

# Spinal cord injury induces acute microbiome shock and system-wide transcriptomic reprogramming

Chi Zhang<sup>1#</sup>, Yufei Du<sup>2#</sup>, Mingxin Wu<sup>3#</sup>, Chuang Li<sup>1#</sup>, Ruizhi Jiang<sup>4</sup>, Enlin Qi<sup>4</sup>, Shaolong Li<sup>4</sup>, Xianfu Yi<sup>5\*</sup>, Bo Chu<sup>6\*</sup>, Shiqing Feng<sup>1, 4\*</sup> and Hengxing Zhou<sup>4\*</sup>

<sup>1</sup>Department of Orthopaedics, The Second Qilu Hospital of Shandong University, Shandong University Centre for Orthopaedics, Cheeloo College of Medicine, Shandong University, Jinan 250033, China.

<sup>2</sup>Department of Endocrinology and Metabolism, The Second Qilu Hospital of Shandong University, Cheeloo College of Medicine, Shandong University, Jinan 250033, China.

<sup>3</sup>Department of Spine Osteopathia, The First Affiliated Hospital of Guangxi Medical University, Nanning 530021, China.

<sup>4</sup>Department of Orthopaedics, Qilu Hospital of Shandong University, Shandong University Centre for Orthopaedics, Advanced Medical Research Institute, Cheeloo College of Medicine, Shandong University, Jinan 250012, China.

<sup>5</sup>Department of Bioinformatics, School of Basic Medical Sciences, Tianjin Medical University, Tianjin 300070, China.

<sup>6</sup>Department of Cell Biology, School of Basic Medical Sciences, Cheeloo College of Medicine, Shandong University, Jinan 250012, China.



Chi Zhang, Yufei Du, Mingxin Wu, Chuang Li, Ruizhi Jiang, Enlin Qi, Shaolong Li, et al. 2026. Spinal cord injury induces acute microbiome shock and system-wide transcriptomic reprogramming. *iMeta* 5: e70128.

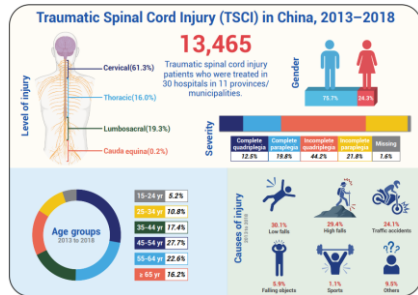
<https://doi.org/10.1002/imt2.70128>

# Background

**Spinal cord injury (SCI) is a highly prevalent condition with a substantial disease burden and represents a major unresolved global health challenge.**

**SCI disrupts neural connectivity between the brain and the spinal cord, resulting in devastating and often permanent neurological damage, including sensory and motor dysfunction, abnormal reflex activity, and autonomic dysregulation.**

