南通大学高层次人才培育计划

培养对象申请表

申 请 人：	代秀
所在单位：	神经再生重点实验室（与神经科学系、神经再生协同创新中心合署）
申报类别：	B 计划
填表时间：	

南通大学高层次人才工作办公室制

填写说明

一、填写本表前，请认真阅读《南通大学高层次人才支持计划实施办法》和相关通知。

二、申请表中应明确填写清楚申报类别、发展目标、目前已具备的基本条件、未来工作计划等各项内容。

三、表中所涉个人前期业绩成果均应做到真实完整、信息准确、无知识产权纠纷及其他异议。

四、本表请采用 A4 纸双面打印。

一、申请人基本情况

姓　　名	代秀	性　　别	女	国　　籍	中华人民共和国
出生年月 年龄（周岁）	1990.07 36	政治面貌	无	党政职务	无
最高学历	博士研究生毕业	最高学位	博士研究生毕业	联系电话	15005159622
现任专业技术职务及任职时间	副教授 2024-10-13				
所在学科一级学科及研究方向	材料工程 生物材料与组织工程				
最高学历毕业学校及毕业时间	南京理工大学 2019-06-19				
海外学习及工作（含博后）经历	(1) 2017-03 至 2017-08, 美国约翰霍普金斯大学（ U.S. News：14）, 材料科学与工程, 联合培养博士生 (2) 2018-03 至 2019-03, 美国约翰霍普金斯大学（ U.S. News：14）, 材料科学与工程, 联合培养博士生				

注：海外经历请注明学习工作高校（科研院所）的世界排名、起止时间及个人职务等情况

二、培育目标及现有基础

申报类别	B 计划	
培育目标	A 计划第一档	A 计划第二档
	B 计划 省杰出青年基金	

现有基础	（对照培育目标，简要列举申请人已具备的基础条件，着重标出已取得的标志性成果，500字内） 一、科研项目： 1. 国家自然科学基金青年科学基金项目，2022.01-2024.12,30 万，主持； 2. 江苏省自然科学基金青年基金项目，2020.07-2023.06,20 万，主持； 3. 江苏省教育厅面上项目，2020.12-2022.12,3 万，主持； 4. 江苏省前沿引领技术基础研究重大项目，2023.10-2026.09，1000 万，参与； 5. 江苏省前沿引领技术基础研究专项，2020.10-2023.09，500 万元，结题，参与。 二、教学教改项目：无 三、论文、专著： 在著名学术期刊上发表 SCI 论文 14 篇，合计引用 452 次。以南通大学为第一作者或通讯作 在本学科 SCI 收录期刊发表 9 篇，其中科院一区论文 4 篇，高被引 1 篇。 四、学术奖励：无； 五、荣誉称号：无； 六、授权国内与国际发明专利、成果转换情况：近五年以第一发明人获授权发明专利 2 项。

三、近五年主要业绩

（一）主要完成或在研的科研项目（作为负责人承担的国家级科研项目可全部列出，一般不超过 5 项）

项目名称	开始时间/到账时间	项目分类	获得资助金额	本人作用	项目级别（纵向）
含取向微通道的壳聚糖/hBMSC-ECM/重组人胶原双层仿生神经移植物的构建及其促进神经再生的机制研究	2021-01	青年科学基金项目	30	主持	国家级

注：本人作用指负责主持；项目进展情况包括已完成、已完成且成果已转化应用或正在进行等。

（二）近五年主要完成或在研的教学教改项目（作为负责人承担的教学项目可全部列出，一般不超过 5 项）

项目名称	获奖、立项等级	本人排名	获奖、立项时间

（三）近五年主要论文、著作情况

1.主要论文目录（按重要性排序，合计不超过 5 篇）

期刊名称	论文题目	论文级别	发表时间	第一署名单位
Chemical Engineering Journal	Chitosan nerve conduit filled with ZIF-8-functionalized guide microfibres enhances nerve regeneration and sensory function recovery in sciatic nerve defects	三级：SCI（中科院一区）	2024-01-15	第一单位
Chemical Engineering Journal	Multifunctional scaffolds based on 3D printing for spinal cord and peripheral nerve defect repair	三级：SCI（中科院一区）	2025-11-15	第一单位
Biomaterials Advances	Chitosan/hBMSC-ECM biomimetic nerve grafts containing orienting microchannels for peripheral nerve regeneration	三级：SCI（中科院一区）	2023-12-01	第一单位
Regenerative Biomaterials	Application of metal-organic frameworks-based functional composite scaffolds in tissue engineering	三级：SCI（中科院一区）	2024-02-01	第一单位
MACROMOLECULAR MATERIALS	Properties of Electrospun Aligned Poly(lactic acid)/Collagen Fibers with Nanoporous Surface for Peripheral Nerve Tissue Engineering	五级：SCI（中科院三区）	2022-07-21	第一单位

2.主要著作目录（按重要性排序，合计不超过 5 本）

书　名	出版社	出版日期

（四）获得主要学术奖励情况（包含科研、教学，按重要性排序，合计不超过 2 项）

获奖项目名称	奖励名称	奖励等级	获奖时间	奖励单位

（五）近五年获得省部级以上荣誉称号情况（按重要性排序，合计不超过 2 项）

荣誉称号	入选时间	颁发部门

（六）授权国内与国际发明专利、成果转换情况（按重要性排序，合计不超过 5 项）

1.授权国内与国际发明专利情况

专利名称	专利号	国别	授权时间	本人排名
Nerve guiding fiber loaded in situ with ZIF-8 and its preparation method	LU504616	国外	2024-01-08	1
一种具有取向微通道的神经移植物及其制备方法	2022113895885	国内	2023-12-19	1

2.成果转化情况

成果名称	转化时间	首次受让企业	本人作用（主要负责或参与）

（七）其他成果

1.其他科研项目

项目名称	开始时间/到账时间	项目分类	获得资助金额	项目状态	本人作用	项目级别（纵向）
仿生组织工程、类器官构建理论与技术创新及其转化	2023-10	重大	1000	进行	参与	省部级

注：本人作用指负责主持；项目进展情况包括已完成、已完成且成果已转化应用或正在进行等。

2.其他教学教改项目

项目名称	获奖、立项等级	本人排名	获奖、立项时间

3.其他论文

期刊名称	论文题目	论文级别	发表时间	学校署名

4.其他著作

书　名	出版社	出版日期

5.其他学术奖励

获奖项目名称	奖励名称	奖励等级	获奖时间	奖励单位

6.其他授权国内与国际发明专利情况

专利名称	专利号	国别	授权时间	本人排名
一种仿生神经移植物及其制备方法	7560189	日本	2024-09-24	第二
一种仿生神经移植物及其制备方法	202391986	欧亚	2024-11-28	第二

