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**11th International Congress on
Biomaterials & Biosensors
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PLENARY SPEAKER

Id-568

Towards A Multi-Organ-on-Chip Model Combining Skin, Lymph Node and Vasculature for Mimicking Innate and Adaptive Immune Responses

S. GIBBS^{1,2,*}

¹Amsterdam UMC location Vrije Universiteit Amsterdam, Molecular Cell Biology & Immunology, De Boelelaan 1117, Amsterdam, The Netherlands

²Department Oral Cell Biology, Academic Centre for Dentistry Amsterdam (ACTA), University of Amsterdam and Vrije Universiteit, Amsterdam, The Netherlands.

*Corresponding author: s.gibbs@amsterdamumc.nl

Abstract: Over the last decade, advancements in microphysiological systems has paved the way for novel human personalized and precision medicine testing strategies in drug discovery. Typically, these model systems consist of single or multiple organoids or spheroids cultured under dynamic flow in a specialized culture bioreactor (Organ-on-Chip). Now the challenge is to incorporate vasculature and immune cells in order to mimic e.g. innate and adaptive immune disease and tumour metastasis which both involve (immune) cell migration into and out of the organoids via the vasculature. With a focus on skin disease, our objective is to develop an immune competent Skin-Lymph Node-on-chip (LymphChip). LymphChip combines our reconstructed human skin (RhS) model, with blood vasculature and draining lymphatics, to a reconstructed lymph node (LN), in order to recapitulate innate and adaptive immune events, show-casing contact sensitization. The building blocks of LymphChip which we have already developed and which will be presented are:

- A human *in-vitro* RhS consisting of a reconstructed, differentiated epidermis on a fibroblast-populated dermis-hydrogel, containing functional dendritic cells.
- Immune activation (maturation and migration) of dendritic cells in RhS-on-chip upon topical exposure to a contact sensitizer
- A human reconstructed LN with LN-derived stromal and immune cells.
- Immune cell clustering and enhanced survival of native immune cells in LN
- Dynamic flow and stable culture for RhS-on-chip and LN-on-chip.
- Novel blood and lymphatic vasculature-based microfluidics, connecting and perfusing the RhS and LN on the TissUse HUMIMIC-chip.

The challenge now is to incorporate the individual building blocks into a single LymphChip platform. Furthermore, development of appropriate sensors to automate readouts will contribute to robustness and scalability. LymphChip will form the basis of an *in vitro* miniature and parallelized industrial therapy-testing platform and contribute to invaluable alternatives to using animals for the investigation of immune mediated disease prior to Phase 1 clinical testing. Future perspectives include incorporating a melanoma in skin model into the LymphChip to investigate tumor cell metastasis, immune suppressive events and immune modulating therapies. SMART Organ-on-Chip consortium, funded by the NWO-TTW Perspective Programme (1292.19.019) & LymphChip consortium, funded by the NWA-ORC programme of the Dutch Research Council (P19-03).

Keywords: Organ-on-chip; Skin; Lymph node; Blood vasculature; Lymphatics; Innate; Adaptive; Immune.

PLENARY SPEAKER

Id-574

Ultrasensitive Biosensors (F-Elisa) for Rapid Onsite Detection of Biological and Chemical Agents in Fluids

G. SUN*, B. PAN, M. NORWOOD

Department of Biological and Agricultural Engineering, University of California, Davis

