重建希望
再生醫學的突破與展望

暨2026年台灣再生醫學學會學術研討會

Rebuilding Hope: Breakthroughs in Regenerative Medicine

2026 Annual Meeting of FARM

摘要集

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主辦：台灣再生醫學學會學術研討會

協辦：上海商業儲蓄銀行 THE SHANGHAI COMMERCIAL & SAVINGS BANK, LTD. 文教基金會

臺大醫學院102講堂

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Rebuilding Hope: Breakthroughs in Regenerative Medicine / 2026 Annual Meeting of FARM

Scientific Program

Time	Topic	Speaker	Institute	Moderator
08:00	**Registration 報 到**			
Session 1				
08:30	**Opening Remark (劉越萍司長致詞)**			
I-01 08:40~09:00	臺灣再生醫療挑戰與展望	劉越萍司長	衛生福利部	張至宏教授
I-02 09:00~09:30	Leveraging Functional Biomaterials for Engineering 3D Tissue in Regenerative Medicine	Prof. Heungsoo Shin	Department of Bioengineering, Hanyang University, Korea	賴瑞陽教授 姚俊旭教授
I-03 09:30~10:00	3D Printing to Engineer Complex Tissues	Prof. Fisher, John	Fischell Department of Bioengineering University of Maryland, USA	方旭偉教授
10:00~10:20 Group photo / Coffee Break				
Session 2				
I-04 10:20~10:50	iPSC Technology-based Regenerative Therapy and Drug Discovery for Kidney Diseases	Prof. Kenji Osafune	Center for iPS Cell Research and Application(CiRA), Kyoto University, Japan	何美泠教授
I-05 10:50~11:20	Regenerative Medicine in Osteoarthritis: The Past, The Present and the Future	Prof. Gun-Il Im	Integrative Regenerative Biomedical Engineering, Dongguk University, Korea	陳崇桓教授
I-06 11:20~11:50	Cartilage Micrografting From the Ear to the Knee Joint - A Regenerative Medicine Approach	Prof. Zsombor Lacza, MD PhD DSc	Center for Sports Medicine and Sports Physiology Hungarian University of Sports Science, Budapest, Hungary	王禎麒教授
11:50~12:00	感念 林峯輝教授/理事長			
12:00 **會 員 大 會** 12:00~13:30 **Lunch Break**				

Time	Topic	Speaker	Institute	Moderator
Session 3				
I-07 13:30~14:00	Therapeutic Applications of Cartilage-Derived Extracellular Matrix and Microvesicles for Arthritis	Prof. Sang-Hyug Park	Pukyong National University, Korea	楊凱強教授
I-08 14:00~14:30	Deciphering the Roles of Ageing & Mechanotransduction in Rotator Cuff Tendon Healing	Prof. Justin Cooper-White	Australian Institute for Bioengineering and Nanotechnology The University of Queensland	鄭乃禎教授
I-09 14:30~15:00	Development of Regenerative Medicine Products Using Cell Sheet Engineering	Setsuko Hashimoto, Ph.D	President ＆CEO, CellSeed Inc. Japan	林泰元教授
15:00~15:30 Group photo / Coffee Break				
Session 4				
I-10 15:30~15:50	Cellular Reprogramming and iPS Technology in Retinal Diseases: From Bench to Clinic	邱士華教授/副院長	陽明交通大學附設醫院	陳志華教授 黃彥華教授
I-11 15:50~16:10	Chimeric Antigen Receptor T Cell Therapy for Autoimmune Disease	張裕享執行長	樂迦再生科技	
I-12 16:10~16:30	Articular Cartilage Regeneration by Decellularized Cartilage and Functional Hydrogel	葉明龍教授	成功大學前瞻醫療器材科技中心 新創加速中心	黃玲惠教授 沈家寧教授
I-13 16:30~16:50	Applications of Microfluidics in stem cells, spheroids and organoids	許佳賢研究員	國衛院生醫工程與奈米醫學研究所	
Closing Remarks & Poster Competition Award				

壁報 Poster

評分委員：王子威教授、曾靖孋教授、黃彥華教授、劉彥良教授、鄭詠馨教授（依姓氏筆畫排列）

壁報論文作者解說時段：13:00~14:00

No.	Classification	Topic	Authors	Institute
參與競賽				
P-01	Biomaterials	A Natural Bioactive Molecule for Cartilage Protection via Modulation of Osteoarthritic Joint Microenvironment: Physicochemical Characterization and Preclinical Safety Evaluation	麥浚銘　黃書葦[#]	國立臺東大學應用科學系
P-02	Biomaterials	Biomimetic Adhesive Microneedles Patch with Bioactive Factors Delivery for Gastric Ulcer Repair	李冠毅　王子威	國立清華大學材料科學工程學系
P-03	Biomaterials	Biomimetic Viscoelastic Hydrogel Incorporating Microfluidic Culture System for Long-term Human Brain Organogenesis	廖恩鋒　王子威	國立清華大學材料科學工程學系
P-04	Biomaterials	Design, Fabrication, and Application Potential of Photocatalytic ZnO Antibacterial Nano-wound Dressings	石睿宏[1] 江俊毅[2] 劉彥良[1,3]	中國醫藥大學生物醫學工程學系[1] 中國醫藥大學老化醫學博士學位學程[2] 中國醫藥大學生物醫學工程碩士學位學程[3]
P-05	Biomaterials	Development of a Functional Methacrylated Carboxymethyl Cellulose Hydrogel Loaded with Glutathione for Dry Eye Therapy	謝昀璇　鄭詠馨[*]	國立臺灣科技大學材料科學與工程系
P-06	Biomaterials	Development of a Hair Growth- Tonic with Polygonum Multiflorum-complex Nanoformulaiton	陳品妤[1] 李佳蓉[2] 曾靖孋[1]	臺北醫學大學生醫材料暨組織工程研究所[1] 臺北醫學大學生藥學研究所[2]
P-07	Biomaterials	Development of an Injectable Hydrogel with Conductive Polymer Complexed and its *in Vitro* Evaluation	黃柏鈞[1] 黃莞喻[1] 陳懷安[1] 鄭詠馨[2] 曾靖孋[1,]	臺北醫學大學生醫材料暨組織工程研究所[1] 國立臺灣科技大學材料科學與工程學系[2]
P-08	Biomaterials	Development of Calcium Phosphate/PLGA Microspheres as Hesperetin Carrier by SPG Membrane Emulsification for Control Release in Alzheimer's Disease Treatment	林佳慶　曾元 楊景昀　林峯輝	國立台灣大學醫學工程學系
P-09	Biomaterials	Development of Injectable Long-Acting Biodegradable Poly(lactic acid)/Polycaprolactone Microspheres for Soft Tissue Regeneration	李宗錡[1,2] 余仲倫[2,3] 張宥承[2,3] 劉怡心[2,3] 方旭偉[2,3,4*]	國立臺北科技大學化學工程研究所[1] 國立臺北科技大學化學工程與生物科技系[2] 國立臺北科技大學高值生醫材料與商品化中心[3] 國家衛生研究院生醫工程與奈米醫學研究所[4]

P-10	Biomaterials	Development of N-Trimethyl Chitosan Nanoparticles as a Transfection Carrier for microRNA Delivery in the Treatment of Allergic Asthma	黃沛丰 [1] 鄭詠馨 [1] 楊凱強 [2]	國立臺灣科技大學材料科學與工程系 [1] 臺北醫學大學牙體技術學系 [2]
P-11	Biomaterials	Development of Starch-Based Sponge and Their Potential in Hemostasis	陳昱翔 [1,2] 李耕源 [2,3] 劉怡心 [2,3] 方旭偉 [2,3,4*]	國立臺北科技大學生化與生醫工程研究所 [1] 國立臺北科技大學化學工程與生物科技系 [2] 高值生醫材料研究與商品化中心 [3] 生醫工程與奈米醫學研究所 [4]
P-12	Biomaterials	Hydrogel-Based Nanofibers with Adipose-Derived Stem Cell Extracellular Vesicles for Skin Repair	邱繼德	中國醫藥大學生物醫學工程學系
P-13	Biomaterials	Ion-Exchanged Zeolite-Based Gelatin/CMC Composite Sponge for Rapid and Effective Hemostasis for Clinical Application	Nguyen Thi Thu Huyen[1,2], 蘇振英 [2,3] Yi-Xin Liu [2,4] 方旭偉 [3,4,5*]	國立臺北科技大學生物化學與生醫工程研究所 [1] 國立臺北科技大學化學工程與生物科技系 [2] 陽明交通大學口腔組織工程暨生技材料研究所 [3] 國立臺北科技大學高加值生物材料研究與商品化中心 [4] 國家衛生研究院生醫工程與奈米醫學研究所 [5]
P-14	Biomaterials	Mechanistic Investigation of EGCG in the Regulation of Periodontal Inflammation and Angiogenesis	吳孟耘 [1] 楊晴卉 [1] 孫瑛穗 [1*] 吳庭瑜 [2]	臺北醫學大學口腔醫學院牙體技術學系 [1] 口腔衛生學系 [2]
P-15	Biomaterials	Research of Natural Biomolecular Hydrogels in Promoting Tissue Regeneration	林禹柔 [1] 孫瑛穗 [1*] 陳沄云 [2] 吳孟耘 [1] 楊晴卉 [1]	臺北醫學大學牙體技術學系 [1] 台灣科技大學機械工程研究所 [2]
P-16	Biomaterials	Therapeutic Potential of Umbilical Cord Mesenchymal Stem Cell-derived Apoptotic Bodies for *Klebsiella Pneumoniae*-induced Intra-abdominal Infection Via Macrophage Modulation	曾翊珈 [1] 林妘霏 [1] 莊漢英 [1] 蕭樑基 [2] 顏伶汝 [3] 王麗姿 [1]	臺北醫學大學醫學檢驗暨生物技術學系 [1] 國家衛生研究院感染症與疫苗研究所 [2] 國家衛生研究院細胞及系統醫學研究所 [3]
P-17	Biomaterials	Ultrasound-Responsive Foam Enhances Pleural Drug Delivery and Fibrosis Progression via Sonoporation-Assisted Penetration	林瑋臻 [1] Ulziijargal Sukhbat[2] 劉彥良 [1, 3, 4]	中國醫藥大學醫學工程學院醫學工程與復健科技產業博士學位學程 [1] 中國醫藥大學生物醫學研究所 [2] 生物醫學工程碩士學位學程 [3] 中國醫藥大學癌症生物精準醫學研究中心 [4]
P-18	Biomaterials	Evaluation of Hemostatic Properties of Compressible CMC Sponges Fabricated via Organic Acid Crosslinking	林筠庭 [1] 李耕源 [2] 方旭偉 [2,3,4*]	國立台北科技大學化學工程研究所 [1] 高值生醫材料研究與商品化中心 [2] 國立台北科技大學化學工程研究所與生物科技系 [3] 國家衛生研究院生醫工程與奈米醫學研究所 [4]

P-18-1	Biomaterials	Establishment of a Novel Biomimetic Friction-Testing Platform for Evaluating Eyelid–Lens Interactions	陳宥廷[1] 蘇真瑩[2,3] 方旭偉[2,3]	國立臺北科技大學化工所[1] 國立臺北科技大學 化工系[2] 國立臺北科技大學高值生醫材料研究與商品化中心[3]
P-19	Bone marrow stem cells	Investigating the Regulation of Astrocyte-Mediated Neuroprotection by 3D Bone Marrow Mesenchymal Stem Cell Spheroids Following Traumatic Brain Injury	柯秉均 黃詩宸 黃玠誠	國立清華大學生物醫學工程研究所
P-20	Bone marrow stem cells	The role of TNF-α-primed Bone Marrow Mesenchymal Stem Cells in Enhancing Osteogenic and Immunomodulatory Functions for Treating Peri-implantitis	王心妤[1] 林妘霏[1] 莊漢英[1] 蔡孟勳[2] 陳漪紋[2] 王麗姿[1]	臺北醫學大學醫學檢驗暨生物技術學系[1] 台灣大學臨床牙醫學研究所[2]
P-21	Others	Artificial Intelligence–Based Deep Matting Segmentation for Localization of Laser-Induced Retinal Lesions on Fundus Fluorescein Angiography	Ngoc Hoang Le, Hsin-Cheng Liu, Erh-Hsuan Hsieh, Pham Hoang Duong, Ching-Li Tseng*	Graduate Institute of Biomedical Materials and Tissue Engineering, College of Biomedical Engineering, Taipei Medical University, New Taipei City, Taiwan
P-22	Others	Rapid Expansion of ADSCs using PVA Microcarriers in a Closed Bag System	黃隆永[1,3] 蘇鴻麟[2]	國立中興大學組織工程與再生醫學博士學位學程[1] 國立中興大學生命科學系[2] 通用幹細胞股份有限公司[3]
P-23	Others	Therapeutic Potential of Adipose-Derived Mesenchymal Stem Cells in Modulating T Cell Responses in Type 2 Diabetes Mellitus	李若宇[1] 陳品瑄[1] 莊漢英[1] 王睦惠[2] 鄭乃禎[2] 王麗姿[1]	臺北醫學大學醫學檢驗暨生物技術學系[1] 臺灣大學醫學院外科[2]
P-24	Others	Umbilical Cord Mesenchymal Stem Cells Attenuate *Candida albicans*–Induced Inflammatory Neutrophil Death While Preserving Antifungal Activity	陳忠忻[1] 李若宇[1] 陳品瑄[1] 莊漢英[1] 許博琛[2] 王麗姿[1]	臺北醫學大學醫學檢驗暨生物技術學系[1] 國立陽明交大微生物及免疫學研究所[2]
P-25	Others	Umbilical Cord MSC–derived Apoptotic Bodies Reprogram Lung Macrophage Subsets to Treat *Klebsiella Pneumoniae* Pneumonia	陳品辰[1] 廖羿婷[2] 莊漢英[1] 蕭樑基[3] 顏伶汝[4] 王麗姿[1]	臺北醫學大學醫學檢驗暨生物技術學系[1] 國立台灣大學醫學院口腔生物科學研究所[2] 國家衛生研究院感染症與疫苗研究所[3] 國家衛生研究細胞及系統醫學研究所[4]
P-26	Regenerative medicine	Development of Dual-responsive PNIPAM-gelatin-based Hydrogels Encapsulating WJ-MSCs for the Treatment of Peripheral Arterial Disease	林居慶 陳新和 鄭詠馨	國立臺灣科技大學材料科學與工程系
P-27	Regenerative medicine	Dual Effects of Placenta-Derived Mesenchymal Stromal Cell–Derived Small Extracellular Vesicles and Chimeric Antigen Receptor–Modified Small Extracellular (CAR-sEVs) in Liver Fibrosis	陳姿妤[1] 劉鴻祺[1] 呂彥葶[1] 王惠鈞[2] 李政忠[2,3] 林泰元[1]	國立臺灣大學醫學院藥理學研究所[1] 臺北醫學大學醫學科技學院轉譯醫學博士學位學程[2] 臺北醫學大學醫學科技學院國際轉譯科學博士學位學程[3]
P-28	Regenerative medicine	Engineered Extracellular Vesicles for Targeted Anti-Inflammatory Therapy Osteoarthritis Treatment	Tran Dieu Linh[1] Chiang Chi-Ling[1] Chi-Ying F. Huang[1] Hsiu-Jung Liao[1,2]	國立陽明交通大學生物藥學研究所[1] 亞東紀念醫院醫學研究部[2]

P-29	Regenerative medicine	Enhanced Corneal Epithelial and Stromal Wound Healing Using Platelet-Derived Extracellular Vesicles (PEVs)	Duong H. Pham[1] 林怡嬋 [1,2*] 曾靖斕 [3*]	臺北醫學大學國際醫學研究博士學位學程 [1] 臺北醫學大學醫學系眼科學科 [2] 臺北醫學大學生醫材料暨組織工程研究所 [3]
P-30	Regenerative medicine	Enhancing Hepatocyte-Like Cell Maturation and Liver Regeneration Using Umbilical Cord–Derived Mesenchymal Stem Cells via Mitochondrial Metabolism Regulation	陳柄益 [1] 曾翊珈 [2] 林妘霏 [2] 蔡宏達 [3] 林聖才 [3] 陳明堯 [3] 莊漢英 [2] 王麗姿 [2]	臺北醫學大學醫學系 [1] 臺北醫學大學醫學檢驗暨生物技術學系 [2] 衛生福利部雙和醫院胃腸肝膽科 [3]
P-31	Regenerative medicine	Hypoxia-Preconditioned Adipose-Derived Stem Cell–Derived Extracellular Vesicles Promote Diabetic Wound Healing	游竣喬 [1] 李嘉鈞 [2] 劉耿帆 [2] 陳榮富 [2] 郭耀仁 [2]	高雄醫學大學學士後醫學系 [1] 高雄醫學大學附設醫院整形外科 [2]
P-32	Regenerative medicine	Peptide-primed Mesenchymal Stem Cell-Derived Extracellular Vesicles Therapy Reduce Pain in Osteoarthritis	Thu Thao Pham[1] Hsiu-Jung Liao[1,2*] Chi-Ying F. Huang[1*]	國立陽明交通大學 [1] 亞東紀念醫院 [2]
P-33	Regenerative medicine	The Preparation of Carvacrol Mixed with Hyaluronic Acid for Early-Osteoarthritis Treatment	陳鈺萍 [1,2] 陳郁君 [3] 林峯輝 [1,2,4]	國立中興大學組織工程與再生醫學博士學位學程 [1] 國家衛生研究院生醫工程與奈米醫學研究所 [2] 國立聯合大學化學工程學系 [3] 國立台灣大學醫學工程學系 [4]
P-34	Regenerative medicine	Diabetic Wound Microenvironment Modulation via Stem Cell-Derived Components and Antioxidant Nanoparticles	林育辰 [1] 張明敏 [2] 潘信誠 [3] Yukio Nagasaki[4] 吳佳慶 [1,2,3]	國立成功大學基礎醫學研究所[1] 國立成功大學細胞生物暨解剖所研究所 [2] 國立成功大學附設醫院 [3] 國立成功大學奈米研究中心 [4]
P-35	Tissue Engineering	Angiogenic, Injectable, Granular, Porous Scaffold for Fat Transplantation	江俊毅 [1] 業沁怡 [2] 劉彥良 [2]	中國醫藥大學老化醫學博士學位學程 [1] 中國醫藥大學生物醫學工程碩士學位學程 [2]
P-36	Tissue Engineering	Biocompatibility Evaluation of Biodegradable Films for Medical Applications on ADSCs	劉庭彣 [1,3,4] 吳淑媚 [2,4,3] 林怡珊 [3,4] 林松彥 [1,3,4]	高雄醫學大學學士後醫學系 [1] 高雄醫學大學醫學研究所博士班[2] 高雄醫學大學骨科研究中心 [3] 高雄醫學大學再生醫學與細胞治療研究中心 [4]
P-37	Tissue Engineering	Biomimetic Stiffness Modulated Chondrocyte Sheet Engineering for Chondral Defect Repair	曾元 [1] 譚大倫 [2] 陳宣佑 [3] 林峯輝 [1] 曾厚 [4]	國立台灣大學醫學工程學系 [1] 中華民國獸醫師公會全國聯合會 [2] 國立台灣大學附設醫院骨科部 [3] 台北醫學大學醫學系 [4]
P-38	Tissue Engineering	Enhancement of the Therapeutic Potential of Stem Cell Spheroid-Derived Matrix for Treating Traumatic Brain Injury Treatment by Polydopamine Nanoparticle Decoration	倪宜安 楊蓓青 黃玠誠*	國立清華大學生物醫學工程研究所

P-39	Tissue Engineering	Exploring the Potential of Collagen Nerve Conduits Containing Hydrogelated Stem Cells to Promote Peripheral Nerve Repair	陳彥瑜 何家欣 黃玠誠*	國立清華大學生物醫學工程研究所
P-40	Tissue Engineering	Stage-Specific MSC Spheroid Fusion Drives Bottom-Up Formation of Multizonal Cartilage Grafts	蔡宜蓁[1] 劉彥良[2] 林峯輝[3] 劉華昌[4]	中國醫藥大學生物醫學工程學系[1] 中國醫藥大學生物醫學工程碩士學位學程[2] 國立臺灣大學醫學工程學系[3] 國立臺灣大學醫學院骨科部[4]
不參與競賽				
P-41	Biomaterials	Human Corneal Regeneration Using Acellular Porcine Corneal Scaffolds for Corneal Ulcer Treatment Via Anterior Lamellar Keratoplasty	陳俊良[1] 徐旭亮[2] 曾繁偉[3] Srinivasan Periasamy[3] 余元仁[3] 趙朝欽[3] 顏克中[3] 戴明正[4] 謝達仁[3]	高雄榮民總醫院[1] 高雄醫學大學附設中和紀念醫院[2] 亞果生醫股份有限公司[3] 三軍總醫院[4]
P-42	Regenerative medicine	Topical *Laurus Nobilis*-derived Extracellular Vesicles Reprogram the Diabetic Wound Microenvironment to Enable Tissue Regeneration	廖秀蓉[1,2] 蔡維妮[2] 吳廣俠[2] 張至宏[3,4] 黃奇英[2]	亞東紀念醫院醫學研究部[1] 國立陽明交通大學生物藥學所[2] 亞東紀念醫院骨科部[3] 元智大學生物工程與技術研究所[4]
P-43	Tissue Engineering	BMSC Loaded Photo-Crosslinked Hyaluronic Acid/Collagen Hydrogel Incorporating FG4592 for Enhanced Cell Proliferation and Nucleus Pulposus Differentiation	林政立[1] 郭承翔[2] 涂庭源[3] 熊彥傑[4*]	國立成功大學醫學院附設醫院骨科部[1] 國立成功大學生理所[2] 國立成功大學生物醫學工程學系[3] 國立成功大學藥學系[4]
P-44	Tissue Engineering	Mitochondrial Transfer from Adipose-Derived Stem Cells Improves the Chondrogenic Phenotype in Senescent Chondrocytes by Ameliorating Mitochondrial Dysfunction	伍哲緯[1,2,3] 黃耀輝[1,3] 邵佩琳[5] 張玲華[1,3] 盧政昌[1,3,4] 陳崇桓[1,3,4] 傅尹志[1,3,4] 何美泠[1,3] 張瑞根[1,3] 吳順成[1,3,5*]	高雄醫學大學再生醫學與細胞治療研究中心[1] 元培醫事科技大學食品科學系[2] 高雄醫學大學骨科學研究中心[3] 高雄醫學大學骨科[4] 亞洲大學護理學系[5]
P-45	Tissue Engineering	Supercritical CO_2–Decellularized Renal Scaffolds Combined with iPSC Cells for Kidney Regeneration	張玲華[1,2] 林怡文[1,2] 陳崇桓[1,2] 傅尹志[1,2,3]	高雄醫學大學骨研中心[1] 高雄醫學大學再生醫學與細胞治療研究中心[2] 高雄秀傳紀念醫院[3]

Invited Lectures

08:40~09:00

I-01

臺灣再生醫療挑戰與展望

劉越萍司長
衛生福利部醫事司

摘要：

目前新興生物醫學科技迅速發展，再生醫療相關領域之技術與知能已逐漸成熟，並加速擴大應用至臨床醫學，鑒於再生醫療之異質性、特殊性及治療複雜性，衛生福利部制定「再生醫療法」業於 113 年 6 月 19 日經總統公布。希望透過再生醫療專法，從醫療執行端、製劑端、細胞製備端全面納管，落實分級分流之安全管理，鼓勵再生醫療相關學研、產業共同投入，建構再生醫療產業鏈，營造永續發展環境。

09:00~09:30

I-02

Leveraging Functional Biomaterials for Engineering 3D Tissue in Regenerative Medicine

Heungsoo Shin, Ph.D. Professor
Department of Bioengineering, Hanyang University, Seoul, South Korea
hshin@hanyang.ac.kr

Abstract:

The growing interest in engineering three-dimensional (3D) tissues continues to drive significant advances in tissue engineering and regenerative medicine. Among various approaches, the use of micro-scale functional units—such as cell aggregates, sheets, or spheroids—has emerged as a promising strategy to recapitulate heterogeneous, complex cellular microenvironment of native target tissues. Stem cell spheroids and organoids have been extensively explored as modular building blocks, as directly assembled or integrated into biomimetic matrices. Effectively harnessing spheroids for constructing 3D tissues requires overcoming several key technological challenges including rapid and size-controlled spheroid production, modulation of spheroid functionality and modularity, precise spatial localization and organization of spheroids within defined biodegradable scaffolds, and promotion of vascularized structures to sustain long-term cell viability and metabolic activity. Integrating cell-instructive biomaterials with spheroid systems may provide an effective strategy to address these challenges by offering a supportive and dynamic microenvironment that guides cellular behaviors and tissue morphogenesis. This presentation highlights our research efforts combining cell-instructive biomaterials with multicellular spheroids to engineer 3D constructs for tissue regeneration, with a particular emphasis on musculoskeletal tissue applications.