8.其他成果转化情况

成果名称	转化时间	首次受让企业	本人作用（主要负责或参与）

四、未来工作计划

突破方向	（对照培育目标及现有条件，分析目标达成中的现实差距及需要突破的方面，500 字内） 对照江苏省杰出青年基金项目的定位与申报条件，本人已具备博士学位和副高级专业技术职务，主持过国家自然科学基金青年科学基金项目（C 类）并已顺利结题，且未获得过国家杰青、国家优青及省杰青等项目资助，在基本条件和年龄要求上符合申报资格。但省杰青项目以“培养国家杰出青年科学基金获得者等高层次人才”为目标，经费强度高（每项不超过 180 万元），竞争极为激烈，本人与省杰青资助要求之间仍存在显著差距： （一）学术影响力与标志性成果的层级差距显著。省杰青要求申报人“在其研究领域有一定的学术建树和国内外影响”。本人目前以唯一/通讯作者发表论文 14 篇，虽在神经修复生物材料领域有一定积累，但缺乏领域内公认的标志性成果（如顶级期刊论文），学术影响力尚未达到省杰青“有望进入科技前沿”的评审要求。 （二）独立学术标签与方向辨识度不足。省杰青强调“成为该领域学术带头人的发展潜力”。本人目前的研究方向与导师/合作者存在交叉，尚未形成具有高度辨识度的独立学术标签和研究体系，在神经再生生物材料领域缺乏独特的科学问题和理论贡献。 （三）主持更高层级科研项目的经历欠缺。省杰青要求主持过省级或省级以上科技计划项目。本人虽主持过国自然青年项目及省青年基金，但尚未主持过国自然面上项目或更高层级的项目，缺乏独立领导较大规模科研项目的经验积累。 （五）成果的原创性与转化潜力有待强化。省杰青强调“面向江苏和国家需求开展创新研究”。本人现有研究偏基础材料构建，在原创性理论突破和面向临床转化的应用基础研究方面尚需进一步深化。

未来工作计划	（对照培育目标、现有条件及拟突破的方向，拟定未来的主要工作及安排，800 字内） （一）标志性成果突破 聚焦“仿生微环境构建与神经再生免疫调控”这一核心科学问题，在现有研究基础上凝练两个具有原创性的子方向：（1）智能响应型神经导管材料及其对神经再生的时空精准调控：基于前期 ZIF-8 功能化取向微纤维和壳聚糖/hBMSC-ECM 复合支架的研究积累，探索材料拓扑结构与生物活性因子的协同控释机制；（2）仿生材料介导的免疫-神经交互调控：围绕“材料－免疫－神经再生”交叉前沿，阐明仿生微环境重塑免疫应答促进神经再生的新机制。目标：争取在 Nature Communications、Science Advances、Biomaterials 等权威期刊发表高水平论文，力争产出 1－2 项具有领域影响力的标志性成果。 （二）高层次项目培育 2026 年下半年完成国家自然科学基金面上项目的申报（围绕上述两个子方向之一），力争 2027 年获得资助，积累主持更高层级科研项目的经验。同步推进省杰青项目申报书的精雕细琢，突出研究的原创性、系统性和个人学术标签的独特性。 （三）学术影响力提升 积极申请加入中国生物材料学会、中国神经科学学会等国内重要学术组织的专业委员会，争取在省级或国家级学会中担任委员或青年委员职务；每年参加 2－3 次领域内高水平学术会议并做邀请报告或口头报告，逐步提升个人在神经再生生物材料领域的学术可见度。加强与约翰霍普金斯大学等国际知名机构的合作，拓展国际合作网络，提升研究的国际影响力。 （四）知识产权与转化探索 围绕核心研究成果，申报中国发明专利 3－4 项、国际发明专利 2－3 项；积极对接南通及长三角地区的生物医药企业和医疗机构，探索神经修复材料的转化应用路径，推动至少 1－2 项专利技术进入临床前验证阶段，体现基础研究服务江苏产业发展的价值。 （五）团队建设与人才培养 协助指导课题组研究生 3－4 名，培养其独立开展前沿科学研究的能力，逐步形成以本人为核心、结构合理的研究团队；积极参与南通大学神经再生重点实验室的平台建设，依托实验室在神经再生领域的优势地位，推动基础研究成果向临床转化方向延伸。

五、需要学校提供的支持

是否实验类	是	
培育建设经费预算	工作计划	预算（万元）
	仿生神经移植物材料表征、细胞实验、动物实验、再生神经分析测序	12
	高水平学术论文版面费、专利申请费	6
	参加国内外重要学术会议（中国生物材料学会、中国神经科学学会年会等，含注册费、差旅费）	2

	合计	20 万元
其他支持需求清单	实验空间保障、大型仪器设备共享使用优惠、学术组织推荐与提名	

五、申请人承诺

（对照未来拟开展的工作，列举需要学院及学校提供的其他支持事项的清单）

1. 以上所填信息均真实有效；
2. 如入选学校培育计划，按期完成培育任务，规范使用学校支持经费；
3. 培育目标达成后，本人志愿在本校服务 10 年以上。

申请人签字：_____

_____年_____月_____日

六、二级单位审核推荐意见

1. 申请人填写的内容是否属实？	是
2. 申请人发展目标是否符合学院发展规划？	是
3. 申请人是否具备培育目标的基础条件及培养潜力？	是
4. 申请人对目标达成的现实差距及突破点的分析是否准确？	是
5. 申请人制定的工作计划是否切实可行？	是
6. 申请人对培育建设经费的预算是否合理？	是
7. 学院是否同意推荐申请人申请相关计划？	是
培养期内，学院为申请人提供以下支持： 在研究生名额分配给予倾斜。 优先使用学院科研和教学平台。 提供优质的科研支撑团队。 党政负责人签字： （单位公章） _____年_____月_____日	

七、学校人才工作领导小组意见

经评审，同意_____同志入选_____培育计划。

组长（签章）：

_____年_____月_____日

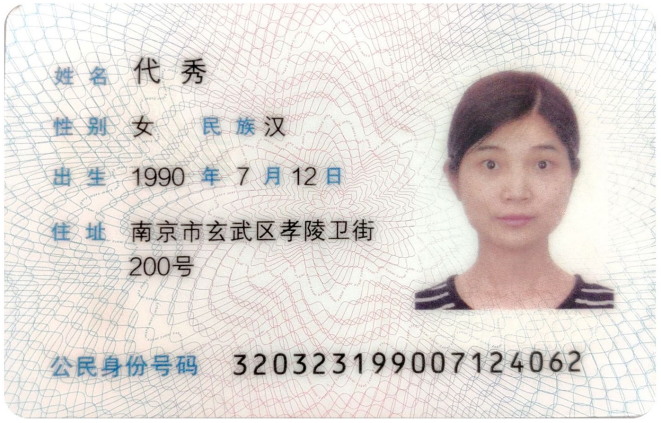
八、学校意见

学校公章：　　校长签字：

_____年_____月_____日

申报材料附件

代秀


姓名 代秀
性别 女 民族 汉
出生 1990 年 7 月 12 日
住址 南京市玄武区孝陵卫街200号
公民身份号码 320323199007124062


中华人民共和国
居民身份证
签发机关 南京市公安局玄武分局
有效期限 2019.06.12-2039.06.12

博士研究生

毕业证书

代秀
314103002311

研究生 代秀 性别 女， 1990 年 7 月 12 日生，于 2014 年 9 月至 2019 年 6 月在 材料科学与工程 专业学习，学制 5 年，修完博士研究生培养计划规定的全部课程，成绩合格，毕业论文答辩通过，准予毕业。