One Shields Avenue, Davis, California, 95616, USA

*Corresponding author: gysun@ucdavis.edu

Abstract: We report a recent breakthrough in development of personal use biosensors for onsite, rapid, accurate, and ultra-sensitive detection of toxic chemicals and microorganisms such as *Escherichia coli* (*E. coli*) O157:H7. The research originated from exploring the use of nanofibrous membranes as a potential media for biosensors with understanding of ideal structural features of materials employed for biosensors. The exploratory use of macroporous framework polymeric structures, especially melamine foams, were discovered as a platform for biosensors with surprisingly good performance and ability for rapidly detecting trace amount of targeted chemicals and biological agents in large volumes of liquid or air samples. The enzyme-linked immunosorbent assay (ELISA) technique with use of specific antibodies, nanobodies, and peptides serves as the probe on the platform to detect target substances in fluids. Different from conventional platforms employed in commercially available ELISA sensors, the macroporous framework foam forms covalent connections to antibodies and biomolecules, allows fast and free movement of large biomolecules, including antibodies and bacteria cells, flowing through the platform structure in every direction. Furthermore, the foam structure and the biological probes on surfaces of the foams have good stability and openness, ensuring accessibility of entire active binding sites of the framework structure with the biomolecules and consequently increasing the sensitivity in detection of biological and chemical targets. The foam-based ELISA sensors, thus named as f-ELISA biosensors, only take less than 1.5 h to complete a quantitative detection of *E coli* in fluids with a sensitivity of 10 CFU/mL, discernible by naked eyes, and an enhanced sensitivity of 5 CFU/mL with the help of a smartphone. The limit of detection of COVID-19 spike protein RBD was 0.1 mg/L for naked eyes and 0.047 mg/L with the help of a smartphone. The sensors could quickly detect fentanyl in 0.005mg/L (5 ng/mL) by naked eyes and 0.001 mg/L (1 ng/mL) with aid of a smartphone. The biosensor material is volume responsive, i.e. with increasing detection sensitivity as the sample volume is increased, highly suitable for testing large-volume fluid samples. These biosensors can provide volume-flexible, rapid, onsite, selective, and ultra-sensitive detection of various pathogenic microorganisms and toxicants in environment for real-world applications. US National Institute of Environmental Health Science (NIEHS)/UC Davis Superfund program 5P42ES004699-30, US Department of Agriculture (USDA-NIFA 2018-67017-28116), US National Institute of Occupational Safety and Health (NIOSH)/Centers of Disease Control and Prevention (CDC) through Iowa State University (R01 OH011947)

Keywords: Foam based biosensor; Rapid and sensitive; Onsite use; Colorimetric; Chemical and biological agents.

PLENARY SPEAKER

Id-598

Harnessing Plasmonic Nanomaterials for Enhanced Optical Sensing and NIR-II Imaging

F. XIE*

Imperial College London, United Kingdom

*Corresponding author: f.xie@imperial.ac.uk

Abstract: Plasmonic nanomaterials have emerged as powerful platforms for amplifying light–matter interactions, enabling new opportunities in optical sensing and biomedical imaging. In this keynote, Professor Fang Xie will present recent advances in the design and engineering of plasmonic nanostructures for optical sensing based on metal-enhanced fluorescence (MEF) and fluorescence imaging in the second near-infrared (NIR-II) window. The talk will explore how tailored plasmonic architectures can significantly enhance fluorescence intensity and extend detection sensitivity in biomarkers detection. In particular, plasmon-fluorophore interactions optimized for NIR-II wavelengths enables deeper tissue penetration, reduced background scattering, and improved imaging contrast. The presentation will conclude with perspectives on translating plasmonic-enhanced optical technologies toward next- generation sensing and imaging applications.

Keywords: Plasmonic nanomaterials; Optical.

PLENARY SPEAKER

Id-....

**Decoding the Brain: How AI and Big Data are Revolutionizing Neurological
Diagnostics**

Ç. AYDIN*

VIB, Belgium

*Corresponding author: cagatay.aydin@kuleuven.be

Abstract: Neuropsychiatric and neurodevelopmental disorders arise from dysfunctional brain circuitry. While our understanding of the underlying neurochemical mechanisms has improved, drug development remains severely hindered by the limited predictive validity of behavioral animal models. Behavioral changes often fail to reflect true circuit-level recovery and may instead stem from unrelated compensatory mechanisms, making preclinical human forecasting highly uncertain. Recent breakthroughs in high-density electrophysiology [1] help overcome this barrier by enabling the precise, large-scale tracking of single-neuron activity in freely moving animals. Utilizing Neuropixels 2.0 probes [2] implanted with lightweight 3D-printed fixtures [3], we chronically recorded over 250 neurons simultaneously in mice across multiple days. To investigate drug-induced neural modulation, we administered varying doses of the NMDA receptor antagonist dizocilpine (MK-801) [4]. Strikingly, we identified profound differences in neural firing patterns between control and dosed groups that were entirely independent of observable behavior. Leveraging temporal variations in single-neuron spike statistics, we built a multiclass classifier to predict the administered drug dosage based solely on these electrophysiological footprints. Our model successfully classified the medication concentration with over 70% accuracy. Ultimately, this platform demonstrates that direct neural activity tracking can serve as a robust, predictive biomarker, paving the way for advanced drug discovery and personalized therapeutic interventions.

Keywords: Neuropixels recording.