09:30~10:00

I-03

3D Printing to Engineer Complex Tissues

John P. Fisher
Fischell Department of Bioengineering
University of Maryland
College Park, MD

Abstract
Generating complex tissues has been an increasing focus in tissue engineering and regenerative medicine. With recent advances in bioprinting technology, our laboratory has focused on developing platforms for treating and understanding clinically relevant problems ranging from congenital heart disease to orthopedic trauma. In this presentation, we focus on engineering both orthopedic and gynecological tissues. We utilize digital light processing (DLP)-based and extrusion-based additive manufacturing to generate engineered tissues. Both approaches begin with CAD models that are then transferred to printing platforms. Prints use a variety of inks, including synthetic (PEG) and natural (GelMA, ECM) materials. Evaluation of printed constructs assesses critical criteria, including print fidelity, material properties (immediately after printing and at longer time points), cell viability, and cell functionality. Tissue function is assessed both in vitro and in vivo. This presentation will cover the diverse range of materials and processes developed in our laboratory and their application to relevant, emerging problems in tissue engineering.

10:20~10:50

I-04

iPSC Technology-Based Regenerative Therapy and Drug Discovery for Kidney Diseases

Kenji Osafune, MD, PhD
Center for iPS Cell Research and Application (CiRA), Kyoto University

Kidney diseases cause both medical and medicoeconomical problems worldwide. The only curative treatment, kidney transplantation, is hampered by the serious problem of donor shortage. Regenerative medicine using human induced pluripotent stem cells (hiPSCs) is expected as a solution. Mimicking kidney developmental processes, we have established differentiation methods for nephron and collecting duct (CD) organoids from hiPSCs through nephron progenitor cells and ureteric buds, respectively. We demonstrated that transplantation of hiPSC-derived nephron progenitor cells treats acute kidney injury (AKI) and chronic kidney disease (CKD) in mice and are preparing for clinical trial of cell therapy for CKD. We have also investigated the iPSC-based disease model for an intractable hereditary kidney disorder, autosomal dominant polycystic kidney disease (ADPKD). We succeeded in further advancing the developmental stage of CD organoids and showed that all CD organoids derived from PKD1$^{-/-}$ hiPSCs spontaneously develop multiple cysts. Moreover, by developing a mass production method for CD cysts using the passage culture, we established a high-throughput screening (HTS) platform that explores therapeutic drug candidates for ADPKD and identified retinoic acid receptor (RAR) agonists as candidate therapeutic drugs. We are conducting clinical trial to test the efficacy and safety of an RAR agonist, tamibarotene, for ADPKD patients in Japan. We have also aimed to create disease models to discover novel drugs for Alport syndrome. We established iPSC-derived collagen α5(IV)-expressing nephron organoids and confirmed that nephron organoids from COL4A5 mutation-corrected hiPSCs restore collagen α5(IV) protein expression. Importantly, our model recapitulates the differences in collagen composition between hiPSC-derived nephron organoids from mild and severe AS cases. Furthermore, we demonstrate that a chemical chaperone, 4-phenyl butyric acid (4-PBA), has the potential to correct glomerular basement membrane abnormalities in nephron organoids showing mild AS phenotypes. In this presentation, I would like to summarize the current status and future perspective of iPSC technology-based regenerative therapy and drug discovery for kidney diseases.

10:50~11:20

I-05

Regenerative Medicine for Osteoarthritis

Gun-Il Im
Department of Orthopaedics, Dongguk University Ilsan Hospital,
Goyang, Republic of Korea.

The high prevalence of osteoarthritis (OA), along with current lack of disease-modifying drugs for OA, has provided a rationale for regenerative medicine as a possible modality for OA treatment. Despite tremendous interest, so far, there is not much evidence proving the efficacy of this modality for clinical application. As symptomatic relief is not sufficient to justify the high cost of regenerative medicine, definitive structural improvement that would last for years/decades and obviate/delay the need for arthroplasty is essential for regenerative medicine to retain a place among OA treatment methods. In this talk, the rationale and current status of regenerative medicine in OA including stem cells, exosomes, and gene therapy is summarized along with the author's data and perspectives as well as practical issues & operational challenges faced in clinical investigation for regenerative medicine for OA

11:20~11:50

I-06

Cartilage Micrografting from the Ear to The Knee Joint – A Regenerative Medicine Approach

Z. Lacza , L. Tünde Herczeg , F.-M. Réka , K. Krisztián , B. Gusztav Stubnya , A. Ivanova, W. Viktor , N. Varjas Balázs
Hungarian University of Sports Science, Budapest, Hungary

Objectives：There is a strong unmet need for articular cartilage regeneration due to the increasing number of osteoarthritic patients. Although hyalin cartilage presents poor regeneration, the auricular cartilage has a remarkable regrowth potential, which offers a therapeutic tool for restoring articular cartilage function. We tested the clinical feasibility of replanting cartilage micrografts from the ear to the knee in patients with osteoarthritis.
Methods：Thirty patients were enrolled in a prospective, uncontrolled study under approval from the National Board of Research Ethics N833. All patients had knee osteoarthritis Kellgren-Lawrence grade 2-3 and were considering knee replacement due to exhaustion of conservative therapies. Cartilage micrografts were harvested under local anesthesia by a 2,5 mm punch biopsy from the ear then mechanically disaggregated by the Rigeneracons device (Regenera Activa, Barcelona, Spain) with a cut-off of 80 microns in saline suspension. The micrografts were injected in the knee joint cavity of the patient after withdrawal of the excess synovial fluid. Patient reported outcomes (KOOS and pain VAS) were registered before and 1 week and 3,6 and 12 months after the procedure. Interleukin 1-beta, 6 and 8 (IL-1beta, IL-6, IL-8) and TNF-alfa were measured in the synovial fluid and the micrograft with multiplex ELISA kits (ELLA, Biotechne, Minneapolis, USA). Moreover, a radiological evaluation of the cartilage has been performed after 12 months to evaluate cartilage injury tendance and change after the treatment.
Results：IL-1beta and TNF-alfa were not elevated in the synovial fluid of any patient, while IL-6 and IL-8 showed high variation in the cohort with a close correlation between the two. Interestingly, IL-1beta was elevated in some cartilage grafts, with a negative correlation (r=-0.66) of KOOS change after 1week - these patients reported discomfort and swelling in the first week after implantation, which spontaneously resolved within 3 days. Synovial IL1-beta correlates negatively with starting PROMs consistent with higher inflammation. Nonetheless, clinical effectiveness of the therapy was already observed by lower pain and increased knee function at 1 week, which further increased at 3 months, with sustained results after 6 and 12 months (pain VAS 4.11±0,36 vs. 2.88±0.41, KOOS 53.0±2.5 vs. 62.9±2.9 before vs. 3months, $p<0.05$, respectively).
Conclusions：Cartilage autografting from the ear to the osteoarthritic knee is a feasible approach to improve articular function. The promising results from this pilot justifies further studies with longer follow ups in order to fully evaluate the potential of this novel regenerative therapy.

13:30~14:00

I-07

Therapeutic Applications of Cartilage-Derived Extracellular Matrix and Microvesicles for Arthritis

Sang-Hyug Park

Major of Biomedical Engineering (BME) Division of Smart Healthcare College of Information Technology and Convergence, Pukyong National University

Abstract

With the increase in average human lifespan and interest in sports, the number of arthritis patients is steadily rising. Once arthritis develops, it cannot be completely cured, and patients experience continuous pain and discomfort through medication, physical therapy, and surgery. Osteoarthritis is a disease related to cartilage friction, caused by inflammation, excessive exercise, or cartilage damage due to aging. Rheumatoid arthritis is an autoimmune disease, and its cause is still unknown. Current treatments include medication or joint replacement surgery to suppress the progression of the disease, but continuous management and treatment are still necessary.

The extracellular matrix (ECM) is a three-dimensional structure secreted by all cells, enhancing cell growth and division, and reducing inflammation. It mainly consists of collagen, glycosaminoglycans, fibronectin, integrins, and extracellular vesicles, and their interactions provide an environment for cell survival. Depending on the tissue extracted, the ECM has distinct characteristics and is currently being extensively researched in various biomaterials and tissue engineering fields. Among them, the ECM extracted from cartilage is rich in proteins such as type II collagen and glycosaminoglycans, which are abundant in cartilage, and is known to have superior anti-angiogenic effects compared to other tissues. Recently, it has been found that cartilage-derived ECM induces chondrogenic differentiation of mesenchymal stem cells and changes the phenotype of immune cells to promote tissue regeneration, making it a material used for inflammation suppression.

This presentation reports on the research findings regarding the effectiveness of cartilage ECM materials in the early treatment of arthritis. The decellularized cartilage ECM has been characterized, and its anti-inflammatory effects have been confirmed through cell experiments. When injected into the joint cavity of an osteoarthritis animal model, it inhibited the progression of cartilage degeneration. Additionally, we explored the potential for combined use with therapeutic drugs in a rheumatoid arthritis animal model. The presentation also briefly introduces the formulation research of cartilage ECM biomaterials through click chemistry-based hydrogel synthesis, which features simple reactions, high yield, and minimal by-products. These results suggest that decellularized cartilage ECM has the potential to be applied as a biomaterial to overcome inflammatory joint diseases.

14:00~14:30

I-08

Deciphering the Roles of Ageing & Mechanotransduction in Rotator Cuff Tendon Healing

Asawari Parulekar [1], Aswathi Gopalakrishnan[1,2], Eleonore Bolle[1], Lisbeth Grondahl [3,4,*], **Justin Cooper-White**[1,4,**]
School of Chemical Engineering, The University of Queensland, Australia[1].
School of Biomedical Sciences, The University of Queensland, Australia[2].
School of Chemistry and Molecular Biosciences, The University of Queensland, Australia[3].
Australian Institute for Bioengineering and Nanotechnology (AIBN), The University of Queensland, Australia[4].

** l.grondahl@uq.edu.au, ** j.cooperwhite@uq.edu.au*

With a globally ageing, but more active population, musculoskeletal tissue injuries are of increasing prevalence in our society. Rotator Cuff (RC) tears, resulting in severe pain and instability in the shoulder, are one such age-related injury, with increasing incidence with age (e.g. 62% of the population above 80 years are affected). Retear rates post-surgery also compound with patient age and can be as high as 94%. Ineffective, fibrotic repair at the tendon-to-bone attachment is the most prominent cause for retears. It has been hypothesised that such poor healing is due to age-related alterations in mechanotransduction (*mechanoageing*) of reparative cells in this tissue. However, the impacts of mechanoageing of resident perivascular stem cells (or pericytes) in the vascular sheath surrounding the tendon (often referred to as perivascular tendon stem/progenitor cells (TSPCs)), known to contribute to tenogenesis and repair, remains unclear. This lack of clarity is due to, in most part, the difficulty in obtaining healthy human RC tissues from young through to old cohorts, and the significant genetic and epigenetic variations across donors. This study aimed to develop a human induced pluripotent stem cell (hiPSC)-based model for cellular ageing to elucidate the contributions of pericyte (or TSPC) mechanoageing to fibrotic tendon repair. A hiPSC line with a doxycycline (DOX)-inducible ageing cassette driving progerin overexpression (reported in real-time by an eGFP-progerin fusion construct) was used to create an *in vitro* ageing model for mesenchymal lineage tissues. hiPSCs were differentiated into hiPSC-derived pericytes. We first confirmed that these pericytes were analogous to perivascular tendon stem/progenitor cells (TSPCs), making this an ideal platform to study the impacts of ageing on tendon regeneration. Thereafter, time-dependent effects of DOX-induction on hiPSC-pericytes was quantified over a period of 14 days using immunofluorescence, flow cytometry, rt-qPCR and SA-β-gal. In the first 7 days post-induction, hiPSC-pericytes exhibited key hallmarks of ageing, including dysmorphic nuclear membranes and altered expression of nuclear mechanoregulatory proteins (Lamin B1, LAP2α), typical biomarkers associated with age-related cell dysfunctionalities, especially senescence, and loss of mechanosensing capability. However, by 14 days following DOX-induction, hiPSC-pericytes entered a pro-inflammatory state and demonstrated a complete reversal in phenotype, lacking typical progeria-induced signatures such as enhanced matrix deposition, cell cycle arrest and senescence. These results indicate aged pericytes/TSPCs 1.) uniquely possess protective mechanisms that provide resilience over time against typical downstream impacts of age-related progerin expression; 2.) do not differentially contribute to age-related fibrosis-dominated repair; and 3.) instead contribute to failed tendon repair after injury in the aged by entering a chronic pro-inflammatory state during the early stages of wound healing, affecting their tenogenic potential. These insights have significant impacts on tissue engineering strategies that rely on TSPCs for regeneration of rotator cuff tissues. Our recent preliminary work on multimodal scaffolds to address these challenges will be introduced and discussed.

14:30~15:00

I-09

Development of Regenerative Medicine Products Using Cell Sheet Engineering

Setsuko Hashimoto, Ph.D
President ＆CEO, CellSeed Inc.

Abstract
Since the introduction of aspirin in 1899 as the first chemically synthesized drug, modern therapeutics have been dominated by low–molecular-weight compounds. Gene cloning in the 1980s then enabled protein therapeutics and launched the era of biopharmaceuticals. Today, research is progressing toward using genes and cells themselves as “medicines”, with university-based discoveries and startup companies playing a central role in creating these new modalities.
In the 1990s, Professor Teruo Okano at Tokyo Women’s Medical University developed temperature-responsive polymer–coated culture dishes that allow confluent cells to be harvested as intact sheets simply by lowering the temperature. This technology minimizes cellular damage and preserves extracellular matrix, enabling rapid engraftment to host tissues and making cell sheets highly suitable for regenerative medicine.
CellSeed Inc. was founded in 2001 to industrialize cell sheet–based regenerative therapies. Collaborative research with clinicians has led to novel treatments in ophthalmology, gastroenterology, and other fields. Among 23 products approved as regenerative medicine in Japan, three of them incorporate cell sheet engineering. Dr. Masato Sato of Tokai University applied cell sheet engineering for cartilage regeneration. We have translated his research to develop an allogeneic chondrocyte sheet for knee osteoarthritis. Currently, we initiated a phase III clinical study in Japan.
CellSeed is committed to advancing the development of regenerative medicine so that these therapies can be delivered to patients around the world at the earliest possible opportunity.

15:30~15:50

I-10

Cellular Reprogramming and iPS Technology in Retinal Diseases: From Bench to Clinic

邱士華教授/副院長
陽明交通大學附設醫院

Abstract
近年來，隨著再生醫學與幹細胞技術的快速進展，以及健康大數據在臨床研究與疾病預測中的應用，細胞治療已突破傳統疾病治療與生理研究的諸多限制，開創個人化與精準醫療的新契機。此領域不僅成為全球醫療創新的競逐焦點，亦為政府推動臺灣創新醫療的重要施政方向之一。
行政院衛生福利部於民國 107 年公布「特定醫療技術檢查驗儀器施行或使用管理辦法」（簡稱「特管辦法」），並制定「再生醫療製劑管理條例」草案，作為推動我國再生醫療與新興生物科技發展的重要法制依據。近年臺日兩國皆致力於推動產業創新與醫療制度改革，透過雙邊經驗交流與臨床試驗合作，期能促進我國再生醫療產業之持續成長，提供更完善的再生醫療產品與服務，造福民眾。展望未來，隨著多中心及跨領域臨床研究的推動，臺灣之幹細胞與再生醫療技術將邁向更高層次，為臨床治療開啟新里程碑。

15:50~16:10

I-11

Chimeric Antigen Receptor T Cell Therapy for Autoimmune Disease

張裕享執行長　樂迦再生科技

Abstract

Chimeric antigen receptor T-cell (CAR-T) therapy has demonstrated remarkable efficacy in hematologic malignancies and is increasingly being explored as a novel therapeutic strategy for autoimmune diseases. Many autoimmune disorders are driven by autoreactive B cells that produce pathogenic autoantibodies, present antigens, and sustain chronic inflammatory responses. Conventional therapies, including anti-CD20 monoclonal antibodies, can reduce circulating B cells but often fail to eliminate tissue-resident autoreactive clones, leading to incomplete responses or relapse.

Recent studies suggest that CD19-directed CAR-T cells can induce profound and sustained B-cell depletion, offering the possibility of durable remission through immune system reprogramming. Early clinical investigations in patients with refractory autoimmune diseases—including systemic lupus erythematosus, idiopathic inflammatory myopathy, and systemic sclerosis—have reported encouraging results, with many patients achieving drug-free remission following a single CAR-T infusion. Safety profiles have generally been favorable, with predominantly low-grade cytokine release syndrome and limited neurotoxicity reported.

In parallel, next-generation platforms such as mRNA-based CAR-T therapies and allogeneic “off-the-shelf” CAR-T products are under development to improve safety, scalability, and accessibility. These advances highlight the potential of cellular immunotherapy to move beyond symptomatic control toward immune reset in autoimmune disease.

Collectively, emerging evidence indicates that CAR-T therapy may represent a transformative approach for patients with severe, treatment-refractory autoimmune disorders, although further clinical studies are required to confirm long-term efficacy and safety.

16:10~16:30

I-12

Articular Cartilage Regeneration by Decellularized Cartilage and Functional Hydrogel

葉明龍教授
成功大學前瞻醫療器材科技中心
新創加速中心

Abstract

The articular cartilage has poor intrinsic healing potential since it has no blood vessels that can supply nutrients, low cellular metabolic activity and limited access to stem cells. Treatment methods include the use of scaffolds and bioactive materials. In this study, decellularized cartilage powder (DCP) was used to provide the template for tissue regeneration and platelet-rich fibrin (PRF) provided the cytokines and growth factors to accelerate the healing of the cartilage. In vitro tests such as cytotoxicity and viability assay, and cell migration were performed to check if the DCP can promote cell proliferation and migration as well as detection of cytotoxic effects to infrapatellar fat pad stem cells (IFPSC). A 3 mm x 3 mm (diameter x depth) articular cartilage defects were made in the patellofemoral grooves of New Zealand white rabbits. PRF and DCP were used to fill the defects, alone or in combination. In addition, fibrin glue was used as an adhesive to keep the PRF and DCP inside the defect. Four weeks post-operation, the animals were sacrificed and subjected to macroscopic evaluation, CT scan, histological and immunohistochemical analyses. The results of macroscopic analysis showed that the cartilage treated with PRF+DCP exhibited the best macroscopic appearance. Histological analysis demonstrated signs of newly formed collagen in the defect for all treatment groups, indicating cartilage repair. However, immunohistochemical analyses showed that all the treatment groups exhibited a mixture of hyaline and fibrocartilaginous phenotype. Overall, the findings that were obtained in this study provided evidence that the autologous PRF and DCP can be another treatment option for full thickness cartilage repair to some extent.

16:30~16:50

I-13

Applications of Microfluidics in Stem Cells, Spheroids and Organoids

許佳賢 Chia-Hsien Hsu
國衛院生醫工程與奈米醫學研究所
Institute of Biomedical Engineering and Nanomedicine, National Health Research Institutes, Taiwan

Abstract
Cell spheroids are three-dimensional spherical cellular aggregates that can better mimic the in-vivo cellular microenvironment compared to the traditional two-dimensional monolayer cell cultures. Cell spheroids can be formed from a wide range of cell types including embryonic stem cells (ESCs) which when cultured in a 3D culture condition can spontaneously aggregate into a three-dimensional sphere called embryonic body (EB). The EB has the ability to form all three germ layers of endoderm, mesoderm, and ectoderm, and can be induced to differentiate into different cell types for fundamental and application research of tissue engineering and regenerative medicine. The formation of EBs can be achieved by several 3D cell culture approaches including suspension culture in bacterial-grade dishes low or vessel bioreactor, culture in methylcellulose semisolid media, culture in spinner flask and more recently, microfabricated devices containing microchannel and microwells. For generating small quantities of EBs, the hanging drop method is most widely used due to it is easy to perform in the laboratory and requires minimal equipment and materials. However, the hanging droplet method requires manual operation for each individual droplets and is limited by the difficulty of exchanging medium in the droplets. To address these problems, we developed of a microfluidic chip-based method for hanging drop culture of cells. Our method uses microchannel with opening wells to form large numbers of hanging droplets at high-throughput and high-reproducibility. We utilized this microfluidic hanging drop method to generate 3D cell spheroids from mouse embryonic stem cell, and human induced pluripotent stem cells. The 3D cell spheroids can be differentiated on-chip to form contracting cardioids whose beating frequencies changes under cardiotoxic drug stimulation.

