheological findings demonstrated that yield stresses of bioinks decreased in respect to increased methacrylation degree. Preliminary biocompatibility tests showed that prepared bioinks were both cytocompatible and hemocompatible.

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Keywords: 3D Printing, Bioink, Hydrogels, Physicochemical properties

OP-22

Synthesis and Modification of Ti_3C_2 MXene (Titanium Carbide) for Biomedical Applications

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Abstract

MXenes, a new class of 2D nanomaterials, have emerged as promising candidates for a wide range of applications due to their unique properties. In recent years, MXenes have gained significant attention due to their exceptional conductivity, piezoelectric effect, biocompatibility, hydrophilicity, and rich surface chemical properties. MXenes have been extensively researched in fields such as energy storage, supercapacitors, and sensors[1,2]. However, the exploration of MXenes in biological applications is relatively recent and their studies in the literature are limited. Ti_3C_2 MXene in particular has shown great promise in biomedical applications due to its biocompatibility [3,4].

In this study, Ti_3C_2 MXene was synthesized by etching Al atoms from the Ti_3AlC_2 (MAX phase) via Minimally Intensive Layer Delamination (MILD) method to ensure environmental safety, biocompatibility and economic efficiency. After the washing and drying processes, Ti_3C_2 MXene was modified with polydopamine via in-situ polymerization of dopamine. For comprehensive characterization of chemical structure, Fourier Transform Infrared (FTIR) spectroscopy, X-ray Diffraction (XRD), and X-ray photoelectron spectroscopy (XPS) were employed. The FTIR spectra confirmed the presence of characteristic peaks corresponding to Ti_3C_2 MXene, indicating formation of the MXene structure. XRD patterns displayed prominent peaks that align with typical Ti_3C_2 MXene, confirming the retention of the crystalline structure post-etching. A noticeable shift in the (002) peak was observed, which is indicative of the successful intercalation and delamination characteristic of MXene materials. XPS spectra revealed distinct peaks corresponding to Ti, C, O and N elements, confirming the formation of Ti_3C_2 MXene and successful coating of polydopamine onto the Ti_3C_2 MXene surface.

In conclusion, these results indicate that Ti_3C_2 MXene was successfully synthesized from MAX phase using a MILD etching method and that subsequent polydopamine modification was achieved, potentially enhancing the properties of Ti_3C_2 MXene for biomedical applications.

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Keywords: MXene, 2D nanomaterials, Titanium Carbide, Polydopamine

OP-23

Hierarchical TiO2 Nanotube Arrays Enhance Mesenchymal Stem Cell Adhesion and Regenerative Potential Through Surface Nanotopography

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Abstract

The integration of surface nanotopography in biomaterials has the potential to enhance the therapeutic efficacy of mesenchymal stem cells (MSCs). This study examines the impact of hierarchical TiO2 nanotube arrays on MSC behaviour, with a focus on cell adhesion, viability, and gene expression. Hierarchical TiO2 nanotube surfaces were fabricated through a two-step electrochemical anodization process, with the objective of diversifying surface nanotopography with different pore sizes, porosities, and hierarchical organizations, which was achieved by changing the applied voltage through anodization steps. Human bone marrow-derived MSCs were cultured on these surfaces, and their responses were analyzed using transcriptomics, flow cytometry, and quantitative real-time PCR (qRT-PCR). Surface properties, including wettability and surface free energy, were characterized. The hierarchical TiO2 surfaces significantly enhanced MSC adhesion and spreading, as evidenced by the upregulation of genes associated with extracellular matrix production. Flow cytometry revealed that surfaces obtained under higher anodization voltages at the second anodization step, such as the 80V-60V sample, increased cell death, indicating a trade-off between surface roughness and cell viability. Surface characterization revealed an increase in hydrophilicity and surface-free energy, which are surface-dependent properties related to fabrication processes. These properties promote protein adsorption, which is essential for cell adhesion. Quantitative reverse transcription polymerase chain reaction (qRT-PCR) results demonstrated that nanodecorated surfaces modulate essential regenerative genes in a surfacedependent manner. Higher voltages upregulated CXCR4 and VEGFA, suggesting enhanced migratory and angiogenic potential. Hierarchical TiO2 nanotube arrays improve MSC adhesion and regenerative potential through controlled surface nanotopography. These findings indicate the potential for optimizing biomaterial surfaces for enhanced cell-based therapies in regenerative medicine. It is thought that future studies concentrate on achieving an equilibrium between the surface properties of the material in question, with the objective of optimizing the therapeutic efficacy of the material while maintaining the viability of the cells.

Keywords: Mesenchymal stem cells, nanotopography, titanium dioxide, electrochemical anodization, tissue engineering, regenerative medicine

OP-24

Cost-Effective Technique for the Preparation of Novel Si_3N_4 Based Functionally Graded Biomaterials with Improved Bioactivity

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Abstract

In this work it is aimed to develop a new, reliable, and cost-effective technique for the preparation of novel Si_3N_4 based functionally graded biomaterials with improved bioactivity for bone tissue ingrowth. The work also aims to enhance the current state of the art on bioactivity of Si_3N_4 by acquiring new knowledge to understand the effect of N/O ratio on the surface layer. The advantages of three techniques, such as tape casting, sintering, and surface treatment by an oxyacetylene flame are combined, for the first time, to develop a new structure of Si_3N_4 bioceramics with gradient functionality. After sintering the functionally graded green bodies, outer part of the material has been treated by an oxyacetylene flame which has rapidly heated up the surface of the material and led to the decomposition of Si_3N_4 and the formation of a porous layer (due to the evaporation of N_2). During this treatment, the bioactive sintering additive of $CaSiO_3$ migrates to the surface, leading to the concentration gradient throughout the material body. Both the surface topography and the concentration gradient significantly improve the bioactivity of the material. Tests are carried out to evaluate the biocompatibility properties of the obtained material and results have shown that a bone-like functionally graded structure has been successfully obtained. The developed material is expected to respond to the unique needs of a person needing orthopedics and spine surgery.

Keywords: Silicon Nitride, Functionally Graded Materials, Tape Casting, Biomaterials

OP-25

Preliminary Investigation of the Usability of Brown Meagre Otoliths in Biomaterial Development

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Abstract

Biomaterials are gaining importance day by day and the latest studies in this field are especially on the development of alternative materials compatible with the body. As a result of earthquakes, wars and accidents, the most needed area is bone structures. Studies with these structures show that the most compatible materials consist of hydroxyapatite (HA, $Ca_{10}(PO_4)_6(OH)_2$). Although biomaterial production is a difficult and costly field, materials such as mollusc shell and diatom cell wall obtained from marine environments are of interest due to their special protein structures and different protein sequences [1,2]. In the literature, otolith structures formed in fish are obtained from species such as cynoscion acoupe, croaker drums, etc. and used in different biomaterial productions. However, the formation stages of these structures (otoliths) in the spontaneously formed stones (otoliths) in Brown meagre skulls used in the study vary in all species. Carrying the effects of different habitats, being osteoinductor, allowing new cell migration are affected by many factors such as temperature, salinity, pollution, metabolic events in the life cycle, age, chemical composition. These structures, which develop in the cell-free environment in the endolymph, show very different formations under the influence of factors such as high K + low Na and changing pH and high CO_2. When the otoliths used in the study are analyzed by SEM and SEM EDX analyses, it is seen that they show a layer-by-layer formation. The otoliths were taken from the skull of Brown Meagre obtained by spearfishing, cleaned and dried at 30ºC. They were then subjected to agate grinding, treated with H_2O_2 and dried. The microchemical structure is very complex and some points are still not fully determined and understood in a limited way. In these structures, otoliths act as depth and equilibrium sensors and these features constitute important and unique data from a genetic point of view. Although brown meagre otoliths have not been previously studied as biomaterials in the literature, when these structures are examined by XRD analysis, it is thought that they have a calcite-aragonite structure and therefore, it is thought that the crystal structure will provide an advantage to obtain hydroxy-apatite structure by combining stoichiometrically with phosphate structures in biomaterial production. [3],[4],[5],[6]. It is seen that there are few studies developed on fish-based products, there is no bio ceramic study on brown meagre otolith, and the need in the field has created great opportunities both economically and humanitarian. Structures in marine anticancer drugs are valuable materials with biological activities such as antioxidant, antihypertensive and advanced technology products. It is aimed to create an alternative material source by providing solutions to the problems that arise in bone tissue with otolith, which constitutes the main structure of the body, for long periods of time or to provide a solution to the inability to regenerate.

Keywords: Biomaterial, Brown Meagre, Otolith, Hydroxyapatite, Material Characterization

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OP-26

Mussel-Inspired Breakthrough in Lung Tissue Adhesives: Antibacterial and Highly Adhesive DOPA-Modified GelMA/ Silk Fibroin for Enhanced Healing and Air Leakage Prevention

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Abstract

Lung tissue adhesives have significantly improved outcomes in lung surgery by reducing complications and enhancing patient recovery. These adhesives play a crucial role in repairing damage to the lung and thoracic cavity during procedures such as lobectomy and pneumonectomy, effectively preventing post-operative pneumothorax (1). Additionally, they expedite healing and mitigate infection risks, particularly in infection-prone areas like the lungs. The incorporation of antibiotics, such as amikacin, into lung tissue adhesives is primarily aimed at providing antibacterial protection, reducing post-operative infections, and accelerating recovery. Amikacin is effective against Gram-negative bacteria, making it ideal for preventing infections at surgical sites (2). Both natural and synthetic adhesives are used in lung surgery, each with distinct benefits. Natural polymers are favored for their biocompatibility, low toxicity, and facilitation of tissue integration, while recent advancements, such as GelMA and silk fibroin (SF) -based adhesives, offer strong adhesion and elasticity, supporting natural lung tissue movement (3). DOPA-based biopolymers, with their water-resistant and durable bonding properties, are particularly effective at sealing surgical sites. Though synthetic adhesives provide high mechanical strength, their non-biodegradable nature can lead to tissue irritation. Hydrogel-based adhesives, with their flexibility, water content, and biocompatibility, are increasingly preferred for their ability to adapt to lung tissue dynamics and promote faster healing (4). The study aims to develop nature-inspired tissue adhesives, based on mussel adhesion, to address the limitations of current options for preventing air leaks after lung surgery. The goal of this study is to develop a DOPA-modified tissue adhesive based on GelMA and SF (GelMA-SF-DOPA) that is compatible with lung tissue, possesses antibacterial properties, and offers high adhesive strength. In this study, DOPA terminal groups were enzymatically incorporated into tyrosine-enriched GelMA and SF biopolymers. The chemical, physical, and mechanical properties of the developed lung tissue adhesives were evaluated through FTIR analysis, swelling, degradation, contact angle, and compression tests. The adhesion and mechanical performance of both GelMA-SF-DOPA and GelMA-SF lung tissue adhesives were assessed using collagen sheets in T-peel, burst pressure, and lap shear tests. According to the burst pressure test results, the mmHg values for GelMA-SF-DOPA and GelMA-SF lung adhesives were found to be 172.21±53.81 and 121.57±22.72, respectively. These results indicate that both adhesives withstood pressures exceeding the 120mmHg threshold, with a significant increase in the DOPA-modified group.

The adhesive performance on wet surfaces was further evaluated via wound closure tests on lung tissue. Additionally, the drug release kinetics of amikacin-loaded adhesives were investigated, while their antibacterial efficacy was examined using the agar diffusion method against *E. coli*, *S. aureus*, and *P. aeruginosa*. Hemocompatibility of both GelMA-SF and GelMA-SF-DOPA lung tissue adhesives was determined, and cytotoxicity was assessed through indirect MTT assays using MRC-5 lung fibroblast cells. Amikacin-loaded GelMA-SF-DOPA tissue adhesives have shown significant potential as new generation natural tissue adhesives due to their biocompatibility, antibacterial properties, mechanical durability and strong adhesion to lung tissue.

Keywords: Lung tissue adhesive, Mussel inspired, GelMA, silk fibroin

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OP-27

Highly Specific and Sensitive Detection of West Nile Virus via CRISPR-CAS Mechanism

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Abstract

Climate change, one of the most pressing challenges of our time, is predicted to contribute to an increase in the prevalence of vector-borne diseases. The emergence of vector-borne diseases in different regions is a major concern and is closely related to geographical location and environmental conditions. Turkey, located between the temperate and subtropical zones which provide a suitable environment for the spread of vector-borne diseases, is among the countries at risk where an increase in the spread of viral infections is expected. Recent studies report the emergence of viral infections carried by sandflies in Turkey. West Nile Virus (WNV), an RNA virus transmitted by sandflies, is expected to become more prevalent in Turkey in the near future. In humans, WNV may lead to neurological problems and diseases such as encephalitis and meningitis or even fatal outcomes. Therefore, there is an urgent need for rapid, reliable and on-site detection technologies to prevent the spread of WNV infection and develop treatment strategies.

Cas12a, a recently identified enzyme from the CRISPR family, is especially useful for detecting pathogens. Cas12a enzyme complexed with crRNA molecule recognizes the target gene, leading to the activation of Cas12a and cleavage of the reporter molecule with a non-specific trans-cleavage activity. This reaction leads to the separation of the fluorescent tag from the quencher molecule, thereby creating a fluorescent signal. There is currently no literature on using Cas12a to detect WNV.

The main goal of this study was to develop a highly specific, sensitive and inexpensive CRISPR-Cas12a-based test method for WNV that can provide rapid and reliable results. The results suggested that WNV was successfully detected by leveraging the Cas12a enzyme's non-specific cleavage ability. Each component was evaluated under different circumstances to determine the optimal conditions for detecting the target nucleic acid quickly and at low concentrations. Our study demonstrated faster viral detection than existing methods, taking less than an hour. Low concentrations (100pg) of WNV genetic material were detected in 20 minutes, and high concentrations (1-100ng) were detected in 5 minutes. Future research will focus on refining the study parameters to create a diagnostic test that can accurately and quickly detect the virus.

Keywords: CRISPR-Cas12a, West Nile Virus, Infectious Diseases, Viral Detection

OP-28

Development of a Magnetically Actuated Drug Delivery System Through Hollow Microneedles

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Abstract

Microneedle (MN) technology allows patients to take drugs painlessly with high bioavailability directly into the skin. Therefore, with the developments in this technology, this system which allows self administered without the need for any specialist will come forward in the future. Dosing systems such as micropumps, ensure the drug level to remain at the therapeutic level for a long time without side effects. When microneedle systems are combined with micropumps, more reliable, effective and hospital/expert-independent drug dosing/management can be achieved compared to traditional drug administration strategies. Within the scope of this study, a micropump-assisted microneedle system with a drug reservoir, capable of dosing in the presence of a magnetic field, has been developed. Accordingly, the hollow polymeric microneedle array containing 6 needles with truncated-cone-shaped was fabricated from poly-L-lactic acid (PLLA) by solvent casting method in a single step within a custom-designed mold. The length, width and tip diameter (OD) of the microneedles were calculated as 1.4 ± 0.2, 0.9 ± 0.1 and 0.20 ± 0.03 mm, respectively. The failure force of the microneedles was found to be 2.9 ± 0.4 N per needle and the decrease in their length was 58 ± 4%. Subsequently, to test the skin penetration abilities of the microneedles, in vitro studies were carried out with the skin model created from Parafilm®. In the artificial skin model, the hollow MN array has effective penetration up to 7 th Parafilm® layers (~ 900 µm). Besides, the liquid drug reservoir was 3D printed from acrylonitrile-butadiene-styrene (ABS) with a diameter of 28 mm, a height of 8 mm, and a diameter of the filling port of 2 mm. It has been observed that the drug solution can be easily filled into the reservoir with a hypodermic needle (21 gauge) and the fluid can be drained through the same opening. Drug delivery through the hollow MN array system was achieved by displacing a magnetic composite membrane reinforced with a Neodymium magnet. The saturation magnetization of the magnetic membranes (10, 20 and 30%, $w_{iron}/w_{membrane}$, %) by mass were measured as 5.5, 10.7 and 15.3 emu/g, respectively. The thickness of the magnetic membranes varies between 0.74 and 0.44 mm. Deflection values of the magnetic membranes at applied voltages (10, 20 and 30 V) are in the range between 0.165 ± 0.014 and1.14 ± 0.1 mm. When the entire system of MN array, magnetic membrane and the drug reservoir was assembled, the total weight was measured as 4.6 g. The dosing performance of the developed system at different voltages (30, 40, 50 and 60 V) was investigated. At the beginning, different voltage values (30, 40, 50 and 60 V) were applied to the system, but pumping did not occur because the deflection of the magnetic membrane alone was not sufficient. Thus, to provide the pumping, a cylindrical neodymium magnet of 10x1.5 mm size was placed on the magnetic membrane.

Accordingly, liquid pumping capacity ranging from 43 ± 17 to 115 ± 8 µL/s was achieved when each voltage between 30 – 60 V (10 V increment) was applied to the system alone, and between 32 ± 12 and 142 ± 45 µL/s was achieved when the system was operated in stages between 30 – 60 V (10 V increment, 2 s on, 2 s off).

Overall, the micropump-assisted microneedle array is thought to come forward as a 'proof of concept' system that patients can apply it directly on their own, adjust the drug dose, and make repeated dosing at a certain time interval.