## Socioeconomic burden of SCI



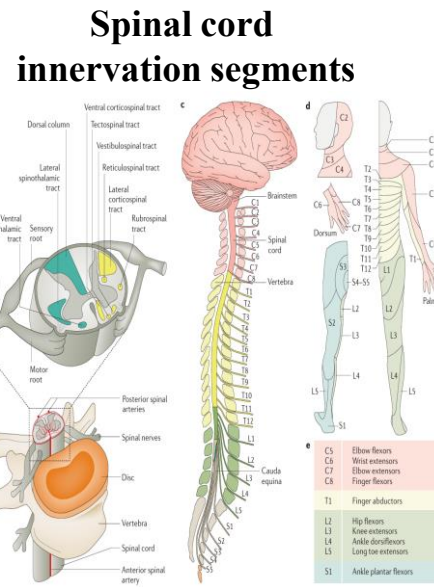
**A large patient population**

**~15.4 million individuals affected worldwide**

**An increasing disease burden**

**The U.S. annual cost: \$7,000,000,000;  
The UK annual cost: £1,400,000,000.**

## SCI levels and phases

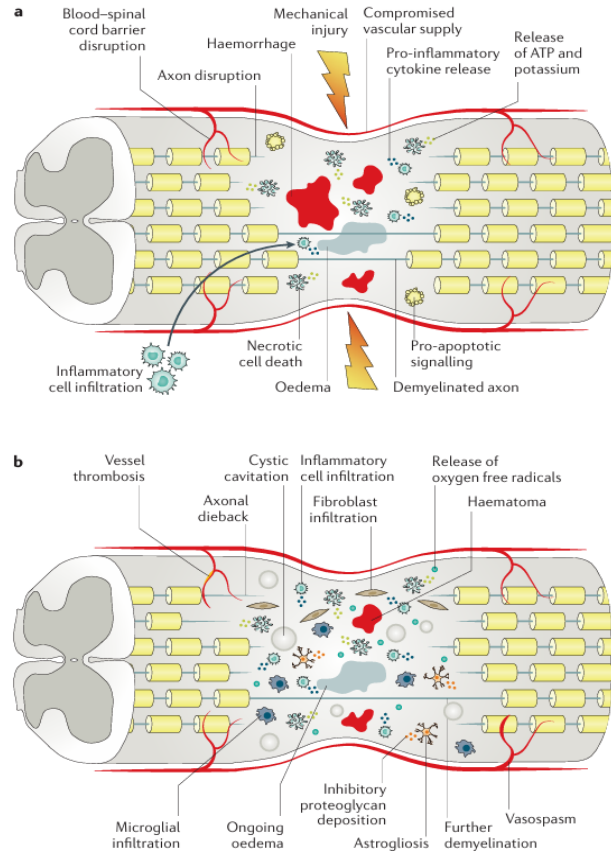




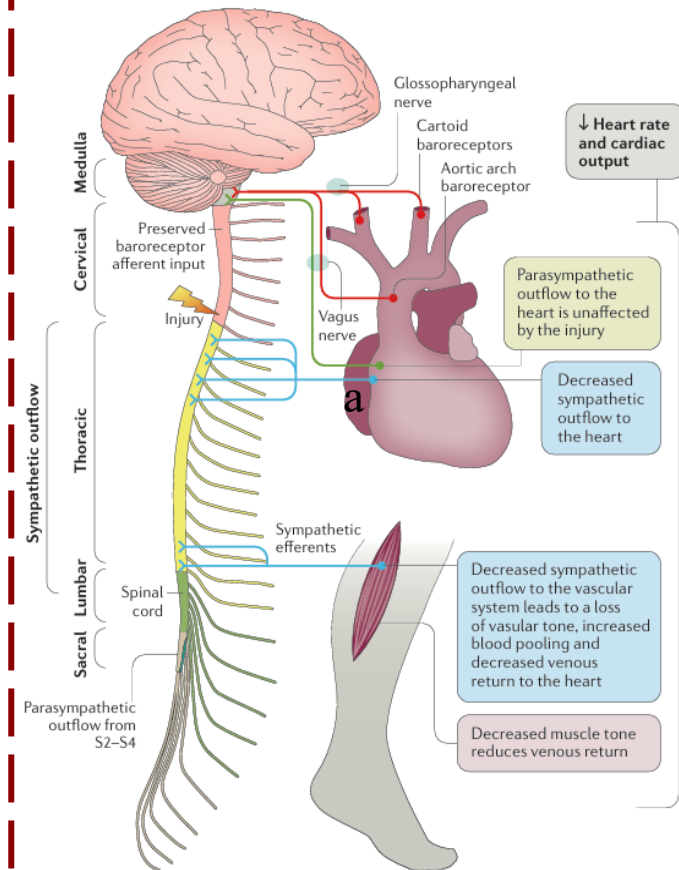
# Background

SCI involves complex pathophysiological mechanisms with systemic effects beyond the site of injury

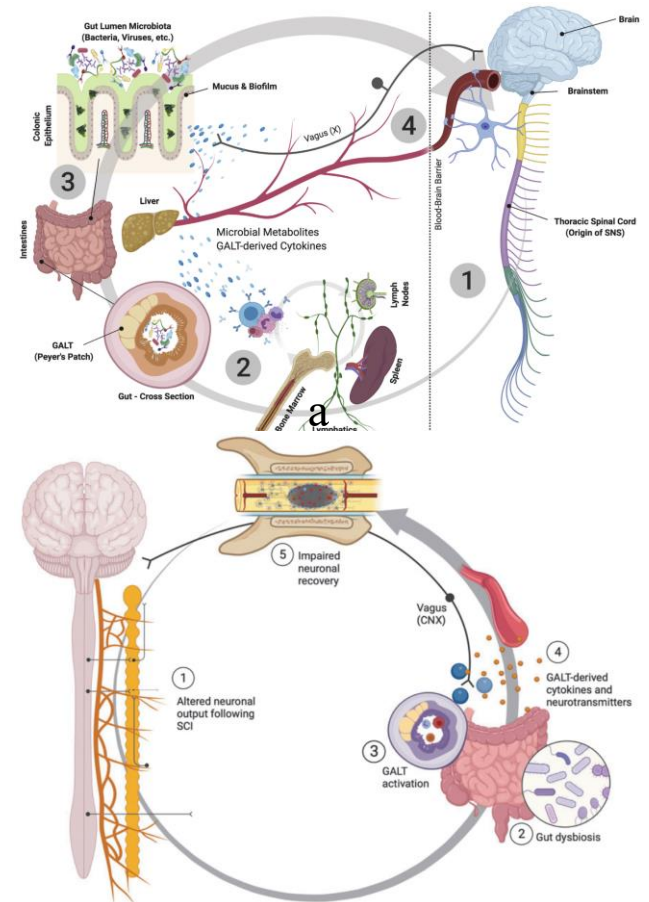
## Phase-specific pathophysiology of SCI