培养单位：南京理工大学 校(院、所)长：

证书编号：10288120190100012 8

二〇一九 年 六 月 十九 日

中华人民共和国教育部学历证书查询网址：http://www.chsi.com.cn

南京理工大学
NANJING UNIVERSITY OF SCIENCE & TECHNOLOGY

博士学位证书

代秀 ，女 ，1990 年 7 月 12 日生。已通过材料科学与工程 学科博士学位的课程考试和学位论文答辩，成绩合格。经南京理工大学学位评定委员会审议，授予 工学 博士学位。

校 长
学位评定委员会主席

团结敬业求是创新

证书编号：1028822019000128

二〇一九 年 六 月十九 日

江苏省高级专业技术资格证书

此证表明持证人具有担任相应专业技术职务的任职资格

姓　　名：代秀

性　　别：女

出生年月：1990-07-12

身份证号：320323199007124062

工作单位：南通大学

评委会名称：江苏省南通大学教师高级专业技术资格评审委员会

资格名称：　副教授

系列（专业）：高等学校教师

专业（学科）：生物医学材料

证书号：243200004231220039

取得资格时间：2024-10-13

文件号：通大人〔2024〕128号

在线证书信息

盖签发单位电子印章

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Chitosan nerve conduit filled with ZIF-8-functionalized guide microfibres enhances nerve regeneration and sensory function recovery in sciatic nerve defects

Xu Zhang [a,1], Tong Qi [b,1], Yu Sun [a], Xinran Chen [a], Pengxiang Yang [a], Shuai Wei [c], Xiyang Cheng [a], Xiu Dai [a,*]

[a] Key Laboratory of Neuroregeneration of Jiangsu and Ministry of Education, Co-Innovation Center of Neuroregeneration, Nantong University, Nantong 226001, China
[b] Department of Rehabilitation Medicine, West China Hospital, Sichuan University; Key Laboratory of Rehabilitation Medicine in Sichuan Province/Rehabilitation Medicine Research Institute, Chengdu 610041, China
[c] Department of Orthopedics, The Second Affiliated Hospital of Soochow University, Suzhou, Jiangsu 215004, China

ARTICLE INFO

Keywords:
Nerve Conduit
ZIF-8
Guide Microfibres
Peripheral Nerve Repair

ABSTRACT

Nerve conduits have shown promise as alternatives to autologous nerves, but their repair effects need to be improved. The topographical guidance and functionalization of scaffolds are crucial in nerve repair. In this work, a chitosan-based nerve graft filled with guiding fibres modified by ZIF-8 nanoparticles (CS@ZIF-8) was fabricated for defective nerve repair. An in vitro study demonstrated that CS@ZIF-8 exhibited excellent cytocompatibility and could significantly promote Schwann cell proliferation. In vivo, nerve conduits filled with CS@ZIF-8 were observed to guide stronger axonal longitudinal elongation. Rats bridged with the conduit filled with CS@ZIF-8 showed significant morphological and functional improvements in terms of regenerated nerve density, the number of myelinated nerve fibres, the number of myelin layers, the thickness of myelin sheath, target muscle recovery and sensory function compared to those transplanted with the hollow conduit and the conduit filled with pure chitosan fibres. The repair effects achieved by using the conduit filled with CS@ZIF-8 were similar to those of autografts. Altogether, the data here show that nerve conduits filled with ZIF-8-loaded guide fibres provide a promising approach for repairing nerve defects.

1. Introduction

Peripheral nerve injuries, which are mainly a result of accidents or diseases, are a medical problem worldwide [1]. Despite great advances in surgical techniques, current surgical methods are not effective in repairing nerve defects. Patients with neurological defects have a poor prognosis and reduced quality of life, which places a great burden on families and society [2,3]. Thus, searching for grafts that can effectively bridge the defect and efficiently induce axon regeneration has become the focus to solve this problem. Autologous nerve grafting is still the gold standard for the repair of nerve defects. However, the use of nerve autografts is hindered by the lack of donor sources, the loss of nerve function at the donor site, and size mismatch [4,5]. With increases in the maturity of tissue engineering theory and technology, artificial nerve grafts have aroused wide attention as promising alternatives for autologous nerves [6,7].

Generally, tissue-engineered nerves are constructed on the basis of neural scaffolds, which play a role in physical support when repairing damaged nerves and provide a suitable microenvironment for nerve regeneration [8,9]. The simple hollow design of the nerve grafts can repair short (<5 mm) nerve defects. However, for longer defects, the orientation topography and structure in the lumen are indispensable for guiding the growth direction of axons [10,11]. For instance, Kaplan et al. reported that the neural repair effect of simple hollow scaffolds was far worse than that of scaffolds with various internally oriented designs [12], and our previous study verified this conclusion [13]. Furthermore, previous studies have shown that the high specific surface area of the internally oriented structure could provide cells with more space for adhesion and the opportunity to communicate with the surrounding environment via biochemical signals [14,15].

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Review

Multifunctional scaffolds based on 3D printing for spinal cord and peripheral nerve defect repair

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ABSTRACT

The repair of spinal cord and peripheral nerve defects remains a major challenge in the field of neuroscience, with the key therapeutic difficulty lying in the precise reconstruction of the damaged microenvironment to promote nerve regeneration and functional recovery. 3D printing, characterized by its high precision, customizability, and ability to construct complex structures, has emerged as a highly promising technology in the field of neural regeneration. Specially, this technology facilitates the fabrication of biomimetic nerve grafts that not only replicate the anatomical structure and mechanical heterogeneity of natural nerves but also allow precise control over the distribution of cells and biomolecules, thus offering innovative strategies for spinal cord and peripheral nerve defect repair. This article aims to systematically review recent advancements in 3D printing for spinal cord and peripheral nerve regeneration, including analyzing its advantages in the preparation of tissue-engineered nerve grafts, categorizing current cutting-edge technologies, and evaluating their potential applications, thereby providing insights for future research directions.