Poster Paper

P-01

天然活性分子調控骨關節炎關節微環境之軟骨保護潛力：前臨床物化特性與生物安全性評估
A Natural Bioactive Molecule for Cartilage Protection via Modulation of Osteoarthritic Joint Microenvironment: Physicochemical Characterization and Preclinical Safety Evaluation

麥浚銘 黃書葦#
國立臺東大學應用科學系

Introduction：骨關節炎（Osteoarthritis, OA）為常見之退行性關節疾病，其病理機制涉及發炎反應、氧化壓力及軟骨基質降解，最終導致關節功能退化與慢性疼痛。現行治療多以症狀緩解為主，難以有效調控疾病進程，因此開發具良好生物相容性之候選分子並建立其前臨床物化特性基礎，為再生醫學研究之重要方向。魚針草（*Anisomeles indica*）來源之天然活性分子魚針草內酯（*ovatodiolide*, OVA）已被報導具有抗發炎與抗氧化潛力。本研究以 OVA 為研究核心，建立其萃取純化、結構鑑定與物化特性分析方法，作為後續生醫應用研究之基礎。
Materials and Methods：秤取魚針草粉末 50 g，加入 95% 乙醇 1 L，於室溫下攪拌萃取 24 小時後抽濾收集濾液，經減壓濃縮取得粗萃取物。粗萃取物以乙酸乙酯溶解後與去離子水進行液液分配，保留有機層並再次減壓濃縮，得到純化用樣品。樣品以核磁共振光譜（nuclear magnetic resonance, NMR）與傅立葉轉換紅外線光譜（Fourier-transform infrared spectroscopy, FT-IR）進行結構鑑定，並以高效能液相層析（high-performance liquid chromatography, HPLC）進行純度分析與定量方法建立。另評估魚針草內酯之溶解特性與溫度穩定性，並以 HPLC 追蹤濃度變化，同時建立秀麗隱桿線蟲（*C. elegans*）之處理條件與實驗設計，作為後續生物安全性評估之基礎。
Results：本研究成功建立魚針草內酯（*ovatodiolide*，OVA）之萃取與純化流程，並穩定取得純化樣品。NMR 與 FT-IR 光譜分析結果確認其化學結構與文獻報導一致。HPLC 分析顯示樣品具有明確之主要峰，並成功建立具良好再現性之定量分析方法，可用於樣品濃度測定與品質控制。溶解特性與穩定性分析結果顯示，OVA 於適當條件下可維持穩定狀態，並完成相關物化特性基礎資料之建立。
Discussion：本研究建立 OVA 之萃取純化與結構鑑定流程，並透過 HPLC 建立可靠之定量分析方法，使樣品品質與濃度分析具備標準化基礎。物化特性與穩定性資料之建立，有助於確認 OVA 於實驗條件下之穩定性與可操作性，並提供後續生物試驗設計之重要參考依據。此外，本研究建立秀麗隱桿線蟲之實驗設計與處理條件，為後續評估其生物安全性與生醫應用潛力奠定基礎。
Conclusions：本研究成功建立魚針草內酯（OVA）之萃取純化、結構鑑定與 HPLC 定量分析方法，並完成其前臨床物化特性基礎建立。所建立之品質控制與物化特性資料，為後續生物安全性評估與再生醫學相關應用研究提供重要基礎。

P-02

仿生黏性之微針貼片結合生物活性因子遞送應用於胃潰瘍修復
Biomimetic Adhesive Microneedles Patch with Bioactive Factors Delivery for Gastric Ulcer Repair

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Introduction：Peptic ulcers result from an imbalance between protective and harmful factors affecting the gastric and duodenal mucosa. Although standard therapies have proven effective for some time, therapeutic challenges, such as antibiotic resistance, PPI-related adverse effects, and unhealed refractory ulcers, have gradually emerged. To address this, we develop a biomimetic adhesive microneedle patch for topical treatment in the gastric environment. By providing long-term mucosal protection and delivering bioactive factors, our patch offers a promising solution for treating refractory gastric ulcers.
Materials and Methods：The biomimetic adhesive microneedle patch consisted of three parts. Core-shell microneedle arrays fabricated using cellulose derivatives comprised the first layer. The second layer was prepared with pectin and tannic acid. The outermost third layer was an electrospun PCL/PEG nanofiber.
Results & Discussion：SEM images confirmed the fabrication of core-shell microneedles, which realized a sequential release of bioactive factors. The core-shell structure enabled penetration of the mucosal barrier and effectively delivered drugs. The tannic acid-functionalized adhesive film achieved strong adhesion across various substrates, including porcine tissues at low pH, highlighting its potential for application in the scenario of this study. The antibiotics and sucralfate were successfully delivered through the nanofiber as well. These results demonstrated that our multilayer adhesive microneedle patch could serve as an active approach for traditional passive therapies.
Conclusions：In summary, the topical adhesive patch integrating multiple drug-loaded dissolving microneedles is meticulously engineered for gastrointestinal ulcer therapy, with each layer performing distinct roles that collectively enhance mucosal regeneration. Through these tactics, this research aims to enhance current therapeutic outcomes, offer an effective alternative treatment suitable for the harsh, acidic gastric environment, and ultimately reduce the burden on patients.

P-03

仿生黏彈性水膠結合微流道培養系統用於長期人類大腦器官生成
Biomimetic Viscoelastic Hydrogel Incorporating Microfluidic Culture System for Long-Term Human Brain Organogenesis

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Introduction：Human tissues and organs are difficult to access, especially during embryonic stages, limiting molecular studies. Animal models mimic disease but differ from humans, while 2D cultures lack complex architecture. Human organoids, derived from stem cells, retain genetic backgrounds and model development and disease. Brain organoids recapitulate cortical layers, circuits, and activity, enabling studies of Alzheimer's, Parkinson's, autism, and epilepsy. However, challenges remain: limited maturation, absence of vasculature, nutrient and oxygen delivery issues, and cell death in the core. Advances in matrix systems and vascularization are needed to achieve complex morphologies and long-term viability for neurological research.

Materials and Methods：We designed two types of biomimetic hydrogels—elastic and viscoelastic—and established two culture conditions: static and dynamic (utilizing gravity-driven microfluidic devices). Brain organoids were encapsulated within these hydrogels and subjected to either culture environment. We aimed to evaluate organoid morphology, hierarchical structures, cell/gene expression profiles, and neuro-electrophysiological activity. This study systematically compares how matrix viscoelasticity and dynamic microenvironments synergistically modulate the structure, functionality, and plasticity of brain organoids.

Results and Discussion：Brain organoid cultures provide valuable 3D models for studying neurological disorders, yet their maturation is limited by unsuitable matrices and poor oxygen/nutrient delivery, leading to necrosis and short culture viability. To overcome these barriers, we developed a biomimetic viscoelastic hydrogel composed of hyaluronic acid and brain proteoglycans, replicating the composition and mechanics of the human brain ECM. This hydrogel promotes brain organoid organogenesis, recapitulates previously inaccessible periods of human brain development and forms mature neuronal structures. Integrated with gravity-driven microfluidic devices, this system enhances mass transport, prolongs culture duration, and delivers physiologically relevant shear stress.

Conclusions：Biomimetic viscoelastic hydrogel incorporating microfluidic culture system can promote brain organoids to form more matured brain ECM structures with neuro-electrophysiological functions, neural plasticity, and hierarchical structures.

P-04

具光催化活性之氧化鋅奈米抗菌傷口敷料：設計、製程與應用潛力
Design, Fabrication, and Application Potential of Photocatalytic ZnO Antibacterial Nano-Wound Dressings

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Introduction：Wound infection significantly delays tissue regeneration, especially in burn injuries and cellulitis. Although moist wound dressings provide a favorable healing environment, accumulated exudates may promote bacterial proliferation if no antibacterial component is incorporated. Silver nanoparticles are widely used but raise concerns regarding cytotoxicity and long-term accumulation. Zinc oxide (ZnO), with better biocompatibility and biodegradability, offers antibacterial potential through reactive oxygen species (ROS) generation and Zn^{2+} ion release. This study developed an atomic layer deposition (ALD)–engineered ZnO-coated porous scaffold to enhance antibacterial efficacy while preserving cytocompatibility.

Materials and Methods：Hyaluronic acid/gelatin porous scaffolds were fabricated via a microfluidic foaming system and chemically crosslinked using EDC/NHS to improve structural stability. Conformal ZnO thin films were deposited via ALD with controlled cycle numbers. ROS generation under 365 nm UV irradiation was quantified using DPBF and ABDA probes. Cytocompatibility was evaluated using L929 fibroblasts using PrestoBlue and LDH assays. Antibacterial activity against *Escherichia coli* was evaluated by colony-forming unit (CFU) counting and validated in an ex vivo porcine skin infection model.

Results：ALD-coated scaffolds demonstrated significantly higher ROS generation compared with ZnO-doped scaffolds, with ROS levels positively correlated with ALD cycle number. Cytotoxicity assays showed cell viability above 90% in all groups, with minimal LDH release, indicating preserved membrane integrity. The 200-cycle ALD group exhibited the strongest antibacterial activity, significantly reducing bacterial colonies under UV exposure.

Discussion：Uniform ZnO thin-film coating via ALD improved surface exposure and photocatalytic efficiency, leading to stronger antibacterial effects without increasing cytotoxicity. However, UV dependence remains a limitation.

Conclusions：Conformal ZnO thin films deposited via ALD enhance photocatalytic ROS production and antibacterial performance without compromising cytocompatibility. The 200-cycle ALD group demonstrated optimal antibacterial efficacy. These findings support ALD-engineered ZnO porous scaffolds as a promising antibacterial wound dressing platform, although UV dependence remains a translational consideration.

P-05

搭載穀胱甘肽之功能性甲基丙烯酸化羧甲基纖維素水膠於乾眼症治療之研究
Development of a Functional Methacrylated Carboxymethyl Cellulose Hydrogel Loaded with Glutathione for Dry Eye Therapy

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Introduction：Dry eye disease (DED) is a multifactorial ocular disorder characterized by tear film instability, hyperosmolarity, oxidative stress, and ocular surface inflammation. Methacrylated carboxymethyl cellulose (MA-CMC) enhances mucoadhesion, improving retention on the ocular surface. Glutathione (GSH), a potent antioxidant, is rapidly cleared from the eye. This study aimed to develop an MA-CMC-GSH system for sustained GSH release in DED treatment.
Materials and Methods：MA-CMC was synthesized by grafting methacrylate groups onto CMC and characterized by nuclear magnetic resonance spectroscopy (NMR) and Fourier-transform infrared spectroscopy (FTIR). The microstructure of the lyophilized hydrogel was examined using scanning electron microscopy (SEM). GSH was incorporated into the hydrogel to prepare MA-CMC-GSH. Osmolality, in vitro drug release, and protective effects against benzalkonium chloride (BAK)-induced corneal epithelial cell damage were evaluated via apoptosis and cell viability assays.
Results：FTIR and NMR analyses confirmed successful methacrylate grafting onto CMC, with an average grafting degree of 21.5%. SEM images showed a porous fibrous structure favorable for drug loading and sustained release. MA-CMC-GSH hydrogel exhibited osmolality of 286.0 mOsm/kg and no cytotoxicity. In the BAK-induced damage model, MA-CMC-GSH significantly reduced corneal epithelial cell apoptosis and improved cell viability.
Discussion：The successful MA grafting onto CMC enhances the mucoadhesive properties of the hydrogel. The porous structure of the hydrogel enables sustained GSH release, while physiologically relevant osmolality and preserved cell viability confirm biocompatibility. Furthermore, sustained GSH release from the developed hydrogel significantly reduces BAK-induced damage in corneal epithelial cells, indicating its protective effect against oxidative stress.
Conclusions：The MA-CMC-GSH is a stable and biocompatible hydrogel capable of sustained GSH release and protection against BAK-induced corneal epithelial cell damage. These findings highlight its potential as a promising therapeutic platform for DED.

P-06

開發何首烏萃取物複合奈米劑型以作為生髮液之應用
Development of a Hair Growth- Tonic with *Polygonum Multiflorum*-Complex Nanoformulaiton

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Introduction：Androgenetic alopecia (AGA) is a prevalent hair loss disorder that significantly affects quality of life, while current treatments by oral medicine (Finasteride) are limited by systemic side effects and poor long-term compliance. The tetrahydroxystilbene glucoside (THSG), extracted from *Polygonum multiflorum*, exhibits antioxidant activity and could affect the hair growth–related pathways. However, its hydrophilicity limits its skin permeability and topical bioavailability. Therefore, this study a biocompatible gelatin-based THSG nanoparticle was designed and developed to enhance the stability, follicular delivery, and hair regenerative efficacy of THSG for applied in hair regeneration

Materials and Methods：Gelatin–THSG nanoparticles (GT-NPs) were prepared via a self-assembly method tested in variant preparation parameters and characterized by DLS, NTA, and TEM. In vitro biocompatibility and antioxidant effects were evaluated in human hair follicle dermal papilla cells (HFDPCs), including a dihydrotestosterone (DHT)-induced damage model. *In vivo* hair growth efficacy was assessed in an androgenetic alopecia mouse model following topical application and histological analysis.

Results：GT-NPs prepared in 1:1 ratio exhibiting uniform nano-sized distribution (234.7 nm), good dispersity (0.37 for PDI), and with more stability compared to free THSG. *In vitro* studies demonstrated that GT-NPs (80 μg/mL) can reduced oxidative stress which cause cell viability at around 95~100%, and protected HFDPCs against DHT-induced damage after 1~3 days treatment.

In vivo topical application of GT-NPs could enhance the drug retain period and penetrating length in skin. And when TSHG at < 160 μg/mL, cells viability can maintain 70% after 1 day cultivation at free TSHG and GT-NPs at low concentration (80 μg/mL), could promote hair regrowth, increased anagen-phase follicles, and enhanced β-catenin and CD31 expression in an androgenetic alopecia mouse model when compared with free THSG and a commercial shampoo which claimed with hair growth capacity.

Discussion：The enhanced hair regrowth efficacy of GT-NPs could be contributed by improved local retention of THSG, overcoming its rapid diffusion and instability in topical application. GT-NPs with THSG encapsulation in it, prolonged THSG bioavailability and alleviated DHT-induced oxidative stress in hair follicle–associated cells. These findings highlight the potential of gelatin-based nanocarriers as a sustained topical delivery strategy for androgenetic alopecia therapy.

Conclusions：GT-NPs exhibited good biocompatibility and provided more stable and consistent hair regenerative effects than free THSG by enhancing β-catenin signaling and vascularization. These results support the translational potential of gelatin-based nanoparticle systems as a topical therapeutic strategy for androgenetic alopecia.

P-07

可注射導電高分子複合水膠之開發與體外測試
Development of an Injectable Hydrogel with Conductive Polymer Complexed and its *in Vitro* Evaluation

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Introduction：With aging, ocular degeneration such as vitreous opacities and macular disorders can impair vision and are often treated by vitrectomy with vitreous substitutes. However, current substitutes, particularly silicone oil, have limitations such as short retention and emulsification. In this study, we designed and developed a conductive hydrogel with antibacterial capacity, HPMC-MA/PDPS/LV, which composed of PEDOT:PSS (PDPS) and levofloxacin (LV) in it. PDPS could enhance retinal electrical stimulation (ES), while levofloxacin helps prevent postoperative infection.

Materials and Methods：The raw hydrogel was composed of hydroxypropyl methylcellulose (HPMC) grafted methacrylic anhydride (MA) to form injectable HPMC-MA. The PDPS was then added to the hydrogel in appropriate ratios and mixed thoroughly forming the conductive hydrogel named HPMC-MA-PDPS3. Electrical properties of this hydrogel were characterized using a potentiostat. Human retinal pigment epithelial cell (ARPE-19) was used to determine the *in vitro* cytocompatibility. Gram negative- *E. coli* was used to check the anti-bacterial capacity when the LV was added in it.

Results：Characterization results showed that HPMC-MA/PDPS3/LV exhibited high optical transparency and physicochemical properties comparable to the native vitreous, including high water content, physiological osmotic pressure, and injectability. And electrical responds of this conductive hydrogel was confirm. *In vitro* assays demonstrated excellent cytocompatibility (>100% cell viability). The hydrogel extract, prepared by mixing the hydrogel with culture medium at ratios of 1:10, 1:20, and 1:30, was co-cultured with ARPE cells for 24 hours, showing no cytotoxic effects. And cell viability was maintained under ES. Antibacterial testing confirmed effective inhibition of *E. coli*, indicating intrinsic antimicrobial activity when 0.005 μg/mL LV was contained in HPMC-MA/PDPS3/LV.

Discussion：The multifunctionality of hydrogel, HPMC-MA /PDPS/LV, arises from its homogeneous polymer network, which enables high transparency and vitreous-mimicking physicochemical properties while minimizing light scattering. The presence of conductive pathways confers electrical responsiveness without cytocompatibility. Unlike Silicone oil, which mainly provide mechanical tamponade as vitreous substitute, this hydrogel integrates optical, electrical, and antibacterial functions within a single material platform. Further *in vivo* studies are required to validate long-term performance and safety.

Conclusions：In this study, the HPMC-MA/PDPS3 hydrogel exhibits several properties resembling those of the native vitreous, including high transparency, appropriate swelling ratio, injectability. And enhanced electrochemical conductivity of hydrogel could helping cells repair under ES. *In vitro* evaluations demonstrated excellent cytocompatibility. Furthermore, electrical stimulation (ES) in combination with the conductive hydrogel significantly improved cell viability. Antibacterial assays confirmed antimicrobial activity, suggesting reduced risk of endophthalmitis post-implantation. Overall, these results highlight the HPMC-MA/PDPS3 hydrogel as a promising next-generation vitreous substitute with multiple functions.

P-08

透過 SPG 膜乳化方式開發磷酸鈣/PLGA 微球作為藥物橙皮素之長效釋放載體並應用於阿茲海默症的治療

Development of Calcium Phosphate/PLGA Microspheres as Hesperetin Carrier by SPG Membrane Emulsification for Control Release in Alzheimer's Disease Treatment

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Introduction：阿茲海默症的主要病理特徵包括 β 類澱粉樣蛋白（Aβ）異常堆積、氧化壓力升高與神經發炎反應；然而現行臨床藥物僅以症狀緩解為主，且部分甚至伴隨顯著副作用。因此，體現出中草藥萃取物如黃酮類化合物橙皮素（Hesperetin, Ht）的治療潛力，期望得利用其抗氧化、抗發炎及影響 Aβ 聚集作用等潛力，延緩改善阿茲海默症病理進程。惟橙皮素因溶解度低且體內代謝快速，導致生物可利用度受限，降低其臨床應用可行性。基於此，本研究擬開發結合聚乳酸-羥基乙酸共聚物（PLGA）與羥基磷灰石（HAp）之複合微球載體系統（HHPs），以提升橙皮素之穩定性並實現控制釋放，進一步增進其治療潛力。

Materials and Methods：以 SPG 膜乳化法將 Ht 與 PLGA/HAp 合成複合微球 HHPs，冷凍乾燥三日後保存。製備完成後利用 Ht 檢量線計算 HHPs 之包覆率（EE%）與載藥率（DLC%）；粒徑分布、形貌與成分分別以雷射繞射、FE-SEM 與 EDS/TGA 評估。基於 HHPs 是肌肉注射給藥，利用肌母細胞株 C2C12 檢測生物相容性，所以體外試驗依 ISO 10993-5/12 以萃取液法進行，分別用 WST-1、LDH 與死活螢光染色進行驗證評估；另於不同 pH 條件下進行體外釋放試驗。

Results：微球直徑中位數為為 15.5 μm，span 值為 1.956，顯示出 HHPs 型態的良好均一性。包覆率為 36.9% 與載藥率為 17.7%，顯示 Ht 在 HHPs 中穩固地整合，同時維持高比例的藥物/載體重量比。而後利用 FT-IR、TGA、FE-SEM 及 EDS 後多方驗證 HHPs 含有 Ht、HAp、PLGA。進行 LDH、WST-1 與死活螢光染色等細胞試驗後，呈現出微量損害。時長 21 天的藥物釋放中，其釋放速率於前 7 天呈現斜率較陡的線性釋放，並在 7 到 21 天約呈現斜率較低的趨於線性釋放，符合研究控制釋放之目的。

Discussion：本研究以 SPG 膜乳化成功製備粒徑均一之 PLGA/HAp 複合微球，顯示其作為橙皮素載體之可行性；未來可延長釋放觀察並結合釋放動力學模型以釐清主導機制；亦可進一步比較與優化製程參數，例如油水比例、乳化方式對藥物之影響等。細胞試驗僅見輕微損害，推測與藥物濃度或製程殘留相關，後續可透過洗滌乾燥或是調整藥量以優化其生物相容性。並進一步以動物模型評估藥效、體內組織相容性與給藥頻率，強化其應用之可行性。

Conclusions：本研究以 SPG 膜乳化成功製備 PLGA/HAp 複合微球並有效包覆橙皮素，相關表徵結果證實其成分與結構。HHPs 於體外呈現可控制且具持續性的釋放行為（多週尺度），達成前言所述之提升橙皮素穩定性與長效緩釋之目的，具作為長效釋放載體之應用潛力。

P-09

用於軟組織再生之可注射型長效生物降解聚乳酸/聚幾內酯微球之開發
Development of Injectable Long-Acting Biodegradable Poly(lactic acid)/Polycaprolactone Microspheres for Soft Tissue Regeneration

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Introduction：The demand for dermal fillers has increased with growing emphasis on physical appearance. However, most existing fillers cannot simultaneously provide biodegradability and long-lasting performance. Biodegradable materials prevent long-term residue, while long-lasting fillers reduce treatment frequency and cost. In this study, we developed a novel poly(lactic acid)/polycaprolactone (PLA/PCL) composite microsphere dermal filler capable of maintaining its filling effect for 1.5–2 years. The combination of PLA and PCL integrates the rigidity of PLA with the flexibility and toughness of PCL, resulting in a balanced mechanical profile suitable for soft tissue filling. The microsphere size was controlled below 75 μm to satisfy clinical injection requirements using needles ≥23G.

Materials and Methods：PLA/PCL microspheres with composition ratios of 9:1, 8:2, and 7:3 were prepared using a double emulsion method with magnetic stirring, where stirring time of 3, 4, and 5 h and speed of 350, 450, and 550 rpm were systematically varied to investigate their effects on particle formation. The collected samples were freeze-dried and characterized by scanning electron microscopy (SEM) to evaluate microsphere morphology, particle size, and aggregation behavior.

Results：Microspheres obtained after 3 h showed particle sizes <75 μm but revealed noticeable aggregation. Aggregation was observed in both PLA and PCL systems, as well as in all composition ratios (9:1, 8:2, and 7:3). Extending stirring time significantly reduced aggregation and improved dispersion. Higher stirring speeds produced smaller microspheres at the same sampling times. Injection testing demonstrated that microspheres with particle sizes below 75 μm could be successfully administered through a 23G needle, indicating their suitability for clinical injection.

Discussion：Stirring time mainly affected particle dispersion by reducing aggregation, while stirring speed mainly controlled particle size by increasing mixing force. These results show that time and speed play different but important roles in microsphere formation. Among the tested conditions, a stirring speed of 450 rpm combined with a stirring time of 5 h best satisfied the experimental objective by providing improved dispersion with suitable particle size. In addition, the ability to use finer needles may improve clinical use and reduce injection pain.

Conclusions：Injectable PLA/PCL composite microspheres were successfully fabricated by optimizing stirring conditions. The developed system exhibited improved dispersion, biodegradability, and compatibility with injection through 23G or finer needles. These findings highlight the potential of the proposed microspheres as long-lasting biodegradable materials for dermal filler applications.