## SCI induces multi-organ dysfunction



## SCI leads to gut microbiota dysbiosis

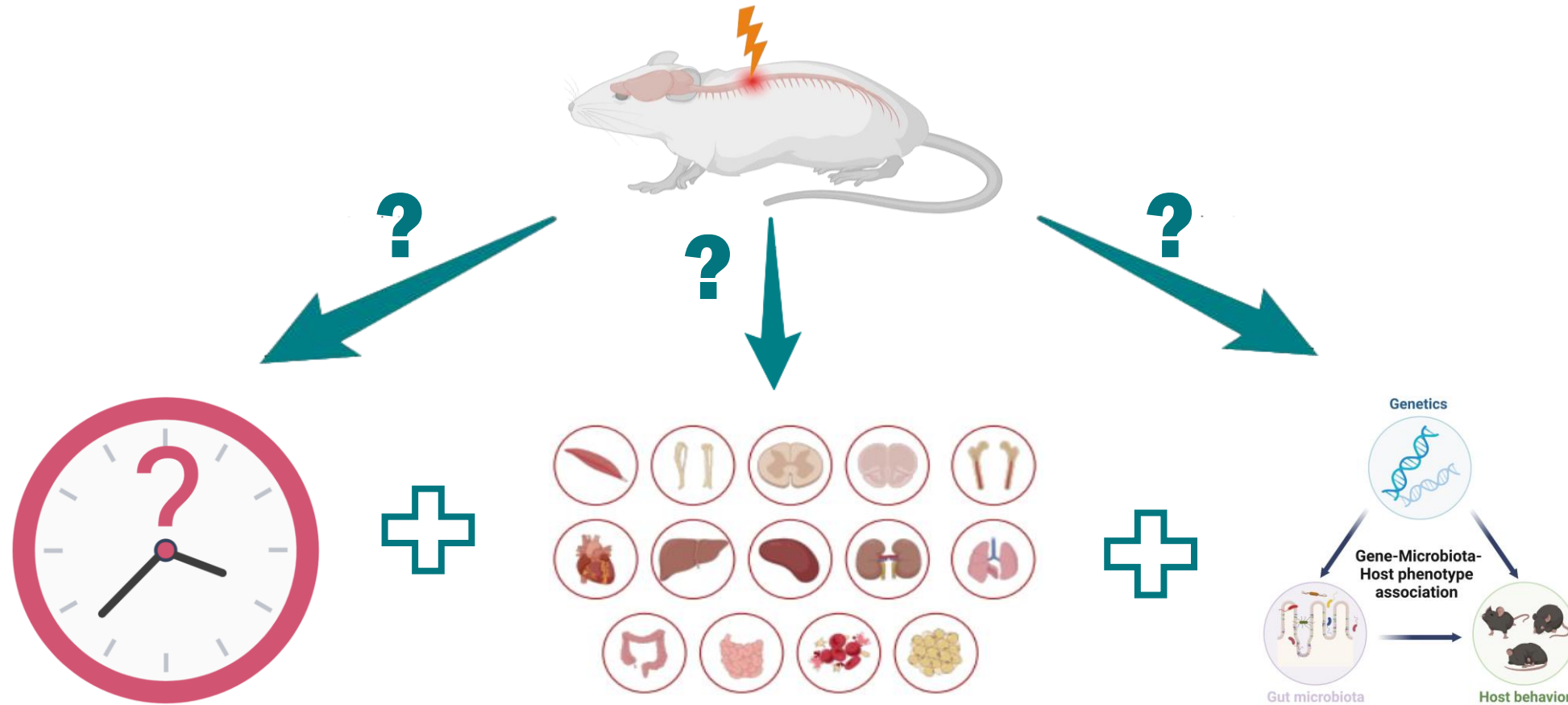




# Background

Most existing SCI studies rely on single or limited time-point analyses

**A comprehensive, time-resolved view of gut microbiota dysbiosis and multi-organ transcriptomic reprogramming remains poorly characterized**