Keywords: Hollow microneedle, solvent casting, micropump, magnetic actuation

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OP-29

Altering Culture Conditions of A549 Cell Line for Improved In Vitro Alveolar Barrier Models

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Abstract

Adenocarcinomic human alveolar basal epithelial cell line (A549) is widely used to create in vitro lung models due to their ability to exhibit characteristics of alveolar epithelial type II (AETII) cells. Despite their advantages, such as high availability, ease of culture, and long term viability, their standard culture conditions often result in a less differentiated phenotype, limiting their effectiveness in replicating the alveolar epithelium, which includes the presence of squamous alveolar epithelial type I (ATI) cells [1]. Recent efforts have aimed to enhance the differentiation and function of A549 cells to make them a more representative model of alveolar function [2]. In this study, improvement of the physiological relevance of A549 cells in a tissue engineered in vitro alveolar model was attempted by altering culture conditions. The model consisted of an electrospun poly(Ɛ-caprolactone) (PCL) mesh coated with ECM proteins (collagen type I, fibronectin, and laminin 511) and was designed to serve as the alveolar basal membrane. A549 cells were cultured in submerged condition until confluence, then transitioned to air-liquid interface (ALI) to simulate the alveolar environment. Cells tested in conventional culture with Ham's F12 Nutrient Mix instead of the standard DMEM F12 medium exhibited a more squamous phenotype with larger cell surface area, suggesting a more differentiated state. TEER (transepithelial electrical resistance) measurements showed a modest but consistent increase at ALI condition with these cells in Ham's F12 medium compared to those in DMEM F12. Quinacrine dihydrochloride staining revealed a higher number of multilamellar bodies (MLBs) in AETII cells cultured in Ham's F12, suggesting enhanced functional maturation. Further analysis using RT-qPCR is underway to assess the expression of surfactant protein C (SP-C) and receptor for advanced glycation end products (RAGE) under the two culture conditions, providing further insight into the differentiation status. These effects of Ham’s F12 may be due to its lower glucose and riboflavin levels, which reduce cellular metabolism and proliferation, along with higher concentrations of lipoic acid and other components that enhance antioxidant protection and DNA synthesis [1, 3, 4]. This study demonstrates the potential to induce differentiation of A549 cells to develop a more physiologically relevant alveolar epithelial barrier model without the need for treatment with corticosteroids like dexamethasone. This is particularly important for studies on lung infection and inflammatory response, where avoiding corticosteroids can help preserve natural cell responses. Additionally, the ease of using A549 cells over primary alveolar epithelial cells makes this an advantageous approach for in vitro models.

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Keywords: In vitro barrier models, A549 cells, alveolar epithelium, ALI culture

OP-30

From Laboratory to Clinic: Regulatory Requirements for Tissue Engineering Products

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Abstract

This presentation will cover the challenges encountered in the transition from laboratory research to clinical practice, and the critical regulations and requirements required to transform R&D products into a marketable medical device. The process of ensuring compliance with international standards such as ISO 13485, ISO 14971 and ISO 10993 will be explained in detail. In particular, design processes, design validation stages and regulatory requirements for the resulting products will be explained in detail.

Design, biocompatibility, technical requirements and risk management processes within the scope of the European Union's Medical Device Regulation (EU) 2017/745 will be examined. The presentation will also cover preclinical studies, EN ISO 10993 biocompatibility requirements, guidance documents and commercial requirements. Practical strategies for managing the regulatory processes and the integration of risk management and clinical data collection into product development stages will be emphasized.

The presentation will present a roadmap for transforming a product in the R&D phase into a regulatory-compliant, market-ready medical device. In this process, the aim will be to ensure safety, effectiveness and regulatory compliance, and to ensure the smooth transfer of laboratory innovation to clinical practice.

Keywords: Tissue Engineering, Medical Devices, Regulations

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Medical Device Regulation (EU) 2017/745.

EN ISO 13485:2016.

EN ISO 10993-1:2018.

OP-31

A New Arthrodesis Nail Design

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Abstract

In this study, the design comparison of the Retrodesis Nail with different ankle arthrodesis nails and the mechanical behaviors suitable for ankle conditions were investigated. Problems such as stabilization problem, stress accumulation at the proximal end, and distal locking screw coming out had to be resolved. Static-dynamic bending tests and comparative dynamic rotation tests were applied to the Retrodesis Nail. Dynamic bending tests were performed on 6 nail samples at 250,000 cycles and only one sample broke under this cycle. According to this result, the nail met the strength conditions. In the dynamic rotation test, the behavior of the new design against traditional cylindrical nails was examined. Tests were performed on both the Retrodesis Nail and the cylindrical nail at 3 Hz. frequency and 250,000 cycles. While the cylindrical nail performed 8.48° rotation at the beginning of the test, this result was measured as 4.34° in the Retrodesis Nail. When the cycle was completed, the cylindrical nail rotated 10.9°, while the Retrodesis Nail completed the test with 5.44°. When the results of both nails at the beginning and end of the test were compared, it was observed that the Retrodez Nail was superior in terms of performance at approximately 95% and 100%. When the results of the bending and rotation tests of the Retrodez Nail were examined together with its design features, it was understood that the nail was improved in both aspects.

Keywords: Artrodesis Nail, Fatigue test, New Design, Biomechanic test

OP-32

Tribological Characterization of Alumina Ceramic for Dental Applications Against Tungsten Carbide

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Abstract

Alumina ceramics have been used as biomaterials for dental and medical applications due to their high fracture toughness, hardness, good wear and corrosion resistance and density. Alumina has been used in dental applications for fabrication of dental implants, orthodontic brackets, endodontic posts, crowns and bridges. The teeth are exposed to a remarkable amount of wear. For that, the dental implants have been widely used. This research investigates the wear characteristics of applications of alumina in dentistry. Alumina ceramics have been pressed under 30 bar, sintered at 1600 ^{o}C for 3 hours. The wear tests have been conducted using lineer reciprocating module at 10 m sliding distance and 0.01 m/s sliding speed with 5 mm sliding stroke. The counter surface was selected as 6 mm tungsten carbide that its hardness near to the alumina. The coefficient of friction was continuously recorded during the tests and the wear-loss was subsequently determined for the samples.

Keywords: Alumina, microstructure, wear, friction, dentistry

OP-33

Sensitive Cell Line for the Detection of Botulinum Neurotoxin A

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Abstract

Botulinum neurotoxins (BoNTs), produced by Clostridium botulinum, are among the most potent biological substances known, capable of causing muscle paralysis in small amounts. Botulism, a potentially fatal neuromuscular disorder induced by BoNT exposure, continues to pose a significant public health threat worldwide. Despite their lethal nature, these toxins are used in controlled doses for medical and cosmetic purposes, making the precise detection of BoNTs crucial for several key reasons: safety in therapeutic use, food safety, bioterrorism prevention. The gold standard for assessing BoNT biological activity has been the mouse bioassay. Due to the severity of animal suffering, non-animal replacement assays for botulinum products' testing are urgently needed. Efforts to replace animal-based assays have led to the use of neuroblastoma cell lines for BoNT detection. In 2012, Fernández-Salas et al. introduced the SiMa neuroblastoma cell line for BoNT/A detection. Subsequently, Rust et al. (2017) advanced this field by creating a one-step ELISA assay using the SiMa cell line for BoNT/B detection. Building on these foundations, we present a novel, highly sensitive neuroblastoma cell line, genetically engineered to enhance its BoNT/A detection capabilities (Caliskan et al., 2024). This new cell line was genetically modified to express a fluorescent reporter fused with NanoLuc luciferase SNAP 25 and to overexpress SV2A receptor, which significantly boosts its responsiveness to BoNT/A. The engineered neuroblastoma cells were exposed to varying concentrations of BoNT/A, and their sensitivity was assessed through both functional and morphological assays. Our results demonstrate that by utilizing a reporter system that overexpress SV2A, we were able to detect BoNT/A activity at concentrations as low as 10 femtomolar (fM). This represents a significant improvement in detection sensitivity compared to previous models. The genetic modifications introduced in this cell line have markedly enhanced its ability to detect BoNT/A, making it an invaluable tool for toxin detection applications. The development of this genetically modified neuroblastoma cell line holds significant promise for replacing animal-based assays in BoNT detection. Furthermore, the potential to replace animal-based assays with this engineered cell line presents a significant step forward in advancing ethical practices within scientific community.

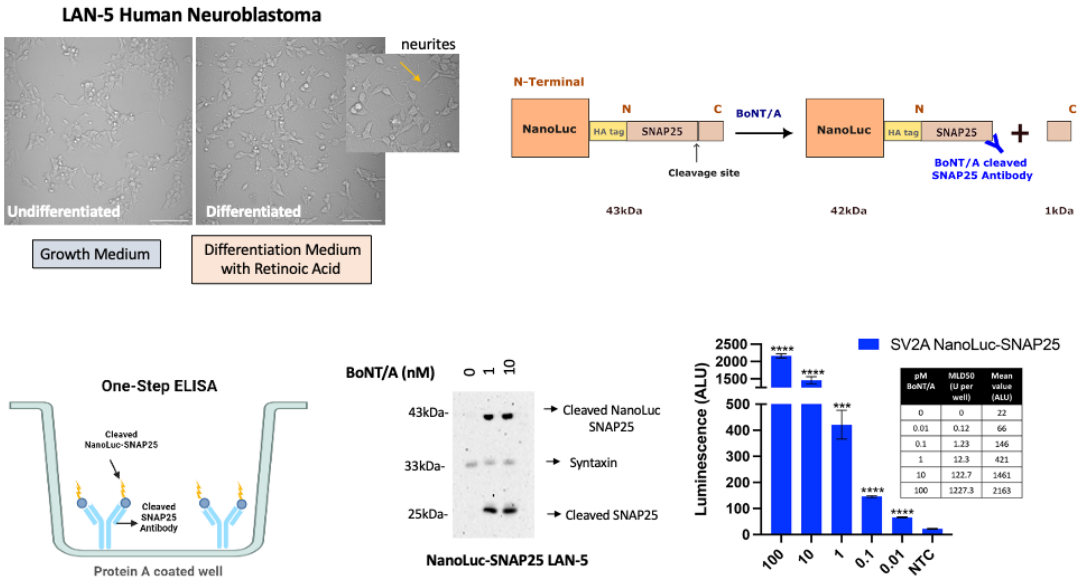

Figure: Development of an ELISA based cell-based assay using re-engineered LAN-5 neuroblastoma cell line. Differentiated and re-engineered SV2A NanoLuc-SNAP25 cells are sensitive to detect BoNT/A cleaved SNAP25 products with one-step ELISA method at the lowest concentration of 0.01 pM (0.12 MLD50).

Keywords: Botulinum neurotoxin; Cell-based assays; LAN-5 neuroblastoma cell line; Botulinum neurotoxin-sensitive cell line.

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OP-34

Development and Characterization of Naturally Derived Scaffolds for Bone Tissue Engineering

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Abstract

Bone tissue engineering (BTE), as an interdisciplinary approach, is focused on addressing bone defects arising from severe injuries, diseases, and other causes through alternative therapeutic strategies. The basic principle of BTE involves the design and development of three-dimensional biological systems by combining cells, bioactive molecules and biomaterials tailored to the specific requirements of the target tissue or organ. In vivo microenvironment of cells imposes complex and highly specific stimuli that directly influence cellular behaviors, such as proliferation, differentiation, and extracellular matrix assembly. Consequently, to successfully engineer functional tissues, the conditions of the natural environment around the cells should be well imitated. A key determinant of success in this field is the creation of optimal biocompatible and biodegradable three-dimensional (3D) biomaterials that can produce appropriate cellular responses. In recent years, natural extracellular matrix (ECM) structures derived from various tissues or organs, along with naturally occurring halloysite nanotubes (HNTs), have gained increasing prominence as preferred biomaterials in bone tissue engineering due to their inherent biological advantages.Based on this information, the objective of this study is to develop and characterize composite scaffolds by utilizing decellularized tendon extracellular matrix (dtECM) and HNTs, and to assess their potential applicability in BTE. To achieve this, bovine tendon tissue was subjected to a decellularization process to obtain dtECM, with the effectiveness of the process evaluated through SEM, FTIR, DNA content analysis, and Lowry protein content analysis. Subsequently, the dtECM was enzymatically digested using a pepsin solution. Following this, neutralized dtECM pre-gel solutions were supplemented with of HNTs. The homogeneous mixtures were then transferred to molds and incubated at 37°C to complete the gelation process. Afterwards, the samples were frozen at -80°C and lyophilized to produce three-dimensional (3D) composite scaffolds. The resulting scaffolds were characterized in terms of microstructure, chemical, physical, biological, porosity, mechanical property. Results indicated that the scaffolds were highly porous and had interconnected pore structures. The pore sizes ranged from several microns to a few hundred microns. The incorporated HNTs were well mixed and physically co-existed with dECM in composite scaffold structures. The addition of 2 % (w/w) HNTs into dECM matrix enhanced the compressive mechanical properties of composite scaffold compared to pure and other scaffolds. Moreover, the MTT cell viability showed that the cells could be viable and proliferate on all the composite scaffolds. Overall, the findings suggest that the composite scaffolds could be suitable candidates for BTE applications.

Key Words: Bone tissue engineering, Halloysite, Extracellular matrix, Composite scaffold.

OP-35

Synthesis and Biological Activity of Functionalized Graphene Oxide Nanolayers with Schiff Bases Via Non-Covalent Interactions

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Abstract

Graphene oxide (GO) nanolayers functionalized with Schiff bases (SBs) through non-covalent interactions offer a versatile platform for biomedical applications [1]. Schiff bases, formed via the condensation of aldehydes and amines, enhance the surface properties of GO without altering its structure [2]. This functionalization can improve the biocompatibility, stability, and solubility of GO, facilitating its use in drug delivery systems and biosensing [3]. This study addresses a notable gap in the literature regarding the functionalization of graphene oxide with Schiff bases for biomedical applications. While there has been considerable research on the properties of graphene oxide itself, there is limited exploration of its non-covalent functionalization with Schiff bases and the subsequent effects on biocompatibility and antimicrobial activity.

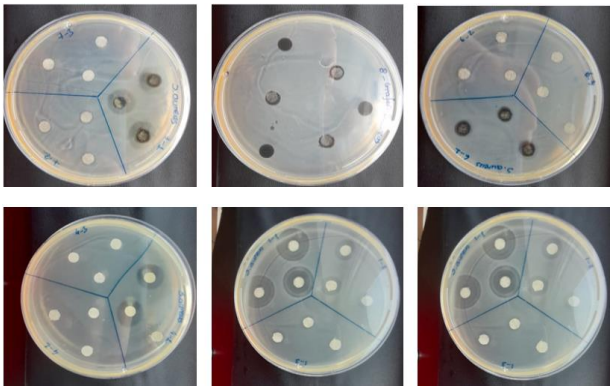

Fig. Antibacterial tests of SBs and GO+SBs

The hypothesis of this study is that non-covalent functionalization of graphene oxide with Schiff bases will improve its biocompatibility, stability, and antibacterial activity while maintaining its structural integrity. Specifically, it is posited that the interactions between GO and SBs will enhance the dispersion and performance of GO in biomedical applications, making it a viable candidate for uses such as antibacterial coatings and drug delivery systems. In this study, we report the synthesis of graphene oxide via a modified Hummers' method, followed by non-covalent functionalization with SBs. This functionalization was achieved through π–π stacking and electrostatic interactions, enhancing dispersion of GO while maintaining its structural integrity. Characterization of the synthesized GO was conducted using techniques such as FTIR, XRD, TEM and SEM to confirm successful oxidation and determine the material's morphology and structure. The structure of SBs was studied and confirmed by NMR, FTIR, UV-Vis. The functionalization was characterized by UV-Vis spectroscopy, FTIR, to confirm interaction and stability.

The antibacterial activity of the GO-SBs was tested against Escherichia coli and Staphylococcus aureus strains using standard disk diffusion methods. Additionally, cytotoxicity was evaluated using MTT assays on MC3T3 osteoblast cell lines to assess biocompatibility. Results indicate that functionalized GO exhibits significant antibacterial activity with low cytotoxicity, making it a potential candidate for biomedical applications, such as antibacterial coatings or drug delivery systems.

Acknowledgement: The research funding by Azerbaijan Science Foundation in the frames of project number AEF-MCG-2022-1(42)-12/11/4-M-11.

Keywords: graphene oxide, Schiff base, non-covalent interaction

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OP-36

Engineering Naturally Based Composite Hydrogel As Flexible Bioadhesivefor Wound Healing of İnternal Organs

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Abstract

In recent times, flexible bioadhesives have been introduced in surgical operations for seamless wound closure. Particularly, hydrogels derived from tropoelastin with high flexibility are being used in bioadhesive compositions. However, these materials are quite expensive. As an alternative, methacryloyl-functionalized gelatin (GelMA) based hydrogels have gained significant interest as low-cost bioadhesives for sealing internal leaks. Nonetheless, GelMA bioadhesives exhibit low mechanical strength and weak adhesion properties. To enhance the bioadhesive performance of GelMA, hybrid structures have been developed using various materials. Among the preferred candidates for preparing these hybrid bioadhesives, alginate derivatives are particularly notable. In this study, hybrid bioadhesives were designed by incorporating Fe+3 ions, which possess more dynamic and reversible cross-linking properties compared to the commonly used Ca+2 ions, into GelMA and methacrylated alginate (AlgMA). The tissue adhesion properties, physical characteristics, biocompatibility, and ex vivo performance of the designed hydrogels were examined. The addition of Fe+3 to the hydrogels was found to increase the ex vivo adhesive strength by 200%, reduce swelling, and enhance hemostatic properties. These bioadhesives demonstrated good biocompatibility in vitro tests conducted on fibroblast cells. These findings provide an important foundation for improving the adhesive properties of tissue adhesives in future studies.