1. Introduction

The human nervous system maintains basic physiological functions through sensory-motor integration between the spinal cord and peripheral nerves, enabling rapid environmental sensing and reflexive responses [1,2]. The spinal cord, as the conduction center of the central nervous system (CNS), bears the important responsibility of neural signal transmission between the brain and various parts of the body. Peripheral nerves, located outside the brain and spinal cord, play a crucial role in transmitting signals between different parts of the body. Although anatomically distinct, both spinal cord and peripheral nerves are vulnerable to traumatic injuries that can lead to severe functional impairments. To be specific, spinal cord injury (SCI) refers to a state of injury that can cause either temporary or permanent changes in the function of the spinal cord [3,4]. Neurological deficits are caused by the primary mechanical injury followed by a cascade of complex biological events, known as secondary injury. These biological events involve cyclic pathological processes such as neuronal and glial cell death, ischemia, inflammatory response, oxidative stress and excitotoxicity, collectively creating a hostile regenerative microenvironment through dual mechanisms (depletion of essential neurotrophic factors and simultaneous accumulation of axonal growth inhibitors), ultimately disrupting neural tissue homeostasis. This self-perpetuating cycle will further aggravate the degree of injury and seriously hinder the regeneration process and functional recovery of nerves [5–7]. In contrast, peripheral nerve injury (PNI) differs from SCI in terms of anatomical structure and functional manifestations, which can lead to sensory, motor, and autonomic dysfunction [8,9]. Although the regenerative capacity of peripheral nerves is stronger compared to that of the CNS, its regenerative process involves complex cellular processes, which involves growth, migration, proliferation, differentiation, as well as the regeneration of axons, remains vulnerable to damage from factors such as ischemia, excessive inflammation, oxidative stress and mitochondrial damage.

These pathophysiological characteristics collectively contribute to the formidable clinical challenges in nerve injury repair. However, current clinical treatments still cannot fully restore the pre-injury neurological function, constrained by the inherent limitations of the regenerative capacity of the CNS and the difficulty in achieving precise targeted regeneration after long-distance defects of peripheral nerves. Particularly, the primary challenge in treating SCI and PNI lies in how to precisely reconstruct the microenvironment of the affected area. To

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Chitosan/hBMSC-ECM biomimetic nerve grafts containing orienting microchannels for peripheral nerve regeneration

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ABSTRACT

Bone marrow mesenchymal stem cell extracellular matrix (BMSC-ECM) can promote peripheral nerve regeneration, and microphysical orientation is essential for peripheral nerve regeneration. In this study, human-derived BMSC-ECM (hBMSC-ECM) and microchannels were introduced into chitosan-based nerve grafts (OCS/ECM) to construct dual biomimetic nerve grafts of structure and composition. For comparison, the same procedure was applied to nerve grafts containing only orienting microchannels (OCS) and autogenous nerves. In vitro experiments showed that the prepared grafts had good blood compatibility and no cytotoxicity. In vivo studies demonstrated that OCS/ECM had better histocompatibility than OCS. The introduction of microchannels allowed chitosan nerve grafts to achieve similar repair effects as autologous nerve grafts in the functional recovery of rats with sciatic nerve defects. Further introduction of hBMSC-ECM may result in synergistic effects on structure and composition that could significantly promote the rate of nerve regeneration, myelination, and target muscle recovery. Dual biomimetic nerve grafts are attractive candidates for the treatment of critical nerve defects.

1. Introduction

War, disease, accidents and natural disasters may lead to peripheral nerve damage at various levels, which seriously affects the quality of life and places great burdens on families and society [1,2]. With the rapid development of clinical equipment and technology, the repair effect of peripheral nerve injury has gradually improved. Gaps with small defects can be directly repaired by microsuturing, while larger gaps need to be bridged by nerve grafts [3,4]. By far, the most widely used and most effective method is autologous nerve transplantation [5]. However, the clinical application of autologous nerve transplantation is restricted by the lack of sensory function at the donor area, the limited source, the difficulty in repairing long-distance nerve defects and the scar left by surgery [6,7]. Numerous studies have demonstrated the promising prospects of tissue-engineered nerves in repairing nerve defects [8–10].

When designing nerve grafts, it is critical to construct a microenvironment that is suitable for nerve regeneration and recovery [11,12]. The peripheral nerve is an oriented tissue consisting of many nerve bundles in which obvious alignment of cells and extracellular matrix (ECM) are observed [13]. Therefore, biomimetic microscopically oriented physical structures have been designed to modulate various chemotactic behaviors of nerve cells [14,15]. Many studies on neural tissue engineering scaffolds have shown that the surface of the micro-oriented physical structure can induce the directional growth of nerve cells and promote nerve regeneration [7,14–16]. It has been reported that polyacrylamide/chitosan composite hydrogels with microgroove surface patterns prepared by the micromolding method can promote the growth of dorsal root ganglion (DRG) neurons and axon orientation in vitro. Furthermore, a composite hydrogel containing 30 μm grooves showed a similar repairing effect on sciatic nerves as autogenous nerves [17]. Anisotropic composite neural scaffolds containing modified carbon nanotubes guide the directed generation of Schwann cells (SCs) and promote the elongation of DRG neuronal axons. Moreover, this treatment can inhibit inflammation, promote angiogenesis and upregulate the expression of genes related to nerve regeneration in vivo [18]. Zhu et al. fabricated ECM scaffolds with parallel microchannels by subcutaneous implantation of 150 μm polycaprolactone (PCL) microfibers. ECM scaffolds with microchannel size of approximately 150 μm could effectively promote the in situ regeneration and repair of peripheral nerves and blood vessels [19]. Most of the microchannels currently constructed in nerve conduits are tens to hundreds of micrometers in size [17,19]. However, due to the limitations of preparation techniques,

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Review

Application of metal-organic frameworks-based functional composite scaffolds in tissue engineering

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Abstract

With the rapid development of materials science and tissue engineering, a variety of biomaterials have been used to construct tissue engineering scaffolds. Due to the performance limitations of single materials, functional composite biomaterials have attracted great attention as tools to improve the effectiveness of biological scaffolds for tissue repair. In recent years, metal-organic frameworks (MOFs) have shown great promise for application in tissue engineering because of their high specific surface area, high porosity, high biocompatibility, appropriate environmental sensitivities and other advantages. This review introduces methods for the construction of MOFs-based functional composite scaffolds and describes the specific functions and mechanisms of MOFs in repairing damaged tissue. The latest MOFs-based functional composites and their applications in different tissues are discussed. Finally, the challenges and future prospects of using MOFs-based composites in tissue engineering are summarized. The aim of this review is to show the great potential of MOFs-based functional composite materials in the field of tissue engineering and to stimulate further innovation in this promising area.