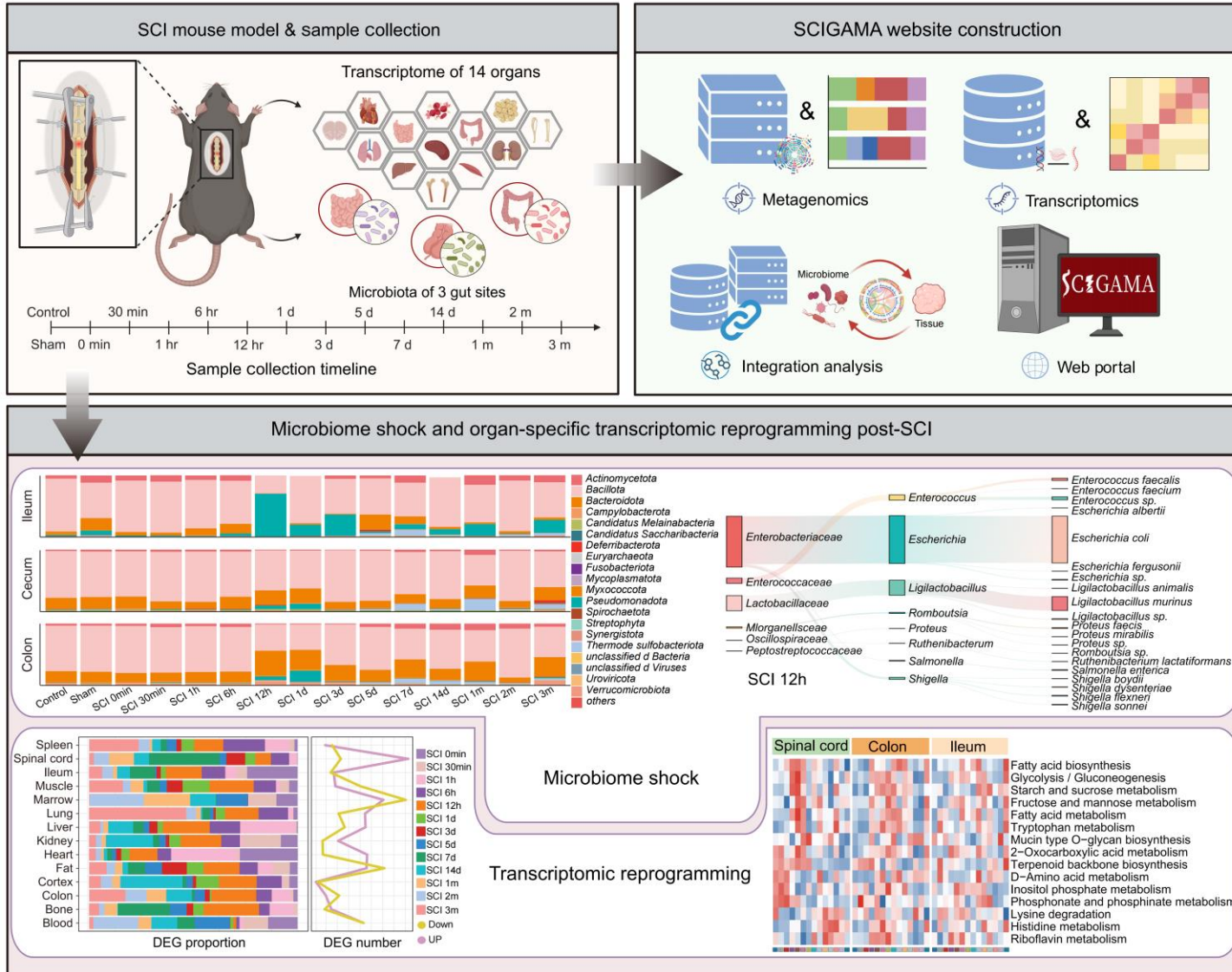
■ Temporal dynamics of injury

■ Multi-organ transcriptomic responses

■ Gut microbiome dynamics

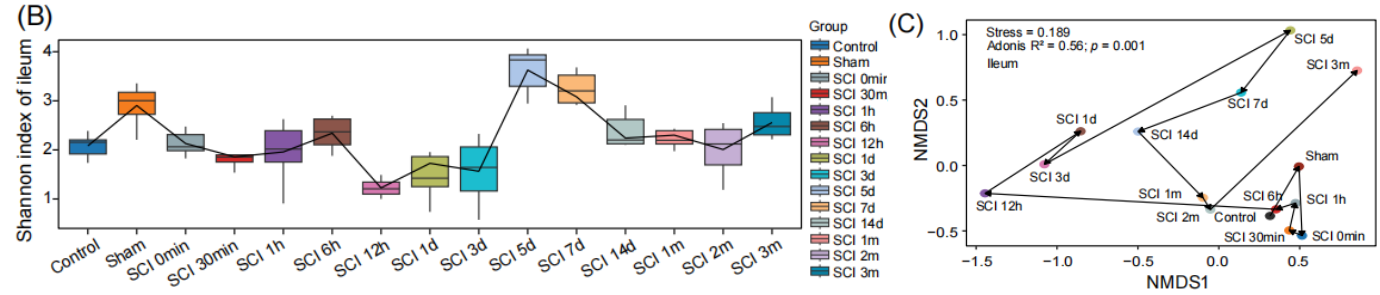
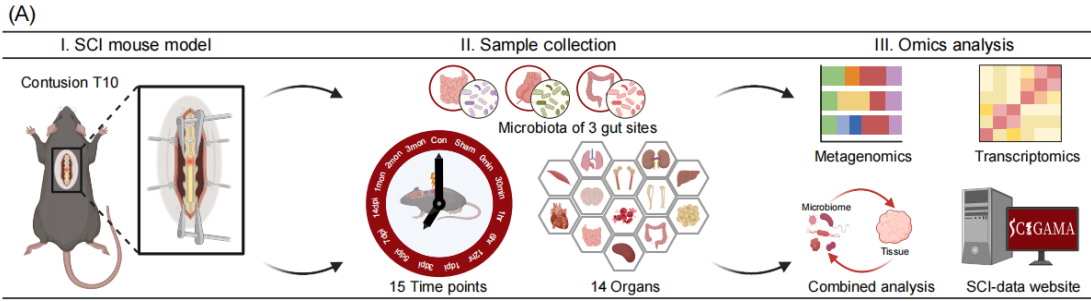


# Highlights

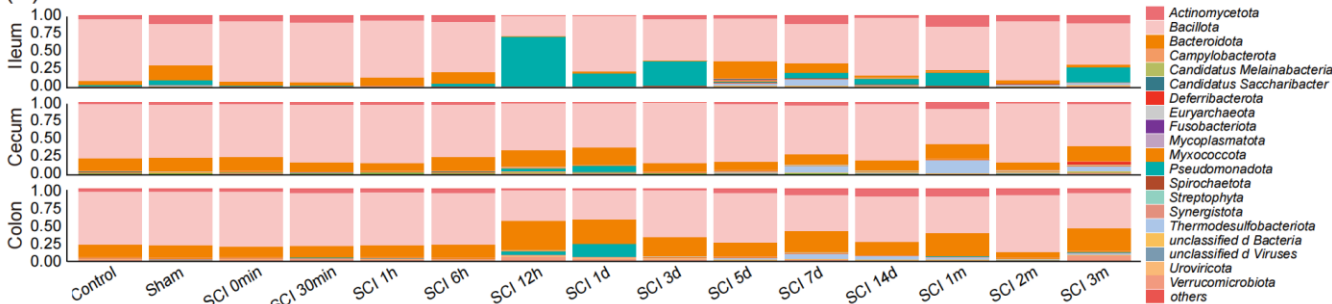


- We identified “**microbiome shock**”, marked by acute microbial disruption at 12 h and partial recovery at 5 days post SCI.
- Combined multi-timepoint metagenomic and multi-organ transcriptome analysis suggests that gut dysbiosis may link to multi-organ immune and metabolic abnormalities after SCI.
- We developed Spinal Cord Injury Gut Microbiome and Multi-Organ Gene Expression Atlas (**SCIGAMA**), the first time-resolved multi-organ and microbiome atlas for SCI.

# Spinal cord injury induces acute “microbiome shock”

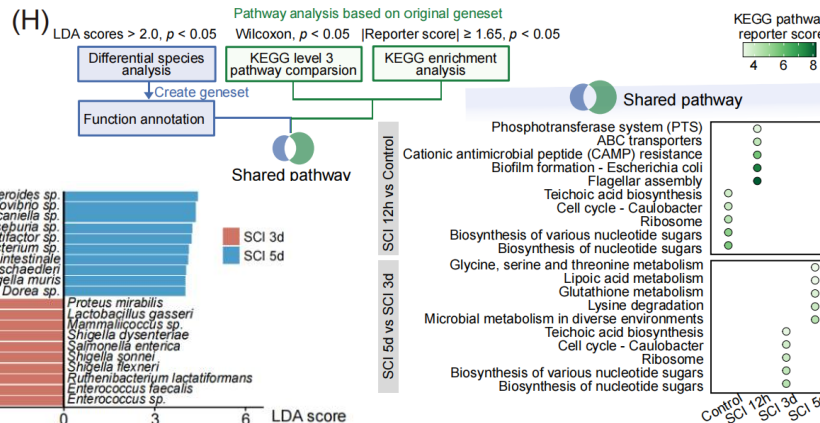
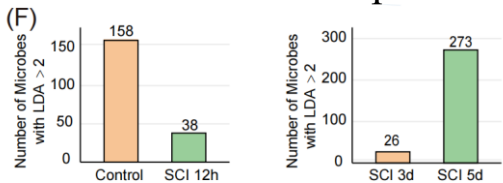
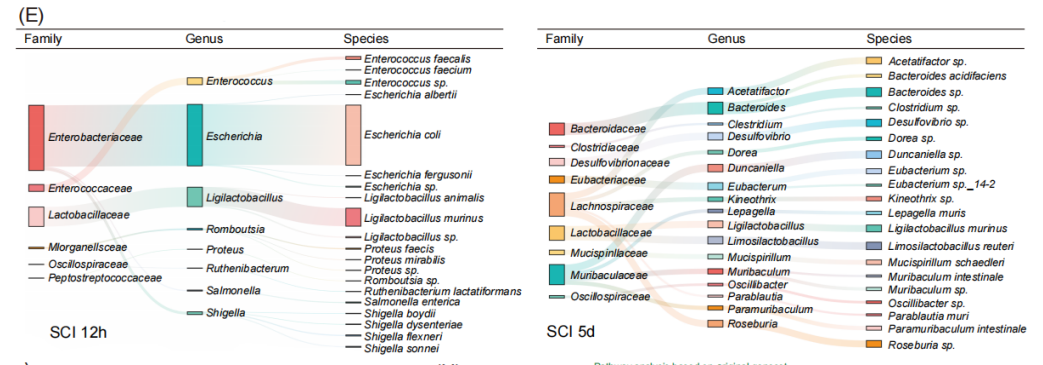