Keywords: Hydrogel, Bioadhesive, Gelatin, Photo-crosslinking

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ABSTRACTS OF POSTER PRESENTATIONS

PP-01

3D Printed Composite PLA Scaffolds for Bone Regeneration

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Abstract

The goal of this study is to design and produce polymer-based scaffolds that are biocompatible and bioactive for use in bone tissue engineering. The approach involves synthesis of mineral-tannic acid nanoparticles (M-TA), using them to produce composite filaments made of poly (lactic acid) and M-TA, and then producing scaffolds out of these filaments using a 3D printer. The composite filaments are designed to be building blocks for the development of bioactive scaffolds with improved mechanical and antibacterial characteristics.

In this study tannic acid was added to the simulated body fluid for the synthesis of M-TA nanoparticles [1] and these nanoparticles were incorporated into PLA filaments through extrusion. The scaffolds with the specified structural characteristics were successfully produced using 3D printing. SEM and Fourier-transform infrared spectroscopy (FTIR) were used to validate the intended shape and content of the nanoparticles. SEM analysis revealed that the M-TA nanoparticles had an average size of 1.08 ± 0.18 µm, while the PLA and PLA/M-TA scaffolds exhibited structural integrity and dimensional accuracy, with an average strip width of 586.95 ± 47.7 µm for PLA and 633.6 ± 25.6 µm for PLA/M-TA, and an average pore size of 454.7 ± 7.4 µm for PLA and 433.4 ± 16.9 µm for PLA/M-TA. FTIR analysis confirmed the presence of phosphate in the nanoparticles. Additionally, compression testing was utilized to assess their mechanical strength. The average Young's Modulus of the PLA/M-TA scaffolds was found as 1222.69 ±108.46 MPa, while the PLA scaffolds had an average Young's Modulus of 629.32 ± 60.16 MPa. This result demonstrates that M-TA incorporation enhances the mechanical properties of the scaffolds. Collagen was applied to the composite scaffolds to promote cell adhesion. Coomassie Blue staining was performed to reveal the collagen on the surface of the scaffolds.

To demonstrate the cytocompatibility of the scaffolds, human fetal osteoblast (HOb) cell line was seeded on PLA and PLA/M-TA/Col scaffolds at specific concentration. After 3 days of culture, cells were fixed and stained with FITC-Phalloidin [2]. The cells were imaged under a confocal microscope and the Z-stack images were obtained. It was observed that more cells adhered to the surface of the collagen coated PLA/M-TA scaffold compared to the PLA scaffold. Presto Blue assay was used to determine cell proliferation on the PLA, PLA/M-TA and PLA/M-TA/Col scaffolds. As a result of the test, the highest cell growth rate was observed on the PLA scaffolds, while the lowest cell growth rate was observed on PLA/M-TA/Col scaffolds. Osteogenic differentiation of the HOb cells seeded on the scaffolds resulted in highest bone mineral deposition on the PLA/M-TA/Col scaffolds, followed by PLA/M-TA scaffolds and the lowest bone mineral deposition on the PLA scaffolds. All these cell culture results indicated that incorporation of M-TA nanoparticles into the PLA scaffolds promotes osteogenic differentiation and that incorporation of both collagen and M-TA nanoparticles results in better osteogenic differentiation. This outcome may be attributed to the better biomimicry of the bone matrix by the PLA/M-TA/Col scaffolds.

Acknowledgements: This study was supported by 2209A and 2210C grants from TUBITAK.

Keywords: PLA, Mineral-Tannic Acid nanoparticles, 3D printing, bone scaffolds.

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PP-02

Fabrication and Characterization of Decellularized Extracellular Matrix-based Composite Scaffolds for Hard Tissue Repair

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Abstract

Tissue engineering is a multidisciplinary field that addresses conventional therapeutic's limitations. A critical factor for the success of tissue engineering efforts is the design and development of three-dimensional, biocompatible, and biodegradable biomaterials that can effectively simulate the native tissue environment for cellular growth and function. In this study, biomimetic composite scaffolds composed of decellularized extracellular matrix (dECM) and curcumin-modified diatomite (dECM-cD) were developed and assessed for their potential application in bone tissue engineering. In the first stage, bovine tendon tissue was decellularized. The efficiency of decellularization was examined by SEM analysis and DNA measurement. In the second stage, diatomites (cD) containing curcumin at different concentrations were prepared, and then, the samples were characterized by FT-IR and XRD. In the third stage, three-dimensional composite scaffolds containing cDE with different ratios were obtained using freeze drying. While different analysis methods examined the physical and chemical properties of the dECM-cD scaffolds, the potential for use in biological applications was evaluated by in-vitro cytotoxicity tests. The results indicate that the composite scaffold holds significant potential as a viable candidate for applications in bone tissue engineering.

KeyWords: Bone tissue engineering, Extracellular matrix, Diatomite, Curcumin

Acknowledgments: This study was financially supported by the Ankara University Scientific Research Fund (BAP grant number FBA-2022-2707).

PP-03

Development of ADA-Gel Based Electroconductive Nanocomposite Hydrogel Bioinks

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Abstract

In recent years, there has been a growing interest in the three-dimensional (3D) bioprinting of conductive biopolymer-based composite hydrogels for the development of biomimetic structures in tissue engineering applications. The achievement of adjustable rheological properties, including optimal shear thinning behavior, a desirable yield strength, and high print accuracy, through the appropriate cross-linking of hydrogel-based bioinks remains a significant challenge. In the context of cellular activities that require bioelectronic communication, the functionalization of bioinks with electrically conductive nanofillers is of paramount importance in the field of tissue engineering. The specific type and quantity of conductive filler material exert a direct influence on the conductivity and rheological properties of hydrogels. It is therefore essential to exercise caution when selecting and utilising these filler materials. In order to achieve this objective, ADA-Gel (alginate dialdehyde-gelatin) hydrogels were synthesized through the periodate oxidation of alginate, thus enabling the creation of bioinks for the formation of three-dimensional structures with cell-loaded hydrogels. The aldehyde groups in ADA molecules were covalently cross-linked with free amino groups of gelatin through the formation of Schiff bases in a dynamic process. Concurrently, a secondary cross-linking process in the presence of divalent cations (Ca^{2+}) was employed to enhance the printability. A variety of concentrations of GO (graphene oxide) were incorporated into the hydrogel matrix and subsequently reduced to rGO (reduced graphene oxide) through a post-reduction process, resulting in the production of an electroconductive bioink. In this study, a stable and conductive bioink was developed with a dual crosslinking strategy for extrusion-based three-dimensional bioprinting. To characterize the bioink, Schiff base bonds in ADA-Gel and aldehyde groups in ADA were approved by ATR-FTIR and NMR spectroscopy, respectively. Rheological tests were conducted to evaluate the storage and loss moduli, shear behavior, and self-healing properties of the materials. It is essential that bioprintable inks possess an optimal loss tangent, ensuring proper extrusion and the maintenance of structural integrity following deposition. Consequently, Loss Tangent Values (LTV) were calculated based on the outcomes of rheological tests. Electrochemical impedance spectroscopy (EIS) and cyclic voltammetry (CV) were employed to investigate the electrical activity. The water uptake capacities of the bioink hydrogels were determined gravimetrically in order to evaluate the diffusion of nutrients and waste products, the structural integrity of the hydrogels, and cell growth. An MTT assay was employed to demonstrate the biocompatibility of the bioink. The results demonstrate that 3D bioprinting of biopolymer-based conductive nanocomposite hydrogels will offer a novel and advanced approach to tissue engineering applications.

Keywords: ADA-gel**,** bioink, conductive hydrogel, nanocomposite, 3D printing

PP-04

Design and Characterization of GelMA-Bioactive Glass Composite Bioinks for Tissue Engineering Applications

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Abstract

Tissue engineering has emerged as a promising strategy for addressing the limitations of traditional treatments in regenerative medicine [1]. Scaffold-based approaches, especially in bone tissue engineering, rely on the development of biomaterials that provide structural support and promote cellular activity. Gelatin methacrylate (GelMA) has garnered significant attention as a bioink component due to its biocompatibility, ease of crosslinking, and tunable mechanical properties [1,2]. However, enhancing its bioactivity for specific applications, such as bone regeneration, remains a challenge. To address this, bioactive glasses have been extensively studied for their osteoconductive properties and ability to promote biomineralization, making them ideal candidates for incorporation into bioinks. Recent advances in composite bioinks combining GelMA with bioactive glasses have shown promising results in mimicking the native bone environment and facilitating tissue regeneration [3].

In this study, we developed a novel composite bioink composed of GelMA and bioactive glasses for tissue engineering applications. Three different types of bioactive glasses (SiO_2, $CaO•SiO_2$ and $MnO•SiO_2$) and were incorporated into the bioink formulation at three varying ratios (1 and 3%) to evaluate their effect on the overall properties of the composite. This study highlights the potential of GelMA-bioactive glass composite bioinks for fabricating bioactive scaffolds with tunable properties for tissue engineering, particularly in bone regeneration. For this reason, the bioinks were subjected to a comprehensive characterization process. The mechanical properties of the composite bioinks were evaluated through uniaxial compression testing, revealing that the inclusion of bioactive glass significantly enhanced the mechanical strength. Rheological properties, on the other hand, were assessed to ensure compatibility with extrusion-based bioprinting techniques, confirming the flow behavior suitable for precise deposition. *In vitro* degradation rates of the bioinks were studied, demonstrating that the incorporation of bioactive glass allowed for controlled degradation, adjustable based on the glass content. Biomineralization was further investigated through assays showing enhanced hydroxyapatite formation due to the presence of bioactive glasses, a key factor for bone tissue engineering applications. Additionally, cytocompatibility of the bioinks was confirmed via cell culture experiments, where higher bioactive glass content was observed to promote increased cell proliferation.

Keywords: GelMA, mesoporous bioactive glass, composite bioink, bone tissue engineering, biomineralization,

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PP-05

Optimization of PLA Composites with GLYMO-Modified Hydroxyapatite: Effects on Mechanical Properties, Thermal Behavior, and Cytocompatibility

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Abstract

Polylactic acid (PLA) is a biodegradable polyester widely used in orthopedic and dental applications. However, its application is limited due to inability to form a direct bond with bone. To overcome this limitation, PLA/hydroxyapatite (HAp) composites have been explored. Despite this, HAp agglomeration within the PLA matrix, due to unfavorable interfacial interactions, adversely affect the mechanical properties and stability of PLA/HAp composites. In this study, 3-(glycidyloxypropyl)trimethoxysilane (GLYMO)-modified HAp particles (G-HAp) were synthesized and incorporated into the PLA matrix to form PLA/G-HAp composites. The PLA/G-HAp composites were prepared by mixing G-HAp (50 wt%) with PLA (10 wt% in chloroform) solution. The mixture was then dried, ground, molded into cylindrical shapes under loading of 15 tons, and cured at 200°C in nitrogen atmosphere. The interfacial interactions of the resulting composites were characterized using Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), and atomic force microscopy (AFM). It was observed that increased crosslinking density at the interface resulted in rougher surfaces for composites. Thermal analyses demonstrated that the glass transition temperature (T_g) of PLA shifted to higher temperatures in correlation with increased crosslinking density. Furthermore, Vicker's hardness and compression tests were performed to assess the effects of interfacial crosslinking, showing improvements in hardness and Young's modulus. Finally, biocompatability test was conducted to evaluate cytotoxicity, revealing that PLA/G-HAp exhibited higher cytocompatibility compared to conventional PLA/HAp composites.

Keywords: Polylactic Acid, Hydroxyapatite, Composites, Mechanical Properties,Thermal Analysis

PP-06

PLA-PGS Composite Electrospun Mats for Construction of an in vitro 3D Human Myocardial Tissue

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Abstract

The development of numerous new drugs has been delayed or halted due to unexpected side effects observed during clinical trials or even after they reach the market. Cardiotoxicity is one of the leading causes of high attrition rates among newly developed drugs. Advances in the differentiation and purification of hPSC-derived cardiomyocytes (hPSC-CMs) and their unlimited availability have led to strategies utilizing these cells for assessing cardiotoxicity in new drugs [1]. Engineered cardiac tissues now encompass any cell culture platform that supports the multicellular, three-dimensional culture of synchronously contracting hPSC-CMs [2]. In general scope, this study aims to develop an in vitro 3D model of multicellular cardiac tissue to investigate drug-induced cardiotoxicity.The design of the 3D multicellular heart tissue involves the differentiation of human iPSCs seeded on a PLA electrospun mat into cardiomyocytes. We used poly(lactic acid) (PLA) to produce aligned-fiber mats via electrospinning. The electrospun fibers were collected between two stainless steel rods. Fiber alignment was controlled not only by electrospinning conditions but also by material composition. Poly(glycerol sebacate) (PGS) was added to 10% (w/v) PLA dissolved in Chloroform:DMF (9:3 v/v) to produce electrospun aligned-fiber mats. It was determined that PGS concentration affects fiber alignment and fiber thickness. Morphological examination of the mats by Scanning Electron Microscopy (SEM) revealed that 2% PGS led to maximum fiber alignment and fiber thickness consistency in comparison to samples with 1% and 4% PGS. An average fiber thickness of 1.627 μm was obtained for PLA with 2% PGS, while use of 4% PGS led to excessive bead formation among the fibers. Young's Modulus of the electrospun mats was determined by performing a tensile test. The tensile test results show that as the PGS content increases, the Young's modulus decreases, indicating greater elasticity. Mats with 1% PGS had an average Young's Modulus of 5.08 N/mm², exhibiting higher stiffness. In contrast, mats with 2% PGS had an average Young's Modulus of 2.08 N/mm², while those with 4% PGS showed the lowest average modulus of 1.61 N/mm², reflecting significantly enhanced flexibility as the PGS content increases.As a preliminary study, human iPSCs were seeded onto electrospun mats prepared from 10% PLA. 24 hours after cell seeding, Live/Dead assay was performed, and evenly distributed cell adhesion was observed on the PLA mats. After the iPSCs reached confluency, differentiation into cardiomyocytes was induced for a 14-day period. Cells were immunostained for Cardiac Troponin-T, counterstained with DAPI, and were observed by confocal microscopy. The cardiomyocytes were observed in clusters in one part of the mat and resided both within and on the mat. No cellular alignment was observed in the cardiomyocyte clusters residing on the fibers. Cell culture studies to examine the effect of PGS content on cardiomyocyte differentiation are in progress.

Keywords: Electrospinning, in vitro myocardial tissue, cardiomyocyte differentiation

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PP-07

Controlled Protein Release from Hydrolytically Degradable 'Click' Chemistry-based Interpenetrating Polymer Network Hydrogels

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Abstract

Hydrogels have distinct characteristics that determine their potential as biomaterials for tissue regeneration and drug-release devices. However, conventional single-network semi-interpenetrating polymer network (SIPN) hydrogels exhibit poor mechanical properties and cellular milieu mimicry. Here, we fabricate a biocompatible interpenetrating polymer network (IPN) hydrogel with improved capabilities for controlled protein release. We utilized a one-pot synthesis strategy consisting of aqueous Diels–Alder (DA) "click" chemistry and photopolymerization techniques to crosslink gelatin methacryloyl (GelMA) within a polymer network of polyethylene glycol bismaleimide (PEGMI) and multi-furan functionalized polyethylene glycol (PEGFU). FTIR and 1H-NMR were used to analyze the chemical structures and compositions of hydrogels. This study compared the protein release in IPN and traditional SIPN hydrogels with varying PEGFU-to-PEGMI ratios. The fully crosslinked IPN hydrogels exhibited superior compression strength and effective energy dissipation compared to SIPN hydrogels. The in vitro protein release kinetics of the IPN hydrogels followed the Korsmeyer-Pappas mathematical model, demonstrating slow and extended therapeutic release. These hydrogels demonstrate good water absorption capabilities and moderate degradation in aqueous environments, making them ideal for temporary drug delivery. The IPN hydrogels demonstrated biocompatibility with fibroblast-3T3 cells, suggesting their potential for tissue engineering applications

Keywords: Diels Alder Reaction, Hydrogels, Tissue Engineering, Drug Delivery

PP-08

Development of a Therapeutic Injectable Hydrogel for Spinal Cord Injury

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Abstract

Traumatic spinal cord injury (SCI) is a dramatic and life-changing condition. SCI is characterized by a primary injury followed by a secondary injury that causes neural degeneration [1]. There is no definitive clinical treatment for SCI [2]. Various protective and pharmacologic drugs are used to suppress inflammation in the treatment of SCI. Another therapeutic approach is the use of biomaterials and biomolecules to regulate the microenvironment and reduce degeneration [3].
In this study, an approach to develop injectable hydrogels that combine materials science and tissue engineering to regulate the microenvironment presented. Injectable hydrogels have many advantages, such as being injected directly into the injury site, localizing the treatment on the targeted area, and being minimally invasive. A biocompatible, injectable basal hydrogel, whose physical and chemical properties can be modified according to the needs using tannic acid (TA) and bacterial cellulose (BS) was developed and characterized. The biodegradability and the gelation kinetics of the formed hydrogel were evaluated. The injectable hydrogel was further modified with graphene and hyaluronic acid, and its regenerative effect on nerve cells was examined with an *in vitro* SCI scratch model. The rate of closure of the scratch area was analyzed on hourly microscopic images and the wound closure times of graphene and hyaluronic acid doped hydrogels were shown comparatively. It was shown that cross linking with TA and modification with graphene improved the wound closure times and neuronal regeneration. Developed hydrogels have potential to be used as an alternative or supplementary treatment for SCI.