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INVITED SPEAKER

Id-583

Position Sensing in the Presence of (Bio)obstacles

K. RÖMER*

TU Graz, Austria

*Corresponding author: roemer@tugraz.at

Abstract: Ultra-wide-band wireless transceivers transmit very short pulses of electromagnetic waves and by measuring the time-of-flight of these signals between a transmitter and receiver one can estimate their distance with an accuracy of a few centimeters. By measuring distances to multiple references points in this way, one can accurately estimate the position of objects, people, or animals. However, in many environments the line-of-sight between a transmitter and a receiver is obstructed by obstacles, which can lead to substantial inaccuracies as the wireless signals then reach the receiver via reflections or the signals travel through the obstacles or along the surface of the obstacles at different propagation speed. A specific challenge are occlusions by humans who either wear the transmitter or receiver, or people who block the line of sight. In this talk I will first present the effects of the presence of obstacles, specifically also humans, on distance sensing. Then I will present several machine-learning-based techniques to detect the presence of (bio)obstacles and to automatically correct the distance measurement errors resulting from their presence.

Keywords: Position Sensing in the Presence of (Bio)obstacles.

INVITED SPEAKER

Id-584

**Technological Solution for the Realization of an Automatic Triggering System
for Gunshot Wound Detection**

M. C. GROSU^{1,*}, E. VISILEANU¹, A. G. ENE¹, R. HERTZOG², A. F. VLADU¹, M. F. DONDEA¹

¹The National Research and Development Institute for Textiles and Leather,
16, Lucretiu Patrascanu street, sector III, code 030508 Bucharest, Romania

²Micro Science SRL, 1, Narciselor street, 200332, Craiova, Dolj, Romania

*Corresponding author: catalin.grosu@incdtp.ro

Abstract: Combat-related gunshot wounds induce complex and rapid physiological, psychological, and behavioural responses that significantly influence survival outcomes. Immediate reactions are mediated by activation of the sympathetic nervous system and include stress-induced analgesia, altered sensory perception, delayed pain awareness, and acute stress responses, which may obscure early recognition of haemorrhage severity. Hemostasis is a tightly regulated physiological process involving vasoconstriction, platelet aggregation, and coagulation; however, in cases of massive vascular injury, natural hemostatic mechanisms are frequently insufficient. Uncontrolled haemorrhage remains the leading cause of preventable death in military trauma, with limb injuries accounting for approximately 55% of all combat wounds, making early haemorrhage control a critical priority in prehospital care. This study integrates current evidence from trauma physiology, emergency medicine, and military psychology to analyse the immediate and subsequent psychological, behavioural, and physiological reactions of soldiers wounded by gunfire in combat. Immediate responses include acute stress reactions, hypovolemic shock, bleeding, and cognitive narrowing, while post-survival reactions may encompass emotional distress, anger, relief, and maladaptive behavioural responses. Elements of a practical framework are proposed to assist comrades and medical personnel in recognising and managing these reactions during casualty care. In parallel, the research presents the development of an innovative demonstration model of an autonomous primary hemostasis system based on smart textile technology. The proposed system employs conductive elastic textiles acting as sensors that detect mechanical disruption or electrical circuit interruption, serving as a physiological proxy for potential haemorrhage. Upon event detection, a command-and-control unit activates pneumatic tourniquets positioned on the proximal segments of the upper or lower limbs. The system is designed to provide rapid haemorrhage control under predefined safety constraints, reducing dependence on immediate human intervention. Advantages, limitations, and safety considerations are analysed in comparison with conventional mechanical tourniquets, highlighting the potential of smart textiles for future applications in trauma care and surgical management. This research was funded by the Romanian National Authority for Research, under the National Research Program 5.7- Partnership for Innovation, Subprogram 5.7.1- Partnerships for Competitiveness, Experimental Demonstrative Project PN-IV-P7-7.1-PED-2024-0353, contract no.56PED/2025 with UEFISCDI.

Keywords: Combat trauma; Hemorrhage control; Gunshot wounds; Tourniquet; Smart textiles.