(D) Experimental Design and Multi-Omics Analysis Protocol

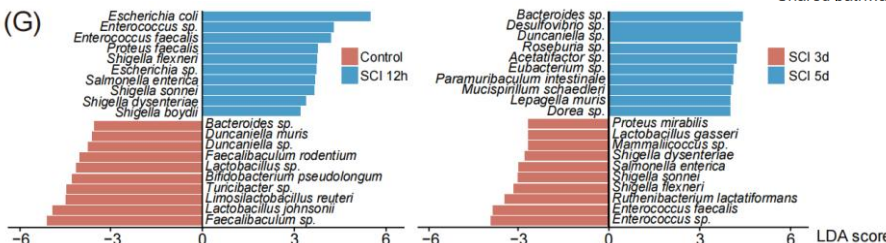


The microbial composition at the phylum level in different gut segments

Diversity changes at different time points after SCI



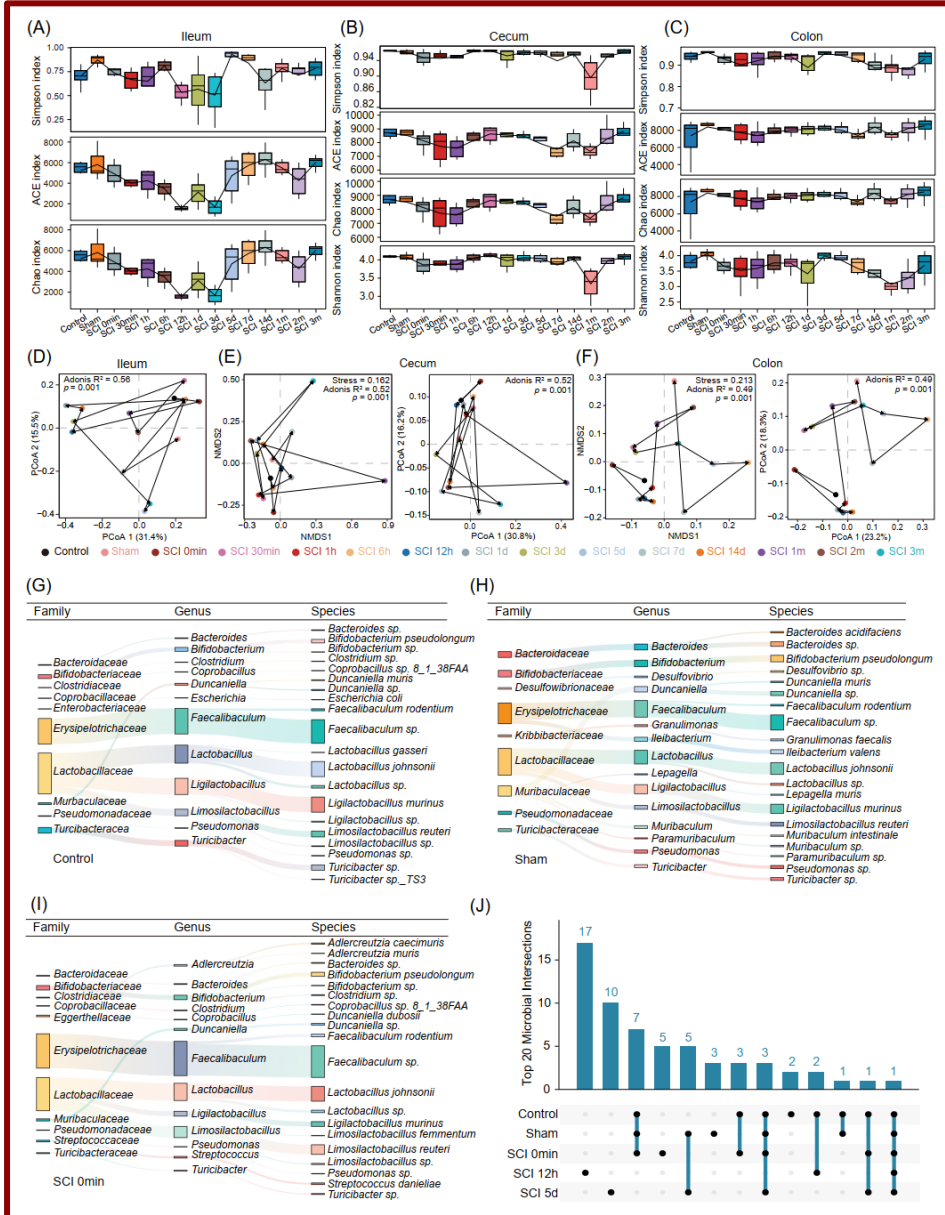
Changes in microbial communities at 12 h and 5 days post SCI