P-10

開發三甲基幾丁聚醣作為微小核糖核酸奈米載體並運用於過敏性氣喘治療之研究

Development of N-Trimethyl Chitosan Nanoparticles as a Transfection Carrier for microRNA Delivery in the Treatment of Allergic Asthma

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Introduction：Asthma is a chronic inflammatory condition of the airways, in which microRNAs (miRNAs) play a critical role in regulating immune and inflammatory responses that contribute to the pathological changes in allergic asthma. In this study, we developed trimethyl chitosan nanoparticles to enable the targeted delivery of miRNAs for the treatment of allergic asthma.
Materials and Methods：Chitosan was chemically modified using methyl iodide to synthesize N-trimethyl chitosan (TMC). The synthesized TMC was characterized using FTIR and NMR. Subsequently, TMC was used to prepare miRNA-146a-5p-loaded nanoparticles via ionic cross-linking with tripolyphosphate. The resulting nanoparticles were then characterized using DLS and NTA. Lastly, the nanoparticles were assessed for cellular uptake, biocompatibility, and their therapeutic effects on house dust mites (HDM)-stimulated human bronchial epithelial 16HBE14o- cells.
Results：The nanoparticles developed in this study had an average size of approximately 100 nm, a zeta potential of about 25 mV, and a PDI of around 0.22. They exhibited good biocompatibility at concentrations below 3.66 x 10^7 particles/mL and achieved higher transfection efficiency than commercial cationic lipids. In addition, transfection with miR-146a-5p using TMC nanoparticles significantly reduced HDM-induced expression of inflammatory and mucus-related genes.
Discussion：The developed TMC-based nanoparticles exhibited suitable physicochemical properties, high miRNA encapsulation efficiency, and good biocompatibility, indicating their suitability for nucleic acid delivery. Compared to commercial cationic lipid, this system showed improved transfection performance with lower cytotoxicity. In the HDM-induced asthma model, effective suppression of asthma-related gene expression suggests that this delivery platform has potential for asthma therapy.
Conclusions：A biocompatible trimethyl chitosan-based nanoparticle system was developed for efficient microRNA delivery. Using an in vitro HDM-induced asthma model, we found that miRNA-146a-5p delivery effectively reduced the expression of asthma-related genes and proteins by inhibiting EGFR signaling. These findings suggest that this nanoparticle-based miRNA delivery system shows promise for asthma treatment.

P-11

澱粉基海綿的研發及其在止血中的應用潛力
Development of Starch-Based Sponge and Their Potential in Hemostasis

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Introduction：Uncontrolled hemorrhage remains a critical challenge in clinical trauma and emergency medicine, accounting for approximately 35% of trauma-related deaths worldwide. Penetrating injuries, such as those caused by gunshot wounds or shrapnel, often result in deep, narrow, and irregular wound channels that are difficult to treat with conventional compression methods. Current hemostatic agents often face limitations, including slow blood coagulation, poor tissue adhesion, or potential biocompatibility concerns. Therefore, this research focuses on developing a starch-based composite sponge that is biodegradable, highly swellable, and capable of providing immediate physical tamponade for effective hemorrhage control in complex wound environments.

Materials and Methods：In this study, starch was selected as the primary matrix due to its excellent biocompatibility and natural abundance. To enhance the structural integrity and performance of the sponge, Sodium Trimetaphosphate (STMP) was utilized as a non-toxic cross-linking agent to modify the starch molecules. The fabrication process involved precise starch modification to create a porous, foam-like structure that exhibits rapid fluid absorption capabilities. The experimental phase includes characterizing the physical properties of the sponge, such as its swelling ratio, pore morphology, and mechanical strength

Results：In this research, the synthesized starch-based sponge, modified with sodium trimetaphosphate as a cross-linking agent, demonstrates a highly interconnected porous structure that is essential for rapid fluid transport. The experimental data indicate that the modification significantly enhances the swelling ratio, allowing the sponge to expand to several times its dry volume within upon contact with liquid. This rapid expansion creates an effective physical tamponade, providing the necessary pressure to seal irregular and deep-seated wound channels.

Discussion：The core mechanism of this hemostatic sponge lies in its dual-action approach: rapid blood absorption and immediate physical expansion. Unlike chemical hemostats that rely solely on biological clotting cascades, this starch-based sponge addresses the physical limitations of treating deep-seated, irregular wounds. The use of sodium trimetaphosphate as a cross-linker not only improves the mechanical properties of the starch but also ensures the safety profile of the device, avoiding the toxicity associated with synthetic polymers. This material offers a promising solution for pre-hospital emergency care and battlefield scenarios where rapid intervention is vital. Its ability to conform to the shape of the wound provides a significant advantage over rigid or non-expanding hemostatic agents currently available on the market.

Conclusions：In conclusion, this research successfully outlines the development of a modified starch-based hemostatic sponge designed for severe and complex hemorrhage control. By combining the natural benefits of starch with effective cross-linking techniques, the resulting material offers a high-performance, biodegradable, and safe alternative to traditional hemostatic methods. The findings suggest that the sponge's rapid expansion and superior absorbency make it an ideal candidate for treating life-threatening penetrating injuries. Future implementation of this technology could significantly improve survival rates in emergency trauma cases and reduce the complications associated with uncontrolled bleeding in both civilian and military medical environments.

P-12

水膠基底奈米纖維搭載脂肪幹細胞外囊泡於皮膚修復之應用研究
Hydrogel-Based Nanofibers with Adipose-Derived Stem Cell Extracellular Vesicles for Skin Repair

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Introduction：Chronic skin wounds are difficult to treat because conventional dressings offer only passive coverage and do not actively modulate inflammation or regeneration. Adipose-derived MSC-EVs provide potent regenerative signals but are rapidly cleared in vivo, so this study combined ADMSC-EVs with electrospun PVA/gelatin nanofibers to create a bioactive scaffold for skin repair.
Materials and Methods：ADMSC-EVs were isolated from serum-free conditioned medium by 0.22 μm filtration, concentration and ExoQuick precipitation, then characterized by NTA, TEM and EV marker analysis (CD9, CD63, CD81, TSG101, Calnexin). EVs were mixed into 16% PVA/15% gelatin (1:9) solutions and electrospun at 20 kV and 0.10 mL/h, followed by glutaraldehyde vapor crosslinking; fiber morphology and EV release in PBS were evaluated by SEM and NTA, and L929 fibroblast viability on EV-loaded or EV-free membranes was measured by CCK-8 up to 7 days.
Results：Isolated ADMSC-EVs showed 30–150 nm size, typical vesicular morphology and strong expression of tetraspanin markers, indicating high purity. The EV-loaded PVA/gelatin nanofibers formed uniform, bead-free networks (~170–214 nm diameter) and released EVs in an initial burst followed by sustained release. EV-loaded membranes significantly increased L929 viability and proliferation versus EV-free controls, especially at medium and high EV doses.
Discussion：Embedding ADMSC-EVs in electrospun PVA/gelatin nanofibers provided both ECM-like structural support and a local depot that protected EVs and prolonged their presence at the wound site. The biphasic release and enhanced fibroblast proliferation support a synergistic effect between the bioactive EV cargo and the gelatin-containing scaffold in promoting skin regeneration.
Conclusions：ADMSC-EV–loaded PVA/gelatin electrospun nanofibers showed controlled EV release and improved fibroblast growth in vitro, suggesting a promising cell-free dressing for enhancing skin wound healing.

P-13

離子交換沸石基明膠/羧甲基纖維素（CMC）複合海綿：用於臨床快速且有效的止血研究
Ion-Exchanged Zeolite-Based Gelatin/CMC Composite Sponge for Rapid and Effective Hemostasis for Clinical Application

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Introduction：Hemorrhage accounts for up to 40% of global trauma deaths, often occurring pre-hospital. Rapid hemostasis is vital to prevent life-threatening complications like shock and multi-organ failure. Consequently, developing efficient, accessible hemostatic materials remains a critical priority in trauma management.

Materials and Methods：This study developed novel CaY zeolite/CMC/gelatin composite sponges via freeze-drying to enhance hemostasis. The material synergetically combines gelatin's stability, CMC's porous absorption, and CaY zeolite's Ca^{2+}-mediated coagulation to accelerate thrombin generation and blood clotting.

Results：FTIR analysis confirmed effective zeolite integration, evidenced by characteristic peaks at 998 and 511 cm^{-1} and hydrogen bonding shifts in amide/carboxylate bands. These molecular features, coupled with the interconnected porosity observed via SEM, underpin the superior swelling capacity of the composites. Notably, swelling ratio tests revealed a remarkable ability to rapidly imbibe fluids, demonstrating the material's potential.

Discussions：The reduced porosity and swelling at higher zeolite loadings suggest that zeolite particles act as structural reinforcements, restricting polymer network expansion. This structural synergy between the hydrophilic base and active zeolite surface is critical for fine-tuning the composite's functional performance.

Conclusions：This study successfully developed CMC/gelatin/CaY Zeolite composite sponges with tunable physicochemical properties. While prelimanary results validate their structural suitability, further in vitro and in vivo biocompatibility assays are essential to fully elucidate the hemostatic mechanisms and ensure safety. These findings provide a promising foundation for the development of advanced. Zeolite-based hemostatic agent for clinical trauma management.

P-14

EGCG 調控牙周發炎與血管生成之分子機制探討
Mechanistic Investigation of EGCG in the Regulation of Periodontal Inflammation and Angiogenesis

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Introduction：牙周炎相關發炎微環境以及口腔癌為目前常見的口腔疾病，疾病相關之治療模型以及疾病微環境周邊血管新生調控的分子機制仍未完全闡明。表沒食子兒茶素沒食子酸酯(Epigallocatechin-3-gallate, EGCG)為綠茶中主要之兒茶素成分，已知具有抗氧化、免疫調節與抗發炎等生物活性。本研究目標為 EGCG 調控發炎與血管新生相關訊號通路，減緩牙齦發炎並影響腫瘤相關血管微環境。

Materials and Methods：本研究以脂多醣 (Lipopolysaccharide, LPS)刺激人類血管內皮細胞(EA.hy926)與人類牙齦纖維母細胞 (hGF-1)，建立體外發炎模型。首先以不同濃度 LPS 處理細胞，評估其對細胞活性之影響，以確立發炎誘導條件。細胞活性分析採用 MTT assay 與 Alamar blue assay 進行定量評估。免疫螢光染色 (Immunofluorescence) 用以觀察細胞骨架重組及相關蛋白質表現變化。西方墨點法 (Western blot) 分析發炎與訊號傳遞相關蛋白之表現量。流式細胞儀(Flow cytometry) 則用於定量細胞內活性氧 (Reactive oxygen species, ROS)之變化。進一步透過 EGCG 對 LPS 誘導發炎反應與細胞功能變化之影響。

Results：細胞活性分析結果顯示，LPS 於 50 μg/mL 時可顯著影響 EA.hy926 與 hGF-1 之細胞活性，並誘導明顯發炎反應，因此後續實驗皆採用 50 μg/mL 作為發炎刺激濃度。在此條件下，LPS 顯著抑制兩種細胞之正常生長並促進細胞過度活化及氧化壓力上升。EGCG 處理可有效降低 LPS 誘導之發炎反應與 ROS 生成，並減少 hGF-1 與 EA.hy926 的過度活化現象。此外，EGCG 亦顯著抑制血管內皮細胞增殖能力。分子機制分析顯示，EGCG 可能透過調控 TGF-β 與 NF-κB 訊號通路，參與發炎與血管新生相關分子之調節。

Discussion：本研究證實 LPS 可在體外成功建立牙周相關發炎微環境模型，並誘導內皮細胞 EA.hy926 與牙齦纖維母細胞 hGF-1 之發炎與氧化壓力反應。EGCG 能有效抑制此發炎級聯反應，顯示其具有調控發炎與氧化壓力之潛力。此外，EGCG 對血管內皮細胞增殖之抑制作用，暗示其可能影響腫瘤微環境中的血管新生過程。透過 TGF-β 與 NF-κB 訊號通路調控，EGCG 可能在發炎與血管生成交互作用中扮演關鍵角色。

Conclusion：本研究顯示，EGCG 具有顯著之抗發炎與抗氧化能力，並可調節血管內皮細胞功能。其作用機制可能與 TGF-β 與 NF-κ B 訊號通路相關。此結果支持 EGCG 作為控制牙周發炎與相關口腔病理變化之潛在治療策略，並為未來探討其在口腔癌微環境調控中的應用提供實驗基礎。

P-15

探討天然分子生物性水凝膠促進組織再生的機制
Research of Natural Biomolecular Hydrogels in Promoting Tissue Regeneration

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Introduction：Chitosan possesses excellent biocompatibility, biodegradability, and antibacterial properties, providing an ideal structural matrix that promotes cell adhesion and periodontal tissue repair. On the other hand, EGCG exhibits potent anti-inflammatory, antioxidant, antibacterial, and antitumor effects, inhibiting pathogen growth and RANKL-mediated bone loss. In addition, the Arg–Gly–Asp (RGD) peptide motif can enhance integrin-mediated cell adhesion, survival, and signaling, making RGD-functionalized hydrogels particularly attractive for supporting endothelial cell function in compromised microenvironments. This study evaluates chitosan- and EGCG-based hydrogels, including RGD-functionalized EGCG hydrogels, as bioactive scaffolds for oral tissue regeneration.
Materials and Methods：Chitosan-GelMA (15% w/v gelatin methacrylate) and EGCG-GelMA hydrogels were prepared and characterized using scanning electron microscopy, Fourier transform infrared spectroscopy, and rheological tests. Dental pulp stem cells (DPSC), gingival fibroblasts (hGF-1), and endothelial cells (EA.hy926) were cultured on the hydrogels, and cell proliferation was quantitatively analyzed using the Alamar Blue method, while cell adhesion to the material surface was observed using electron microscopy. Furthermore, cells were cultured on the surface of grafted RGD hydrogels to simulate in vitro tissue regeneration, replacing animal experiments. The effect of RGD on tissue regeneration was assessed by histological section staining.
Results：The hydrogel containing 10% chitosan promoted significant pseudopodia formation, showing enhanced cell adhesion and spreading. Conversely, the formulation containing 15% EGCG achieved the highest cell viability, exhibiting excellent cell compatibility and surface properties, providing support for cell adhesion and growth. Swelling experiments confirmed the physicochemical properties of the chitosan-EGCG hydrogel as a stable, sustained-release biomaterial. Tissue staining results showed that RGD effectively promoted tissue proliferation.
Discussion：The EGCG hydrogel exhibits comparable cell compatibility and regenerative potential to the chitosan hydrogel, effectively promoting the adhesion and proliferation of DPSC, hGF-1, and EA.hy926, showed it an ideal 3D scaffold material. Moreover, EGCG provides anti-inflammatory and antioxidant protection, regulates their proliferation and mineralization, and simultaneously improves the biocompatibility of bone substitute materials. RGD-functionalized EGCG hydrogels enhanced integrin-mediated cell adhesion and cell proliferation, consistent with previous findings on RGD-modified scaffolds.
Conclusion：Both chitosan and EGCG hydrogels provide multifunctional platforms for the biological microenvironment, offering structural support, growth factor release, and cell growth functions, making them suitable for oral tissue regeneration. The optimal hydrogel ratio is 10% chitosan and 15% EGCG. Furthermore, grafting RGD onto the hydrogel surface achieves multifunctionality, enabling these hydrogels to be used for periodontal soft/hard tissue regeneration, representing promising injectable scaffolds for oral disease treatment.

P-16

臍帶間質幹細胞衍生凋亡小體透過調控巨噬細胞對肺炎克雷伯菌所致腹腔內感染之治療潛力
Therapeutic Potential of Umbilical Cord Mesenchymal Stem Cell-Derived Apoptotic Bodies for *Klebsiella Pneumoniae*-Induced Intra-Abdominal Infection Via Macrophage Modulation

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Introduction：*Klebsiella pneumoniae* (*KP*) K1 is a highly virulent pathogen causing severe intra-abdominal infection (IAI) marked by excessive inflammation and immune cell dysfunction. In the peritoneal cavity, large and small macrophage (MΦ) subsets coordinate pathogen clearance and immune regulation. Umbilical cord MSC–derived apoptotic bodies (UCMSC-ABs) may provide a potent cell-free therapy by delivering immunomodulatory cargo to reprogram MΦ responses.

Materials and Methods：Single-cell RNA sequencing (scRNA-seq) was performed to reveal that UCMSC apoptosis potentially enhances their immunomodulatory capacity. Flow cytometry was used to characterize peritoneal MΦ subsets—including resident large peritoneal macrophages (LPMs) and monocyte-derived small peritoneal macrophages (SPMs)—following *KP* K1 exposure and treatment with UCMSC-ABs *in vitro*. A lethal dose of *KP* K1 was administered *in vivo* to evaluate peritoneal MΦ responses and potential effects of UCMSC-ABs.

Results：scRNA-seq data demonstrated that apoptosis amplifies the immunomodulatory transcriptional profile of UCMSCs, supporting enhanced regulatory potential. UCMSC-ABs were successfully generated and validated in our laboratory. *In vitro*, *KP* K1 challenge induced pronounced M1 polarization in peritoneal MΦs. Importantly, UCMSC-ABs more efficiently redirected both LPMs and SPMs toward an anti-inflammatory M2 phenotype compared with viable UCMSCs. *In vivo*, lethal-dose *KP* K1 infection further confirmed dominant M1 skewing of peritoneal MΦs. Ongoing studies aim to define the therapeutic efficacy and immunomodulatory mechanisms of UCMSC-ABs *in vivo*.

Discussion：*KP* K1–induced IAI drives dominant M1 polarization of peritoneal MΦs, highlighting MΦ reprogramming as a key pathogenic mechanism, while UCMSC-ABs emerge as a targeted approach to reshape inflammatory responses.

Conclusion：UCMSC-ABs counteract *KP* K1–induced inflammatory MΦ reprogramming and hold therapeutic potential as a targeted cell-free immunomodulatory approach for severe IAI.

P-17

超音波響應式泡沫以聲穿孔效應提升胸腔內藥物遞送與纖維化進程
Ultrasound-Responsive Foam Enhances Pleural Drug Delivery and Fibrosis Progression via Sonoporation-Assisted Penetration

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Introduction：Pleurodesis is used to prevent recurrent malignant pleural effusion, but its success rate (~70%) is limited by insufficient distribution of sclerosing agents. To address this, an ultrasound-responsive foam (Sonofoam) was developed to enhance coverage of the pleural cavity and improve drug and agent delivery through ultrasound-induced sonoporation, thereby increasing therapeutic efficacy..
Materials and Methods：Microbubbles with an average size of approximately 26 μm were generated and characterized. Foam formulations were prepared to increase surface coverage within the pleural cavity. Ultrasound was applied to induce microbubble cavitation and evaluate sonoporation effects in vitro. Drug penetration was assessed using DAPI uptake in 3T3 cells under varying ultrasound intensities (0.2–1.5 W/cm²). Tissue penetration studies were conducted in lung tissue, and pleurodesis models were established to evaluate adhesion, inflammation, and fibrosis markers. Deep learning methods were incorporated to analyze histological fibrosis distribution.
Results：Ultrasound-induced cavitation markedly enhanced sonoporation, improving cellular uptake up to 90% and achieving an average tissue penetration depth of 62 μm. The foam formulation provided broader cavity coverage than liquid agents, enabling more uniform drug distribution and resulting in stronger pleural adhesion in the TG and Sonofoam groups on days 14 and 35. Deep learning histology further revealed increased collagen deposition in the Sonofoam group. Corresponding inflammatory and cytokine shifts—early neutrophil and macrophage elevation with rising TGF-β and PDGF-AB—indicated accelerated fibrosis progression.
Discussion：The ultrasound-responsive foam enhanced delivery efficiency of sclerosing agents by improving surface coverage and facilitating ultrasound-mediated drug penetration. Sonoporation significantly increased cellular and tissue uptake, supporting its utility as a combination therapeutic approach. Increased fibrosis, pleural adhesion, and characteristic inflammatory and cytokine responses in the Sonofoam group suggest improved pleurodesis outcomes. The deep learning model further confirmed the spatial distribution of fibrosis, providing a quantitative framework for evaluating treatment efficacy.
Conclusions：Ultrasound-responsive foam enables uniform drug distribution across the pleural cavity and enhances drug and agent penetration through sonoporation. This combined strategy improves pleurodesis performance and has strong potential for improving the clinical management of malignant pleural effusion, ultimately benefiting patient quality of life.

P-18

透過有機酸交聯製備之可壓縮 CMC 海綿止血特性評估
Evaluation of Hemostatic Properties of Compressible CMC Sponges Fabricated via Organic Acid Crosslinking

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Introduction：Research has shown that the majority of trauma-related deaths caused by massive hemorrhage result from the failure to achieve timely hemostasis, particularly in deep wounds such as gunshot or puncture injuries . Conventional treatments, including gauze and bandages, are limited in their ability to manage deep bleeding and cannot provide sufficient internal pressure for effective hemostasis . Furthermore, some experimental hemostatic materials utilize toxic chemical crosslinkers (e.g., glutaraldehyde), which may remain in the material and induce cytotoxicity or immune responses, thereby delaying wound healing . Therefore, the development of hemostatic materials that are both safe, biocompatible, and functional remains a significant challenge.
Materials and Methods：In this study, carboxymethyl cellulose (CMC), which possesses strong hydrophilicity, good biocompatibility, and low immunogenicity, was selected as the primary matrix material . Environmentally friendly organic acids, citric acid and fumaric acid, were used as crosslinkers, and a green crosslinking strategy was employed to fabricate a porous and compressible hemostatic sponge.
Results：The fabricated hemostatic sponges exhibited excellent compressibility and resilience, and could be compressed to 20% of their original volume. After fluid absorption, the sponges restored their original structure within 10 seconds, achieving a swelling ratio exceeding 20-fold.
Discussion：The rapid structural recovery and high swelling capacity of the sponges may be attributed to the hydrophilic functional groups of CMC and the interconnected porous network formed through organic acid crosslinking. Their compressible nature suggests potential application for filling deep or irregular wounds, while rapid expansion upon fluid absorption may generate internal pressure, further enhancing their hemostatic potential.
Conclusions：In conclusion, a green crosslinked CMC-based hemostatic sponge was successfully fabricated using citric acid and fumaric acid. The material demonstrated high compressibility, rapid recovery, and strong fluid absorption capacity, indicating its potential for application in deep wound filling and hemorrhage control.