Keywords: spinal cord injury, biomaterials, tissue engineering, hydrogel

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PP-09

Evaluating the Antimicrobial Potential of Hydrogel Membranes Incorporating Plant-Derived Essential Oils

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Abstract

The global concern over microbial resistance, particularly the emergence of antibiotic resistance, underscores the imperative for novel antimicrobial strategies. Plant essential oils and biopolymers offer promising alternatives to conventional drugs for bacterial and fungal infections. The objective was to achieve optimized antibacterial activity and to identify the phytochemical component of the essential oil. The essential oils passed the screening confirmed by GC–-MS analysis. The synthesized hydrogel was prepared by freeze drying polyvinyl alcohol (PVA)/gum Arabic with the addition of a crosslinker. The EOs compounds' antimicrobial effectiveness was confirmed using FT-IR analysis upon their integration into the hydrogel membrane. Furthermore, SEM analysis was performed to investigate the morphological structure of the hydrogel membranes, and the results indicated that the material was successfully loaded. The antibacterial efficacy was evaluated against two gram positive and gram-negative bacteria strain. The best results of the antibacterial study for the synthesized hydrogels were obtained with the addition of 0.2 mL of SMEO to the PVA/GA hydrogels of S. aureus and B. subtilis, which were 10.2 ± 0.16 mm and 9.3 ± 0.3 mm, respectively, while those of 0.4 mL were 8.2 ± 0.21 mm and 8.2±0.3mm, respectively. Additionally, with 0.2 mL of SMEOs, the moisture retention capacity (MRC) and water vapor transmission rate (WVTR) were 93.12% and 32.73 g/m^{2}h, respectively. The results of this research study suggested that the phytochemical component of the essential oil and the synthesized hydrogel membrane exhibit greater antibacterial activity and physical features, making it suitable for use in various biomedical applications.

Keywords: Essential oil, Phytochemical analysis, Hydrogel membrane, Characterization, Antimicrobial Study.

PP-10

Development of Hydrogel-Based Microneedle Patches for the Transdermal Delivery of Tetracycline and Retinoic Acid in Acne Vulgaris Treatment

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Abstract

Acne vulgaris is a prevalent and chronic dermatological condition, particularly during adolescence, resulting from the inflammation of pilosebaceous units, colonization by *Propionibacterium acnes*, sebaceous gland hyperactivity, and influenced by genetic, hormonal, and lifestyle factors [1]. Conventional treatments often involve a combination of oral or topical antibiotics and retinoids, typically delivered through tablets, creams, or gels. However, recent advancements have identified microneedle (MN) patches as promising platforms for transdermal therapeutic delivery due to their superior penetration capabilities. In addition to their enhanced penetration ability, MN patches offer a pain-free treatment option [2].This study focuses on the design and fabrication of hydrogel-based MN patches loaded with tetracycline (TCH), an antibiotic frequently used in acne treatment, and retinoic acid (RA), a retinoid derivative. The MNs were prepared using gelatin (Gel) and poly(vinyl alcohol) (PVA) through a micro-molding technique. The patches were loaded with varying doses of TCH and RA, characterized for their structural, thermal, and antibacterial properties, and evaluated for their efficacy in potential dermatological applications. Morphological analyses via light microscopy and scanning electron microscopy (SEM) confirmed the successful fabrication of square-based pyramidal microneedles with a height of approximately 650 µm. Both TCH and RA were effectively loaded onto the MNs. Thermal stability was assessed using Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA). The microneedles exhibited thermal degradation around 325°C, with mass losses ranging from 76% to 82% between 300°C and 450°C. The addition of active substances did not significantly affect the thermal degradation profile. DSC thermograms revealed two distinct glass transition temperatures, 37.5°C for PVA and 49.22°C for gelatin, with melting points at 110°C for gelatin and 195.36°C for PVA. Biocompatibility testing using the L929 cell line demonstrated that the microneedle patches were non-toxic. A penetration study using parafilm confirmed that the 650 µm microneedles penetrated to the 5th and 6th layers, indicating their capability to reach the dermal skin layer. Antibacterial testing against *Staphylococcus aureus* (ATCC 29213) revealed that the MN patches exhibited significant antibacterial properties. In conclusion, hydrogel-based MN patches loaded with TCH and RA demonstrate promising potential for enhancing transdermal drug delivery and offer an innovative approach for the topical treatment of acne vulgaris by combining both antibiotic and retinoid therapies in a single platform.

Keywords: Microneedle, tetracycline, retinoic acid, acne vulgaris, PVA, gelatin

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PP-11

Optimization of Hydrogel Composition to Mimic Brain Tissue of Neurovascular Unit

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Abstract

The brain extracellular matrix (ECM) plays a crucial role in providing structural support for nervous tissue cells. Comprising 20% of the total brain volume, ECM consists of a macromolecular network of glycosaminoglycans (e.g., hyaluronan), proteoglycans (lecticans), glycoproteins (tenascin), and minimal amounts of fibrous proteins (collagen, fibronectin). Hyaluronan (HA), the primary component of brain ECM, enhances tissue hydration and regulates molecule diffusion and cell migration. HA interacts with lecticans, which are crosslinked by tenascins, providing cell attachment sites and mechanical integrity. Mechanical properties of the nervous tissues in the neurovascular unit, with a Young's modulus less than 1 kPa, significantly influence in vitro cell behavior, attachment, and growth. Hydrogel is a promising approach for mimicking the mechanical properties and chemical composition of soft tissues like nervous tissue. In tissue engineering, developing an appropriate 3D constructs that accurately mimic the mechanical and compositional properties of the brain ECM and support heterogeneous tissue architectures remains a challenge. This study was aimed to optimize a hydrogel composition that mimics the brain ECM and provides a supportive microenvironment for neurons and glial cells. In addition, The neurovascular unit, which includes the brain and blood vessels, contains pericytes. In this study, Wharton's Jelly mesenchymal stem cells, functioning as pericytes, were used. Hydrogels composed of methacrylated hyaluronic acid (HAMA) and proteins, collagen and fibronectin were produced to mimic the chemical composition of the brain extracellular matrix (ECM) and to provide cell attachment sites, respectively.Various HAMA-based hydrogels with different concentrations of collagen (3-6%) and fibronectin (2.5%-15%), and then crosslinking under UV light were prepared. The hydrogels were optimized based on cell viability, morphology, and stability. Hydrogels were tested with HAMA concentrations ranging from 1% to 3%, using UV crosslinking conditions of 1.6 J for 1.5 min or 0.160 J for 2 min. The results showed that increasing collagen concentration improved cell viability and spreading; however, increasing HAMA concentrations beyond 0.75% in the hydrogel did not provide additional benefits when collagen concentration was kept constant. Fibronectin promoted initial cell attachment, but did not significantly enhance cell spreading. The optimal hydrogel composition was determined to be 3% HAMA and 6% collagen in a 1:3 ratio, based on the best spindle-shaped morphology observed in WJ-MSCs. After determining the performance of this hydrogel composition on cell spreading, the hydrogel was further characterized using SEM, FTIR, and mechanical tests. The results showed that its structure and mechanical properties could mimic brain ECM properties.
Then, this hydrogel was used with astrocytes and neurons, as well as co-culture of neuron, pericytes and astrocytes. Live-Dead assay results showed that the cells were successfully incorporated, attached,

spread, and remained viable throughout a 10-day culture in both monoculture and co-culture conditions within this hydrogel composition. These results suggest that the hydrogel, with its ability to mimic the structure of brain ECM and provide a supportive environment for cell attachment and viability, could potentially be used in 3D brain tissue *in vitro* models

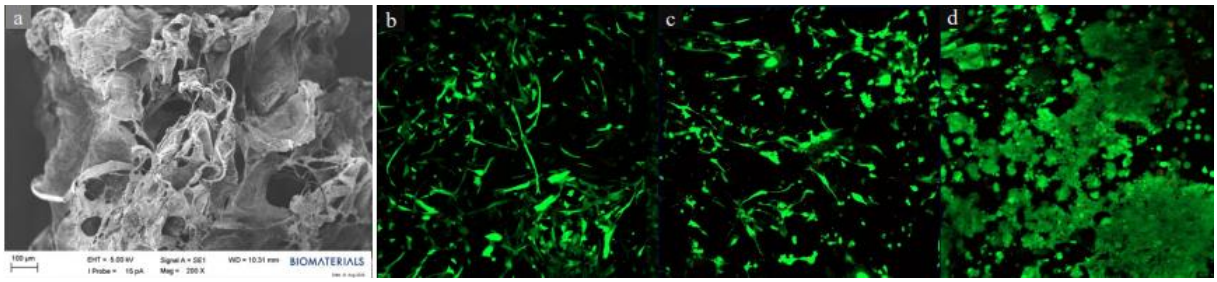

Figure 1: Morphological and biological characterization of brain ECM-like hydrogel. (a) SEM image of the hydrogel structure. LSCM images of (b) WJ MSCs, (c) astrocytes, and (d) neurons in hydrogel on 7 days of culture after LIVE/Dead assay application (green = live cells, red = dead cells).

Keywords: Brain ECM, Hyaluronic Acid (HAMA), Hydrogel, Tissue

PP-12

Quercetin-Conjugated Self-Healing PectaGel: A Novel Hydrogel for Enhanced Angiogenesis and Tissue Regeneration

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Abstract

Angiogenesis, the formation of new blood vessels, is a crucial factor in tissue regeneration as it ensures the delivery of essential nutrients and oxygen to damaged tissues. Motivated by this, we developed a hydrogel through the crosslinking of dialdehyde pectin with adipic acid dihydrazide (ADH) and conjugation with quercetin (QC), a compound known for its potent antioxidant properties. QC plays a significant role in wound healing by enhancing fibroblast activity and promoting angiogenesis, thereby increasing blood flow to the wound site [1]. When applied to tissue, the hydrogel adheres to body fluids, extending the availability of growth factors crucial for tissue regeneration [2].

In this study, we employed a crosslinking strategy involving pectin periodate oxidation and ADH, which can also function as cell binding sites [3]. Additionally, the hydrogel was loaded with procaine (PC), a bioactive agent known for its antioxidant, antibacterial, and membrane-modulating properties.

Oxidized pectin was conjugated with QC, and arginine was incorporated into the hydrogel. The final hydrogel structure was formed via crosslinking with ADH and subsequently characterized by FTIR, rheological, antioxidant, and angiogenesis tube formation assays. Despite the oxidation and conjugation processes, the hydrogel retained a remarkable antioxidant capacity, achieving 98% DPPH inhibition, primarily attributed to the presence of QC. Rheological oscillatory thixotropic analysis revealed the hydrogel's self-healing properties, driven by dynamic Schiff base reactions and secondary bonding. These findings, coupled with the hydrogel's strong antioxidant activity, suggest its potential utility in tissue engineering applications.

Keywords: oxidized pectin, quercetin, tissue engineering, wound healing, angiogenesis

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PP-13

UV-B-Induced Extracellular Vesicles in 3D Wound Model

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Abstract

The skin has many important functions for the integrity of the organism, including protection against external factors, thermal regulation, sensory perception, and hemostasis. Therefore, wounds on the skin can be of vital importance. Wound healing is a complex and coordinated process in which many factors such as various growth factors, cells, and the extracellular environment play a role [1]. Different studies on wound healing have shown that the mesenchymal stem cell (MSC) approach is the most attractive approach [2]. It has been shown that the potential of MSCs in clinical applications lies mostly in extracellular vesicles (EV). It is known that they reflect the characteristics of the cell from which they are secreted. They are actively involved in many regenerative processes due to their role in intercellular communication [3]. Various studies have shown that MSCs exposed to UV light secrete more protective and healing secretions, which leads to an increase in their potential [4-6]. In this study, we examine the healing potential of MSC EVs derived from fat and bone marrow exposed to UV light in two- and three-dimensional wound models. Different doses of UV-B were applied to MSCs, and the most appropriate dose was determined by cell viability and apoptosis analyses. Following the isolation of EVs from UV-induced MSC groups, EVs were characterized by a variety of methods. EVs were also analyzed to determine their levels of IL-6, PDGF-BB, VEGF-A, and TGF-ß. After that, two and three-dimensional wound models were created *in vitro* using two different cell lines. In order to generate a two-dimensional wound model by co-culturing the cells, a "Scratch Wound Model" was created and different doses of the EVs obtained were applied to the wound model. The proliferation analysis was performed in order to track cell proliferation, while wound closure measurements were made by analyzing photographs using the Image J software program. As a final step, the three-dimensional wound model was created using the system of "Air-Liquid Interface" by first creating a skin model and then creating wounds. The EV doses applied to the three-dimensional wound models were the doses obtained from the scratch experiment results. Following wound healing, histological sections were taken from tissue samples and healing rates were examined by randomly sampling the sections. In conclusion, EVs were successfully isolated from UV light-induced MSCs. It was found that UV light had no negative effect on the morphology of EVs. Content analysis of EVs also revealed that induced MSC EVs contained higher levels of growth factors and cytokines than non-induced MSC EVs. According to the results of the "Scratch Wound Model" experiment, UV-induced MSC EVs closed more wounds than those that were not UV-induced. Results from the three-dimensional wound model were consistent with those obtained from the two-dimensional wound model. The results of the study demonstrate a positive change in the potential of EVs obtained from UV-induced MSCs and a higher performance in *in vitro* wound models based on the results obtained. This research suggests that UV-induced MSC EVs may have potential for use in regenerative medicine.

Keywords: Mesenchymal stem cell, Extracellular vesicles, UV light, Scratch assay, Three-dimensional wound model

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PP-14

Injectable Adhesive and Transparent Wound Dressing Based on PRF-Integrated, Glycidyl Methacrylate-Functionalized Silk Fibroin for Corneal Ulcer Treatment

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Abstract

The cornea is a transparent, dome-shaped structure at the front of the eye. It plays a crucial role in vision by acting as a protective barrier and refracting light onto the retina. This process enables the cornea to effectively gather and focus incoming light, thereby facilitating the sense of vision. (1). In order to carry out this function effectively, the cornea must maintain its transparency and remain free from any form of scarring or ulceration. (2). The process of corneal thinning, the development of corneal ulcers due to exposure to various pathogens, and perforations represent significant ocular tissue diseases that contribute to ocular morbidity and, in advanced stages, are responsible for causing substantial vision impairment (3). In contemporary ophthalmology, diverse treatment modalities are available, contingent upon the etiology of the ailment and the dimensions, site, and clinical phase of the corneal lesion area. For minor perforations, cyanoacrylate-based adhesives, conjunctival flaps, and amniotic membrane transplants have demonstrated efficacy. Nevertheless, corneal transplantation is the preferred approach in advanced stages, notwithstanding the notable constraint posed by the risk of rejection of the transplanted tissue (4). Recent investigations have underscored the utilization of platelet-rich fibrin (PRF) as an innovative modality in bioactive wound dressings. PRF constitutes a multifaceted fibrin matrix encompassing a substantial concentration of platelets and growth factors inherent in the circulatory system. It comprises a spectrum of transforming growth factor-beta (TGF-β), platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), insulin-like growth factor-1 (IGF-1), and glycoproteins such as thrombospondin. Moreover, PRF contains a dense fibrin network with leukocytes, cytokines, and glycoproteins, accelerating wound healing and skin regeneration (5). The objective of this study was to fabricate silk fibroin-based adhesive hydrogel wound dressings modified with glycidyl methacrylate for potential application in the treatment of corneal ulcer wound beds. Silk fibroin derived from silkworm cocoons were functionalized with glycidyl methacrylate. The chemical and morphological characterization of the developed material was conducted using FTIR, BCA, SDS-PAGE, and SEM analyses. Wound dressings were underwent swelling and degradation tests in PBS and artificial tear environments. Mechanical strength tests of the wound dressings, as well as *in vitro* and *ex vivo* burst pressure tests, were carried out. The mechanical strength results of the samples without PRF for irradiation times of 20, 40, and 60 seconds were observed as 537.47±54.50, 666.39±65.20, and 822.775±152.90 kPa, respectively. In contrast, the mechanical strength results for the samples containing PRF for the same irradiation times were observed as 1244.00±295.94, 1415.79±232.89, and 1610.03± 300.32 kPa, respectively. Based on these results, it is evident that PRF enhances the strength of the copolymer structure. The light transmittance percentage was determined through transparency analysis for corneal applications. The biocompatibility of the prepared ocular adhesive wound dressings with corneal fibroblast cells was assessed using MTT assays. The results of the tests strongly suggest

that the developed wound dressings hold promise as biomaterials for addressing tissue perforations associated with infiltration in corneal ulcer wound beds.

Keywords: Adhesive hydrogel, Wound dressing, Corneal ulcer, Silk fibroin, Platelet-rich fibrin

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PP-15

Comparison of Extracellular Matrix Components for Biofabrication of Bone Tissue Engineered 3D-Printed Models

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Abstract

The interaction between the extracellular matrix (ECM) and biomaterials is critically important for understanding how cells behave on biomaterials in tissue engineering. ECM provides structural support to cells but also contains biochemical signals that guide cellular activities. When cells interact with biomaterials, they respond to ECM proteins and their mechanical properties. This interaction is essential for cell adhesion, proliferation, differentiation, and survival. Therefore, aligning biomaterials with the ECM is a key strategy for maintaining cell function and promoting tissue regeneration. Especially for cells like osteoblasts, the mechanical and biochemical signals of the ECM play a vital role in achieving successful outcomes in bone tissue engineering.

Using 3D bioprinting technology, flat plates and three dimensional (3D) scaffolds made of polylactic acid (PLA) were produced. After sterilization, these structures were coated with extracellular matrix components, including Type I Collagen, Fibronectin, Laminin, as well as bovine serum albumin and RGD peptide. hFOB 1.19 fetal pre-osteoblast cells were then seeded onto the coated surfaces. Following a 24-hour incubation at 37°C in a 5% CO2 environment, the cells were stained with Phalloidin 488 and Hoechst 33342 fluorescent dyes and visualized. Subsequently, hFOB 1.19 pre-osteoblast cells were seeded onto body-centered cubic structure (bcc) and body-centered structure (bcs) PLA scaffolds, whose surfaces had been coated with extracellular matrix components, and after 48 hours of incubation, cell viability was assessed using the MTT viability assay.