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11th International Congress on Biomaterials & Biosensors

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INVITED SPEAKER

Id-591

Novel Approach for Diabetic Wound Healing: Adipose-Derived Mesenchymal Stromal Cells Exo@Sphydrogel Combined with Laser Therapy

W. CHEN, J. YE, Q. WU*

Fujian Medical University, The First Affiliated Hospital of Fujian Medical University, Fuzhou, China

*Corresponding author: qiaoyiwu@zju.edu.cn

Abstract: This study investigates a multifunctional hydrogel system incorporating chlorophyll-rich *Spirulina platensis* (SP) and adipose-derived mesenchymal stromal cell exosomes (AD-MSC-exo) for diabetic wound healing. Single-cell transcriptome sequencing of rat wound tissues revealed a significant decrease in endothelial cells and macrophages, providing a mechanistic rationale for therapeutic intervention. The developed AD-MSC-exo@SP hydrogel demonstrated excellent biocompatibility, with a hemolysis rate below five percent and no cytotoxicity to skin-related cells. In vitro, the hydrogel promoted endothelial cell proliferation, migration, and tube formation, while inducing macrophage polarization and increasing anti-inflammatory cytokine secretion. Under the laser irradiation, SP generated reactive oxygen species and oxygen, effectively alleviating biofilm hypoxia and disrupting *S. aureus* biofilms. In a diabetic rat wound infection model, combination therapy with AD-MSC-exo@SP hydrogel and laser significantly accelerated wound closure by day fourteen, enhanced collagen deposition, upregulated angiogenesis (VEGF, α -SMA) and proliferation markers (PCNA), reduced pro-inflammatory cytokines (TNF- α), and promoted macrophage polarization. These findings demonstrate that AD-MSC-exo@SP hydrogel combined with laser therapy represents a promising multifunctional strategy for enhancing diabetic wound healing through angiogenesis promotion, immunomodulation, and antimicrobial effects. This work was supported by the National Natural Science Foundation of China and the Zhejiang Provincial Key Research and Development Program. The authors thank the Core Facilities of Zhejiang University School of Medicine for technical assistance.

Keywords: Diabetic wound healing; Hydrogel; Adipose-derived mesenchymal stromal cells; Exosomes; Laser therapy.

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INVITED SPEAKER

Id-594

Next-Generation Wound Dressings: Lyophilized Synbiotic Microparticles for the Management of Infected Burn Wounds

F. H. FARAHANI^{1,*}, F. MORAFFAH¹, N. SAMADI^{2,3}, M. SHARIFZADEH⁴, H. MOTASADIZADEH⁵, A. VATANARA¹

¹Department of Pharmaceutics, Faculty of Pharmacy, Tehran University of Medical Sciences, Tehran 1414614411, Iran

²Department of Drug and Food Control, Faculty of Pharmacy, Tehran University of Medical Sciences, Tehran 1414614411, Iran

³Pharmaceutical Quality Assurance Research Center, The Institute of Pharmaceutical Sciences (TIPS), Tehran University of Medical Sciences, Tehran 1414614411, Iran

⁴Department of Pharmacology and Toxicology, Faculty of Pharmacy, Tehran University of Medical Sciences, Tehran 1414614411, Iran

⁵Department of Pharmaceutical Nanotechnology, Faculty of Pharmacy, Tehran University of Medical Sciences, Tehran 1414614411, Iran

*Corresponding author: Heliahasani77@yahoo.com

Abstract: Burn wound infections, particularly those caused by multidrug-resistant pathogens like *Pseudomonas aeruginosa* and *Staphylococcus aureus*, remain a critical challenge in clinical settings. While topical antibiotics are standard, the rise of resistance necessitates alternative therapeutic strategies. This study presents the design and evaluation of a novel bioactive wound dressing based on lyophilized microparticles containing *Lactiplantibacillus plantarum* and Fructooligosaccharide encapsulated within a Chitosan-Alginate matrix. The goal was to develop a stable, absorbent, and effective formulation for accelerating the healing of infected burns. A D-optimal design was employed to optimize the encapsulation process, using Chitosan and Sodium Alginate as the polymeric matrix. The formulation was stabilized via freeze-drying to enhance storage stability and porosity. The optimized microparticles were characterized for swelling behavior, water vapor transmission rate (WVTR), and probiotic viability. The therapeutic efficacy was evaluated in vivo on Wistar rats with partial-thickness burn wounds infected with *P. aeruginosa* and *S. aureus*, comparing the results with standard antibiotic ointment. The optimized synbiotic formulation demonstrated a high swelling ratio of approximately 2000%, ensuring rapid absorption of wound exudates while maintaining a moist environment. The freeze-drying process preserved probiotic viability at over 82%. In animal models, the formulation significantly accelerated wound closure and re-epithelialization compared to the control groups. Notably, the probiotic-loaded particles were as efficacious as Silver Sulfadiazine in reducing infections but represented superior outcomes in modulating inflammation and reducing oxidative stress markers. The developed lyophilized synbiotic powder represents a promising advancement in wound dressing technologies. By combining the antimicrobial properties of probiotics with a highly absorbent polymeric matrix, this formulation not only controls infection but also actively promotes tissue regeneration. This approach offers a viable, non-antibiotic alternative for the management of infected burn wounds.