P-18-1

建立新型仿生摩擦測試平台評估眼瞼與隱形眼鏡之交互作用
Establishment of a Novel Biomimetic Friction-Testing Platform for Evaluating Eyelid–Lens Interactions

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Introduction：Contact lens discomfort is largely driven by eyelid–lens friction, yet tribological research rarely focuses on the complex interactions between two soft materials. This study focuses on the establishment of a specialized biomimetic testing platform designed to accurately simulate and evaluate these soft-on-soft interfaces.
Materials and Methods：The platform utilizes commercial contact lenses and poly(dimethylsiloxane) (PDMS) to replicate the eyelid–lens interface. 1-DAY ACUVUE MOIST lenses were tested against PDMS substrates with varying curing ratios (1:5, 1:10, 1:15, 1:20). Friction was measured using a CETR UMT-2 tribometer under a 60 mN normal load. The system was optimized by transitioning from rotational motion to linear sliding at 0.1 mm/s to ensure mechanical stability.
Results：The establishment of this platform successfully addressed initial issues of high variability caused by sample securing difficulties. By implementing linear sliding kinematics, the platform achieved significantly higher consistency and increased the effective contact area. This optimization led to a substantial improvement in data reproducibility, providing a reliable baseline for evaluating soft material friction.
Discussion：The newly established platform provides a robust framework for soft-on-soft tribological testing at physiologically relevant speeds. By overcoming the slippage issues inherent in conventional setups, this system demonstrates high sensitivity in differentiating the frictional responses of various materials. It offers a standardized method to quantify the lubricity and interaction at the eyelid–lens interface.
Conclusions：We have successfully established a promising and reliable biomimetic platform for evaluating eyelid–lens friction. This methodology facilitates the development of next-generation contact lens materials and care systems by providing a precise tool for predicting wearer comfort during the design phase.

P-19

探討三維骨髓間質幹細胞球體在創傷性腦損傷後調控星狀膠細胞介導之神經保護潛能
Investigating the Regulation of Astrocyte-Mediated Neuroprotection by 3D Bone Marrow Mesenchymal Stem Cell Spheroids Following Traumatic Brain Injury

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Introduction：Traumatic brain injury (TBI) triggers secondary damage, including excitotoxicity and neuroinflammation, leading to neuronal loss. Reduced GLT-1 expression and A1 astrocyte polarization contribute to this process. This study evaluated the therapeutic potential of three-dimensional bone marrow mesenchymal stem cells (3D BMSC) in modulating these pathological mechanisms.
Materials and Methods：BMSCs were isolated from 4-week-old male C57BL/6NCrl mice. After sacrifice, bilateral humeri, femurs, and tibiae were harvested. The bone marrow was flushed out using a 27G needle after both ends of the bones were cut, and the collected cells were cultured as primary BMSCs. Minimum Essential Medium Alpha (MEM-α) was purchased from Thermo Fisher Scientific.
Results：3D BMSC-conditioned medium increased astrocyte survival and upregulated GLT-1 under excitotoxic conditions. It suppressed A1 markers and promoted A2 polarization. PI3K/AKT signaling was significantly activated. In vivo, 3D BMSC reduced apoptosis and improved behavioral recovery compared with controls.
Discussion：The enhanced therapeutic efficacy of 3D BMSC may be attributed to their superior paracrine activity compared with conventional 2D cultures. Three-dimensional spheroid formation has been reported to increase the secretion of neurotrophic and anti-inflammatory factors, which may activate the PI3K/AKT pathway. AKT activation is associated with GLT-1 stabilization and suppression of pro-inflammatory signaling, thereby reducing excitotoxicity and A1 astrocyte polarization. These findings suggest that 3D culture conditions critically influence the regenerative potential of MSC-based therapies.
Conclusions：Three-dimensional BMSC exhibit multifaceted neuroprotective effects in TBI by enhancing GLT-1 expression, modulating astrocyte polarization, activating PI3K/AKT signaling, and reducing apoptosis. These results support the potential application of 3D BMSC as a promising cell-based therapeutic strategy for traumatic brain injury.

P-20

TNF-α 能增強骨髓來源間質幹細胞的免疫調節功能和骨分化能力有效治療植體周圍炎
The role of TNF-α-primed Bone Marrow Mesenchymal Stem Cells in Enhancing Osteogenic and Immunomodulatory Functions for Treating Peri-Implantitis

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Introduction：Bone marrow mesenchymal stem cells (BMMSCs) have gained attention as a promising therapy for bone diseases and immune-related conditions due to their ability to differentiate into osteoblasts and modulate immune responses. Mitochondrial metabolism plays a critical role in influencing osteogenesis and immunomodulation of BMMSCs. Peri-implantitis, characterized by inflammation of tissues surrounding dental implants and accompanying bone loss, is often exacerbated by the cytokine TNF-α. While BMMSCs have demonstrated enhanced therapeutic functions in response to inflammatory cytokines like TNF-α, the mechanisms through which TNF-α-primed BMMSCs address peri-implantitis remain unclear.
Materials and Methods：Bioinformatics analysis was employed to investigate the role of TNF-α in mediating peri-implantitis and its effects on BMMSCs. T cell activation and proliferation assays were performed to evaluate the immunomodulatory effects of BMMSCs using flow cytometric analysis. Additionally, the mitochondrial functions of BMMSCs were assessed to link their capabilities to immunomodulation and osteogenesis.
Results：Transcriptomic analysis indicated that TNF-α is critical in peri-implantitis and enhances the immunomodulatory properties of BMMSCs. Functional assays revealed that TNF-α primes BMMSCs to more effectively suppress T cell activation and proliferation. Notably, mitochondrial content was significantly increased in TNF-α-primed BMMSCs, suggesting improved immunomodulatory and osteogenic potential.
Discussion：Further research is needed to elucidate the complex mechanisms underlying BMMSC therapy for peri-implantitis, particularly involving mitochondrial transfer and metabolism in immunomodulation and osteogenesis.
Conclusion：This study aims to develop novel therapeutic strategies for treating peri-implantitis and to clarify the mechanisms involving BMMSCs and mitochondrial activity, ultimately enhancing treatment efficacy for inflammatory conditions.

P-21

基於深度影像摳圖模型之人工智慧系統於螢光素眼底血管攝影中雷射誘發視網膜損傷定位之應用
Artificial Intelligence–Based Deep Matting Segmentation for Localization of Laser-Induced Retinal Lesions on Fundus Fluorescein Angiography

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Introduction：Laser photocoagulation is commonly used to induce controlled retinal injury in wound healing models. Fundus fluorescein angiography (FFA) is performed longitudinally to assess lesion size and vascular leakage. Manual lesion delineation is time-consuming and subject to variability, which limits reproducibility in quantitative studies. We developed a deep matting–based AI framework for automated and continuous lesion localization on FFA images.
Materials and Methods：FFA images from experimental laser injury models were intensity-normalized and aligned before analysis. Ophthalmologists provided manual annotations for supervised training. A Deep Matting Segmentation model built on a 2D U-Net backbone was implemented to predict continuous alpha maps ranging from 0 to 1 instead of binary masks. The model was trained using Dice loss combined with regression loss and compared with nnU-Net and Swin-UNeTR. Inference time per image was recorded.
Results：The proposed model achieved a Dice score of 0.92 against ophthalmologist annotations, outperforming nnU-Net (0.89) and Swin-UNeTR (0.86). The continuous output clearly differentiated severely damaged cores from intermediate transitional regions, enabling more biologically meaningful quantitative assessment. Prediction required less than one second per image, compared with approximately five minutes for manual delineation.
Discussion：The deep matting approach improves boundary modeling and captures lesion heterogeneity more effectively than binary segmentation. High accuracy and rapid inference support large-scale longitudinal wound healing studies.
Conclusions：Deep matting–based AI segmentation enables accurate, fast, and quantitative localization of laser-induced retinal lesions on FFA images, enhancing reproducibility in experimental retinal research.

P-22

利用 PVA 微載體於封閉式培養袋系統中進行脂肪幹細胞之快速增殖
Rapid Expansion of ADSCs using PVA Microcarriers in a Closed Bag System

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Introduction：Traditional 2D culture faces significant scalability and contamination challenges. This study demonstrates a cost-effective, closed-bag system using PVA microcarriers for rapid expansion of adipose-derived stem cells (ADSC) with stemness characteristics. This lab-feasible platform is straightforward and minimizes manual contamination risk, offering a scalable and practical solution for automated, large-scale stem cell bioprocessing.

Materials and Methods：Human ADSCs were expanded using the xeno-free AllPhase MSC medium (DuoGenic StemCells) on three types of microcarriers: Cytodex 1, UnitanTrix, and PVA microcarriers AS. The experimental workflow consisted of two stages. Initially, the optimization of microcarrier concentration and cell seeding parameters was conducted in ultra-low attachment 6-well plates under static, undisturbed conditions. Subsequently, the optimized parameters were transitioned to a closed-bag culture system using NIPRO cell culture bags. To prevent cell aggregation and maintain a homogeneous suspension, the bags were subjected to a shaker with 20◦ tilt for mixing cells at intervals of 45 minutes during the expansion phase.

Results：Our results indicated that using PVA microcarriers AS at a concentration of 4 mg/mL with a seeding density of 2,000 cells/cm^2 yielded an 11.6-fold expansion within 4 days (doubling time = 27.17 hrs). The expanded ADSCs consistently expressed positive MSC markers (CD90, CD73, CD44, and CD105) while remaining negative for CD34, CD11b, CD19, CD45, and HLA-DR. For cell dissociation, a 10-minutes TrypLE incubation was the optimal condition for harvesting. These optimized parameters were subsequently applied to a 7-day culture in cell culture bags. By implementing a tilting motion every 45 minutes, cell aggregation was effectively mitigated, resulting in a 12.369-fold expansion (DT=33.07 hrs). The harvested cells maintained their characteristic immunophenotype and tri-lineage differentiation potential (osteogenic, chondrogenic, and adipogenic). Furthermore, the successful implementation of bead-to-bead transfer enabled further cell expansion without enzymatic dissociation, providing a streamlined approach for large-scale bioprocessing.

Discussion：Experimental results demonstrated that ADSCs could be expanded 11.6-fold in 4 days under static conditions (6-well plates) using optimized parameters: 4 mg/mL PVA microcarriers and 2,000 cells/cm² seeding density. In the closed-bag system with intermittent tilting, a 12.369-fold expansion was achieved within 7 days.

Conclusions：This system offers a closed, affordable, and efficient 3D platform that bypasses the need for complex bioreactor setups.

P-23

探討脂肪間質幹細胞透過調節 T 細胞治療第二型糖尿病的潛力
Therapeutic Potential of Adipose-Derived Mesenchymal Stem Cells in Modulating T Cell Responses in Type 2 Diabetes Mellitus

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Introduction：T cells are critical in metabolic inflammation and insulin resistance, with growing evidence linking them to the pathogenesis of type 2 diabetes mellitus (DM). Adipose-derived mesenchymal stem cell (AdMSC) therapy is garnering attention for its immunomodulatory and regenerative properties. In Taiwan, AdMSCs have been approved for clinical use under the Regenerative Medicine Act. However, the effectiveness of AdMSCs derived from DM patients in regulating T cells is still unclear.

Materials and Methods：This study employed single-cell RNA sequencing (scRNA-seq) to evaluate the heterogeneity of AdMSCs from DM patients compared to healthy donors (HD). We assessed the ability of these AdMSCs to modulate T cell responses and their mitochondrial functions *in vitro* and established a murine model of diabetic wounds to evaluate the therapeutic potential of AdMSCs from both DM patients and HD.

Results：Our analysis identified at least 11 distinct clusters in the AdMSC populations, many of which were associated with elevated T cell inflammation in DM. Notably, DM-derived AdMSCs significantly increased the frequency of inflammatory T cells, including Th1 and Th17 cells. Consistent with previous findings, high glucose levels were linked to increased mitochondrial metabolism and dysfunctional senescence in MSCs; DM-derived AdMSCs exhibited markedly heightened mitochondrial metabolism compared to HD-derived counterparts. In the murine diabetic ulcer model, AdMSCs from HD demonstrated therapeutic effects by reducing inflammatory T cell responses.

Discussion：Additional studies are necessary to understand the mechanisms driving the therapeutic effects of DM-derived AdMSCs, particularly in their interactions with T cell responses.

Conclusion：Our findings indicate that AdMSCs may offer innovative strategies for treating DM-associated complications through autologous therapy and mitochondrial manipulation.

P-24

臍帶間質幹細胞透過調節嗜中性球發炎性死亡途徑與抗真菌能力以治療白色念珠菌感染
Umbilical Cord Mesenchymal Stem Cells Attenuate *Candida Albicans*–Induced Inflammatory Neutrophil Death While Preserving Antifungal Activity

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Introduction：*Candida albicans* (*C. albicans*) is a commensal fungus that can become pathogenic under immune dysregulation, driving excessive neutrophil activation and tissue-damaging inflammation. While neutrophils are critical for antifungal defense, their hyperactivation leads to inflammatory necrotic death. Umbilical cord–derived MSCs (UCMSCs) possess potent immunoregulatory capacity, but their role in modulating neutrophil fate during *C. albicans*–induced inflammation remains unclear.

Materials and Methods：We analyzed transcriptomic data to assess neutrophil responses to *C. albicans* and compared them with functional responses to non-pathogenic *Saccharomyces cerevisiae* (*S. cerevisiae*). We further evaluated the modulatory effects of UCMSCs versus bone marrow–derived MSCs (BMMSCs) on *C. albicans*–stimulated neutrophils.

Results：Transcriptomic analyses revealed that *C. albicans* exposure drives excessive neutrophil activation and inflammatory injury signatures. Functionally, *C. albicans*—but not non-pathogenic *S. cerevisiae*—induced robust ROS production and necro-inflammatory neutrophil death. UCMSCs more effectively suppressed *C. albicans*–induced inflammatory neutrophil death than BMMSCs while potentially preserving antimicrobial respiratory burst, supported by elevated expression of cytoprotective and neutrophil-regulating factors.

Discussion：*C. albicans*–induced neutrophil hyperactivation contributes to inflammatory tissue injury, and that UCMSCs can selectively rebalance neutrophil responses by limiting necro-inflammatory death while maintaining antimicrobial function

Conclusion：UCMSCs represent a promising immunomodulatory strategy to mitigate *C. albicans*–associated inflammatory damage without compromising antifungal defense.

P-25

臍帶間質幹細胞衍生之凋亡小體透過調節肺部巨噬細胞亞群治療肺炎克雷伯菌所致肺炎
Umbilical Cord MSC–Derived Apoptotic Bodies Reprogram Lung Macrophage Subsets to Treat *Klebsiella Pneumoniae* Pneumonia

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Introduction：*Klebsiella pneumoniae* (*KP*) pneumonia drives acute lung injury through excessive inflammation and macrophage dysregulation, especially in high-risk patients. Umbilical cord MSC–derived apoptotic bodies (UCMSC-ABs) offer a promising cell-free therapy enriched with immunomodulatory cargo. Their effects on distinct lung macrophage (MΦ) subsets and metabolic reprogramming in *KP* pneumonia remain unclear.

Materials and Methods：Flow cytometry was performed to evaluate the responses of lung MΦ subsets following *KP* exposure both *in vitro* and *in vivo*. Bioinformatic analyses were conducted to characterize the therapeutic impact of apoptotic MSCs on inflammatory lung tissues.

Results：Both lipopolysaccharide (LPS) and capsular polysaccharide (CPS) from *KP* potently activate lung MΦs, driving a phenotypic shift from M2 toward a pro-inflammatory M1 state in alveolar (AMΦs) and interstitial macrophages (IMΦs) *in vitro*. *In vivo*, lethal KP challenge induces profound MΦ reprogramming, characterized by reduced M2 polarization in AMΦs and marked M1 skewing in IMΦs and recruited macrophages (RMΦs). Induction of MSC apoptosis promotes M2 polarization in lung MΦs under inflammatory lung conditions. We have successfully generated UCMSC-ABs; ongoing studies will define their therapeutic efficacy and underlying mechanisms in *KP* pneumonia.

Discussion：Collectively, these findings suggest that *KP*-induced lung injury is driven by subset-specific MΦ reprogramming toward a dominant M1 inflammatory phenotype, and that UCMSC-ABs may represent a rational cell-free strategy to restore macrophage balance by promoting M2 polarization and potentially reprogramming metabolic and inflammatory pathways in distinct lung MΦ populations.

Conclusion：*KP* pneumonia drives pathogenic MΦ reprogramming toward a pro-inflammatory M1 state, and UCMSC-ABs hold promise as a targeted cell-free therapy to rebalance lung MΦ subsets and mitigate inflammatory lung injury.

P-26

開發負載瓦頓氏凝膠間質幹細胞之 PNIPAM-明膠雙應答水膠用於治療周邊動脈疾病
Development of Dual-Responsive PNIPAM-Gelatin-Based Hydrogels Encapsulating WJ-Mscs for the Treatment of Peripheral Arterial Disease

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Introduction：Peripheral arterial disease (PAD) leads to impaired tissue perfusion, creating a hostile microenvironment characterized by excessive oxidative stress and chronic inflammation. To address these challenges, we developed a ferulic acid-grafted PNIPAM-Gelatin (GPTF) hydrogel with dual temperature- and ROS-responsiveness, encapsulating Wharton's jelly-derived mesenchymal stem cells (WJ-MSCs) to enhance therapeutic efficacy.
Materials and Methods：The synthesis of GPTF was confirmed using NMR spectroscopy and the ninhydrin assay. The sol-gel transition behavior was characterized using a rheometer. The biological effects of the GPTF hydrogel encapsulating WJ-MSCs were evaluated in HUVECs exposed to oxidative stress using qPCR and Western blotting. A mouse hindlimb ischemia model was established to assess inflammatory markers and caspase-3 activity.
Results：NMR confirmed the successful synthesis of GPTF, and the Ninhydrin assay revealed a high modification rate with only 4.83% residual amines. The rheological analysis showed gelation temperature of GPTF was 31.88°C. Under oxidative stress environment, WJ-MSCs-loaded GPTF significantly enhanced HUVEC viability, downregulated TNF, IL6, and MMP3/9 expression, and activated p-PI3K/p-AKT pathways. In vivo study showed that WJ-MSCs-loaded GPTF significantly reduced IL-1β and TNF levels, along with inhibited caspase-3 activity.
Discussion：The results suggested that the synergistic interaction between the antioxidant capacity of GPTF and the bioactivity of WJ-MSCs significantly attenuates oxidative stress. WJ-MSCs-encapsulated GPTF hydrogels suppresses endothelial apoptosis by enhancing PI3K/AKT signaling and regulating apoptosis-related protein expression, highlighting the therapeutic potential of this platform for PAD-associated tissue repair.
Conclusions：This study demonstrates that the dual-responsive GPTF hydrogels encapsulating WJ-MSCs exhibits significant anti-inflammatory and anti-apoptotic effects in both in vitro and hindlimb ischemia models, highlighting its potential as a therapeutic strategy for peripheral arterial disease treatment.

P-27

胎盤間質性幹細胞所衍生之小型細胞外囊泡及其嵌合抗原受體修飾型之小型細胞外囊泡在肝纖維化中的雙重作用

Dual Effects of Placenta-Derived Mesenchymal Stromal Cell–Derived Small Extracellular Vesicles and Chimeric Antigen Receptor–Modified Small Extracellular (CAR-sEVs) in Liver Fibrosis

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Introduction：Liver fibrosis is a progressive pathological process driven by chronic liver injury and persistent activation of hepatic stellate cells (HSCs), ultimately leading to cirrhosis and liver failure. Mesenchymal stromal cell (MSC)–derived small extracellular vesicles (sEVs) have emerged as a promising cell-free therapeutic strategy due to their immunomodulatory and anti-fibrotic properties. However, the lack of tissue-specific targeting following systemic administration remains a major barrier to their therapeutic translation.

Materials and Methods：To overcome this limitation, we developed a bioorthogonal engineering platform to generate chimeric antigen receptor–modified sEVs (CAR-sEVs) derived from human placenta choriodecidual membrane–derived mesenchymal stromal cells (pcMSCs). Azido groups were introduced onto pcMSCs and their secreted sEVs via metabolic glycan engineering using Ac4ManNAz, followed by copper-free click chemistry to conjugate DBCO-linked single-chain variable fragments (scFv) targeting hepatocyte-associated antigens.

Results：CAR-sEVs exhibited size distribution and physicochemical characteristics comparable to unmodified pcMSC-sEVs, while demonstrating significantly enhanced uptake by human hepatic cells in vitro. In a bile duct ligation (BDL)–induced cholestatic liver fibrosis mouse model, systemic administration of CAR-sEVs markedly attenuated liver injury and fibrosis, as evidenced by reduced necrotic areas, collagen deposition, α-smooth muscle actin (α-SMA) expression, and extracellular matrix accumulation, accompanied by improved liver function parameters.

Discussion：Importantly, CAR modification did not alter the intrinsic anti-fibrotic effects of pcMSC-sEVs in transforming growth factor-β (TGF-β)–activated HSCs, indicating preserved direct suppression of stellate cell activation. Furthermore, mechanistic studies revealed that hepatocyte injury alters hepatocyte-derived sEV signaling, thereby exacerbating pro-fibrotic activation of HSCs. Therapeutic treatment with pcMSC-sEVs or CAR-sEVs partially reprogrammed injured hepatocytes, leading to attenuation of downstream pro-fibrotic hepatocyte–stellate cell crosstalk.

Conclusions：Collectively, these findings demonstrate that bioorthogonally engineered CAR-sEVs exert dual anti-fibrotic effects by combining enhanced liver targeting with preserved intrinsic anti-fibrotic activity. This platform provides a versatile, non-genetic strategy for precision extracellular vesicle–based therapy in liver fibrosis.