The results demonstrate that coating PLA surfaces with Type I Collagen, Fibronectin, and Laminin significantly improves cell spreading and the formation of organized cytoskeletal structures in osteoblasts, as compared to uncoated or RGD peptide and BSA-coated surfaces. Furthermore, cell viability was notably higher on coated PLA scaffolds across all porosity levels and geometries (bcc and bcs), reinforcing the importance of ECM protein incorporation for optimizing scaffold designs in bone tissue engineering.

In conclusion, the study highlights the critical role of extracellular matrix (ECM) proteins in enhancing cell adhesion, morphology, and viability on polylactic acid (PLA) scaffolds. These findings underscore the potential of ECM-based surface modifications to improve the performance of biomaterials in regenerative medicine applications.

Keywords: Bone Tissue Engineering, Extracellular matrix, 3D Printing, Poly Lactic Acid

PP-16

Development of a 3D Printed Honeycomb Scaffold for Spinal Cord Injuries

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Abstract

Spinal cord injuries are catastrophic and irreversible, affecting over 15 million individuals globally. The primary challenge is the regeneration of nerve cells and glial scar formation, which leads to permanent functional loss. In the study of such a complex phenomenon, a simplified extracellular matrix and cellular composition mimicking the essential properties of the defect site would be extremely valuable. This study focuses on the development of a hydrogel based microenvironment model to study spinal cord injuries and glial scar tissue.

In order to mimic the natural composition of the spinal cord, a gelatin based hydrogel GelMA, was used. Methacrylation was confirmed through ^{1}H-NMR analysis, and the degree of methacrylation was calculated as 87.06%. Prominent components of the spinal cord extracellular matrix, hyaluronic acid, chodroitin sulfate and laminin were incorporated into the hydrogel and verified through FTIR analysis. The hydrogel was 3D printed with a honeycomb design and crosslinked. Honeycomb structured channels were introduced to mimic the multiple channels present in the spinal cord. Mechanical strength was measured by compression test. The elastic modulus of the hydrogels was 89.62, 122.22, and 98.85 kPa on Days 1, 7 and 14, respectively. Equilibrium water content (EWC) was determined to be 88.98%. Scanning electron microscopy (SEM) analysis of morphology demonstrated that the multi channels formed by honeycombs were 350 µm in size and uniformly printed.

The results indicated that GelMA+HA+CS+Laminin hydrogels exhibited significant potential for *in vitro* testing to study spinal cord injuries.

Keywords: spinal cord, spinal cord injury, hydrogels, 3D printing, honeycomb

PP-17

Fabrication of *In Vitro* 3D Human Dermal Model

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Abstract

In vitro 3D human skin models have been used as suitable semi *in vivo* models for *in vitro* diagnostics and cosmetics testing [1], for evaluating the potential of various vitamins [2], and drugs such as antibiotics [3], anti-cancer [4] and anti-viral molecules and for studying the carcinogenic biomarkers [5]. In developing these models, the presence of a dermal component with vessel may increase the similarity to native human skin and therefore, more accurate analyses results can be achieved when used as an *in vitro* 3D model. In this study, an *in vitro* 3D human dermal model consisting of dermis and hypodermis with vessel-like structures was developed. The methacrylated gelatin (GelMA) hydrogel (8% w/v) was produced by photocrosslinking and the results of its swelling ratio (16.14 ± 1.51 %), degradation ratio (2.98 ± 1.52 %) and compressive modulus (8.25 ± 2.26 kPa) was proved that the hydrogel was a suitable material for fabricating of an *in vitro* 3D human dermal model. For hypodermis, human adipose-derived mesenchymal stem cells (hAT MSCs) at passage 3 ($2x10^6$ cells/mL) and human umbilical vein endothelial cells (HUVECs, $4x10^6$ cells/mL, passages 2-5) were suspended in GelMA prehydrogel solution (8% w/v) and exposed to UV A lamp for 5.5 min. The dermis consisting of dermal fibroblasts ($4x10^6$ cells/mL, passages 2-5) and HUVECs ($2.25x10^6$ cells/mL, passages 2-5) was constructed over the hypodermis by photocrosslinking for 11 min. HUVECs ($6.3x10^4$ cells/cm^2, passages 2-5) were seeded on both of layers to increase the formation of vessel. After 35 days of incubation, the fluorescent micrographs showed that the dermal layer had homogeneously spread cells while the hypodermis contained well-differentiated adipocytes and hAT MSCs. Moreover, the dermal and hypodermal layers had vessel-like structures, especially in the regions close to the surface of hydrogel. It can be concluded that developed *in vitro* 3D human dermal model is an ideal candidate for evaluating the skin-related researches.

Keywords: *In vitro* 3D human dermal model, Dermis, Hypodermis, Vessel-like structure, GelMA

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PP-18

Innovative Wound Dressings Fabricated with Snail Mucus Extract Using a 3D Handheld Bioprinter for Diabetic Foot Ulcer Applications

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Abstract

Diabetic foot ulcer is a condition characterized by deep wounds in the foot region of diabetic patients, which are challenging to treat. As these ulcers advance, treatment becomes increasingly difficult, and depending on the severity of the wound, amputation of the foot or, in some advanced cases, below-knee amputation may be required (1). Factors that complicate the healing of diabetic ulcers include prolonged inflammation, insufficient collagen deposition, poor vascularization, and impaired epithelialization (2). The 3D handheld bioprinter, featuring a pen-shaped design, shows significant potential for advancing *in situ* bioprinting by reducing processing time and enabling the precise formation of bioinks to match the geometric shape of the wound (3). The device features a bioink cartridge, a light-curing unit, and a nozzle for printing. Using a syringe-like extrusion system, the bioink is pushed out of the cartridge while the light-curing unit activates, allowing the material to photocrosslink during bioprinting (4). The 3D handheld bioprinter offers the advantage of *in situ* bioprinting, an important factor for fabricating wound dressings on site that fit the deformed wounds associated with diabetic foot ulcers. Snail mucus has been used for wound healing for over 2000 years (5). *Achanita fulica (white body)* snail mucus has antibacterial properties and various components such as allantoin, collagen, elastin, and glycosaminoglycans that induce wound healing, cell proliferation and promote angiogenesis (6, 7).
In this study, *A. fulica* (white body) snail mucus was extracted and incorporated into bioinks with varying concentrations of lyophilized mucus (0, 5, 10, and 15 mg/ml). The bioinks were prepared by combining snail mucus with 15% w/v GelMA (gelatin methacryloyl) and LAP (lithium phenyl-2,4,6-trimethylbenzoylphosphinate) as a photoinitiator. The bioinks were then utilized for in situ printing using a 3D handheld bioprinter, where the crosslinking of the bioinks occurred under visible light for 60 seconds, forming hydrogel wound dressings. These dressings were designated as Gel_SM0, Gel_SM5, Gel_SM10, and Gel_SM15 based on their snail mucus content. To optimize the printing process, key parameters such as extrusion rate and printing speed were evaluated by creating grid-like structures. The study aimed to assess the mechanical properties, adhesive qualities, as well as the swelling and degradation behaviors of the hydrogel dressings enriched with snail mucus. For Gel_SM0, Gel_SM5, Gel_SM10, and Gel_SM15 hydrogels, compression strengths were found to be 426.019 kPa, 513.882 kPa, 587.911 kPa, and 481.957 kPa, respectively. That concludes, snail mucus addition increases the mechanical strength up until a certain concentration. To understand the hemocompatibility of dressings, hemolysis assay was performed and the results showed hemolysis rate under %5 in all experimental groups. MTT assay was performed on CCD1064Sk cells to assess the cytotoxicity levels of the dressings and the results showed above 80% of the cells are viable and the dressings are not toxic after application.

Additionally, *in vitro* scratch assay was conducted to evaluate the wound-healing properties of the dressings, while their antibacterial and antioxidant properties were also assessed. All results demonstrated that the *in situ* bioprinted dressing containing snail mucus extract holds significant potential for diabetic foot ulcer applications.

Keywords: 3D handheld bioprinting, Snail mucus, Diabetic foot ulcer, Gelatin methacrylate

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PP-19

Hemocompatible Decellularized Human Placental Membrane as Potential Graft for Pediatric Cardiac Surgery

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Abstract

Ventricular Septal Defect (VSD) is one of the most common congenital heart anomalies, characterized by an abnormal opening in the interventricular septum, which allows blood to flow between the left and right ventricles [1]. Congenital heart defects are often treated by cardiovascular surgery. Over time, treated patients may experience issues such as calcification within the heart, diminished contractility and progressive deterioration, depending on the characteristics of the graft used during surgery [2]. The goal of our study is to determine the feasibility of utilizing the placental membrane as a cardiac graft through in vitro tests. The whole placental membrane was decellularized using detergents (SDS and Triton X-100) and DNase and decellularization evaluated according to the Badylak criteria [3]. DAPI staining revealed no cell nuclei and DNA extraction revealed that more than 95% of DNA was successfully removed by decellularization. By using an sGAG quantification kit the sGAG content of native placental membrane was determined as 1.9 µg/mg dry weight, and in decellularized membrane (dPM) it was determined as 3.5 µg/mg dry weight. Masson's trichrome staining revealed the collagen remaining in the dPM. For acquisition of hemocompatibility, the decellularized placental membranes (dPM) were first crosslinked with glutaraldehyde and then modified with dopamine-heparin. The amount of heparin on the modified dPM (mPM) was determined with Toluidin Blue assay. Hemocompatibility of the mPM was evaluated with hemolysis and platelet adhesion tests. Results from the hemolysis test revealed that mPM causes hemolysis to a degree almost equivalent to the negative control, registering at 0.3±0.002 %. In contrast, dPM displayed a significant degree of hemolysis at 11.8±1.14 %. The comparative analysis between dPM and mPM revealed notable differences in platelet adhesion and aggregation patterns. While the dPM amniotic surface showed signs of increased thrombogenicity, mPM demonstrated reduced platelet attachment, potentially due to its surface treatments. Lastly, cytocompatibility of the mPM was determined by seeding human fibroblasts, HUVECs and human iPSC derived cardiomyocytes on its both sides. Results indicated that mPM had a hemocompatible surface and supported attachment of fibroblasts, endothelial cells and ventricular cardiomyocytes especially on its chorionic side.

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Keywords: Human Placental Membrane, Decellularization, Congenital Heart Diseases, Cardiothoracic Surgery.

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PP-20

Mesoporous Silica a Tunable Support in Polyphenol Delivery

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Abstract

Silica-based mesoporous materials with tunable properties (particle size and morphology, dual functional surface (external and internal) and chemical composition) are promising materials in biomedical applications. Porous materials belonging to the MCM-41s class are important three-dimensional structures which can be used in developing peripheral nerve guidance conduit (NGC), which permits the infiltration of drugs, genes, vitamins, nutrients, and molecular signaling molecules with direct impact in nerve regeneration. Porous structures with tunable properties are being used to construct permeable, semi-permeable, and asymmetric peripheral NGCs for the replacement of traditional nerve autografts in the treatment of peripheral nerve injury [1].

In this study, two types of mesoporous silica with different characteristics (structure and porosity) loaded with resveratrol and quercetin, were synthesized by the soft-templating method). The obtained mesoporous materials were characterized from morphological and structural point of view by specific techniques: X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Fourier Transform Infrared Spectroscopy (FTIR) and Thermogravimetric Analysis (TGA). The *in vitro* study was performed in two types of simulated biological fluids with different pH, simulated gastric fluid (SGF) and simulated intestinal fluid (SIF). Finally, the obtained materials will be tested for various biomedical applications as systems with controlled release of polyphenols extracted from natural sources, including tissue engineering with a focus on nerve regeneration) but also as supplements.

Keywords: porous materials, tunable properties, peripheral nerve grafting and regeneration

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PP-21

Effect of Polymer Concentration and Freezing Temperature on the Pore Structure of Foams Produced by Lyophilization

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Abstract

Poly(L-lactide-co-glycolide) (PLGA) and poly(L-lactide-co-D,L-lactide) (P(L-D,L)LA) are biodegradable polymers widely utilized in biomedical applications such as biomaterials, tissue engineering and drug delivery system. Due to their biocompatibility and controllable degradation profiles, they have gained significant attention in medical research. The aim of this study was to develop P(L-D,L)LA-PLGA foams with homogeneous porosity throughout the construct, providing an appropriate environment for cell ingrowth that mimics endometrial tissue, to facilitate blastocyst implantation in future studies..These foams were produced using the lyophilization method. This preliminary study focused to investigate the effects of polymer concentration, and freezing temperature applied before freeze-drying, on the pore structure, interconnectivity, and homogeneous pore distribution of P(L-D,L)LA-PLGA foams.

The polymer blend of P(L-D,L)LA-PLGA was prepared as a stock solution at a 4% (w/v) concentration by dissolving the polymers in 1,4-dioxane at a 1:1 weight ratio (w/w). The stock solution was then diluted with the solvent to prepare polymer solutions at concentrations of 1%, 1.5%, 2%, 2.5%, 3%, 3.5%, and 4%, which were used for foam production.To investigate the effects of different freezing conditions, the polymer solutions were poured into petri dishes and frozen at two different temperatures, -20°C and -80°C. After freezing, all samples were freeze-dried to obtain foam structures by lyophilization. The foams were then analyzed using Scanning Electron Microscopy (SEM) to assess their general morphology, pore size, interconnectivity and pore distribution throughout the foam.

The results indicated that both the freezing temperature and polymer concentration significantly influenced the foam's pore structure. Variation in pore diameters was observed between the foams prepared at the two different freezing temperatures, particularly for those prepared with 1.5%, 2% and 2.5% polymer concentrations (Fig. 1-A). The foams prepared with 1.5%, 2%, and 2.5% polymer concentrations exhibited better pore connectivity and more homogeneous pore distribution at both freezing temperatures. In the present study, the foam prepared with 2% polymer concentration and frozen at -20°C was chosen due to its desired pore size of approximately 50 µm, along with high pore interconnectivity and favorable internal structure (Fig. 1-B). It was concluded that these parameters—2% concentration and freezing at -20°C before freeze-drying would provide optimal conditions for cell applications, offering a balanced pore size that allows cells to penetrate and distribute homogeneously within the 3D foam.

This study demonstrated that freezing conditions and polymer concentration significantly affect the pore structure of P(L-D,L)LA-PLGA foams. Optimizing these parameters is essential for achieving desirable

pore characteristics, which are crucial to provide an appropriate environment for cell infiltration and tissue growth in tissue engineering and regenerative medicine.

Keywords: P(L-D,L)LA-PLGA, Lyophilization, Foam, Pore size, Tissue engineering

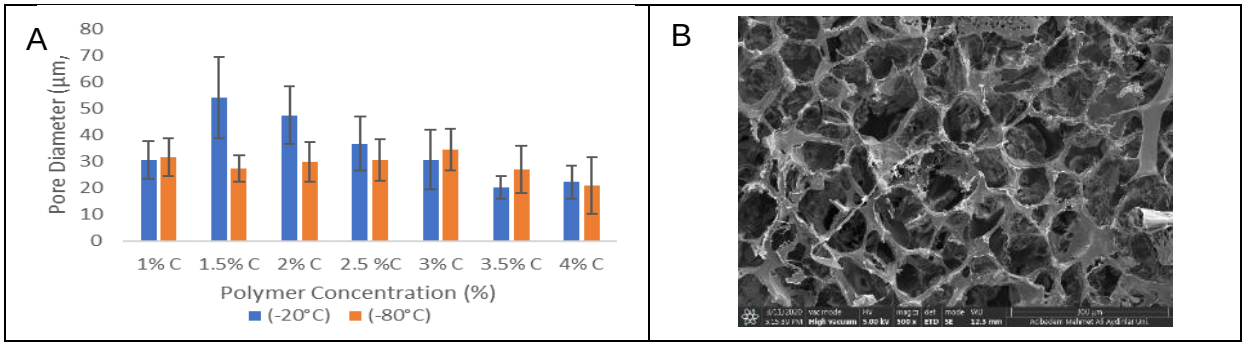

Figure 1. (A) Pore diameters (in µm) of foams prepared with different polymer concentrations (1% to 4%) and frozen at either -20°C (blue bars) or -80°C (orange bars) before lyophilization. (B) SEM image of PLGA-PLDLLA foam prepared with a 2% concentration and frozen at -20°C before freeze-drying

PP-22

In Vitro Gliosis Model on Electrospun Polycaprolactone Fibers

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Abstract

Injuries and damages at central nervous system (CNS) have severe repercussions for people and society. Patients, suffering from CNS injuries face drastic declines in their life quality and the injury may even lead to their deaths. Due to limited regenerative capabilities of the CNS, the damaged tissue cannot repair itself and becomes chronic. In response to these physical and chemical changes happening at CNS, astrocytes and other glial cells produce a response called as “gliosis”. During gliosis astrocytes become active and are subject to hypertrophy leading to morphological changes. The aim of this study is to mimic CNS damages in vitro.

To achieve that the physical and chemical damages were applied on astrocytes differentiated from C6 cell line. C6 cells were seeded on electrospun polycaprolactone (PCL) scaffold and differentiated to astrocytes with cAMP. Then physical damage was applied with a bioreactor system to exert stretching force. To produce chemical damage model cells were treated lipopolysaccharide (LPS) thus producing an oxidative stress that will lead to gliosis induction. The third gliosis model was induced both physical and chemical damages simultaneously by combining the protocols. Cell viability was measured by Alamar Blue Assay and the morphological changes were observed by GFAP and vimentin immunofluorescence staining.