Keywords: Probiotic; Prebiotic; Freeze-drying; Microencapsulation; Wound dressing; Burn wound.

ORAL PRESENTATION

Id-565

Development of Hemocompatible Membranes for Total Artificial Hearts: From Manufacturing to in vitro Evaluation

A. THIO-PERA^{1,2,*}, P. VIGNERON², H. CHIGAMA², S. PLUMEJAULT¹, N. L'HEUREUX³, S. CHABANE¹, M. VAYSSADE²

¹R&D, Procope Medicals SAS, Nantes, France

²Université de technologie de Compiègne, BMBI, Compiègne, France

³Université de Bordeaux, INSERM, BIOTIS, U1026, F-33000 Bordeaux, France

*Corresponding author: athioipera@procope-medicals.com

Abstract: Heart failure, defined as the inability of the heart to pump blood effectively, affects more than 26 million people worldwide, with prevalence rising with aging populations. For patients with end-stage disease, heart transplantation remains the most effective treatment; however, donor organ shortages and long waitlist underscore the urgent need for alternative circulatory support strategies. Total Artificial Hearts (TAHs) represent a promising solution as a bridge to transplant by providing complete mechanical substitution of both ventricles. A key component of fluid-driven TAH function is a flexible membrane housed within each artificial ventricle, which cyclically transitions from concave to convex in response to pressure modulation, thereby replicating systolic ejection and diastolic filling. Durability, hemocompatibility, and mechanical integrity of this membrane are essential to limit hemolysis, thromboembolic events, and device failure. This study aims to identify, bio-fabricate, and characterise next-generation biomaterials suitable for TAH membrane construction. Four candidate materials were evaluated: thermoplastic polyurethane (TCPU), glutaraldehyde-fixed bovine pericardium (BP), a human cell-assembled extracellular matrix (CAM), and a polyurethane–pericardium hybrid composite (Hybrid). Membrane geometry was defined using device-specific structural constraints and blood-flow simulations. The fabrication of biological materials introduced several challenges, primarily related to three-dimensional shaping of soft tissues, achieving stable adhesion between different materials, and maintaining structural fidelity during processing. To address these issues, dedicated bio-manufacturing methods were developed to achieve successful membrane formation across all material types. Mechanical and surface characterisation included uniaxial tensile testing to assess compliance, stiffness, and ultimate tensile strength, providing insight into the materials' capacity to withstand cyclic deformation. Surface analyses—including wettability measurements and high-resolution imaging—revealed distinct physicochemical profiles: TCPU exhibited a smooth, slightly hydrophobic surface with potential anti-fouling behaviour; BP retained its native serosa–fibrosa microarchitecture; Hybrid materials combined the hydrophobicity of TCPU with the biological features of pericardium; and CAM displayed an extremely hydrophilic uniform surface. Biocompatibility was examined through standard cytocompatibility and hemolysis assays. TCPU supported minimal cellular attachment, whereas CAM membranes promoted robust adhesion of fibroblasts and endothelial cells. Indirect cytotoxicity assays revealed altered metabolic activity for HUVEC cells when cultured with CAM and BP extracts, while direct-contact assays confirmed strong cell adhesion and proliferation on CAM. Haemolysis assays

indicate that materials did not induce human erythrocyte lysis. Ongoing work includes expanded hemocompatibility testing following ISO 10993-4 guidelines—evaluating complement activation, coagulation cascades, and inflammatory markers using whole blood—as well as accelerated dynamic fatigue testing to predict long-term membrane durability over tens of millions of cycles. Overall, this study establishes an integrated framework for the selection, fabrication, and preliminary evaluation of biomaterials for TAH membrane design. Mechanical, surface, and biocompatibility data will guide the final material selection for the membrane of the total artificial heart under development by Procope Medicals.

Keywords: Total Artificial Heart; Hemocompatibility; Thermoplastic Polyurethane; Bovine Pericardium; Extracellular Matrix Biomaterial.