P-28

工程化細胞外囊泡於骨關節炎靶向抗發炎治療中的應用
Engineered Extracellular Vesicles for Targeted Anti-Inflammatory Therapy Osteoarthritis Treatment

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Introduction：Osteoarthritis (OA) is a degenerative joint disease-causing pain, stiffness, and functional impairment, affecting approximately 654 million people worldwide in 2019. The development of disease-modifying OA therapies requires promoting cartilage regeneration, preserving joint function, and preventing structural damage. Although traditionally classified as non-inflammatory, OA is now recognized to involve persistent inflammatory components, particularly in advanced stages. NF-κB plays a central role in sustaining chronic inflammation and accelerating joint degradation. APOE has been implicated in NF-κB–associated inflammatory programs within activated synovial tissues. In addition, impaired chondrogenesis and insufficient anabolic repair contribute to progressive cartilage loss and CCN2 (CTGF) serves as a key anabolic regulator of cartilage matrix synthesis and chondrocyte differentiation.
CatiPep®, a peptide designed using AlphaFold2, has demonstrated superior chondrogenic induction in vitro and in vivo. Extracellular vesicles derived from CatiPep®-primed mesenchymal stem cells (BesKne-Exo®) represent a promising cell-free therapeutic strategy. This study investigates whether peptide-primed EVs enhance chondrogenesis while modulating inflammatory signaling pathways in OA models.
Materials and Methods：Two commonly used mesenchymal stem cell (MSC) sources, infrapatellar fat pad MSCs (IPFP-MSCs) and adipose-derived stem cells (ADSCs), were primed with CatiPep® to evaluate anti-inflammatory potential and to generate peptide-primed extracellular vesicles (EVs). EVs were isolated using tangential flow filtration (TFF) or Amicon ultrafiltration and characterized by nanoparticle tracking analysis (NTA) for size and concentration, quantitative PCR (qPCR) for RNA profiling, and Western blot for protein markers. To model OA-associated inflammation, C20A4 human chondrocytes were stimulated with IL-1β at multiple time points. To evaluate chondrogenic induction, cells were treated with TGF-β to activate anabolic cartilage programs. The expression of inflammatory and chondrogenic markers was assessed by qPCR and Western blot analysis.
Results：Peptide-primed EVs enhanced chondrogenic differentiation in OA-derived IPFP-MSCs under induction conditions, as shown by increased SOX9, COMP, COL2A1, and ACAN expression compared with naïve EVs. CCN2 expression was primarily driven by TGF-β stimulation. Peptide treatment alone induced only a modest increase in CCN2; however, in the presence of TGF-β, peptide further enhanced CCN2 expression, indicating a cooperative rather than initiating role in anabolic signaling. In PBMC-derived macrophages, peptide-primed EVs promoted M2 polarization, as reflected by increased CD206 and CD163 expression, supporting immune-modulatory potential. In contrast, in IL-1β–stimulated chondrocytes, IL-1β robustly induced APOE and NF-κB activation, whereas peptide treatment alone did not clearly reduce NF-κB signaling. Collectively, peptide-primed EVs enhance chondrogenic programs and macrophage polarization, while direct suppression of NF-κB in inflamed chondrocytes was not evident under the tested conditions.
Discussion：The present findings indicate that peptide-primed EVs enhance anabolic chondrogenic responses in OA-derived MSCs, as reflected by increased expression of key cartilage markers. CCN2 upregulation was primarily driven by TGF-β stimulation, while peptide treatment alone exerted only a modest effect. The further enhancement of CCN2 expression in the presence of TGF-β suggests that the peptide functions as a modulator of anabolic signaling rather than an independent inducer. In parallel, peptide-primed EVs promoted M2 macrophage polarization, supporting an immune-modulatory

mechanism of anti-inflammatory action. However, peptide treatment alone did not clearly attenuate NF-κB activation in IL-1β–stimulated chondrocytes, indicating that direct suppression of inflammatory signaling in chondrocytes may not be the dominant mechanism under the tested conditions. Overall, these results suggest that regenerative enhancement and immune modulation, rather than direct NF-κB inhibition, may underlie the observed therapeutic potential.

Conclusions：Peptide-primed EVs enhance chondrogenic differentiation and promote anti-inflammatory macrophage polarization. Peptide treatment cooperatively augments TGF-β–driven CCN2 expression, whereas direct suppression of NF-κB signaling in inflamed chondrocytes was not evident. These findings suggest a regenerative and inflammation-modulatory mechanism in OA.

P-29

血小板衍生細胞外囊泡促進角膜上皮與基質傷口癒合之研究
Enhanced Corneal Epithelial and Stromal Wound Healing Using Platelet-Derived Extracellular Vesicles (PEVs)

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Introduction：Corneal injury is a major cause of visual morbidity, and current therapies (lubricants, antibiotics, NSAIDs, steroids, amniotic membrane) are often sub-optimal or delay healing and carry adverse effects, underscoring a need for regenerative biologics. Extracellular vehicles (EVs) with multifunction have drawn attention for helping tissue regeneration, and platelet derived-EVs (PEVs) are abundant, readily produced from clinical platelet concentrates, and carry trophic factors with intrinsic anti-inflammatory/angiogenic-modulating potential, supporting their potential as ocular biotherapeutics. To evaluate whether topical delivery of PEVs accelerate and improve corneal epithelial and stromal wound healing, a rat corneal wound model was studied and also compared with some commercial agents such as corticosteroid and artificial tears to evaluate the therapeutic effect of PEV.
Materials and Methods：A standardized corneal epithelial-stromal injury was created and randomized eyes were received PEVs (1%), corticosteroid (CT), artificial tears (AT), or no injury eye as Normal group. Corneal repair outcomes evaluation included central/peripheral corneal thickness (OCT), horizontal/vertical defect diameters, H&E histological examination. And immunobiological staining including ΔNp63 (basal epithelial progenitors) and α-SMA (fibroblast/myofibroblast activation), were performed. The intraocular pressure (IOP) was also monitored as follow.
Results：PEVs consistently accelerated wound closure (near-complete by Day 5–8) with smaller horizontal and vertical defect diameters than CT and AT. Corneal thickness recovery rate was faster and more uniform in the PEV group, which's also approaching to Normal values by Day 8; whereas AT showed delayed/variable recovery, and CT lagged further. Histological results demonstrated well-organized epithelium and stromal structure in PEV-treated corneas; AT group exhibited stromal disorganization, and H&E result of CT showed slower remodeling. The ΔNp63 staining indicated basal epithelial stem/progenitor were activation in all groups, with highest frequency/intensity in PEVs. The staining of α-SMA was minimal in PEVs treated one but more widespread in AT, this revealed fibrotic activation reduced with PEV therapy. IOP remained stable without between-group differences, supporting ocular safety.
Discussion：The PEVs acts as bioactive nanomedicine delivering platelet-derived growth factors, lipids, and regulatory RNAs directly to injured corneal cells; therefore, PEV-treated corneas showed faster epithelial defect closure, recovery of central and peripheral pachymetry toward normal values, and near-normal histo-architecture by Day 8 compared with CT/AT which had less active components for treatment. The lipid bilayer structure of PEVs facilitates cellular uptake and improves local bioavailability after topical application. Increased ΔNp63 expression indicates activation of basal epithelial progenitor programs, while reduced α-SMA expression suggests suppression of myofibroblast differentiation and fibrotic remodeling. These findings align with—and extend—prior evidence that platelet-derived products restore corneal thickness and dampen inflammation, and that platelet biotherapies (and carriers) can hasten epithelial recovery.
Conclusions：Topical PEVs promote rapid epithelial closure and stromal remodeling, enhance basal progenitor activity (ΔNp63), limit myofibroblast/fibrotic responses (α-SMA), and maintain normal IOP,

which had superior therapeutic effect for corneal wound healing compared with corticosteroid and artificial tears in this rat corneal wound damaged model.

Keywords*: Platelet-derived extracellular vesicles (PEVs), Corneal wound healing, Ocular surface regeneration, Optical coherence tomography (OCT), Intraocular pressure (IOP), Artificial tears, Corticosteroids.*

P-30

臍帶間質幹細胞透過調節粒線體功能以促進類肝細胞成熟與肝臟再生
Enhancing Hepatocyte-Like Cell Maturation and Liver Regeneration Using Umbilical Cord–Derived Mesenchymal Stem Cells Via Mitochondrial Metabolism Regulation

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Introduction：Liver diseases represent a growing global health burden, and orthotopic liver transplantation remains the only curative treatment for patients with decompensated liver failure. Yet critical limitations—including severe donor organ shortages, high surgical risk, long-term immunosuppression, and substantial cost—underscore the urgent need for effective regenerative alternatives. Mesenchymal stem cells (MSCs) have emerged as a promising therapeutic platform for liver repair due to their immunomodulatory properties, trophic factor secretion, and capacity to transdifferentiate into hepatocyte-like cells (HLCs).
Materials and Methods：We compared the transdifferentiation potential of umbilical cord–derived MSCs (UCMSCs) and adult bone marrow MSCs (BMMSCs) through transcriptomic profiling, with functional validation by glycogen storage assays. A yeast-based platform incorporating mitochondrial mutants was employed to screen candidate compounds that enhance HLC maturation and function.
Results：Transcriptomic analysis revealed distinct clustering of UCMSCs from BMMSCs, with UCMSCs enriched in liver regeneration and hepatocyte differentiation pathways. UCMSCs expressed higher *FGF2* and *HGF* levels, further amplified by hepatogenic induction. UCMSC-derived HLCs showed greater *AFP* and *ALB* expression and increased glycogen storage, indicating superior maturation. Yeast-based screening identified candidate compounds that enhance mitochondrial complexes II, III, and IV activity, which will be further validated in MSCs to determine their effects on mitochondrial function and HLC transdifferentiation efficiency.
Discussion：UCMSCs exhibit enhanced hepatogenic commitment and maturation, likely driven by intrinsic growth factor expression and metabolic advantages.
Conclusion：UCMSCs represent a more effective cell source than BMMSCs for promoting functional liver regeneration.

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低氧預處理脂肪來源幹細胞衍生細胞外囊泡促進糖尿病傷口修復
Hypoxia-Preconditioned Adipose-Derived Stem Cell–Derived Extracellular Vesicles Promote Diabetic Wound Healing

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Introduction：Chronic non-healing wounds are a serious complication of diabetes and frequently lead to infection and amputation. Extracellular vesicles (EVs) derived from adipose-derived stem cells (ADSCs) have demonstrated significant regenerative and pro-angiogenic potential. Hypoxic preconditioning has been shown to enhance the therapeutic efficacy of stem cell–derived products. This study aimed to investigate whether normoxic and hypoxic ADSC-derived EVs could improve diabetic wound healing in a streptozotocin (STZ)-induced diabetic mouse model.
Materials and Methods：ADSCs were cultured under normoxic (21% O_2) or hypoxic (1% O_2) conditions. EVs were isolated from the conditioned media by ultracentrifugation and characterized using nanoparticle tracking analysis, transmission electron microscopy, and assessment of EV surface marker expression. A dorsal full-thickness excisional wound model was established in streptozotocin (STZ)-induced diabetic mice. Normoxic or hypoxic ADSC-derived EVs were locally administered to the wound sites. Wound closure rate, histological regeneration, collagen deposition, and neovascularization were subsequently evaluated.
Results：In this study, we demonstrated that both normoxic and hypoxic ADSC-derived extracellular vesicles significantly accelerated wound closure compared with the control group in the STZ-induced diabetic mouse model. Notably, hypoxic ADSC-derived EVs exhibited superior therapeutic efficacy, as evidenced by faster re-epithelialization, increased collagen deposition, and enhanced neovascularization. Furthermore, histological analyses revealed improved tissue organization and more advanced regenerative architecture in EV-treated wounds, particularly in the hypoxic EV group.
Discussion：These findings suggest that ADSC-derived EVs promote diabetic wound repair, likely through the enhancement of angiogenesis and tissue regeneration. Hypoxic preconditioning appears to further potentiate the therapeutic efficacy of EVs, possibly by enriching their regenerative bioactive cargo.
Conclusions：Hypoxic ADSC-derived EVs markedly enhance the rate and structural quality of diabetic wound repair, underscoring their translational potential as an effective cell-free therapeutic approach for chronic non-healing diabetic wounds.

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胜肽預處理之間質幹細胞衍生細胞外囊泡療法緩解退化性關節炎疼痛
Peptide-primed Mesenchymal Stem Cell-Derived Extracellular Vesicles Therapy Reduce Pain in Osteoarthritis

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Introduction：Osteoarthritis (OA) is a degenerative joint condition that causes pain, swelling, and stiffness, affecting a person's ability to move freely, with about 654 million people worldwide living with it in 2019. Cartilage degradation and pain are two main symptoms during OA, with pain is the primary factor guiding clinical decision-making and treatment, as it directly impacts quality of life and functional disability. Importantly, OA pain is largely driven by joint inflammation rather than cartilage loss, so it is crucial for a treatment to have the anti-inflammatory properties to provide a strong analgesic effect. A peptide called CatiPep® designed via AlphaFold2 has previously been investigated and confirmed to have the superior chondrogenic induction in both *in vitro* and *in vivo*, and its primed mesenchymal stem cell (MSC)-derived EVs called BesKne-Exo® even better in reducing pain-like symptoms in OA-induced rat models, along with less knee swelling. Thinking of the interplay between inflammation and pain, this study is investigating the anti-inflammatory effects of CatiPep® and its primed MSC-derived extracellular vesicles (EVs), linking to the analgesic potential of these treatments at molecular levels.

Materials and Methods：Two common MSC sources, infrapatellar fat-pad mesenchymal stem cells (IPFP-MSCs) and adipose-derived stem cells (ADSCs), were primed with CatiPep® to evaluate anti-inflammatory effects via the reduction of catabolic markers involved in pain and inflammation, and to produce peptide-primed EVs. EVs were isolated via TFF or Amicon filtration and underwent quality control, including NTA (size/concentration), Qubit (RNA), protein quantification, and sterility testing. Peripheral blood mononuclear cells (PBMCs) were used to evaluate M2-macrophage polarization induced by each treatment, using IL-4 as a positive control. To model OA inflammation, C20A4 human chondrocytes were stimulated with IL-1β for 24 hours. The expression of inflammatory and pain mediators was then assessed via RT-qPCR and ELISA.

Results：Results demonstrate that while CatiPep® effectively reduces inflammatory and pain mediators (IL-1β, IL-6, TNF-α, CCL2, CXCL2, PTGES, NGF, etc.) in MSCs, its direct function is unstable across different cell types. The peptide failed to suppress inflammation in human chondrocytes even at escalated dosages (1000 ng/mL) and showed minimal effect on M2-macrophage polarization in PBMCs. However, CatiPep®-primed IPFP-MSC-derived EVs successfully overcame this instability, exhibiting superior therapeutic efficacy compared to naïve EVs, ADSC-derived EVs (BesKne-Exo®), and SOX9-CNP-EVs. Specifically, the IPFP-EVs significantly suppressed key pro-inflammatory cytokines (IL-1β, IL-6, and TNF-α) and neurotrophic pain markers (CCL2, NGF) in the inflamed chondrocyte model, establishing the peptide-primed EV formulation as the superior, stable strategy for OA intervention.

Discussion：Since joint treatment effects involve interactions among various cell types, future studies must evaluate peptide and EV functions across multiple cell lineages for a comprehensive understanding. Additionally, MicroRNA profiling is required, as miRNA cargo likely differs between IPFP-MSCs and ADSCs. We propose performing RNA-seq on target cells to identify DEGs and regulated pathways (via GSEA), subsequently tracing the potential regulatory miRNAs involved.

Conclusions：CatiPep® can give EVs remarkable anti-inflammatory properties by reducing pro-inflammatory cytokines, chemokines, and pain related molecules. This study provides robust molecular evidence that peptide-primed EVs modulate inflammation and pain transmission pathways, offering a mechanistic explanation for the observed behavioral pain relief in OA models.

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製備香芹酚結合透明質酸用於早期骨關節炎治療
The Preparation of Carvacrol Mixed with Hyaluronic Acid for Early-Osteoarthritis Treatment

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Introduction：Osteoarthritis (OA) is a degenerative joint disease in which inflammation and oxidative stress contribute to chondrocyte dysfunction and extracellular matrix (ECM) loss. Hyaluronic acid (HA), a major component of synovial fluid, is essential for joint lubrication but undergoes fragmentation and molecular weight reduction under inflammatory conditions, resulting in impaired function.
Clinically, HA is commonly administered via intra-articular injection to improve joint lubrication; however, its lack of anti-inflammatory and antioxidant activity limits its therapeutic effects largely to symptomatic relief.
Carvacrol is a natural phenolic compound with anti-inflammatory and antioxidant properties. Therefore, this study prepares an HA–Carvacrol formulation by simple mixing and conducts a proof-of-concept evaluation in early OA, focusing on inflammation, oxidative stress, and ECM-related outcomes.
Materials and Methods：An HA-Carvacrol formulation was prepared by simple mixing and evaluated using *in vitro* and *in vivo* models, with HA alone as a reference.
Results：HA-Carvacrol showed higher antioxidant activity than HA alone. Under inflammatory conditions, HA-Carvacrol reduced inflammatory and oxidative stress related responses and improved ECM related outcomes. *In vivo*, HA-Carvacrol reduced OA related pain behaviors without apparent adverse effects.
Discussion：In OA, persistent inflammation and oxidative stress drive cartilage degradation and pain progression. In this study, HA-Carvacrol treatment reduced inflammatory and oxidative stress related responses, preserved ECM related outcomes, and alleviated pain behaviors.
Conclusions：The HA-Carvacrol formulation was prepared by simple mixing and evaluated in models relevant to OA. These findings support further preclinical investigation of HA–Carvacrol in early-stage OA.

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幹細胞衍生成分與抗氧化奈米粒子於糖尿病傷口微環境之調節作用
Diabetic Wound Microenvironment Modulation via Stem Cell-Derived Components and Antioxidant Nanoparticles

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Introduction：Diabetic wounds are characterized by a stalled healing process due to persistent inflammation, ROS accumulation, and impaired tissue regeneration. In this microenvironment, macrophages often remain in a pro-inflammatory M1 state, while fibroblast function is compromised by oxidative stress. We hypothesized that a combined therapy using antioxidant nanoparticles (aoNP) and stem cell-derived mitochondria (scMito) could synergistically modulate this hostile microenvironment. This study investigates whether this combination can reduce ROS, switch macrophage polarization, and accelerate healing in diabetic models.

Materials and Methods：ASCs were cultured on chitosan-coated dishes for 72 hours to form spheroids. Mitochondria were extracted from 2D ASCs and 3D spheres (sphMito) through centrifugation and homogenization. The isolated mitochondria were resuspended in PBS；Design of a new aoNP, Antioxidant polymer with PSMA backbone for conjugating nitroxide radicals (4-amino-TEMPO) as an antioxidant and PEG for enhanced bioavailability and low immunogenicity.

Results：The combination of aoNP and sphMito significantly reduced intracellular ROS levels and rescued fibroblast migration and proliferation under HGII conditions. Crucially, the combined treatment effectively counteracted the pro-inflammatory effects of CW-EVs, promoting a macrophage phenotype shift from M1 to anti-inflammatory M2 markers through the activation of the STAT/PPAR signaling pathway. In the db/db mouse model, the combined therapy significantly accelerated wound closure, enhanced collagen deposition, and increased the population of M2 macrophages in the wound bed compared to single treatments or controls.

Discussion：This study highlights the synergistic potential of targeting oxidative stress and mitochondrial dysfunction simultaneously. While aoNPs effectively scavenge excessive ROS, sphMito provides immunomodulatory support. The results suggest that sphMito may offer robust therapeutic effects due to diabetic microenvironment properties. The activation of the STAT/PPAR pathway identifies a specific molecular mechanism by which this combination therapy resolves chronic inflammation, a key barrier in diabetic wound healing.

Conclusions：The combination of antioxidant nanoparticles and stem cell-derived mitochondria represents a promising therapeutic strategy for diabetic wounds.

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用於脂肪移植之促血管新生、可注射、顆粒狀且多孔的支架
Angiogenic, Injectable, Granular, Porous Scaffold for Fat Transplantation

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Introduction：Although autologous fat grafting remains the preferred method for natural volume augmentation, its utility is severely limited by ischemia-induced adipocyte apoptosis and variable retention rates. The grand challenge lies in sustaining graft viability during the revascularization latency period. Here, we present a solution: an injectable, angiogenic microbubble-based scaffold. This matrix serves as a bioactive template that not only mechanically prevents graft compression but also biologically accelerates angiogenesis, securing the long-term stability and quality of the regenerated adipose tissue.

Materials and Methods：AIGPS was fabricated from hyaluronic acid and gelatin using a template-free microfluidic foaming system to generate uniform microbubble scaffolds with interconnected microporosity. Following crosslinking and lyophilization, scaffolds were minced to produce shear-thinning injectable granules. VEGF was encapsulated in poly(lactic-co-glycolic acid) (PLGA) nanoshells via double emulsion and incorporated into the scaffold (SF-VEGF-NS). Scaffold structure was characterized by micro–computed tomography, mechanical testing, swelling/degradation assays, and rheology. Cytocompatibility was assessed using 3T3-L1 adipocytes and viability assays. Angiogenic potential was evaluated by endothelial tube formation, chick chorioallantoic membrane (CAM) assay with photoacoustic imaging, hemoglobin quantification, and a murine subcutaneous fat graft model with histological and immunohistochemical analyses (CD31, perilipin-1).

Results：Micro-CT demonstrated a highly ordered, isotropic porous architecture with lower volume fraction and thinner struts compared with freeze-dried hydrogels, supporting enhanced interconnectivity. Granularized scaffolds exhibited elastic solid behavior at low strain and shear-thinning injectability at high strain. VEGF-loaded nanoshells (≈216 nm) showed sustained degradation over 42 days and minimized burst release relative to free VEGF. *In vitro*, scaffolds were cytocompatible and VEGF-NS significantly enhanced endothelial tube formation. In the CAM model, SF-VEGF-NS increased vessel density, oxygen saturation, and hemoglobin content compared with controls. *In vivo*, VEGF-NS–functionalized scaffolds significantly improved graft volume retention, preserved adipocyte morphology, and increased CD31-positive microvascular density up to 16 weeks.

Discussion：The dual-level porosity of AIGPS reduces diffusion distances and facilitates vascular invasion, while nanoshell-mediated VEGF release provides sustained angiogenic signaling. This structural–biochemical synergy overcomes limitations of growth factor delivery and scaffold-only approaches.

Conclusions：AIGPS combining injectable granular meta-biomaterial architecture with controlled VEGF nanoshell delivery significantly enhances adipose graft vascularization and long-term retention, representing a scalable platform for soft tissue regeneration and next-generation dermal fillers.

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脂肪幹細胞於生物降解薄膜生物相容性測試

Biocompatibility Evaluation of Biodegradable Films for Medical Applications on ADSCs

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Introduction：Articular cartilage defects commonly result from sports-related injuries or trauma. Research indicates that adipose-derived stem cells (ADSCs) possess multilineage differentiation potential and rapid proliferation capabilities, which can significantly facilitate the repair of cartilage defects. In this study, we developed a biodegradable scaffold using photopolymerizable PGSA and 3D printing technique to precisely control pore architecture. We hypothesized combined with stem cells or disc cells, the scaffold promotes tissue regeneration and functional restoration at the defect site.

Materials and Methods：PEGS, PGS, and PPF prepolymers were synthesized by polycondensation of PEG/glycerol with sebacic acid or propylene glycol with fumaric acid under nitrogen atmosphere. Acrylation/methacrylation was performed through standard esterification and purification steps to obtain PEGSA, PGSMA, and PPFDA. These polymers were used for 3D printing to construct the 3D gyroid scaffold.

Results: Biocompatibility and Cell Distribution

Live/Dead staining revealed material-specific patterns in ADSC behavior over 5 days. **PGSA** showed progressive growth, moving from sparse Day 1 attachment to marked increases in coverage by Day 5. In contrast, **2D-PEGSA** exhibited variability: 2D-PEGSAb showed initial abundance followed by localized viability, while 2D-PEGSA-c displayed diffuse fluorescence lacking clear cell morphology.

Regarding **3D-PEGSA**, 3D-PEGSA b demonstrated strong early alignment with the porous architecture, which became scattered by Day 5; 3D-PEGSA ' showed late-stage intensification primarily at the periphery. For **PPFDA**, cell coverage peaked significantly on Day 2 but underwent a pronounced decline by Day 5. Collectively, these results highlight distinct temporal shifts in cell viability and structural integration across the tested scaffolds.

Discussion：The minimal red fluorescence observed across all groups indicates the **absence of acute cytotoxicity**, confirming the safety of the synthesized photopolymers.