İn our first gliosis model after we applied a 0,747 N pulling force on the PCL scaffold and after physical damage cell viability was %89 and we observed a significant increase in GFAP expression. Control group GFAP/vimentin ratio of fluorescent intensity was 0,68 in physical damage model the GFAP/vimentin ratio was 1,87. At second gliosis model there was no significant decrease in cell viability, but we observed a significant increase in GFAP staining also a significant decrease in vimentin staining and GFAP/vimentin ratio was 2,89. In our last model where we applied both physical and chemical damage cell viability was %81. The GFAP/vimentin ratio of this our model was 4.06.

These findings showed that the highest GFAP/vimentin ratio was observed in combined injury model where we applied both physical and chemical damage. With this model, the gliosis state is more realistically mimicked and has the potential to be used as a suitable in vitro damage model for testing therapeutics to be used in the treatment of damage.

Achknowledgement

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Keywords: electrospining, gliosis, injury model

PP-23

In Situ Fabrication of Poly(n-Butyl Methacrylate) Microneedles with an Innovative Micromolding Technique for Transdermal Drug Delivery

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Abstract:

Microneedle (MN) technology, which uses micron-sized needles with a height of 25-2000 μm, offers many advantages for transdermal delivery of various drugs such as minimally invasive, painless, effective, and application that does not require an expert. Hollow MNs, which are miniature versions of hypodermic needles, allow the infusion of drugs through channels created into the skin. However, since the fabrication methods of hollow MNs involve complex multi-step processes that are quite costly, labor-intensive, and time-consuming, activities in this field are limited. In this study, a method that allows the fabrication of hollow MN arrays in a single step was developed. The method uses the well-known Stereolithography (SLA) 3D printer for positive mold fabrication simply and cost-effectively. Firstly, the master mold was designed as a 2x2 array, conical shaped, 1.0 mm and 1.5 mm long, 0.4 mm tip diameter needles with 0.4 mm channels inside via SLA 3D printer. Then, metal pins made of stainless steel with a length of 5 mm and a diameter of 200 μm were placed through the hollow channels of the 3D-printed needles to form the master mold. Negative mold from poly(dimethylsiloxane) (PDMS) was then successfully obtained with the novel master mold design. The metal pins in this innovative master mold ensure that the flow channels are always formed in the middle of the microneedle tip during fabrication and minimize human error in the micromolding technique. Additionally, this master mold can be used repeatedly to obtain both a negative mold and the final microneedle fabrication. In this novel negative mold, poly(butyl methacrylate) (PBMA), which is biocompatible and has suitable mechanical properties, was used in microneedle fabrication by *in situ* photopolymerization. For this purpose, microneedle fabrication was completed in a negative PDMS mold by transferring monomer solutions containing different crosslinker ratios (low, middle, and high). Poly(butyl methacrylate) microneedles fabricated with monomer solution containing a high crosslinker ratio were excluded from the study due to their brittleness. A special microfluidic channel test was applied to characterize the channel apertures of the hollow MNs and measure the solution flow rates, and solution flow was observed from all 4 MNs. The morphology of the hollow MNs was visualized by scanning electron microscope (SEM). The lengths of MNs fabricated with a low crosslinker ratio were 0.87 ± 0.01 mm for the 1.0 mm design and 1.32 ± 0.08 mm for the 1.5 mm design, while these values were 0.79 ± 0.04 mm and 1.23 ± 0.08 mm for the high crosslinker ratio. According to thermogravimetric analysis, PBMA microneedles do not show significant mass loss between 25-200°C, indicating that the developed microneedle system is suitable for autoclave sterilization method frequently used for biomedical products. As a result of mechanical analysis, mechanical strength values for 0.2 mm displacement for the 1.0 mm design were found as 1.65 ± 0.25 and 1.00 ± 0.74 N/needle for low and middle crosslinker ratios, respectively, whereas these

values were 0.55 ± 0.36 and 1.43 ± 0.25 N/needle for 1.5 mm design. These values are greater than the force required for the microneedles to penetrate the skin, ~0.058 N/needle. In the Parafilm M® penetration tests, the successful penetration of the hollow MN arrays was obtained as ~380 µm for the 1.0 mm length and ~508 µm for the 1.5 mm length.

As a result, hollow microneedles were easily produced in a single step and at low cost. It is thought that a great contribution will be made to the literature by overcoming most of the difficulties in hollow microneedle production. This MN system will be used for dose-controlled transdermal drug delivery in future studies by combining it with various micropumps.

Keywords: Hollow Microneedle, Microfabrication, Micromolding, SLA 3D Printing.

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PP-24

A Cost-Effective Fabrication of Polyvinyl Alcohol Microneedle Patches with Different Geometries

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Abstract

Microneedles are painless short needle arrays developed for transdermal delivery of therapeutic agents. Recent studies have aimed to develop microneedle systems that patients can self-administer without needing a specialist. Microneedles can be produced using various polymers. Poly(vinyl alcohol) (PVA) is one of the primarily used polymers, due to their properties such as being biocompatible. Various methods such as micromolding, lithography etc. can be used in the production process of microneedles. Micromolding with a stereolithography (SLA) 3D printer is a method that provides high precision, high resolution, fast manufacturing, minimized process steps, the ability to print a wide variety of shapes also cost-effective. Using this method, the molds were designed by a computer-aided design program, and the printing is carried out in the desired size and resolution. Negative molds were created by using the master molds that have been produced by printing. Within the scope of this study, micromolding was performed using an SLA 3D printer for the master mold production. Firstly, microneedle designs in terms of conical and pyramidal shapes were made using SolidWorks. The needles were arranged in 2x2 and 5x5 shapes on the patches. Conical and pyramidal microneedles were designed with a base diameter and length of 1.0 mm, a needle length of 1.0 mm, and a tip diameter of 1.0 μm. For the material that had been used, two different molecular weights (i: Mw = 13,000-23,000 kDa, degree of hydrolysis = 87-89%, ii: Mw = 30,000-70,000 kDa, degree of hydrolysis = >85%) and three different concentrations for each molecular weight (10, 15 and 20%, w/v) of PVA solution was chosen. The produced microneedles were characterized by a digital camera, scanning electron microscopy (SEM), thermogravimetric analysis (TGA), and mechanical analysis. The base diameter, length and tip diameter (OD) of the conical microneedles were calculated as 1.0 ± 0.04, 0.8 ± 0.02 and 0.1 ± 0.02 mm, respectively. Pyramidal microneedles were calculated as 1.2 ± 0.08, 0.76 ± 0.05 and 0.09 ± 0.02 mm, respectively. As the result of TGA analysis, a mass loss of less than ~7% up to 150° C was observed in all samples of PVA microneedles. Moreover, between 150-230° C, no mass loss and no degradation in the structure was observed. As the result of mechanical analysis, no fracture point was observed. However, the microneedles could be deformed by bending. The force per needle results of 10%, 15%, and 20% (w/v) concentrations of conical PVA microneedles with low molecular weight (Mw = 13,000-20,000 kDa) were measured as 2.2 ± 0.61, 2.0 ± 0.06, 1.7 ± 0.72 (N/needle), and the force of high molecular weight (Mw = 30,000-70,000 kDa) were measured as 2.0 ± 0.32, 2.4 ± 0.01, 0.73 ± 0.28 (N/needle), respectively. The force per needle results of 10%, 15%, and 20% (w/v) concentrations of pyramidal PVA microneedles with low molecular weight (Mw = 13,000-20,000 kDa) were measured as 0.44 ± 0.07, 1.1 ± 0.84, 0.16 ± 0.06 (N/needle), and the force of high molecular weight (Mw = 30,000-70,000 kDa)

were measured as 1.6 ± 0.07, 1.7 ± 0.6, 1.0 ± 0.30 (N/needle), respectively. Conical needles have higher mechanical strength and additionally, many studies show that conical needle tips can enter the skin more easily than pyramid needle tips.

In this study, microneedle arrays were obtained with high accuracy. The design features and microneedle properties aligned with the desired outcomes. It can be said that by changing 3D printing parameters, design, and polymer type, the microneedles with better precision could be produced using SLA 3D printing. It was supported by the related analyses that the microneedles, which are easy to manufacture, have high mechanical strength, are resistant to temperatures, and can also be sterilized by autoclaving, were successfully produced. Consequently, PVA microneedle patches are promising products that can be used in many areas such as drug delivery, diabetes, inflammatory skin diseases, diagnosis and monitoring, cosmetics and cancer.

Keywords: Microneedle, poly(vinyl alcohol), SLA 3D printing.

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PP-25

Impact of EBSD Analysis on Biomaterials Characterization

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Abstract

To develop biomaterials, it is essential to understand their properties and behavior comprehensively. Microtexture characteristics can influence up to 20% of a material's strength. This study focuses on the impact and significance of Electron Backscatter Diffraction (EBSD) analysis on metallic biomaterials, particularly Ti6Al4V, 316L stainless steel, and CoCr alloys. EBSD analysis provides critical data, including the phases formed in corrosion zones, crystallographic orientation, and dislocation density. Moreover, it enables the quantification of recrystallization in biomaterials induced by heat treatment. EBSD offers numerous advantages, allowing for a wide range of microstructural characterizations that are unattainable using conventional methods. It facilitates the analysis of microstructure and other properties across various scales and levels. Through EBSD, information on grain size, individual grain orientations, texture, local texture correlations, phase distribution, and grain boundary properties can be obtained. Additionally, EBSD generates significant material maps, such as inverse pole figures, grain orientation spread (GOS), kernel average misorientation (KAM), grain reference orientation deviation (GROD), and grain average image quality (IQ). Consequently, EBSD analysis stands as a transformative technique, unlocking a deeper understanding of biomaterial microstructures and enabling advancements in their design and application.

Keywords: Biomaterial, electron backscatter diffraction (EBSD), microstructural characterization, crystallographic orientation, dislocation density

PP-26

In Vitro Tissue and Disease Models

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Abstract

The reason for much biomedical research is to understand the molecular basis of human diseases to develop effective treatments for them. The use of human or human embryos raises ethical issues and the animals used in in vivo experiments, such as mice and rabbits, cannot effectively mimic human disease physiologically. Ipsc (induced pluripotent stem cells) cells have been the solution to this problem. In this presentation, we will describe in vitro 2b cell cultures, ipsc(induced pluripotent cells), 3b methods in terms of their proximity to in vivo studies and models developed for diseases of organs such as heart, lung, intestine and neurological diseases developed using these techniques in order to better understand the structure and functioning of in vitro tissue and disease models.

Keywords: 2b and 3b models, transwell attachments, disease models

PP-27

Design and Construction of a 3D Brain Tissue Model

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Abstract

Study of the brain is challenging due to it being physiologically inaccessible. Even minimal changes in the brain tissue can affect the patients dramatically. Thus, brain research is complex, both because of ethical issues and physical limitations. Animal models such as rats, mice and monkeys are widely used in brain research and this results in ethical problems. Furthermore, animal models cannot fully mimic the human brain complexity. Use of tissue engineering models is an alternative method to study the brain. This discipline provides a more controllable and economical, less ethically problematic experimental platforms compared to animal models. (Fabbri et al., 2023) Engineered tissue models are frequently used in tissue engineering to produce more reproducible, controlled tissue models compared to other methods such as organoid and spheroid cultures. (Benam et al., 2015) This study aims to construct a 3D Brain Tissue Model (BTM) that mimics the white and gray matter in the brain tissue. The 3D Brain Tissue Model will be used for the evaluation of drugs that affect the neuron activities in the brain. This model is expected also to provide an alternative platform to animal testing. Method The brain tissue model will include two different biomaterials, the model will include an inner and an outer ring (Figure 1). The gray matter in the brain tissue will be mimicked by the outer part of the model and the white matter by the inner ring. The outer part of the 3D model will be constructed using 3D Printing of methacrylated collagen (ColMA) and the inner hydrogel will be composed of methacrylated hyaluronic acid (HaMA). Finally, these two parts will be merged in the final form of the 3D brain tissue model. After the characterization of 3D model, carrying out swelling, degradation, mechanical tests and SEM analysis, PC12 neuroblastoma cells will be seeded into the outer part of the model.

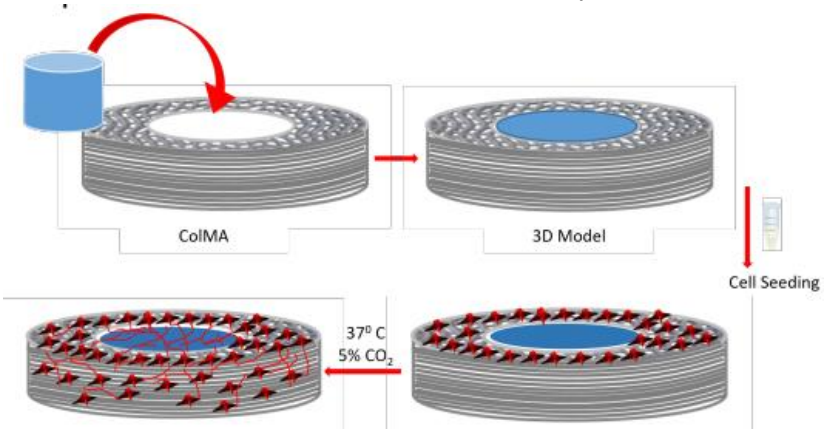

Figure 1. Construction of 3D Brain Tissue Model

Axons of neurons are expected to innervate the inner hydrogel and mimic the white matter. The model with seeded cells will also be characterized using Live Dead Assay, DAPI/AlexaFluor-488 Phalloidin and immunohistochemical staining. Finally, the model will be treated with Aβ25-35 to imitate Alzheimer's Disease in vivo. At the end of the incubation, the effect of phosphocreatine on the Aβ25- 35-treated groups will be evaluated by immunohistochemical stains, and morphological changes will be studied. Results and Discussion the HaMA samples were brought to equilibrium swelling in PBS (24 h, at 37°) before mechanical testing. Mechanical compression tests were conducted at 1 mm·min−1 strain rate, using 10 N force on cylindrical HaMA samples (n=3). Samples were compressed until failure or until 80% of the initial thickness was reached. Young's modulus E was calculated from the 25-35% strain region in the stressstrain curves. According to the compression test data Young's modulus was calculated to be 0.0603 kPa in HaMA hydrogel samples.

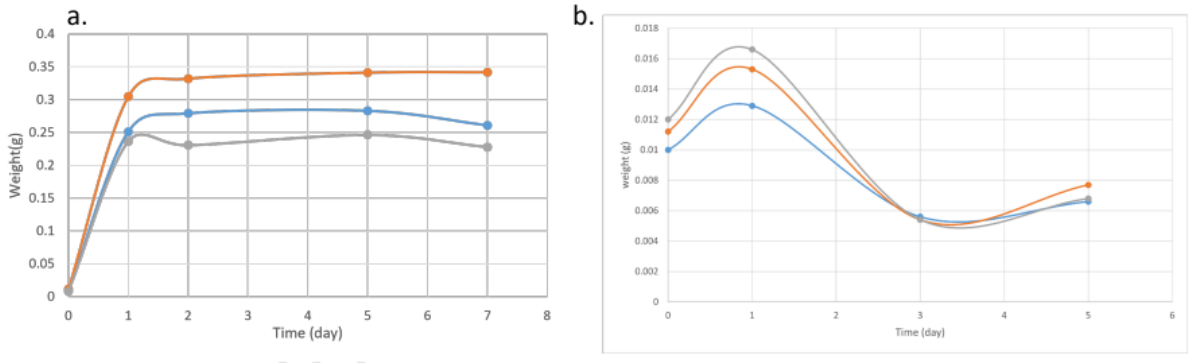

Figure 2. Model Characterization tests a. Swelling test, b. Degradation test

For swelling test, HaMA hydrogel samples were incubated in PBS in a 37° incubator. The weights of the swollen hydrogels were determined on days 1,3,5 and 7 (Figure 2.a). Degradation test was performed by weighing the freeze-dried hydrogel samples on Day 0, and after incubation at PBS after Days 1,3 and 5 after freeze drying the samples. In vitro experiments will soon be initiated.