Comparison of the abundance and functionality of high-abundance microbial communities at 12 h and 5 days post SCI

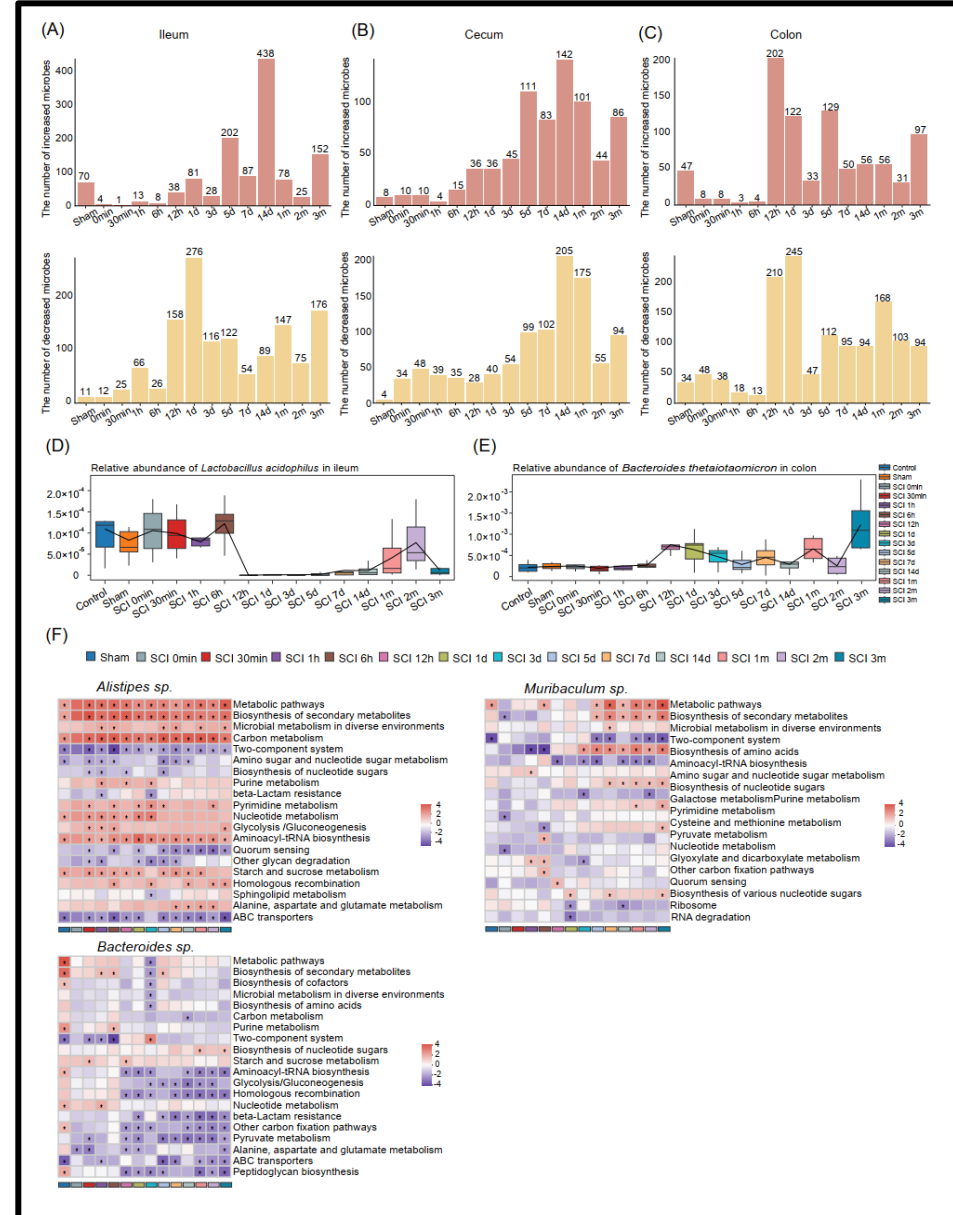
Rapid and severe microbiome disruption occurs within 12 h post SCI and persists up to 5 days → Defined as “microbiome shock”

# Spinal cord injury induces acute “microbiome shock”

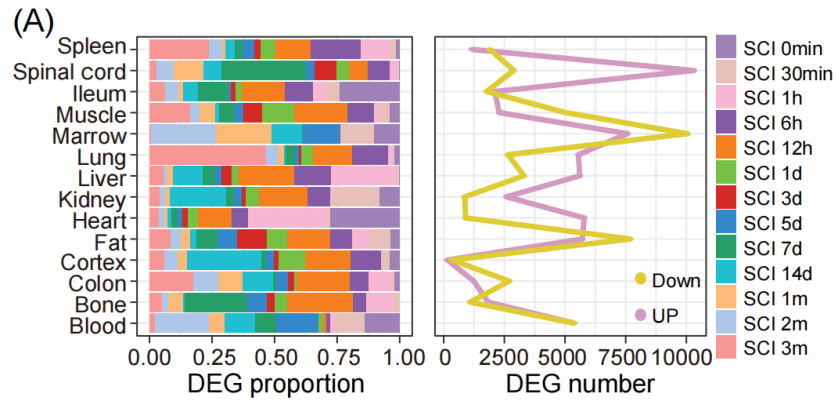


Time-dependent shifts in microbiome composition and function post SCI

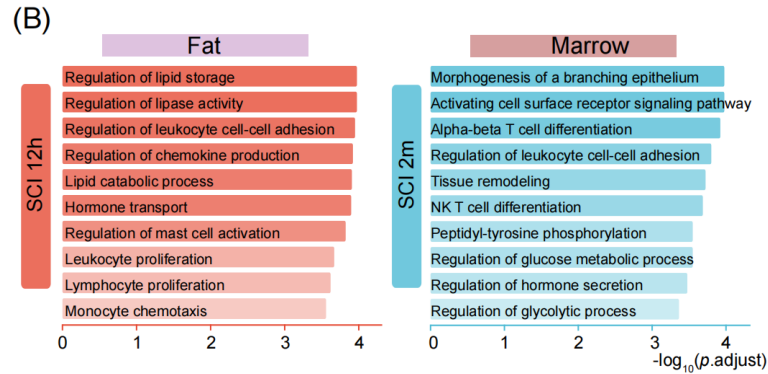
The microbial composition and function undergo dynamic changes post SCI