Keywords: metal-organic frameworks; function; composite scaffold; tissue engineering

Introduction

Tissue engineering scaffold materials are the material basis for reconstructing tissues and organs using tissue engineering technology and are thus one of the key factors in tissue engineering research [1–3]. With the rapid development of materials science and the increasing maturity of tissue engineering technology and theory, various scaffolds for tissue engineering have emerged [4–8]. Due to the complexity of the structure and composition of tissue, the specificity of various tissue functions and the limitations of biomaterial functions, it is difficult for a single biomaterial to meet the needs of tissue reconstruction. Therefore, functional composite scaffolds with special properties have attracted much attention [9–14]. Functional composite scaffolds usually consist of matrix materials and functional materials. Matrix materials determine the basic performance parameters of biomaterials, while functional materials determine the specialized performance parameters of biomaterials.

Among the wide variety of functional materials, metal-organic frameworks (MOFs), also known as porous coordination polymers, are a type of organic–inorganic hybrid material that has emerged in the field of tissue engineering in recent years. Compared with conventional organic and inorganic materials, MOFs have the advantages of compositional and structural diversity, porousness, ultrahigh specific surface area and excellent thermal and chemical stability [15–19]. Since the inception of MOFs, scientists have focused on their applications in the fields of gas storage [20–22], catalysis [23, 24], sensing [25–27] and drug delivery [28–31] due to the unique structure and properties of MOFs. With in-depth research on the properties of MOFs and the further expansion of their possible applications, an increasing number of studies on the application of MOFs in tissue engineering have been conducted in recent years, especially the last 5 years. It has been reported that some MOFs have desirable biocompatibility and biodegradability [32–35]. Some MOFs nanoparticles can enhance stem cell attachment, proliferation and differentiation [36, 37]. Furthermore, the functional groups of MOFs themselves, corresponding intelligent properties (such as pH responsiveness, photo responsiveness and thermal responsiveness), and degradation products can confer unique functions on modified materials, such as anti-inflammatory properties [38–40], antibacterial properties [41, 42] and angiogenesis promotion [43, 44]. In addition, the physical and chemical properties of biomaterials, such as roughness, porous structure, hydrophilicity and mechanical properties, will be altered by modification with MOFs, with the potential to promote cell adhesion, spreading, growth and proliferation [45–47]. Moreover, the high surface area and excellent porosity of nano-MOFs enable them to be used as

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Properties of Electrospun Aligned Poly(lactic acid)/Collagen Fibers with Nanoporous Surface for Peripheral Nerve Tissue Engineering

*Tao Xu, Xu Zhang, and Xiu Dai**

It is important for the functional recovery of defective nerves to construct a suitable microenvironment for nerve regeneration by optimizing the topological structure and biological functions of nerve grafts. Electrospun fibers are employed to mimic the extracellular matrix (ECM) and the effect of the porous features on fiber surface draws much attention. Yet, little is known about the effect of the nanotopology of the fiber surface in conjunction with collagen I (COL) on neural cells. Herein, poly(lactic acid) (PLA)/COL hybrid fibrous membranes with a nanoporous structure on a fiber surface are fabricated. The performance of the obtained fibrous membranes is investigated by scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), water contact angle (WCA), and tensile test measurements. The cytotoxicity and biocompatibility of PLA/COL hybrid fibrous membranes and their effects on neural cells are systematically investigated. The physicochemical test results show that the PLA/COL hybrid fibrous membranes have appropriate mechanical properties and improved hydrophilicity. The MTT assay and hemolysis assay suggest the nontoxicity and good hemocompatibility of PLA/COL membranes. The nanoporous structure on the fiber surface and the introduction of COL synergistically promote proliferation and elongation of Schwann cells (SCs) and the extension of dorsal root ganglion (DRG) neurites.

1. Introduction

Peripheral nerve injury is a common clinical disease with poor prognosis and high disability rate, which seriously affects the patients' life quality. Autologous nerve transplantation is the "gold standard" for repairing peripheral nerve defects so far. However, it has been limited by insufficient donor source, the loss of donor nerve function, and the size mismatch between donor and recipient. Artificial nerve graft is a promising alternative for nerve defect repair due to its advantages of adjustable structure size, rich material source, and good processability.

It is critical to construct a suitable microenvironment in artificial nerve graft for nerve regeneration and functional recovery.[1,2] The composition and structure of neural tissues are very complex, and their arrangement is anisotropic, inhomogeneous, and directional.[3] Its micro-oriented physical structure is one of the key factors in regulating the chemotactic behavior of nerve cells. Therefore, acellular nerve allografts that retain the microstructure and active ingredients of nerves have been used to repair damaged peripheral nerves with remarkable effect.[4] However, it is still limited by insufficient donor source, storage difficulties, and possible risk of viral infection.[5] Extracellular matrix (ECM) is the external environment that cells rely on for survival, activity, and regulation. Schilling et. al reported that skeletal muscle derived ECM mitigates denervation atrophy after sciatic nerve transection.[6] Much effort has been made to simulate the microstructure and composition of ECM.[7,8] In the last decade, electrospinning fibers, which can highly mimic the grid-like structure of the natural ECM, have drawn much attention in the field of tissue engineering.[9,10] It has been reported that the size, surface morphology, and orientation of the electrospun fibers can regulate the growth morphology, differentiation, and expression of related functional genes of neural cells.[11–17] For instance, researchers have found that oriented nanofibers can not only promote the differentiation of stem cells into nerve cells and regulate the direction of axon extension but also have the potential to promote the maturation of Schwann cells (SCs).[16,17] Therefore, the establishment of a microenvironment with micro-oriented physical structures is an effective strategy to guide nerve growth, migration, and cell differentiation. Furthermore, it has also been found that the fiber surface nanotopography plays a much important role in regulating cell adhesion, growth, proliferation, orientation, and production of specific proteins and differentiation.[18–22] However, the materials used in these fiber surface nanotopographical studies are all pure synthesized polymer, such as poly(lactic acid) (PLA), poly(lactic acid)-co-poly(pentadecalactone) (PLA-PPDL), and poly(lactic-co-glycolic acid) (PLGA). Although these

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Regulatory T cells in neurological disorders and tissue regeneration: Mechanisms of action and therapeutic potentials