Acknowledgements

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PP-28

Exploring the Potential of Keratin/PRF/GelMA/Hyaluronic Acid Scaffold Prepared via 3D Hand-Held Bioprinting Technology for Bone Tissue Damage Treatment

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Abstract

Many individuals globally experience orthopedic traumas, injuries, infections, and bone-related conditions, including osteoarthritis, osteomyelitis, and osteoporosis. These conditions can lead to the deterioration of bone tissue due to various factors such as congenital abnormalities, accidents, falls, aging, excessive body weight, and sedentary lifestyle. Natural bone grafting has disadvantages such as high cost and scarring with damage in the donor area. Considering the studies conducted, synthetic bone scaffolds lack osteoinduction, stability, and biodegradability. Regarding regeneration, bone tissue scaffolds combined with biomaterials and bioactive factors stimulate cell growth, proliferation, and differentiation in bone tissue to repair damaged bone (1, 2). 3D handheld bioprinters are portable devices that enable the direct printing of polymeric materials onto bone defect sites for in situ bioprinting and tissue reconstruction, while also allowing for the slow and controlled release of drugs or bioactive factors (3, 4). This study aims to develop 3D hand-held bioprinted bone scaffold containing GelMA, hyaluronic acid, keratin and platelet-rich fibrin (PRF). GelMA is widely used in tissue engineering to mimic the ECM due to its high biocompatibility. At the same time, its low strength necessitates a combination with rigid polymers for better results, and it is preferred for its complementary properties with keratin (5, 6). Keratin, a fibrous structural protein, was selected for its biocompatibility, stability, and antibacterial properties (7). Hyaluronic acid, a fundamental ECM component, enhances tissue regeneration by supporting cell migration and reducing inflammation. PRF contains a variety of bioactive substances that significantly enhance tissue regeneration. Among these are key growth factors such as platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), vascular endothelial growth factor (VEGF), and bone morphogenetic protein (BMP), which promote tissue regeneration by enhancing cell proliferation, migration, differentiation, and matrix deposition (8). In this study, a 3D-printed structure composed of GelMA, hyaluronic acid, keratin, and PRF was first prepared and then crosslinked in situ under visible light at varying exposure times (20, 40, and 60 seconds) in the presence of the photoinitiator lithium phenyl-2,4,6-trimethylbenzoylphosphinate. FTIR and SEM analyses were conducted to characterize the chemical composition and morphology of the 3D-printed bone scaffold. A compression test was performed to assess its mechanical properties, while swelling and degradation tests were conducted in PBS. The biocompatibility of the scaffold with osteoblast cells was evaluated through MTT analysis. The extracted keratin structure from human hair was characterized using SDS-PAGE and BCA analysis. Two bands with molecular weights of 52–38 kDa, representing low sulfur-containing 'alpha' keratin, were observed, confirming the successful extraction of keratin. Based on the BCA analysis, the total protein content in the keratin structure was calculated to be 3.35 mg/mL. Mechanical strength tests of bone scaffolds with and without PRF were conducted at irradiation times

of 20, 40, and 60 seconds. For bone scaffolds without PRF, mechanical strength increased with irradiation time, measuring 503.65 ± 119.51 kPa at 20 seconds, 846.05 ± 155.71 kPa at 40 seconds, and 1325.33 ± 152.01 kPa at 60 seconds. In PRF-containing scaffolds, strength also increased with time but remained lower, with values of 344.82 ± 31.11 kPa at 20 seconds, 519.05 ± 70.86 kPa at 40 seconds, and 881.05 ± 143.13 kPa at 60 seconds. The results of all analyses indicate that the developed tissue scaffold is a promising biomaterial for future therapeutic use in bone damage, as it accelerates healing by supporting bone tissue regeneration.

Keywords: 3D Hand-Held Bioprinting, Platelet Rich Fibrin, Bone scaffold, GelMA, Keratin

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PP-29

Inspection of the Impacts of Variable Degumming Timeframes and Tyrosine Functionalization on the Biofunctional Efficacy and Adhesive Potency of Silk Fibroin-based Skin Tissue Adhesives

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Abstract

Skin tissue adhesives including organic/inorganic-based hydrogel bioadhesives with biocompatibility and biodegradability, are one of the most remarkable transformative approaches to wound closure, especially for delicate tissue of epidermis. These adhesives possess significant advantages over conventional sutures and staples in medical treatment that could facilitate speedier healing, mitigate the risk of infection, retain moisture, and preserve tissue integrity [1,2]; however, their clinical usage is restricted due to some limitations such as unregulated biodegradation rate, toxicity, and feeble tissue adhesion [3]. Protein-based tissue adhesives such as silk fibroin (SF) that are derived from Bombyx mori silkworm with superior mechanical features including strength and flexibility, biocompatibility, biodegradability, as well as replicating the extracellular matrix (ECM), play a promising role in cell proliferation, differentiation, and tissue regeneration, which resulted in being an optimal candidate for tissue rehabilitation and regenerative healing [4]. Recent advancements in SF-based bioadhesives have concentrated on enhancing their mechanical durability and tissue adhesion to moist environments, which are the primary obstacles to their clinical applications [5]. In this study, to improve the mechanical strength and adhesion capability of SF skin adhesives, the effects of synthesis parameters, including boiling time during the degumming process and tyrosine-functionalization, on their medical effectiveness were investigated. To accomplish this goal, SF hydrogel-based adhesives with a constant concentration of SF (15%) that the silk previously was boiled in the presence of Na_2CO_3 solution as a degumming agent at various durations of 30 and 60 min, were prepared through the light-induced photopolymerization technique in the presence of riboflavin/sodium persulfate photoinitiator system, and their impact on adhesive properties were evaluated. The adhesives' structural and morphological characters, mechanical strength, and surface wettability were examined via FT-IR, SEM, compression test, and statistic contact angle measurements, respectively. Furthermore, the biocompatibility, performance and functionality in the biological environment of the adhesives in promoting wound healing were examined through MTT towards CCD1064Sk cell lines and hemolysis characterizations, sequentially, which exhibited non-toxicity and hemo-compatibility behaviors. The protein composition and molecular weight of the adhesive components were assessed through SDS-PAGE analysis, besides the *in vitro* adhesive features analyzed using the burst pressure (ASTM F2392-04) test. Our findings indicate that the boiling duration of 30 min in comparison to 60 min provided nearly complete sericin removal while the molecular integrity of SF was preserved and resulted in a final product with intrinsic strength and elasticity that are primary characteristics in adhesive development. Furthermore, the process of boiling excessively could disturb the functionality of the existing crystalline and

amorphous regions of SF; as a result, the mechanical strength and elasticity of SF, as observed in this experiment, could be decreased. Moreover, the results indicate that the efficacy of the SF structure could be enhanced by enhancing the content of tyrosine amino acids that lead to the generation of more covalent di-tyrosine bonds; consequently, improve the SF-adhesives' mechanical strength along with their adhesion feature due to the increasing interaction between the existing tyrosine of SF and the site of action during the photo-crosslinking procedure over the skin. These findings underscore the significance of fine-tuning synthesis parameters to optimize SF-based adhesives for specific dermal and transdermal applications, potentially improving their clinical efficacy.

Keywords: Skin Tissue Adhesive, Hydrogel, Silk Fibroin, Tyrosine, Photo-crosslinking.

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PP-30

Development of PVP-Tannic Adhesive for Enhanced Tissue Regeneration and Wet Adhesion

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Abstract

Bioinspired tissue adhesives designed for wet environments play a vital role in wound healing and surgical applications. The demand for tissue adhesives with strong adhesion properties in fluid environments, along with regenerative capabilities, has increased significantly.

In this study, we developed a novel lignin-based wet environment tissue adhesive designed for surgical applications, exhibiting both tissue adhesion and antioxidant properties to support tissue regeneration. The adhesive was formulated by incorporating polyvinylpyrrolidone (PVP), tannic acid (TA), a known source of catechol and galloyl groups found in marine organisms [1], and polyethyleneimine (PEI), which mimics the cationic proteins in biological systems [2]. The resulting formulation rapidly formed a hydrogel through supramolecular interactions, enabling strong adhesive and regenerative properties.

The developed tissue adhesive was characterized by rheological analysis, adhesion strength tests using a tensile machine (adhesion strength following ASTM F2255-05), and antioxidant assays. Rheological analysis demonstrated significant self-healing properties, while antioxidant assays showed over 95% DPPH inhibition, indicating potent antioxidant activity. Additionally, the modification process led to an improvement in adhesion strength, making the hydrogel a promising candidate for wet environment tissue adhesives in surgical applications.

Keywords: Tissue adhesive, antioxidant, lignin, tannic acid, hydrogel

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PP-31

Advanced Lens Design and Analysis for Vascular Imaging in the Mwir Band

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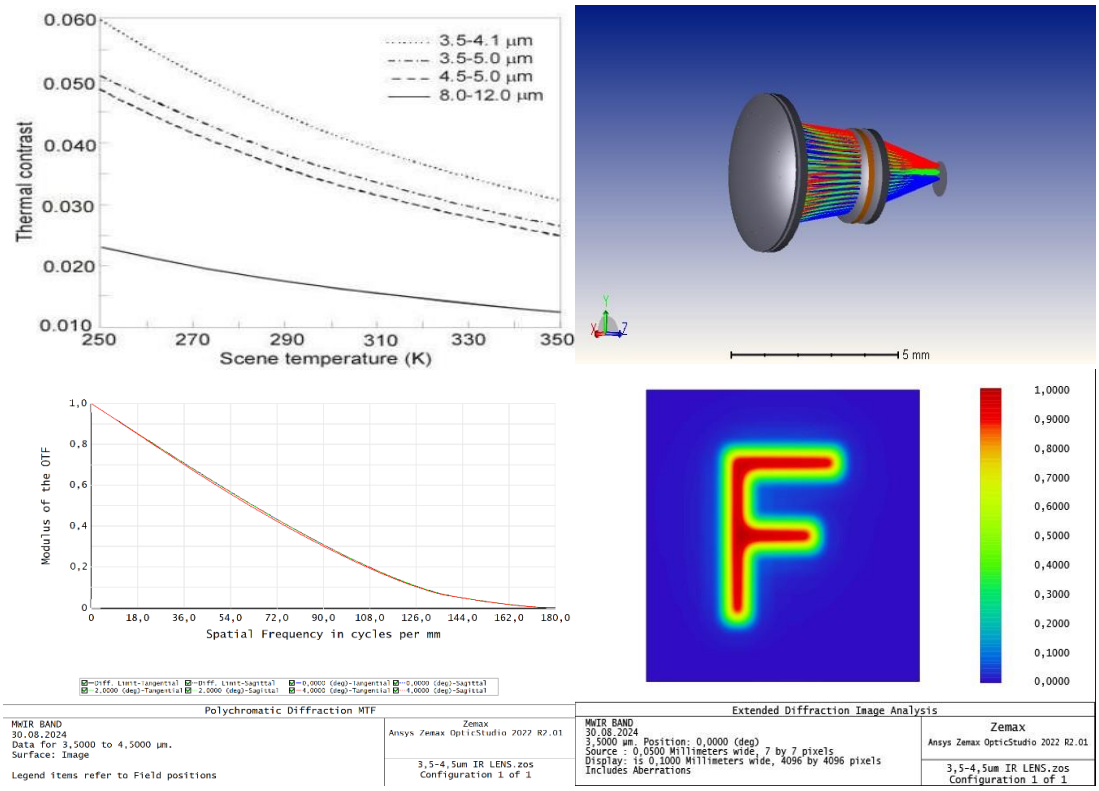
Abstract

Modern medical imaging technologies play a critical role in early diagnosis and treatment of diseases. Vascular imaging and blood flow analysis are particularly important for the diagnosis of cardiovascular diseases. When the beams are directed at the skin, they penetrate into the subcutaneous tissue, where deoxygenated hemoglobin in the vessels absorbs more than the surrounding tissues. Ultrasound is one of the methods used in vascular imaging, but it requires additional skills, assistance, and is costly[1]. Another method for vascular imaging involves using an infrared light source to image the vessels. This allows the vascular patterns to be seen darker than other tissues using an infrared camera[2]. In the literature, the NIR(Near Infrared) wavelength is often used for vascular imaging[3][4]. The MWIR(Mid-Wave Infrared) band is generally more logical for thermal imaging of blood and vessels. There are several reasons for this. MWIR rays penetrate deeper into the tissues compared to NIR rays, allowing for clearer and deeper images of vessels. Thermal radiation emitted depending on body temperature is stronger in the MWIR band. Although the NIR band provides high resolution due to its short wavelengths, the MWIR band can penetrate deeper into the tissues. MWIR wavelengths are less scattered and absorbed by tissues, resulting in sharper images. While NIR usually requires active illumination (e.g. IR LEDs), MWIR works by its own thermal emission, meaning it provides vision even in the dark. This feature makes it easier to distinguish vessels from surrounding tissues and makes vascular anomalies more visible. Blood moving in vessels has a certain temperature that can be detected, making it suitable for designing a lens operating in the MWIR wavelength. We can notice that the contrast in the MWIR bands at 300 K is 3.5-4% compared to 1.6% in the LWIR(Long-Wave Infrared) band. Therefore, the LWIR band has higher sensitivity for objects at ambient temperature, while the MWIR band has more contrast[5]. In this work, a lens design operating in the 3.5-4.5 μm MWIR range is presented, offering high sensitivity and resolution for detailed imaging of vascular structures and blood flow. MWIR increases thermal contrast between tissue types and better aligns with the natural thermal emission of the human body. At around 37.5°C, thermal contrast in the MWIR range is approximately 2.5 times higher than in the LWIR range, allowing for clearer visualization of vessels and blood flow. The applicability of this lens for vascular imaging analysis has been thoroughly analyzed using ZEMAX. The figures represent a few illustrations of the design analysis. The figures present Spectral photon contrast, Shadow Pattern, MTF and Diffraction Image Analysis respectively. In addition to these, Spot Diagram, 3D Viewer, PSF, Field Curvative and Distortion, Seidel Diagram, Merit Function, Geometric Image Analysis and Optical Path Difference analyses will be included.



Keywords: ZEMAX, MWIR, Lens Design, Vascular Imaging

Acknowledgement: This work was partially supported by Nokta Muhendislik AS.

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PP-32

Regenerative Effects of Exosomes on *In Vitro* Spinal Cord Injury Model

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Abstract

Spinal cord injury (SCI) is a medical condition resulting from severe trauma, which leads to neuron death, disruption of the conduction pathway, and loss of motor and sensory functions below the plane of injury, with the potential for paralysis at the central nervous system [1]. Its pathophysiology is characterized by an initial primary injury that is followed by a secondary phase, in which oxidative stress plays a critical role [2]. Accordingly, methods that could be developed to prevent oxidative stress after spinal cord injury or to reduce the extent of the damage may serve as potential strategies for the treatment of spinal cord injury [1]. Exosomes are extracellular vesicles with diameters ranging from 30 to 150 nm, rich in various miRNAs, RNAs, proteins, and other biological contents [3]. The molecules delivered by exosomes can bind to intracellular targets, modulate relevant signaling pathways, and ultimately influence physiological processes within the target cells [4]. In recent years, advancements in research on exosomes derived from mesenchymal stem cells (MSC-Exos), have shown that exosomes can overcome some of the limitations of mesenchymal stem cells in the treatment of various diseases [5]. In this study, neural and astrocytic cell lines were co-cultured to mimic the central nervous system injuries. Mechanical damage, as well as, chemically induced oxidative stress were applied to cells, and BMSC-derived exosomes were introduced to the damaged constructs. Neurite regeneration was examined at specific time intervals by fluorescence microscope. It has been observed that exosome applied groups showed faster recovery, and nerve regeneration was promoted.

Keywords: Spinal Cord Injury, Exosomes, Oxidative Stress, *In Vitro* Model

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PP-33

Synthesis of Black Titanium Dioxide Nanostructures by Electrochemical Methods and Evaluation of Their Antibacterial Properties

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Abstract

Titanium dioxide (TiO_2 - titania) nanotube arrays are renowned for their distinctive structural and electronic properties, which render them valuable in many applications, including the development of antibacterial surfaces. Black titania is preferred over normal titania due to its significantly reduced band gap, which enhances light absorption and photocatalytic activity, improving its efficacy in antibacterial applications. The objective of this study is to examine the synthesis of black titania nanotube arrays through the use of an electrochemical reduction method. The synthesis process entailed the anodic oxidation of titanium in ethylene glycol at varying voltage values and subsequent cathodic polarization under diverse conditions in a Na_2SO_4 electrolyte. Anodic oxidation was conducted in a two-step process, resulting in two distinct sample groups. The first group underwent both steps at 60 V for 30 minutes (6060), while the second group was processed at 60 V for 30 minutes in the first step and 60 V for 20 minutes in the second step (6020). Cathodic polarization was performed for both sample groups using voltage and time combinations of 2.5 V for 60 seconds, 5 V for 60 seconds, 10 V for 60 seconds, 5 V for 30 seconds, and 5 V for 120 seconds. The results indicate that the transformation of normal titania nanotubes into black titania nanotubes did not lead to significant changes in morphology or crystal structure. Both sample groups require adequate voltage and time for conversion to black titania through cathodic polarization, with the 6060 sample achieving a narrower bandgap through short-term high-voltage application, while the 6020 sample exhibited a reduced bandgap under prolonged high-voltage conditions. The 6060 sample was found to be less structurally stable under long-term high-voltage exposure, with the bandgap for both groups decreasing from 3.10–3.20 eV to 2.9–3.0 eV. EDS, XPS, and ESR analyses confirmed the successful synthesis of black titania. Antibacterial analyses conducted on S. aureus, a Gram-positive bacterium commonly found in implant environments, demonstrated that black titania nanotubes exhibit significant antibacterial activity under illuminated conditions due to enhanced absorbance capabilities. Both normal and black titania forms from the 6060 and 6020 groups displayed stronger antibacterial properties in dark conditions as well. These results were validated through colony-forming unit (CFU) tests. Notably, the untreated 6020 sample exhibited high antibacterial activity due to its unique morphology and abundance of free radicals. These findings indicate the potential of black titania nanotubes synthesized through electrochemical reduction methods as effective antibacterial materials in medical devices and antimicrobial coatings, addressing the need for advanced solutions in combating bacterial infections.