- **PGSA:** The marked increase in cell coverage by Day 5 demonstrates excellent cytocompatibility. The primary advantage of PGSA is its **tunable degree of acrylation (DA)**, which allows for precise adjustment of stiffness and degradation rates to match specific tissue regeneration timelines.
- **PEGSA:** The rapid Day 1 attachment on **2D-PEGSA** is attributed to enhanced **hydrophilicity** from PEG incorporation. In the **3D-PEGSA** configuration, ADSCs exhibited a distributed 3D morphology rather than a flat one, though internal cell growth assessment may be constrained by current imaging depth limitations.
- **PPFDA:** The high cell density on Day 2 reflects the material's potential for early-stage integration. Due to its **hydrophobicity**, PPFDA maintains superior toughness and stiffness in wet states compared to PEGSA. This higher mechanical modulus is particularly advantageous for supporting **osteogenic or chondrogenic differentiation**.

Conclusions：In conclusion, while all tested materials supported initial cell attachment, they exhibited distinct temporal and structural influences on ADSC behavior. PGSA showed the most stable long-term proliferation, whereas PPFDA supported rapid early growth followed by a decline in viability. Furthermore, the 3D-PEGSA scaffolds successfully guided cell alignment along their porous architecture, although this structural integration diminished over time, suggesting that both material composition and scaffold geometry are critical determinants of long-term cell maintenance.

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用以軟骨缺損修復具仿生軟硬度之片狀軟骨細胞工程
Biomimetic Stiffness Modulated Chondrocyte Sheet Engineering for Chondral Defect Repair

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Introduction：Articular cartilage possesses a minimal capacity for self-repair, making high-grade chondral defects a primary precursor to osteoarthritis. While Cell Sheet Engineering (CSE) provides a "scaffold-free" strategy that avoids the inflammatory risks of exogenous scaffolds, traditional thermosensitive platforms (e.g., pNIPAAm) often lack the mechanical stiffness required to support chondrogenic signaling. This mechanical inadequacy fails to provide the biophysical cues necessary for optimal cell growth. This study validates a novel, non-thermosensitive redox-sensitive CSE platform engineered with biomimetic stiffness for functional articular cartilage regeneration.
Materials and Methods：Poly-γ-glutamic acid (γ-PGA) was grafted onto PET membranes via disulfide linkers. Surface properties were verified by XPS and AFM. Rabbit chondrocyte sheets were harvested via reductive agent (cystamine) to preserve the endogenous ECM. Triple-layered autologous constructs were implanted into rabbit trochlear defects and evaluated at 12 weeks using MRI and ICRS histological scoring.
Results：Analytical characterization confirmed successful interfacial functionalization and the high fidelity of the chemo-responsive detachment mechanism by XPS. Critically, AFM analysis demonstrated that the hydrated substrate exhibited a stiffness of approximately 16.2 MPa, achieving a physio-mechanical biomimicry that directly parallels the compressive modulus of native human articular cartilage. The platform facilitated the formation of robust, multi-layered constructs characterized by significantly elevated expression of Type II Collagen and Aggrecan, while effectively suppressing Type I Collagen (fibrocartilage) markers. In vivo results at 12 weeks revealed the regeneration of smooth, hyaline-like tissue with excellent lateral integration and subchondral bone remodeling, demonstrating statistically superior repair compared to the untreated control group.
Discussion：Unlike physical thermosensitive systems, this redox-responsive platform offers superior tunability of the substrate's physicochemical properties. The 16.2 MPa stiffness acts as a critical mechanotransducive regulator, providing the necessary mechanical environment to maintain the chondrocyte phenotype and prevent cellular dedifferentiation during ex vivo expansion. Furthermore, the high interfacial uniformity suggests strong potential for reproducible, clinical-grade manufacturing. While longitudinal molecular data is pending, the current structural outcomes provide a robust proof-of-concept.
Conclusions：By integrating physiological stiffness with a benign detachment mechanism, this CSE platform successfully orchestrates functional cartilage restoration in a translational model, offering a potent clinical strategy for chondral repair.

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以聚多巴胺奈米粒子修飾幹細胞球體衍生基質以提升其用於腦傷治療潛能
Enhancement of the Therapeutic Potential of Stem Cell Spheroid-Derived Matrix for Treating Traumatic Brain Injury Treatment by Polydopamine Nanoparticle Decoration

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Introduction：植入型生物材料的應用近年來逐漸展現出治療創傷性腦損傷（TBI）的潛力。實驗室過去的研究中，已證實間質幹細胞(MSC)所製成的三維細胞外間質球體(Decellularized extracellular matrix , dECM)因富含幹細胞分泌因子，可透過免疫調控與促進組織再生作為有效的生物材料促進 TBI 後的腦部修復。然而其本沒有足夠的組織貼附能力且抗氧化力有限，為了克服以上困難，本研究選用具有生物相容性、黏附性質、清除活性氧物質(Reactive oxygen species, ROS)能力的 PDANP (Polydopamine nanoparticle)進行 dECM 表面修飾，以提升其治療 TBI 的效能。

Materials and Methods：透過調控合成過程中的 pH 值與離心速度製備不同粒徑的 PDANPs，並選擇具較佳抗氧化表現的粒徑作為後續實驗材料。將 PDANPs 分散於磷酸鹽緩衝液中，並與三維 dECM 於室溫下搖晃反應 1 小時。隨後評估 dECM-PDANP 的自由基清除能力與塗佈飽和度，並進行體外細胞氧化壓力、免疫調控與神經分化分析。最後利用 PDANP 的黏附性將 dECM-PDANP 組裝成片狀，應用於小鼠 TBI 模型，透過行為測試與組織切片分析其治療效果。

Results：結果顯示，dECM-PDANP 具有良好生物相容性，且能顯著減少細胞氧化壓力。神經分化特有 Tuj-1 免疫螢光染色顯示支架內神經突生長增加，顯示其促進神經分化的能力。在 RT-qPCR 及 iNOS 免疫螢光染的結果皆顯示能下調 M1 相關表達，證實其免疫調控的能力。在體內實驗中，dECM-PDANP 展現出對大腦皮質組織的強黏附性，藉由降低氧化損傷並抑制神經發炎，最終促進神經細胞存活及神經新生，並顯著改善 TBI 小鼠的運動與神經功能。

Discussion：dECM-PDANP，結合 dECM 的結構支撐性與 PDANP 的抗氧化與黏附特性，可建立有利於神經修復的微環境。透過降低氧化壓力並抑制促發炎反應，dECM-PDANP 有助於減緩 TBI 後的繼發性損傷，提升神經細胞存活與功能恢復。

Conclusions：本研究凸顯 PDANP 修飾三維 MSC 球體去細胞後的 dECM，能簡單又有效的增強 dECM 治療能力並賦予其清除自由基的功能。結果顯示，dECM-PDANP 良好生物相容性，做為細胞支架使細胞浸潤的可行性，及透過減輕氧化壓力促進神經分化，還有其免疫抑制的能力。動物實驗進一步證實 dECM-PDANP 能有效保留於傷口，除了顯著改善行為表現外，亦可減緩發炎反應、降低組織氧化壓力、誘導細胞遷移，並提供有利於神經分化的微環境。

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探討含凝膠化幹細胞之膠原蛋白神經導管促進周邊神經修復的潛能
Exploring the Potential of Collagen Nerve Conduits Containing Hydrogelated Stem Cells to Promote Peripheral Nerve Repair

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Introduction：周邊神經損傷常導致活動能力下降及相應身體部位感覺喪失。臨床多以自體神經移植治療，但受限於供體有限，故可以使用神經導管(nerve guidance conduits, NGCs)作為替代方案。本研究開發一款結合兩種材料之複合型 NGCs，利用第一型膠原蛋白層片作為結構支撐及細胞貼附表面。並對間葉幹細胞(mesenchymal stem cell, MSC)以及大鼠脂肪來源間葉幹細胞(rat adipose-derived stem cell, rADSC)，進行細胞膜內凝膠化反應，其分泌之細胞外基質及多種生長因子能固定於原位，引導神經再生。針對兩種材料結合形成的含凝膠化幹細胞之膠原蛋白層片，以評估兩種材料之複合型 NGCs 在神經再生中的治療潛力。

Materials and Methods：本研究配製 12 wt% 甲基纖維素溶液，利用其溫度敏感特性以利完整取出膠原蛋白層片。首先將甲基纖維素均勻鋪於孔盤底部，待其形成凝膠後，加入 2.5 或 3.5 mg/mL 膠原蛋白預成膠溶液並使其成膠。隨後將 MSCs 懸浮於含 25 mg/mL Ficoll 400 的培養基中並加入孔盤培養至細胞長滿。接著加入含 4 - 10% (v/v) PEG-DA 及 I2959 或 LAP 光起始劑之水凝膠緩衝液，經紫外光照射完成細胞膜內凝膠化，製得含凝膠化幹細胞之膠原蛋白層片。最後將其應用於大鼠背根神經細胞外植體(rat dorsal root ganglion explant, DRG explant)培養，評估對神經突生長之影響。

Results：本研究成功利用水凝膠緩衝液製備含凝膠化幹細胞修飾之膠原蛋白層片，透過 Ficoll 400 顯著提升幹細胞分泌與沉積之細胞外基質(extracellular matrix, ECM)，形成較為完整的 ECM 網絡結構。凝膠化後的 MSCs 以及 rADSC 可於原位保留，並持續釋放多種細胞因子至周圍環境，在與膠原蛋白層片結合後，能夠進一步提升其整體機械穩定性。於 DRG explant 體外模型中評估神經再生效果時，僅塗佈膠原蛋白之對照組其神經軸突生長受限，而含有膠原蛋白之 gADSC 組別則顯著促進神經突延伸與分布面積。此結果顯示，凝膠化幹細胞除提供營養支持與細胞因子釋放外，亦可功能化膠原蛋白層片，進一步強化 NGCs 系統於神經引導與再生上的效果。

Discussion：MSCs 於神經組織中的存活率有限，影響其長期治療效果。本研究利用細胞膜內凝膠化方式使 MSCs 轉化為具生物活性的類細胞材料，其 ECM 中的生長因子與細胞激素可被保留，達到持續且微量釋放生物活性因子的功能。但因與膠原蛋白層片結合製成的神經導管，其機械強度仍相對不足，未來可考慮與 PU 或 PCL 等合成材料改善機械性能與降解行為。此外，本研究尚未進行體內神經功能恢復評估及免疫反應與血管新生等機制探討，未來仍需進一步深入研究以提升其於周邊神經修復之臨床應用潛力。

Conclusions：本研究成功開發具備物理支撐結構及貼附生物活性物質表面雙重特性的 NGC。利用凝膠化幹細胞固定於膠原蛋白層片表面，保留並釋放 ECM 與細胞因子，以引導訊號促進神經再生。體外實驗中觀察到凝膠化幹細胞具有增進細胞貼附、增生以及促進神經細胞突生長的能力。將含有凝膠化幹細胞之膠原蛋白層片捲起製成神經導管，可修改並裁剪神經導管至適當大小，為神經損傷修復提供多元創新方案。

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階段特異性間質幹細胞球體融合驅動多區域軟骨移植物之自下而上建構，製造多層軟骨移植物
Stage-specific MSC Spheroid Fusion Drives Bottom-up Formation of Multizonal Cartilage Grafts

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Introduction：Cartilage defects are a major cause of chronic pain and disability worldwide, with associated mobility impairments increasing mortality rates by approximately 11%. Umbilical cord–derived mesenchymal stem cells (UC-MSCs) possess strong proliferative and immunomodulatory properties, making them promising candidates for allogeneic cartilage repair. We compared UC-MSCs and bone marrow–derived MSCs (BM-MSCs) and developed a stage-programmed, bottom-up strategy to fabricate multizonal cartilage grafts by assembling chondrogenic spheroids of defined maturation states.

Materials and Methods：Human BM-MSCs and UC-MSCs were induced to undergo chondrogenic differentiation, and spheroids were collected at 7, 14, and 21 days to assess their maturation and transcriptomic profiles. Composite spheroids were created to evaluate integration capacity, and multilayered constructs were assembled to mimic native cartilage structure. A porcine femoral condyle defect model was used to compare the repair efficacy of BM-MSC-derived, UC-MSC-derived, and autologous cartilage grafts, with recovery assessed six months post-transplantation.

Results：Histological analysis confirmed the chondrogenic differentiation potential of both BM-MSCs and UC-MSCs. Bulk RNA-seq revealed activation of extracellular matrix organization and cartilage development programs during chondrogenesis in both cell types. However, distinct transcriptomic signatures were observed between sources, particularly in collagen subtype expression and hypertrophy-related genes. Less mature spheroids exhibited superior integration, and encapsulating more mature spheroids within less differentiated ones improved overall cohesion. The stratified arrangement of spheroids successfully replicated the layered structure of native cartilage, with undifferentiated MSCs enhancing integration with bone substitutes. *In vivo* experiments demonstrated that MSC-derived spheroids achieved superior tissue integration and repair outcomes compared to autologous cartilage transplantation.

Discussion：The findings indicate that UC-MSCs exhibit strong chondrogenic potential and hold promise as an allogeneic cell source for cartilage repair. Future studies should focus on evaluating the immunological safety and long-term efficacy of this approach to enhance its clinical feasibility and expand treatment options for cartilage defects.

Conclusions：This study establishes differentiation-stage programming, supported by bulk transcriptomic profiling, as a mechanistically informed principle for bottom-up cartilage biofabrication. Stratified assembly of MSC-derived spheroids recapitulates cartilage hierarchy and enhances tissue integration. UC-MSC–derived constructs demonstrate translational potential as an off-the-shelf cell source for multizonal cartilage regeneration.

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以去細胞豬源角膜支架經前板層角膜移植治療角膜潰瘍之人類角膜再生
Human Corneal Regeneration Using Acellular Porcine Corneal Scaffolds for Corneal Ulcer Treatment Via Anterior Lamellar Keratoplasty

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Introduction：Infectious corneal ulcers are the main reason for the blindness worldwide. The most common pathogens liable for infectious keratitis include bacteria, fungi, and viruses. About 10 million cases of blindness worldwide are reported for corneal blindness. Corneal transplantation is a valuable surgical treatment for the corneal blindness. However, the source of corneal tissue suitable for transplantation has never met worldwide demand. In the present study, we used supercritical CO2-processed acellular porcine cornea (APC) for the first time in Taiwan, in a clinical trial to evaluate its safety and efficacy as an alternative material for human donor corneal tissue in an anterior lamellar keratoplasty operation.

Materials and Methods：A prospective, open-label, single-arm, multi-centre clinical study involving 8 patients, with ABCcolla® Collagen Ophthalmic Matrix for lamellar keratoplasty done between November 2020 and October 2022. All patients had corneal ulcers and underwent ALK with ABCcolla® Collagen Ophthalmic Matrix. The parameters for evaluating the study device included the incidence of irreversible graft melting or irreversible rejection within 24 weeks, as well as post-operative best-corrected visual acuity (BCVA) and transparency of the ABCcolla® Collagen Ophthalmic Matrix.

Results：Corneal ulcers were treated to eight patients via ALK with ABCcolla® Collagen Ophthalmic Matrix. In the eight study eyes in the subjects from the Safety Set, one eye experienced irreversible graft melting or irreversible rejection; the rate of incidence was 12.5%. In the seven study eyes in the subjects from the Per-Protocol Set, none experienced irreversible graft melting or irreversible rejection; the rate of incidence was therefore 0%. Five (62.5%) subjects experienced 21 adverse events in total; three (37.5%) subjects experienced three serious adverse events (SAEs) in total. Only one SAE was possibly related to the study device. After 651 days, a patient received a matched human donor cornea, replacing the acellular porcine cornea (APC). Histological and immunohistochemical analyses of the explanted APC revealed reconstruction by human corneal epithelial cells and keratocytes.

Discussion：Altogether, these findings recommends that the ABCcolla® Collagen Ophthalmic Matrix assists as a supportive microenvironment for both limbal epithelial stem cells and terminally differentiated epithelial cells, allowing the repopulation of corneal cells and encouraging complete corneal regeneration.

Conclusions：ABCcolla® Collagen Ophthalmic Matrix, over a 6-month follow-up on the subjects treatment the transplantation surgery in the study, the results produced during the investigation offered adequate sustenance for the product's proposed use, which was to be used as an substitute material for human donor corneal tissue in an ALK operation.

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局部施用月桂來源胞外體透過重編程糖尿病傷口微環境促進組織再生
Topical *Laurus Nobilis*-derived Extracellular Vesicles Reprogram the Diabetic Wound Microenvironment to Enable Tissue Regeneration

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Introduction：Chronic non-healing wounds represent one of the most devastating complications of diabetes, driven by persistent epithelial dysfunction, extracellular matrix collapse, and unresolved cellular stress within the wound microenvironment. Despite advances in systemic metabolic control, current therapies fail to restore intrinsic regenerative capacity at the tissue level, leaving a substantial proportion of patients vulnerable to chronic ulceration, infection, and limb-threatening outcomes. The lack of locally acting, mechanism-driven regenerative therapeutics underscores a critical unmet clinical need. Plant-derived extracellular vesicles (PDEVs) have recently emerged as scalable, cell-free bioactive nanovesicles capable of modulating intercellular signaling and stress adaptation. However, their therapeutic potential in diabetic wound regeneration remains largely unexplored. *Laurus nobilis*, traditionally valued for its skin-repairing properties through anti-inflammatory, antioxidant, and wound-soothing bioactivities, represents a promising botanical source of regenerative signaling. Leveraging extracellular vesicles as a delivery platform enables stabilization and concentration of plant-derived bioactive cargos while enhancing cellular uptake and localized microenvironmental modulation, providing a translationally attractive strategy for topical regenerative applications. Here, we investigate whether topical administration of *Laurus nobilis*–derived extracellular vesicles (*L.N.*-EVs) can restore epithelial resilience and extracellular matrix remodeling, thereby reactivating regenerative programs in diabetic wounds.

Materials and Methods：*L.N.*-EVs were isolated and purified using the NanoEx purification system, a high-efficiency platform designed to maximize vesicle recovery while preserving structural integrity and minimizing protein and small-molecule contaminants. This approach enabled the generation of highly pure and biologically active vesicle preparations suitable for topical therapeutic application. Purified *L.N.*-EVs were applied to full-thickness excisional wounds in diabetic *db/db* mice. Wound closure kinetics were monitored longitudinally, and histological analyses were performed to assess re-epithelialization, collagen deposition, and epidermal differentiation. *In vitro*, keratinocytes were treated with NanoEx-purified *L.N.*-EVs under glycation- and UVB-induced stress conditions. Cellular proliferation, differentiation-associated markers, and extracellular matrix–related gene expression were evaluated using quantitative PCR and protein-level analyses to determine the regenerative and stress-modulating effects of the purified vesicles.

Results：Topical administration of *L.N.*-EVs significantly accelerated wound closure in diabetic mice. Treated wounds exhibited enhanced re-epithelialization, increased collagen deposition, and restoration of organized epidermal architecture. At the cellular level, *L.N.*-EVs promoted keratinocyte proliferation and reinforced differentiation-associated pathways essential for epidermal repair. Under glycation- and UVB-induced stress conditions, *L.N.*-EVs mitigated stress-associated gene activation and suppressed fibrotic signaling, while restoring regenerative and matrix-remodeling programs. Collectively, these findings indicate that *L.N.*-EVs directly enhance epithelial resilience and extracellular matrix reconstruction within the diabetic wound microenvironment.

Discussion：This study demonstrates that *L.N.*-EVs function as a locally acting regenerative modulator in diabetic wound repair. Rather than relying on systemic metabolic intervention, *L.N.*-EVs act directly on epithelial cells to enhance stress adaptation and promote extracellular matrix reorganization. By

restoring keratinocyte proliferative capacity and reinforcing matrix remodeling pathways, *L.N.*-EVs re-establish a pro-regenerative microenvironment that supports tissue repair. These results highlight plant-derived extracellular vesicles as a novel bioactive platform capable of reshaping impaired wound niches through localized cellular reprogramming.

Conclusions：Topical administration of *L.N.*-EV–based products promote diabetic wound healing by enhancing keratinocyte resilience and extracellular matrix remodeling, thereby restoring regenerative capacity within the wound microenvironment. These findings support *L.N.*-EVs as a scalable extracellular vesicle–based regenerative product with clear mechanistic activity and promising translational potential for chronic wound applications. Collectively, our findings establish *L.N.*-EVs as a mechanism-defined extracellular vesicle therapeutic, offering a cell-free regenerative product platform for diabetic wound repair.

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結合 FG4592 與 BMSC 之光交聯玻尿酸/膠原蛋白水膠：促進細胞增生與髓核分化
BMSC Loaded Photo-Crosslinked Hyaluronic Acid/Collagen Hydrogel Incorporating FG4592 For Enhanced Cell Proliferation and Nucleus Pulposus Differentiation

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Introduction：We developed a photo-crosslinkable hydrogel incorporating FG4592 to support the growth and differentiation of bone marrow-derived mesenchymal stem cells (BMSCs) into nucleus pulposus (NP) cells. After BMSC cultivating, there was an upregulation in the expression of glycosaminoglycans, aggrecan, type II collagen, and keratin 19 proteins
Materials and Methods：The hydrogel precursor was prepared by blending collagen, hyaluronic acid, and glycosaminoglycans (GAG) with riboflavin as the photo-initiator for BMSCs 3D cell culture. 10 μL of BMSC-loaded hydrogel was slowly injected into the center of the NP through the previously created puncture site, and the hydrogel was then exposed to blue light to facilitate gelation within the coccygeal disc.
Results：In this study, we successfully developed a photo-crosslinked hydrogel with mechanical stiffness mimicking human nucleus pulposus tissue. Incorporating the hypoxia-mimicking agent FG4592 significantly enhanced BMSC proliferation and differentiation by stabilizing HIF-1α. In both rat and human 3D cultures, FG4592 treatment robustly upregulated essential NP markers, aggrecan, type II collagen, and keratin 19, while increasing glycosaminoglycan production.
Discussion：Despite challenges regarding *in vivo* light penetration depth, this injectable, bioactive scaffold effectively directs stem cell fate, presenting a promising therapeutic strategy for regenerating early-stage partial disc defects.
Conclusions：We developed a biodegradable photo-crosslinked Tyr-HA/collagen hydrogel mimicking human NP mechanics. Incorporating FG4592 creating a hypoxic niche that robustly drove BMSC differentiation into NP-like phenotypes. This injectable system significantly enhanced aggrecan and collagen II expression in both rat and human cells, offering a potent strategy for intervertebral disc regeneration.