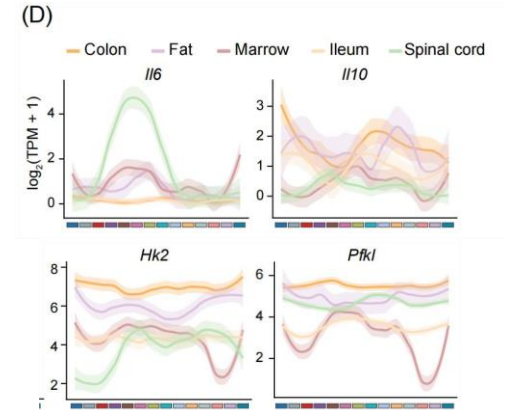
# Gut microbiome and multi-organ transcriptome integration reveals the necessity for phase-specific interventions post SCI



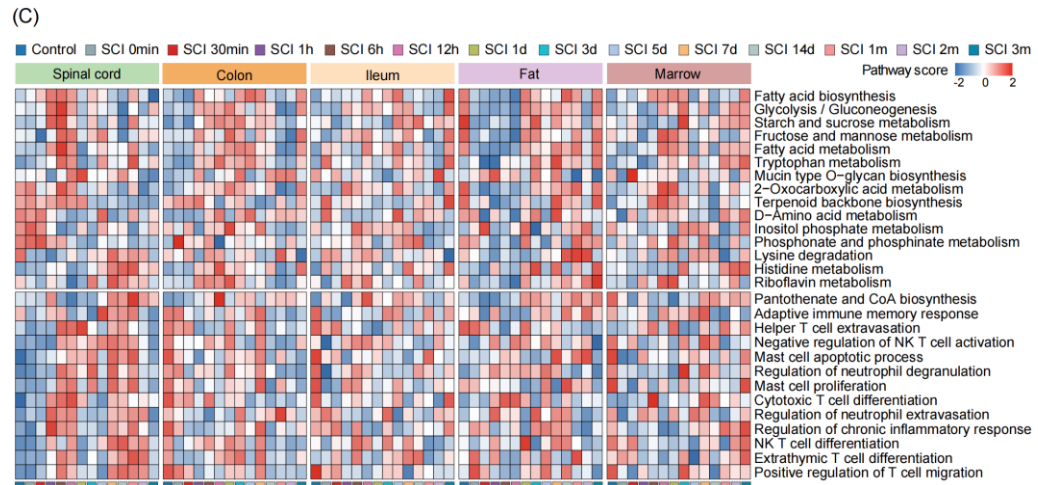
Organ-specific transcriptomic changes



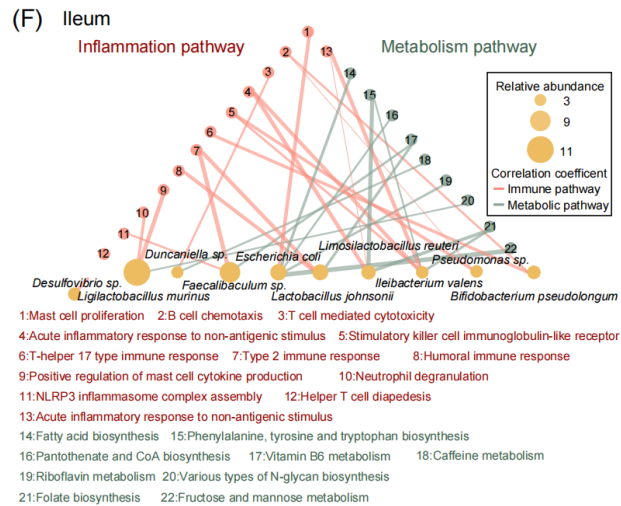
Functional enrichment analysis of upregulated genes in fat and bone marrow



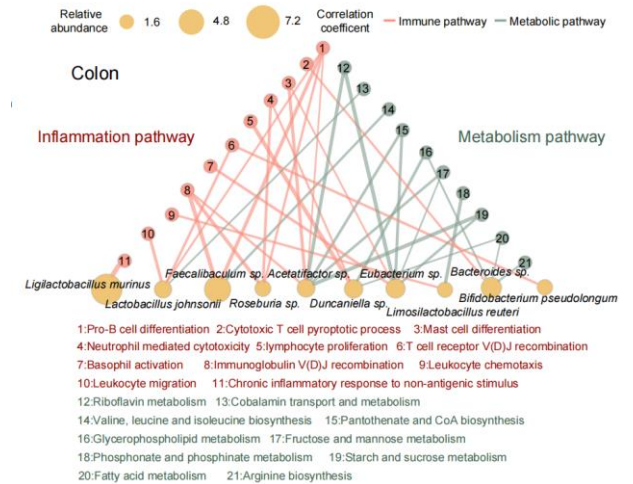
Expression levels of inflammation-related genes