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From the Contents

Abstract

Regulatory T cells, a subset of $CD4^+$ T cells, play a critical role in maintaining immune tolerance and tissue homeostasis due to their potent immunosuppressive properties. Recent advances in research have highlighted the important therapeutic potential of Tregs in neurological diseases and tissue repair, emphasizing their multifaceted roles in immune regulation. This review aims to summarize and analyze the mechanisms of action and therapeutic potential of Tregs in relation to neurological diseases and neural regeneration. Beyond their classical immune-regulatory functions, emerging evidence points to non-immune mechanisms of regulatory T cells, particularly their interactions with stem cells and other non-immune cells. These interactions contribute to optimizing the repair microenvironment and promoting tissue repair and nerve regeneration, positioning non-immune pathways as a promising direction for future research. By modulating immune and non-immune cells, including neurons and glia within neural tissues, Tregs have demonstrated remarkable efficacy in enhancing regeneration in the central and peripheral nervous systems. Preclinical studies have revealed that Treg cells interact with neurons, glial cells, and other neural components to mitigate inflammatory damage and support functional recovery. Current mechanistic studies show that Tregs can significantly promote neural repair and functional recovery by regulating inflammatory responses and the local immune microenvironment. However, research on the mechanistic roles of regulatory T cells in other diseases remains limited, highlighting substantial gaps and opportunities for exploration in this field. Laboratory and clinical studies have further advanced the application of regulatory T cells. Technical advances have enabled efficient isolation, *ex vivo* expansion and functionalization, and adoptive transfer of regulatory T cells, with efficacy validated in animal models. Innovative strategies, including gene editing, cell-free technologies, biomaterial-based recruitment, and *in situ* delivery have expanded the therapeutic potential of regulatory T cells. Gene editing enables precise functional optimization, while biomaterial and *in situ* delivery technologies enhance their accumulation and efficacy at target sites. These advancements not only improve the immune-regulatory capacity of regulatory T cells but also significantly enhance their role in tissue repair. By leveraging the pivotal and diverse functions of Tregs in immune modulation and tissue repair, regulatory T cells–based therapies may lead to transformative breakthroughs in the treatment of neurological diseases.

Key Words: demyelinating diseases; gene editing; immune regulation; immune tolerance; neural regeneration; neurological diseases; non-immune mechanisms; regulatory T cells; stem cells; stroke; tissue homeostasis; tissue repair

Introduction

The global population affected by neurological dysfunctions due to acute injuries, chronic diseases, or aging is steadily increasing, posing a great burden on healthcare systems, families, and societies (Li et al., 2018; Yang et al., 2023c; Gao et al., 2024). Historically, the nervous and immune systems were considered distinct domains, primarily due to the presence of the blood–brain barrier (BBB) and the blood–spinal cord barrier (BSCB) (Ning et al., 2024; Wang and Bai, 2025). However, in the last decades numerous studies have challenged this century-old concept of central nervous system (CNS) immune privilege, revealing a significant overlap between the CNS and the peripheral immune system (Castellani et al., 2023; Peng et al., 2024). Despite the restriction imposed by the BBB and BSCB to the passage of toxins, large molecules, and cells into the CNS (Yin et al., 2025), neuroimmune interactions are becoming increasingly evident at the tissue, cellular, and molecular levels (Louveau et al., 2015; Hu et al., 2018). It is now clear that the CNS operates under continuous immune surveillance and regulation, and that a close intertwining exists between lymphatic vessels and peripheral nerves (Alves de Lima et al., 2020; Badimon et al., 2020).

The complexity of neurological disorders and the limited regenerative capacity of the nervous tissue present central challenges in medicine. Researchers widely acknowledge that precisely regulating the immune system can effectively resolve inflammation and restore the structure and homeostasis of neural tissue (Feng et al., 2022; Yang et al., 2023a; Holl et al., 2024). Conversely, excessive or unregulated immune responses may exacerbate damage, leading to fibrosis and scar formation, which hinder the self-repair capacity of injured sites (Asboth et al., 2018; Adusei et al., 2021; Wang et al., 2023b). Therefore, there is an urgent need to deepen our understanding of the immune mechanisms underlying neurological disorders and tissue repair. This knowledge is essential for designing effective therapies aimed at counteracting the pathological processes that lead to organ dysfunction, promoting nerve regeneration, and enhance tissue repair.

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Unleashing Axonal Regeneration Capacities: Neuronal and Non-neuronal Changes After Injuries to Dorsal Root Ganglion Neuron Central and Peripheral Axonal Branches

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Abstract
Peripheral nerves obtain remarkable regenerative capacity while central nerves can hardly regenerate following nerve injury. Sensory neurons in the dorsal root ganglion (DRG) are widely used to decipher the dissimilarity between central and peripheral axonal regeneration as axons of DRG neurons bifurcate into the regeneration-incompetent central projections and the regeneration-competent peripheral projections. A conditioning peripheral branch injury facilitates central axonal regeneration and enables the growth and elongation of central axons. Peripheral axonal injury stimulates neuronal calcium influx, alters the start-point chromatin states, increases chromatin accessibility, upregulates the expressions of regeneration-promoting genes and the synthesis of proteins, and supports axonal regeneration. Following central axonal injury, the responses of DRG neurons are modest, resulting in poor intrinsic growth ability. Some non-neuronal cells in DRGs, for instance satellite glial cells, also exhibit diminished injury responses to central axon injury as compared with peripheral axon injury. Moreover, DRG central and peripheral axonal branches are respectively surrounded by inhibitory glial scars generated by central glial cells and a permissive microenvironment generated by Schwann cells and macrophages. The aim of this review is to look at changes of DRG neurons and non-neuronal cells after peripheral and central axon injuries and summarize the contributing roles of both neuronal intrinsic regenerative capacities and surrounding microenvironments in axonal regeneration.

Keywords Axonal regeneration · Dorsal root ganglion neuron · Central axonal branch · Peripheral axonal branch · Glial cells · Conditioning lesion

Introduction

Nerve injury is a common neurological disorder that induces sensory and motor dysfunction; elicits numerous complications such as pain, burning sensation, paresthesia, fibrosis, and muscle atrophy; and fundamentally impairs patients' quality of life. Traumatic brain injury has an estimated age-standardized incidence rate of 331 to 412 patients per 100,000 people and an increase in rates and disability-adjusted life-years [1]. Spinal cord injury has an estimated age-standardized incidence rate of 11 to 16 patients per 100,000 people. Although the incidence of spinal cord injury is relatively lower as compared with traumatic brain injury, spinal cord injury generally causes permanent disability and thus has an even high disability-adjusted life-years [1]. Although the statistical data of the incidence of peripheral nerve injury on a global scale is unavailable, peripheral nerves are commonly exposed to physical injuries [2]. With the high incidence and severe consequences of nerve injury, promoting axon regeneration is of great clinical significance. Additionally, stimulating the growth and elongation of axons may also benefit the treatment of many neurological diseases, such as stroke and amyotrophic lateral sclerosis [3–5].

Axon regeneration capacity in the adult mammalian central nervous system is extremely limited. In contrast to the central nervous system, neurons in the peripheral nervous

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Enhancing antibacterial activity, PM filtration and degradation in river water of the electrospun polylactic acid (PLA) membranes by incorporating Ag@ZnCo-ZIF, creating porosity and reducing the fiber diameter

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ABSTRACT

Despite its biodegradability, the natural degradation rate of polylactic acid (PLA) fiber membranes in the environment is relatively slow, limiting their practical applications. To address this issue and enhance the performance of the electrospun PLA membranes with the antibacterial and particulate matter (PM) filtration capability, Ag nanoparticles were loaded on ZnCo-ZIF to prepare Ag@ZnCo-ZIF and was then introduced into PLA to fabricate the PLA/Ag@ZnCo-ZIF membranes. Benefiting from the porous structure and fine diameter of fibrous membranes as well as the presence of Ag@ZnCo-ZIF, the prepared membrane exhibited good antibacterial properties and PM filtration capacity, and its degradation ability in river water was also enhanced evidently. The degradation mechanism of the membranes in river water was discussed in detail.