ORAL PRESENTATION

Id-575

Enantiospecific Biosensor for Antibiotics Detection Based on Lateral Flow Testing

O. D. HENDRICKSON*, N. A. BYZOVA, A. V. ZHERDEV, B. B. DZANTIEV

Bach Institute of Biochemistry, Research Center of Biotechnology of the Russian Academy of Sciences,

Leninsky Prospekt 33, 119071, Moscow, Russia

*Corresponding author: odhendrick@gmail.com

Abstract: Antibiotics are among the major contaminants of food products due to their extensive use in veterinary practice for the treatment and prevention of infectious diseases in farm animals. The overuse of antibiotics leads to the accumulation of their residues in food products of animal origin, thereby increasing the prevalence of antibiotic-resistant bacteria. Fluoroquinolones, including ofloxacin (OFL), are widely used synthetic antibiotics characterized by broad antibacterial activity. OFL is a chiral compound existing as a racemic mixture of two enantiomers, S-OFL and R-OFL, which differ significantly in biological activity. The antibacterial effect of OFL is mainly attributed to the S-enantiomer, whereas the R-enantiomer exhibits substantially lower activity and even toxicity to humans and animals. Because conventional chemical synthesis produces racemic mixtures and enantiomer separation is technologically challenging and costly, both OFL isomers may be present in pharmaceutical preparations and, consequently, in food products of animal origin. This necessitates enantioselective control of OFL residues in food matrices. Traditional analytical methods for enantiomer determination, such as chromatography, provide high sensitivity and selectivity but require sophisticated equipment and trained personnel, which limit their applicability for rapid on-site analysis. In this context, biosensors based on antigen-antibody interactions represent a promising alternative, particularly lateral flow tests (LFT), which combine simplicity, rapidity, and cost-effectiveness. In this study, polyclonal antibodies were produced by immunization of rabbits with the OFL racemic mixture. As a colorimetric label, gold nanoparticles were synthesized and conjugated with antibodies. Conditions for enantiospecific LFT of both OFL isomers with negligible cross-reactivity were established. For this purpose, the same antiserum but different coating antigens were utilized. Therefore, a double lateral flow test was developed for the first time, which enables the simultaneous determination of S- and R-OFL in a heterologous assay format. The high analytical performance of the LFT was achieved, with instrumental/visual detection limits of 0.001/10 and 0.007/30 ng/mL for S-OFL and R-OFL, respectively. The assay duration was 15 min, fulfilling the requirement for rapid testing. The developed LFT was successfully applied to the analysis of milk as a food matrix, which potentially can be contaminated with antibiotic residues. No specific sample preparation was required, except for diluting the milk with buffer. The recoveries of S-OFL and R-OFL were 85–95%. The proposed double LFT allowed for the selective detection of both the biologically active and less active OFL enantiomers, reducing the risk of false-negative results in food safety monitoring. This investigation demonstrates the potential of an enantioselective biosensor as an efficient tool for rapid control of chiral antibiotics or other toxicants in

agricultural products. This study was financially supported by the Russian Scientific Foundation (project No 24-46-00026).

Keywords: Fluoroquinolones; Ofloxacin; Enantiomers; Biological activity; Biosensing; Lateral flow tests; Food safety.

ALL SUBMISSIONS & TOPICS

Advanced Functional Materials	Id 591 - Novel Approach for Diabetic Wound Healing: Adipose-Derived Mesenchymal Stromal Cells Exo@Sphydrogel Combined with Laser Therapy
Biomaterials and Cardiovascular Devices	Id 565 - Development of Hemocompatible Membranes for Total Artificial Hearts: From Manufacturing to in vitro Evaluation
Biosensors	Id 574 - Ultrasensitive Biosensors (F-Elisa) for Rapid Onsite Detection of Biological and Chemical Agents in Fluids
Antibodies	Id 575 - Enantiospecific Biosensor for Antibiotics Detection Based on Lateral Flow Testing
	Id 576 - Lateral Flow Immunoassay of Beta-Agonist Mabuterol Using Au@Ce Nanoparticles as a Signal-Enhancing Label
Sensors With Transducers	Id 583 - Position Sensing in The Presence of (Bio)obstacles
Optical	Id 598 - Harnessing Plasmonic Nanomaterials for Enhanced Optical Sensing and NIR-II Imaging
Advanced Wound Dressing Technologies	Id 594 - Next-Generation Wound Dressings: Lyophilized Synbiotic Microparticles for the Management of Infected Burn Wounds
Regenerative Medicine and AI Technologies	Id 568 - Towards A Multi-Organ-On-Chip Model Combining Skin, Lymph Node and Vasculature for Mimicking innate and Adaptive immune Responses