Keywords: Black titania nanostructures; Anodic oxidation; Electrochemical reduction; Photocatalytic activity; Antibacterial activity

PP-34

Silk-Based Bilayered Membrane with Bioactive Glass Nanoparticles for Dental Barrier Membrane Applications

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Abstract

Dental barrier membranes (DBM) are biomedical devices used in guided tissue regeneration (GTR) applications. They are used to prevent overlapping of relatively fast growing soft epithelial tissue into the area where bone tissue regeneration is desired. A degradable DBM should have a degradation rate that matches the healing rate of bone tissue at sites lacking sufficient bone. Additionally, mechanical properties of DBM should be high enough to maintain its barrier function and resist the pressure of the overlapping soft tissue. In this research, a bilayered DBM with suitable degradation rate and mechanical properties was designed and fabricated to promote bone growth. Membrane was mainly composed of silk fibroin (SF), one of the two main components of silk fiber which has superior mechanical properties with a relatively slow degradation rate, and silk sericin (SS), the other main component of silk fiber having weaker mechanical properties with a relatively fast degradation rate. For each DBM layer, a different SS/SF ratio was used to fabricate the layer. First layer, which would interact with the bone tissue, had 70 wt% SS and 30 wt% SF. In addition, this layer contained 1 wt% strontium doped bioactive glass (Sr- BG) nanoparticles to promote bone cell functions. The second layer, which would be in contact with the epithelium, composed of 60 wt% SF and 40 wt% to promote mechanical properties and maintain its barrier function. Membranes also had a glycerol content to provide plasticity. In addition to degradation, swelling, water contact angle and mechanical tests, characterization (SEM, XRD, FTIR, AFM) of the fabricated membrane was completed. In vitro biological experiments were conducted with fibroblast and osteoblast cells to evaluate cytotoxicity and cellular proliferation. XRD data of Sr-BG particles showed that amorphous particles were synthesized successfully. SEM images showed that the uniformly formed spherical BG particles were distributed homogenously throughout the first layer of the membrane and the membrane has a suitable thickness for DBM applications. Degradation results proved that combining SS and SF in different ratios altered the degradation rates. The layer with higher SF ratio showed slower degradation rate compared to the layer with higher SS content. Membrane showed no toxicity upon seeding the osteoblasts independent of the presence or absence of Sr-BG. However, osteoblasts proliferation increased on the membrane containing Sr-BG particles. Obtained results cumulatively showed that designed SS/SF/Sr-BG bilayered composite membrane is a potential candidate for DBM applications.

Keywords: Barrier Membrane, Silk Sericin, Silk Fibroin, Bioactive Glass, Osteoblast

PP-35

Food Formulation for the Improvement of Brain Function-A Pilot Study

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Abstract

Dietary supplements are used worldwide and represent a broad category of ingestible products that are distinguishable from conventional foods and drug. Everyday diets were “supplemented” to make up for deficiencies. Various food supplements are available in society, either as a single ingredient or as poly nutraceuticals. Ultimately, the food supplement given must aid in supporting the betterment of human life by balancing the metabolism as well as acting as an immune booster and improving brain activity based on the proportion of the percentage of each ingredient used. This formulation encapsulated in a low-cost, easily consumable capsule that comprises six vital ingredients like *Moringa Olifera, Centella Asiatica, Murraya koenigii, Sphagneticola Calendulacea, Linum usitatissimum, Arachis hypogaea* are chosen for their nutritional content and cognitive benefits. Evaluation studies including granule formulation, powder characterization, micrometric properties viz. bulk density, Tapped density, Compressibility, Hausner ratio, angle of repose to ensure its stability and effectiveness were carried out for 9 formulas (PFF-1 to PFF-9). The results from the angle of repose, and Hausner’s ratio showed that the Nutraceutical food Formulations Granules possess good flow properties. The physical properties of PFF-1 to PFF-9 were determined for the uniformity in weight, hardness, drug content and friability which have complied with the official requirements, and comply with the official limits mentioned in IP 2010. The PFF-3 showed good disintegration property and dispersion time as compare to other formulation. The HPLC results suggests that the absence of any chemical interaction between the Nutraceutical food Formulations Granules and the excipients used in the capsule. The release of the compounds from each ingredient has been represented in the spectrum informs that the retention time is between 5.87 to 26.831. PFF-3 kept for stability studies and observed that it was reproducible even on stored for three months.

Keywords: PFF (Poly Food Formulation), Nutraceutical, HPLC, Immune booster.

PP-36

Production of Alumina (15 wt %) - Zirconia Based Dental Ceramics and Investigation of Bioactivity and Mechanical Properties

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Abstract

Dental ceramics are the materials of choice for oral restorations due to some of their properties such as adequate aesthetics, high fracture toughness and chemical stability. Nowadays, dental professionals can choose from a large number of ceramic systems with slight differences in terms of their chemistry, processing temperatures, mechanical strength and clinical applications[1]. In general terms, polycrystalline ceramics are non-metallic inorganic ceramic materials that do not contain a glass phase, providing higher strength and fracture toughness compared to glass ceramics. The main feature of the ceramics included in the polycrystalline group is the small grain crystal structure that gives strength and fracture toughness[2]. Alumina and zirconia are the most preferred materials in polycrystalline ceramics. Alumina has an important position in implant material technologies thanks to its high biocompatibility, superior hardness and high Young's modulus, while zirconia offers a preferred alternative in dentistry with its excellent mechanical properties and high fracture toughness. The combination of these two materials has great potential to both reinforce their individual strengths and overcome existing limitations.

This study focuses on the innovative development of dental composites based on alumina and zirconia. High purity alumina powder is used together with 3 mol% Y-TZP zirconia powder obtained by Nanografi Company. The composite was prepared in proportions of 15 wt.% alumina and 85 wt.% 3YSZ. In the preparation of the mixture, mixing was carried out for 4 hours at a mixing speed of 140 rpm using a zirconia ball. The prepared mixtures were separately pulverised and 10 mm diameter pellets were formed at 350 MPa pressing pressure in accordance with the British standard. The formed pellets were sintered at 1250 °C and 1350 °C at a sintering speed of 5°C/min for 2 hours. These samples were then used for density and microhardness measurements and *in vitro* bioactivity tests. Density measurements were made for samples sintered at 1250 °C and 1350 °C. Archimedes method was used for density calculations. The microhardness measurements of the samples sintered at different temperatures were measured by applying 200 g load for 15 seconds. The density and Vickers microhardness values of the composites increased in direct proportion to the increasing temperature. The highest density (4.94 g/cm^3) and the highest Vickers microhardness value (1004 HV) were obtained in the composite containing 15 wt% alumina sintered at 1350 °C. According to the density and hardness results of Alumina (15 wt.)-Zirconia composites, it was observed that they increased depending on the sintering temperature. The results are promising for dental applications. The higher density increases the durability of the material, while the improved hardness values support that it can provide longer lasting and reliable solutions in dental restorations. The composite samples containing 15 wt% alumina were used for bioactivity test. Samples were soaked in simulated body fluid (SBF) for 1 week, 2 weeks, 3 weeks and 4 weeks, seperately. The SBF liquid was replaced with freshly prepared liquid every two days to maintain the ion concentration at its original value. Increasing apatite formation was observed in the composite surface with increasing soaking time.

In conclusion, the obtained results showed that zirconia-based dental ceramic composite containing 15 wt% alumina have a promising potential.

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Keywords: Alumina, Zirconia, Bioceramic, Dental ceramics.

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PP-37

Synthesis and Characterization of Nano Hydroxyapatite

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Abstract

Hydroxyapatite (HAp) is a calcium phosphate mineral defined by the chemical formula $Ca_{10}(PO_4)_6(OH)_2$ and plays an important role in biological fields. Being a natural component of bone and tooth tissue, HAp is a preferred option in biocompatible material applications such as dental implants and fillings. In addition, it is used as building blocks to promote cellular growth in tissue engineering and functions as a platform to provide targeted drug delivery in drug delivery systems. It is considered an important component in the cosmetic field due to its anti-aging properties and contributions to skin repair. It also plays a role as an effective adsorbent in the removal of pollutants in water treatment processes. These versatile applications reveal the potential of HAp in the field of biomaterials. In this study, Nano-sized HAp particles were synthesized by emulsion formation-precipitation-solvent evaporation technique due to their advantages such as homogeneous distribution, controllable size, low temperature processing and high purity. Nano adsorbent characterization was carried out by X-Ray Diffractometer (XRD), scanning electron microscopy (SEM), spot energy dispersive spectroscopy (EDS) analyses, and Fourier transform infrared spectroscopy (FT-IR).

Keywords: Nano-HAp, XRD, SEM-EDS

PP-38

Development of Human IgG Specific DiagnoBody Molecules

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Abstract

ELISA (Enzyme-Linked Immunosorbent Assay) is widely used for detecting specific proteins or antibodies in a sample. However, traditional antibody-based methods face several challenges, including high production costs, extensive use of single-use plasticware, and the need for sterile manufacturing environments. DiagnoBody molecules—synthetic polymers of α-amino [alpha-amino] carboxylic acid monomers— can be used as alternatives to animal-derived antibodies. DiagnoBody molecules offer key advantages, such as lower production costs, no requirement for sterile conditions, and high binding affinity and stability.

This study investigated the use of DiagnoBody molecules as substitutes to address the challenges associated with traditional secondary antibodies in ELISA systems. Given that anti-human IgG is the most widely used antibody worldwide, it was selected as the primary target for these novel molecules. The research involved calculating the binding affinities of DiagnoBody molecules initially in silico, followed by in vitro evaluation. Initially, a candidate molecule library was created, and their binding affinities to IgG were calculated through molecular docking. Candidates were then grouped based on their phylogenetic relationships. Those with high calculated affinities were synthesized and conjugated to Horseradish Peroxidase (HRP) for in vitro studies. The candidate DiagnoBody molecules were then evaluated for sensitivity and specificity using serum and/or plasma specimens and compared to traditional antibody-based methods.

Out of 70 candidate DiagnoBody molecules, 7 were selected based on their high calculated affinity and used for in vitro screening. During this phase, various working conditions—including coating, blocking, sample dilution, conjugate dilution, and washing—were optimized to enhance performance. Among the screened molecules, 2 showed promising results, with 1 selected for further studies. The DiagnoBody molecules demonstrated a 70% increase in accuracy compared to traditional secondary antibodies. Additionally, their use resulted in a 99% reduction in plastic consumption, 90% reduction in the cost of producing affinity molecules and a 5-10% reduction in overall kit production costs.

Keywords: DiagnoBody, ELISA, antibody test, IgG specific antibodies, affinity molecules

PP-39

Formation of Diverse Nanotube Morphologies on Ti6Al7Nb Alloys via Electrochemical Anodic Oxidation and Investigation of the Surface Characteristics

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Abstract

Among the metals employed for orthopedic applications, titanium alloys are the preferred option due to their corrosion resistance, resistance to metal fatigue, and inert properties that do not stimulate the immune system or cause inflammation. While titanium alloys possess advantageous chemical characteristics that contribute to desirable properties, their lack of bioactivity presents a challenge in clinical applications, particularly with regard to osseointegration. For this reason, investigations are being conducted into surface modifications that improve the interaction with bone tissue, especially oxidation methods, in order to leverage the benefits offered by the titanium-based implants. In this study, metal oxide nanotube structures with varying hole diameter and wall thickness were fabricated on innovative Ti6Al7Nb alloy surfaces through anodic oxidation using varying electrical potentials and additional chemical oxidation treatments. The impact of these morphological variations on the biocompatibility of the surfaces was then assessed, in terms of nanomorphology, wettability, cell proliferation and spread. The results demonstrate that the surfaces obtained through varying voltage applications result in different wettability degrees via sessile drop contact method, exhibiting very high hydrophobicity on hierarchical nanotube arrays. This is attributed to the dominant influence of hierarchical nanotube formation on the surface. Additionally, it was observed that the wettability value undergoes a change with mild etching. Furthermore, notable differences were identified in the proliferation and spreading profiles of osteoblast cells cultured on hierarchical and uniform nanotube patterns.

Keywords: Titanium, Ti6Al7Nb, Orthopedic implants, Anodic oxidation, Nanotube

PP-40

Assessment of Anticancer Potential of Bergaptol, a Furanocoumarin Derivate

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Abstract

Furanocoumarins are compounds produced by plants. They have been used for centuries in Eastern countries for therapeutic purposes. One of these compounds is bergaptol. Bergaptol is a furanocoumarin found in citrus fruits such as lemon and bergamot. In this study, we aimed to evaluate the anti-cancer and anti-angiogenic potential of bergaptol.

In this study, HeLa, HepG2 and MDA-MB-231 cells were used to analyze the anticancer effect of bergaptol, HUVEC cells for anti-angiogenic effect and HDF cells as healthy control. For this purpose, MTT assay was performed to assess the cytotoxic effects of bergaptol, fluorescence imaging with AO/PI staining to detect live/dead cells, and colony formation assay to evaluate its impact on cancer colonies. Furthermore, 3D microtissues were created and calcein AM/PI staining was performed after bergaptol treatment to better understand the potential effect on tumor tissue.

The results showed that after bergaptol treatment at a concentration of 50 µg/ml, cell viability was significantly reduced in cancer cells and HUVEC, while there was no significant decrease in cell viability in HDF (control cells). Moreover, bergaptol treatment suppressed colony formation in cancer cells. Calcein AM/PI staining of 3D microtissues showed an increase in the number of dead cells due after bergaptol treatment. The data showed an inverse correlation between the increase in bergaptol concentration and cell viability.

Keywords: furanocoumarins, bergaptol, anticancer, anti-angiogenic, 3D microtissues.

PP-41

Design of a Photobioreactor for Microalgae Production and PHB Extraction from the Produced Microalgae

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Abstract

In recent times, the harmful effects of petroleum and chemical-based materials, particularly their non-sustainable and non-renewable nature, have become a significant concern, leading to research efforts aimed at limiting their production. This project primarily aims to produce bioplastic materials with biodegradable, renewable, ecological properties that are derived from bio-based and sustainable resources. Additionally, to promote the use of eco-friendly materials, microalgae a natural polysaccharide source has been employed to enable the synthesis of high-value biocomposite materials using natural materials. In this context, the project has been defined in two parts: the design of a photobioreactor and the synthesis stages of the bio-based material. In the first phase, a portable photobioreactor (PBR) with a capacity of approximately 2 liters was designed, facilitating microalgae production. To monitor the growth phases of the microalgae culture within the PBR, temperature and color sensors were integrated into the reactor. To proliferate microalgae within the PBR, a commonly known culture medium, the Bristol Medium, was prepared with seven different chemical stock solutions. Using this medium, microalgae were cultivated in approximately 1 liter of volume. Subsequently, to obtain a polymer known as polyhydroxybutyrate (PHB), belonging to the polyester class, the microalgae were dehydrated and converted into biomass. This biomass was dissolved in solvents such as sodium hydroxide and chloroform, the microalgae's cell walls were broken down, and PHB extraction was carried out. The polymer obtained was analyzed using FTIR (Fourier Transform Infrared) spectroscopy to verify that the desired material was indeed produced. As a result, it has been concluded that the microalgae production and cultivation process can be easily performed in a photobioreactor environment. This successful process indicates that a biocomposite material from microalgae can be designed and developed, identifying microalgae as one of the essential sources of PHB production.

Keywords: Biocomposite, Bioplastic, Microalgae, Photobioreactor, Polyhydroxybutyrate (PHB)

PP-42

Synthesis and Characterization of Hydroxyapatite Derived from Eggshell

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Abstract

Nowadays, the need for biomaterials is increasing for many applications. Hydroxyapatite (HAp) is the primary component of bones and teeth in vertebrates. HAp and HAp composites imitate natural properties and provide high porosity, surface area, crystallinity, mechanical properties, stability and biocompatibility. These special properties make them ideal biomaterial candidates for biomedical applications such as drug carriers, surgical implants, bone grafts and environmental remediation to remove toxic dyes and heavy metals from wastewater. Various methods from phosphate and calcium precursor sources and natural biowastes, such as low-cost eggshells, synthesize HAPs. Biowastes include vertebrate bones, eggshells, and seashells, and their use is economical and helps with sustainability. The properties of the final product depend on the type of precursor source used and the synthesis method applied.Approximately 94% of waste eggshells consist of calcium carbonate ($CaCO_3$), which makes it possible to obtain the precursor compound calcium oxide (CaO), which can be used for the synthesis of hydroxyapatite (HAp). This study uses chemical precipitation and calcination methods to synthesize natural HAp from eggshell waste. In the first stage, the powdered eggshell was calcined at 900 °C to convert the calcium carbonate ($CaCO_3$) in the eggshell into calcium oxide (CaO), the precursor particles of HAp, before being subjected to chemical precipitation. To obtain HAp, the calcined eggshell powder was mixed with deionized water, and the suspension, whose pH was adjusted to 8.5 using phosphoric acid, was allowed to age. The precipitates obtained in the second stage were calcined at different temperatures (500 °C, 700 °C, 900 °C, 1000 °C and 1100 °C) to obtain HAp with the highest purity for the characterization of HAp samples synthesized at different calcination temperatures, phase analysis (XRD; X-Ray Diffraction), chemical analysis (XRF; X-Ray Fluorescence) and thermal analysis (DTA–TG; differential thermal analysis and thermogravimetric). XRD patterns show that the most suitable calcination temperature for HAp is 900 °C, and samples calcined at 900 °C, 1000 °C and 1100 °C contain peaks belonging to biphasic HAp and β-tricalcium phosphate (β-TCP) phase. The chemical analysis results show that HAp samples are mostly composed of Ca, P and O elements. The calculated Ca/P ratio for HAp samples recalcined at 900 °C is 1.73, which is close to the expected stoichiometric ratio of 1.67. HAp recalcined at 900 °C exhibited characteristic peaks at 571, 632, 962, 1046 and 1090 cm^{-1}. The intensities of most of the bands belonging to phosphate vibrations of HAp increased at calcination temperatures of 900 °C and above. As a result, the study showed that HAp can be synthesized from eggshell waste by using the precipitation and calcination methods together.

Keywords: Calcination; Characterization; Chemical precipitation; Hydroxyapatite (HAp); Eggshell

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