1. Introduction

The electrospun fibrous membranes of polylactic acid (PLA) exhibited extensively potential application in the fields of environmental remediation and biomedical engineering attributed to their high specific surface area, degradability and biocompatibility. However, the uncontrollable degradation characteristics of PLA in natural water have raised serious doubts about its environmental friendliness [1–3]. The tightly packed amorphous structure, high crystallinity, and hydrophobicity of PLA impeded the penetration of water molecules and the attachment efficiency of microorganisms, thereby making it difficult to initiate an effective degradation process [4]. Deroiné studied the degradation of PLA and found that the degradation of PLA samples started only after 6 months of immersion in seawater at 40 °C [5]. Currently, the exploration on the hydrolytic degradation of PLA has primarily focused on conducting studies in ethanol solutions, distilled water, and aqueous solutions with varying pH values, or on enhancing hydrolysis efficiency by increasing the temperature of the hydrolysis environment [5–7]. Therefore, it is necessary to study the degradation behavior of PLA in natural water bodies for the expansion of its application fields.

The contact area between the fibrous membrane and the surrounding water was one of the key factors influencing degradation process of the electrospun PLA membranes. By modulating the structure of the electrospun PLA membranes, such as creating porous structure and fine diameter, high specific surface area could be significantly increased, thereby providing more attachment sites and penetration pathways for water molecules and microorganisms [8–13]. The formed porous structure not only enhanced the degradation efficiency but also improved the particulate matter (PM) filtration performance and antibacterial properties of the fibrous membrane. Dai prepared porous electrospun membranes of PLA via a phase separation and incorporated ZIF-8 into the fibers, which exhibited good filtration performance for PM2.5 and PM10 particles [11]. Hou incorporated a porogen and polyvinyl butyral (PVB) into PLA to fabricate the porous PLA membranes via centrifugal spinning. The resulting porous membranes demonstrated superior biodegradability compared to the smooth ones [12]. By adjusting the electric field parameters and optimizing the solution system, the fiber diameter of fiber in electrospun membranes could be reduced to some extent.

Metal-organic frameworks (MOFs) were crystalline porous materials assembled from metal ions coordinated with organic linkers and possessed high specific surface areas, tunable pore sizes and

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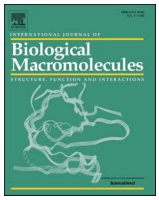

Mechanically enhanced biodegradable scaffold based on SF microfibers for repairing bone defects in the distal femur of rats

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ABSTRACT

Silk-based biodegradable materials play an important role in tissue engineering, especially in the field of bone regeneration. However, while optimizing mechanical properties and bone regeneration characteristics, modified silk fibroin (SF)-based materials also increase the complexity of scaffold systems, which is not conducive to clinical translation. In this study, we first added synthetic biomimetic mineralized collagen (MC) particles to SF-based materials to improve the bone regeneration properties of the scaffolds and simultaneously regulated the degradation rate of the scaffolds to match the bone regeneration rate. Second, SF microfibers were prepared by hydrolysis with alkaline heating and added to SFMC scaffolds with excellent osteogenic stimulation ability to prepare SF microfiber (mf)-modified SFMC-mf scaffolds with excellent mechanical properties, whose compression modulus increased from 4.58±0.23 MPa to 14.63±0.88 MPa. Finally, the SFMC-mf scaffold was implanted into the weight-bearing bone defect area of the distal femur of rats, and the results showed that the SFMC-mf scaffold significantly promoted functional recovery of the affected limb and increased the amount of new bone in the defect area compared with those in the SFC-mf group and the blank control group. In addition, the RNA-seq results suggested that the genes with upregulated expression in the SFMC-mf scaffold group were mainly enriched in vascular regeneration. In conclusion, this SF microfiber modification method effectively improved the mechanical properties of SFMC scaffolds without moving the SF scaffold system in the direction of compositional complexity, providing new insights for the subsequent development of more effective bionic repair materials for bone defects and assisting in their clinical translation.

1. Introduction

Bone is a highly dynamic tissue that has a certain inherent regenerative or repair ability for external injuries. On a global scale, large-scale bone injuries and even bone defects caused by tumors, traffic accidents, and orthopedic surgeries not only cause serious physiological and psychological trauma to patients but also consume a large amount of medical resources [1]. Although bone has a certain tissue regeneration ability, it is inadequate for large or critical bone defects, and surgical intervention or the use of bone grafts is often needed in clinical work to assist in the healing process. Research data show that in the United States alone, >1.6 million bone transplant surgeries are required annually, resulting in more than $27 billion in medical expenses [2]. For decades, autologous bone transplantation and allogeneic bone transplantation have been the standard treatment options for nonhealing or delayed healing bone defects in clinical practice [3]. Meanwhile, allografts have emerged as the ideal autograft substitute for patients and surgeons in the treatment of complex bone defects, accounting for nearly one-third of all bone grafts used in North America [4]. However, these methods have many obvious drawbacks, such as postoperative donor site pain, sensory abnormalities or deficiencies, immune rejection, and potential risks of disease or virus transmission [5,6]. Fortunately, tissue engineering technology has been widely used for tissue repair and regeneration of damaged tissues or organs.

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发明专利证书

发 明 名 称：一种具有取向微通道的神经移植物及其制备方法

发　明　人：代秀;张旭

专　利　号：ZL 2022 1 1389588.5

专利申请日：2022年11月08日

专 利 权 人：南通大学

地　　址：226000 江苏省南通市崇川区启秀路19号

授权公告日：2023年12月19日　　授权公告号：CN 115591016 B

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发明人：

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LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Économie

Le Ministre de l'Économie,

Vu la loi du 20 juillet 1992 portant modification du régime des brevets d'invention, telle que modifiée ;

Vu le règlement grand-ducal du 17 novembre 1997 concernant la procédure et les formalités administratives en matière de brevets d'invention ;

Vu le dépôt de la demande de brevet luxembourgeois daté du : **28/06/2023** ;

Arrête :

Art. 1er.- Il est délivré à la (aux) personne(s) mentionnée(s) sur le tableau des données bibliographiques attaché au présent arrêté, sous le numéro de code 73, un

BREVET D'INVENTION N° LU504616

pour : Nerve guiding fiber loaded in situ with ZIF-8 and its preparation method
tel que décrit dans les duplicata des pièces techniques joints en annexe.

Art. 2.- Le brevet est délivré sans examen préalable de la brevetabilité de l'invention, sans garantie de l'exactitude de la description et aux risques et périls des demandeurs.