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脂肪來源幹細胞粒線體轉移可改善老化軟骨細胞功能並提升其軟骨生成表型
Mitochondrial Transfer from Adipose-Derived Stem Cells Improves the Chondrogenic Phenotype in Senescent Chondrocytes by Ameliorating Mitochondrial Dysfunction

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Introduction：Obtaining sufficient chondrocytes by monolayer expansion in vitro is used for articular cartilage tissue engineering. However, chondrocytes lose their chondrogenic phenotype after monolayer expansion via mitochondrial dysfunction-induced senescence. Intercellular mitochondrial transfer (MT) is a cell-to-cell signaling involving the active incorporation of healthy mitochondria into stressed/injured recipient cells. MT by mesenchymal stem cells (MSCs) into recipient cells is involved in MSCs-triggered repair of damaged cells. Importantly, Adipose-derived stem cell (ADSC) is known to provide mitochondria to recipient cells for improving function of senescent cells. We hypothesize that ADSC mitochondrial transfer (ADSC-MT) improves the chondrogenic phenotype of senescent chondrocytes.
Materials and Methods：After monolayer expansion in vitro, chondrocytes were subjected to ADSC-MT. Cell senescence was evaluated via analysis of p16 and p21 expression and senescence-associated β-galactosidase (SA-β-gal) staining. The chondrogenic phenotype was evaluated by measuring collagen type II (Col-II) and collagen type I (Col-I) levels. Oxidative stress was assessed by determining the mitochondrial superoxide and 8-hydroxydeoxyguanosine (8-OHdG) levels. Mitochondrial dysfunction was assessed by determining the mitochondrial membrane potential (MMP) and PGC-1α levels. Finally, SOD-2, SIRT-1, SIRT-3, TFAM, MFN-1, MFN-2, OPA-1, Pink-1 and Parkin levels were used to assess mitochondrial quality control (MQC).
Results：ADSC-MT-recipient chondrocytes exhibited alleviated senescence with decreased p16 and p21 expression and SA-β-gal staining. The increased Col-II and decreased Col-I expression indicated that the chondrogenic phenotype of the chondrocytes was restored. Decreased mitochondrial superoxide and 8-OHdG levels indicated alleviated oxidative stress. The increased MMP indicated alleviation of mitochondrial dysfunction. For MQC, SOD-2, PGC-1α, TFAM, SIRT1, and SIRT3 were upregulated, and Pink-1 and Parkin were downregulated, indicating that antioxidant defences, mitochondrial biogenesis and mitophagy in MQC were increased in ADSC-MT-recipient chondrocytes, whereas MFN-1, MFN-2 and OPA-1 were not changed, indicating that mitochondrial dynamics was not affected.
Discussion：For regeneration of articular cartilage defects in the clinic, chondrocyte senescence remains the major barrier in chondrocyte-based articular cartilage tissue engineering. For example, autologous chondrocyte implantation (ACI) has been used for more than 30 years in the clinic and is still considered the gold standard for treating articular cartilage defects. However, chondrocytes lose their chondrogenic phenotype after monolayer expansion in vitro, which impairs their ability to synthesize hyaline cartilage. In this study, we show that ADSC-MT improves the chondrogenic phenotype of senescent chondrocytes by ameliorating mitochondrial dysfunction, suggesting that ADSC-MT may be a strategy for chondrocyte-based articular cartilage tissue engineering.
Conclusions：ADSC-MT improves the chondrogenic phenotype of senescent chondrocytes by ameliorating mitochondrial dysfunction.

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超臨界二氧化碳去細胞化腎臟支架結合誘導性多功能幹細胞進行腎臟再生
Supercritical CO_2–Decellularized Renal Scaffolds Combined with iPSC Cells for Kidney Regeneration

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Introduction：Chronic kidney disease (CKD) and end-stage renal disease (ESRD) continue to impose a substantial global health burden, while the severe shortage of donor kidneys limits the effectiveness of transplantation as a definitive therapy. The development of alternative regenerative strategies to replace conventional kidney transplantation has become a critical goal in regenerative medicine. This study integrates regenerative medicine, tissue engineering, and stem cell biology to establish an innovative kidney regeneration platform using supercritical carbon dioxide ($SCCO_2$)-decellularized kidney scaffolds combined with human induced pluripotent stem cells (iPSCs). We hypothesize that $SCCO_2$ decellularization may offer distinct advantages over conventional detergent-based methods, including efficient cell removal without chemical residue, preservation of native extracellular matrix (ECM) architecture, and maintenance of intact vascular networks, thereby reducing immunogenicity and enhancing biocompatibility. The anticipated outcomes will provide a novel and clinically relevant framework for kidney regeneration, with broad implications for ESRD therapy and personalized regenerative medicine.

Materials and Methods：This study was conducted in collaboration with Asia-Pacific Biomedical Co., Ltd., utilizing supercritical carbon dioxide ($ScCO_2$) perfusion technology to remove cellular components from porcine kidneys while preserving the intact extracellular matrix. The iPSCs were obtained from the Taiwan Human Disease Induced Pluripotent Stem Cell Service Consortium, BCRC Strain Collection (firdi.org.tw). These iPSCs were maintained exclusively in E8 medium without the addition of exogenous growth factors for renal induction and were labeled with the CMFDA green fluorescent cell tracker to monitor cell viability, growth, distribution, and morphology. Cells on the decellularized renal sheets were collected at weeks 1, 2, and 3, and then immunohistochemical staining was performed to evaluate differentiation toward renal lineage cells.

Results：In this study, iPSCs displayed green fluorescence on the scaffold, confirming successful cell attachment, proliferation, and growth. Cells within the scaffold sections progressively aggregated to form hollow tubular architectures resembling the loop of Henle, collecting ducts, and Bowman's capsule–like structures. Samples were collected at weeks 1, 2, and 3 for renal marker analysis. Immunohistochemical staining revealed positive expression of WT1, Pax2, NPHS1, and podocalyxin in cells within the scaffold sections, indicating differentiation of iPSCs into early renal lineage cells, nephron progenitor cells (NPCs), and mature podocytes. In addition, AQP2, SLC12A3, and CD34 positivity was observed, corresponding to ureteric bud/collecting duct lineage, renal tubular cells, and vascular endothelial cells, respectively. These findings suggest that the scaffold possesses intrinsic cues that promote renal differentiation. Notably, iPSCs formed tubular and organoid-like structures on thin slices of the $ScCO_2$-decellularized renal scaffold during in vitro culture, further demonstrating that this scaffold provides a supportive microenvironment for renal lineage differentiation and holds promise for applications in kidney regeneration.

Discussion：Our study demonstrates that $ScCO_2$-decellularized renal scaffolds provide a supportive microenvironment for iPSC attachment, proliferation, and differentiation into multiple renal lineages, including nephron progenitors, podocytes, tubular cells, collecting ducts, and vascular endothelial cells, even in the absence of exogenous growth factors. The formation of tubular and organoid-like structures indicates that the scaffold preserves essential structural and biochemical cues for kidney tissue

organization. These results suggest that the scaffold itself can guide renal lineage specification and holds promise as a platform for kidney tissue engineering. In future work, we plan to seed renal progenitor cells onto the scaffold to further enhance renal regeneration and functional maturation.

Conclusions：In conclusion, the $ScCO_2$-decellularized renal scaffold supports iPSC attachment, growth, and differentiation into renal lineages, demonstrating its intrinsic inductive properties. The scaffold's ability to promote the formation of tubular and organoid-like structures highlights its potential as a bioengineered platform for kidney regeneration. Future studies using renal progenitor cells may further improve scaffold-mediated renal tissue reconstruction, advancing translational applications in regenerative medicine.

台灣再生醫學學會 (個人、贊助、準) 會員入會申請書

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<tr><td colspan="11">本人贊同貴會宗旨，擬加入為會員，嗣後並願意遵守會章，共圖發展

此致 台灣再生醫學學會 申請人： (簽章)

中 華 民 國 年 月 日</td></tr>
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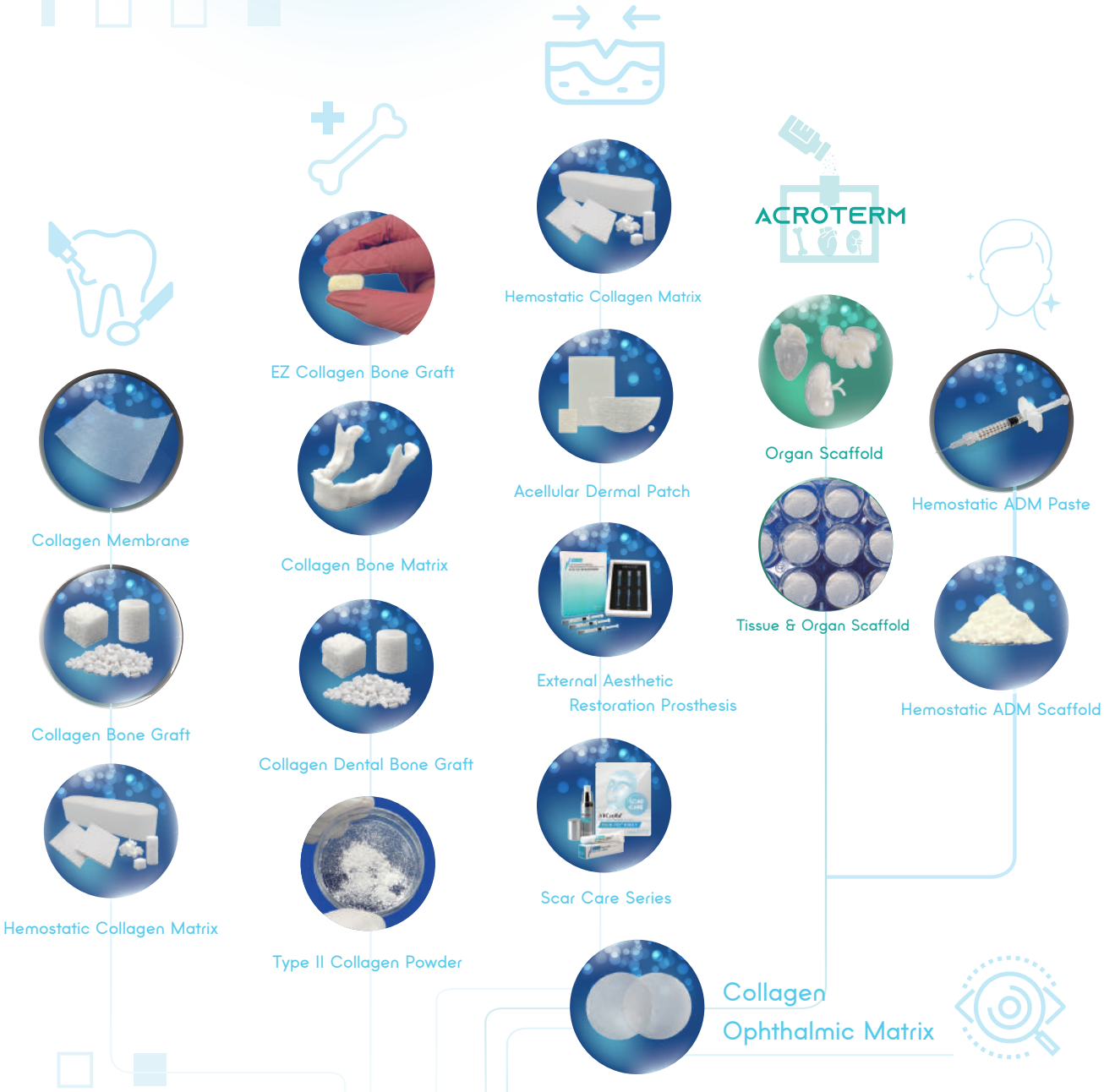

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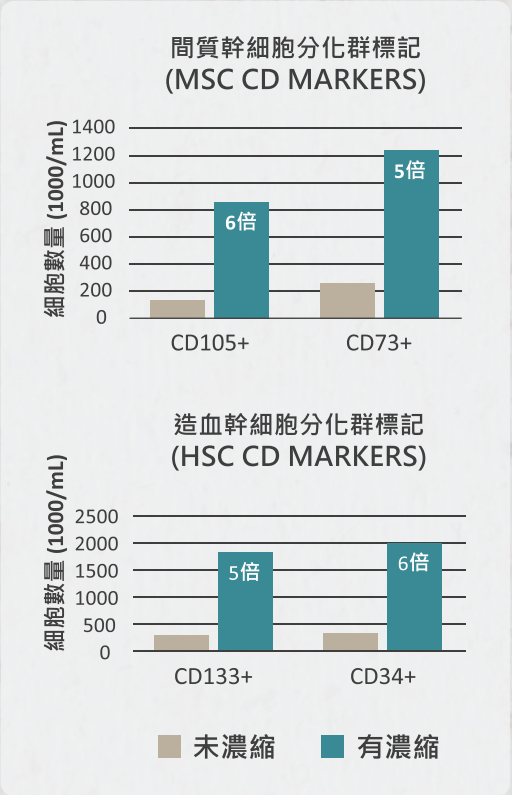

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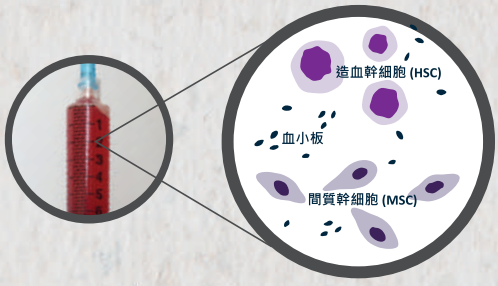

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1. Sierra DH. Fibrin sealant adhesive systems: a review of their chemistry, material properties and clinical applications. *J. Biomater Appl.*

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- 再生醫療技術累積收案數突破200[註6]

資料來源:註1.iScience. 2025 Jan 3;28(2):111705. 註2.Syst Biol Reprod Med. 2021 Jun;67(3):177-188. 註3.Sci Rep. 2021 Jan 15;11(1):1584 註4.J Sex Med. 2021 May;18(5):926-935. 註5:訊聯收案結果與2023年TFDA公告細胞治療年報結果一致 註6:再生醫療技術

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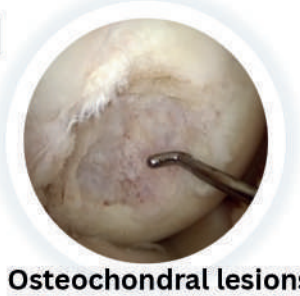
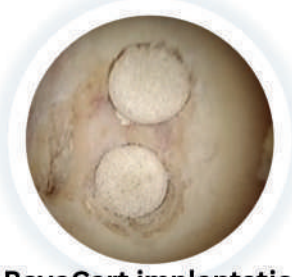


Osteochondral lesions



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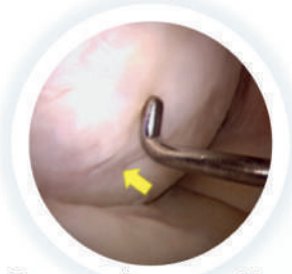
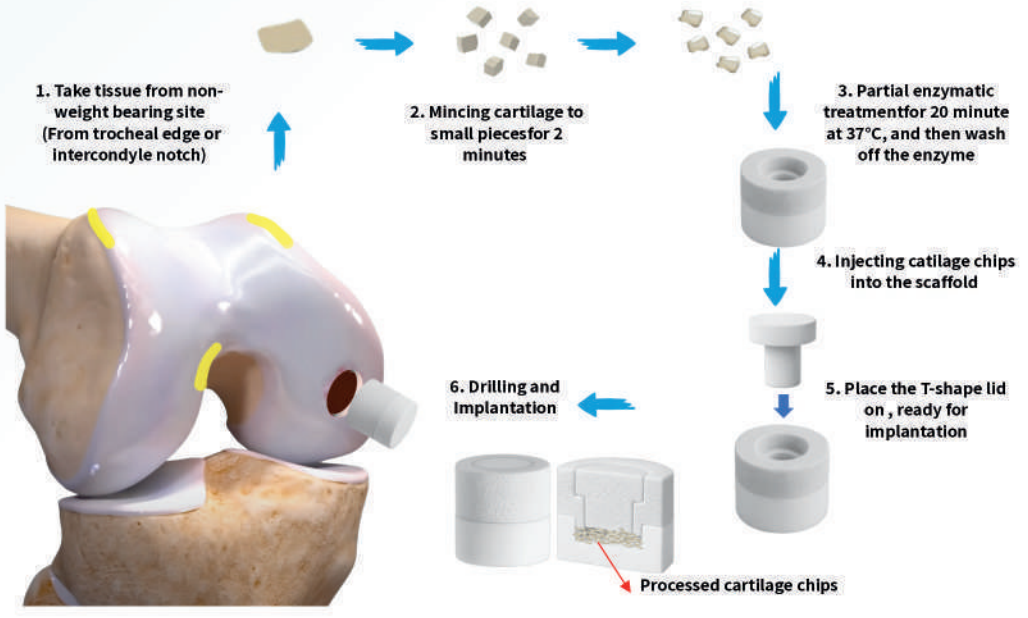
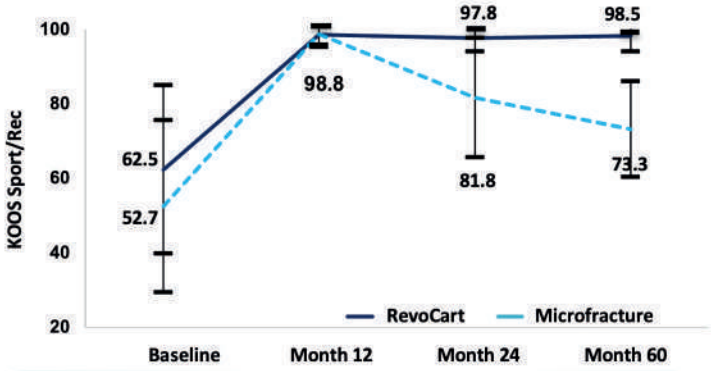
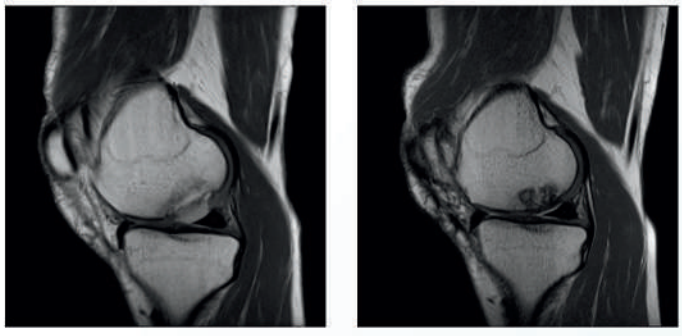


12-momth second look

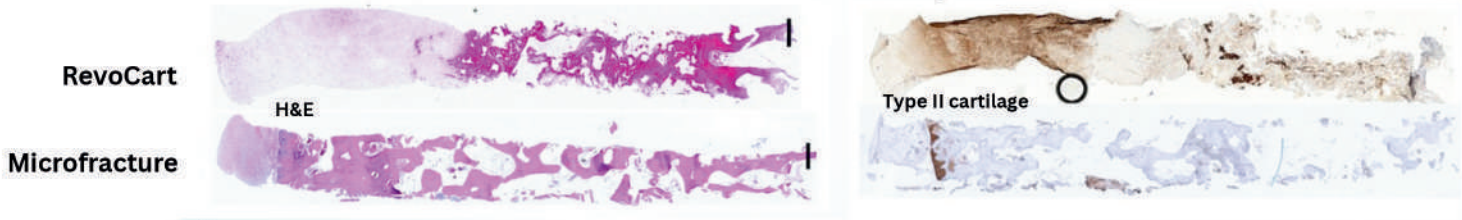




RevoCart shows superior long-term results vs. microfracture



Long-term MRI confirms durable cartilage repair with bony integration



RevoCart regenerates hyaline-like cartilage — histologically confirmed

1. Arthroscopy 2025, vol 41, No. 3, pp688-699
2. J Orthop Surg Res. 2025 Jan 20;20(1):73
3. ICRS World Congress, September 9-12, 2023, Barcelona, Spain. [Poster Presentation]
4. ICRS World Congress, April 12-15, Berlin, German. [Poster Presentation]

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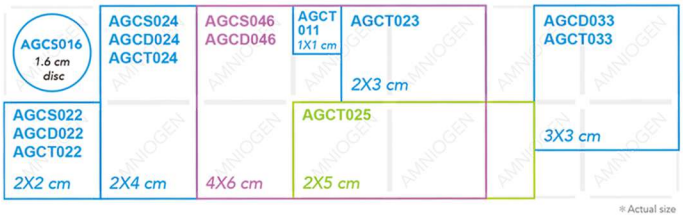

1 Silini, Antonietta R. et al. "The Long Path of Human Placenta, and Its Derivatives, in Regenerative Medicine." Frontiers in Bioengineering and Biotechnology 3 (2015): 162. PMC. Web.
2 ElHeneidy, Hossam et al. "Amniotic Membrane Can Be a Valid Source for Wound Healing." International Journal of Women's Health 8 (2016): 225-231. PMC. Web.

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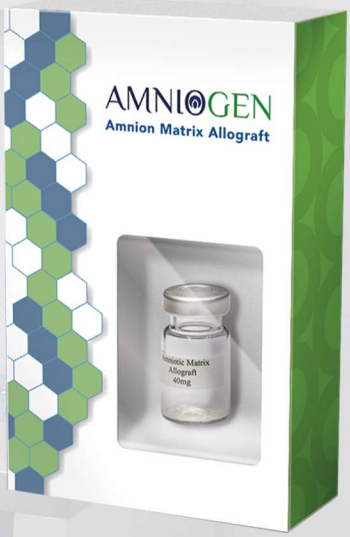

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* C. Zelen et al., "Prospective, Randomized, Blinded, Comparative Study of Injectable Micronized Dehydrated Amniotic/Chorionic Membrane Allograft for Plantar Fasciitis - A Feasibility Study." Foot & Ankle International. 34 (2013):1332-1339

** A. Gellharn et al., "The Use of Dehydrated Human Amnion/Chorion Membrane Allograft Injection for the Treatment of Tendinopathy or Arthritis: A Case Series Involving 40 Patients. " American Academy of Physical Medicine and Rehabilitation 9 (2017): 1236-1243

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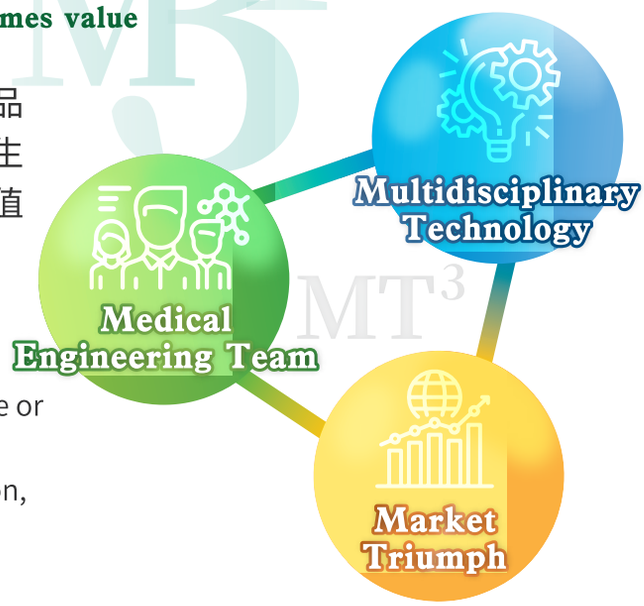

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