Art. 3.- Le présent arrêté, qui constitue le titre de protection, est expédié au(x) mandataire(s) agréé(s), mentionné(s) sur le tableau des données bibliographiques attaché au présent arrêté, sous le numéro de code 74 ou, à défaut, à la (aux) personne(s) visées(s) à l'article 1er, pour servir de document probant à celle(s)-ci.

Luxembourg, le **09/01/2024**

Le Ministre de l'Économie, des PME,
de l'Énergie et du Tourisme,

Lex Delles

(19) LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Économie

(11) N° de publication : LU504616

(12) BREVET D'INVENTION B1

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(74) Mandataire(s):
IP SHIELD - 1616 Luxembourg (Luxembourg)

(54) Nerve guiding fiber loaded in situ with ZIF-8 and its preparation method.

(57) The present invention relates to a nerve guiding fiber loaded in situ with ZIF-8 and its preparation method, it is prepared by the following steps: the chitosan-based fibers are prepared by mold casting method, the chitosan-based fibers are placed in the synthetic solution of ZIF-8 to in-situ load ZIF-8 crystals, that is, the nerve guiding fibers loaded with ZIF-8 are obtained. The nerve guiding fiber of the present invention is composed of chitosan-based fiber and ZIF-8 crystal, including the chitosan-based fiber is prepared by mold casting method, and ZIF-8 nano-particles are loaded on the surface of the fiber by in-situ growth method, the preparation nerve guiding fiber has an ultra-high specific surface area and a good adsorption capacity.

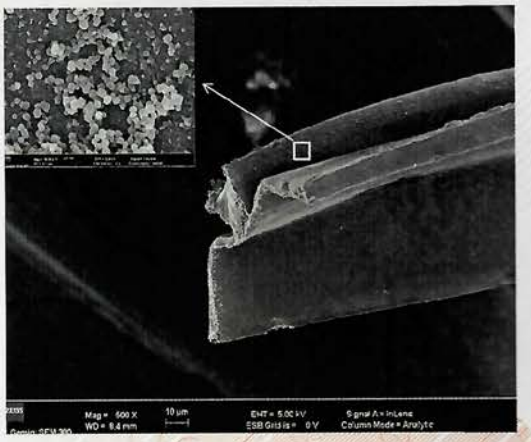

Fig 2

特許権設定登録通知書

特許料納付期限日

特許番号　　第７５６０１８９号
登録日　　令和　６年　９月２４日
出願番号　　特願２０２３－５５１２５８
出願日　　令和　４年１１月１０日
請求項の数　１０
納付年分　　第　３年分まで
納付金額　　１０，９５０円
納付日　　令和　６年　９月１１日
設定登録時の特許料の減免を認めました。

納付年分	納付期限日
第　４年分	令和　９年(2027年)　９月２４日
第　５年分	令和１０年(2028年)　９月２４日
第　６年分	令和１１年(2029年)　９月２４日
第　７年分	令和１２年(2030年)　９月２４日
第　８年分	令和１３年(2031年)　９月２４日
第　９年分	令和１４年(2032年)　９月２４日
第１０年分	令和１５年(2033年)　９月２４日
第１１年分	令和１６年(2034年)　９月２４日
第１２年分	令和１７年(2035年)　９月２４日
第１３年分	令和１８年(2036年)　９月２４日
第１４年分	令和１９年(2037年)　９月２４日
第１５年分	令和２０年(2038年)　９月２４日
第１６年分	令和２１年(2039年)　９月２４日
第１７年分	令和２２年(2040年)　９月２４日
第１８年分	令和２３年(2041年)　９月２４日
第１９年分	令和２４年(2042年)　９月２４日

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https://www.jpo.go.jp/system/process/toroku/kigen_tsuchi_service.html

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特許担当　内線２７０８

特　許　証
(CERTIFICATE OF PATENT)

特許第７５６０１８９号
(PATENT NUMBER)

発明の名称
(TITLE OF THE INVENTION)
バイオミメティック神経グラフト及びその調製方法

特許権者
(PATENTEE)
中華人民共和国　２２６０１９　江蘇省南通市蔷園路９号

国籍・地域　中華人民共和国

南通大学

発明者
(INVENTOR)
顧　暁松

代　秀

（その他別紙記載）

出願番号
(APPLICATION NUMBER)
特願２０２３－５５１２５８

出願日
(FILING DATE)
令和　４年１１月１０日 (November 10,2022)

登録日
(REGISTRATION DATE)
令和　６年　９月２４日 (September 24,2024)

この発明は、特許するものと確定し、特許原簿に登録されたことを証する。

(THIS IS TO CERTIFY THAT THE PATENT IS REGISTERED ON THE REGISTER OF THE JAPAN PATENT OFFICE.)

令和　６年　９月２４日 (September 24,2024)

特 許 庁 長 官
(COMMISSIONER, JAPAN PATENT OFFICE)

小野洋太

特　許　証

(CERTIFICATE OF PATENT)

（続葉　　１）

特許第７５６０１８９号(PATENT NUMBER)

特願２０２３－５５１２５８　(APPLICATION NUMBER)

発明者
(INVENTOR)

顧　興中

ゴン　蕾蕾

李　枚原

孫　華林

銭　天梅

王　鴻奎

徐　来

［以下余白］

ЕВРАЗИЙСКАЯ ПАТЕНТНАЯ ОРГАНИЗАЦИЯ
ЕВРАЗИЙСКОЕ ПАТЕНТНОЕ ВЕДОМСТВО

ЕВРАЗИЙСКИЙ ПАТЕНТ
НА ИЗОБРЕТЕНИЕ
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Название изобретения:

БИОНИЧЕСКИЙ ТРАНСПЛАНТАТ НЕРВА И СПОСОБ ИЗГОТОВЛЕНИЯ ТРАНСПЛАНТАТА НЕРВА

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Изобретатели:

Гу Сяосун, Дай Сю, Гу Синчжун, Гун Лэйлэй, Ли Мэйюань, Сунь Хуалинь, Цянь Тяньмэй, Ван Хункуй, Сюй Лай (CN)

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ЕВРАЗИЙСКАЯ ПАТЕНТНАЯ ОРГАНИЗАЦИЯ ЕВРАЗИЙСКОЕ ПАТЕНТНОЕ ВЕДОМСТВО

ДОКУМЕНТ ПОДПИСАН ЭЛЕКТРОННОЙ ПОДПИСЬЮ

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Владелец: **Ивлиев Григорий Петрович**

Действителен:с 15.04.2022 по 14.04.2027

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项 目 编 号 BK20232023

项 目 名 称 仿生组织工程、类器官构建理论与技术创新及其转化

项 目 类 别 JD0109 生物医学工程

起 止 年 限 2023 年 10 月 至 2026 年 9 月

项目负责人 顾晓松 电话及手机 15962956669

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