Dynamic immune and metabolic reprogramming

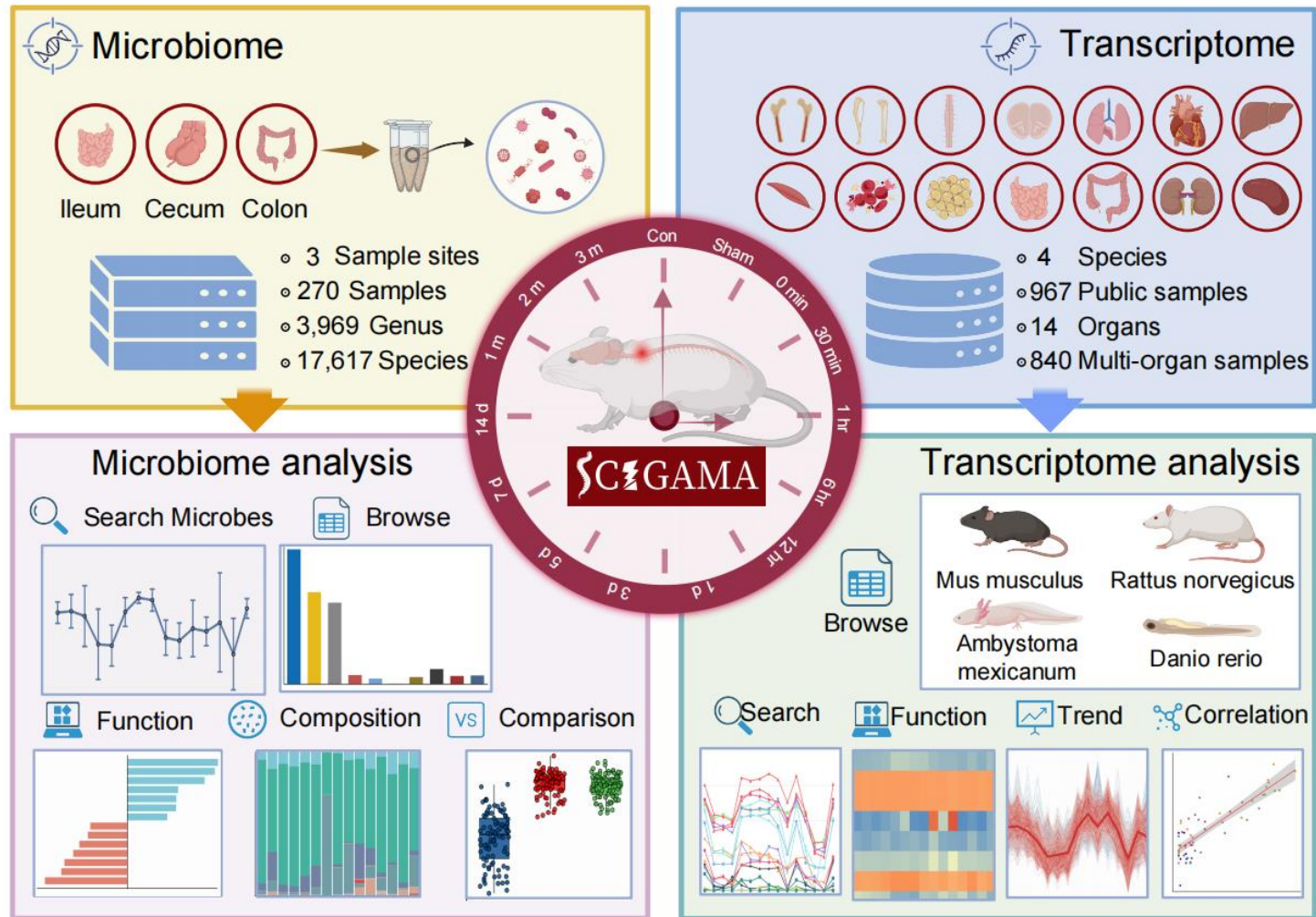


Correlations between gut microbiota and multi-Organ immune and metabolic functions



**Microbiome alterations are broadly associated with multi-organ responses, indicating systemic effects beyond the gut**

# Gut microbiome and multi-organ transcriptome integration reveals the necessity for phase-specific interventions post SCI



**SCIGAMA:** A time-resolved multi-organ and microbiome atlas for SCI.

A comprehensive platform integrating multi-temporal microbiome and multi-organ transcriptomic data.

- Data**
  - 15 time points following SCI
  - 14-organ transcriptomic profiles
  - 3 sites of gut microbiome data across time points
- Analysis**
  - Spatiotemporal microbiome dynamics
  - Multi-organ transcriptomic analysis
  - Integrated microbiome–host correlation analysis



# Summary

- ❑ This study identifies rapid, severe gut dysbiosis occurring within 12 h after spinal cord injury; this dysbiosis persists and partially resolves by day 5 post SCI, and we term this phenomenon “microbiome shock”.
- ❑ Multi-organ transcriptional reprogramming induced by spinal cord injury is revealed, characterized by systemic immune and metabolic remodeling.
- ❑ The SCIGAMA database with integrated multi-module analytical functions is constructed to provide a reliable data platform for spinal cord injury research.

Chi Zhang, Yufei Du, Mingxin Wu, Chuang Li, Ruizhi Jiang, Enlin Qi, Shaolong Li, et al. 2026. Spinal cord injury induces acute microbiome shock and system-wide transcriptomic reprogramming. *iMeta* 5: e70128.

<https://doi.org/10.1002/imt2.70128>

# iMeta: To be top journals in biology and medicine

# WILEY





“**iMeta**” launched in 2022 by iMeta Science Society, **impact factor (IF) 33.2**, ranking **top 65/22400 in the world**. It aims to publish innovative and high-quality papers with broad and diverse audiences. Its scope is similar to *Cell*. The average citation is > 40 in 2025, similar to *Nature* and *Science*. Its unique features include video abstract, bilingual publication, and social media with 600,000 followers. Indexed by [SCIE/ESI](#), [PubMed](#), [Google Scholar](#) etc.

“**iMetaOmics**” launched in 2024, indexed by [ESCI](#), [PubMed](#), [Google Scholar](#), with a **target IF>15**, and its scope is similar to *Nature Communications*, *Science Advances*, *Advanced Science*, *Nucleic Acids Research*, etc.

“**iMetaMed**” launched in 2025, with a target IF>15, similar to *Med*, *Cell Reports Medicine*, *eBioMedicine*, *eClinicalMedicine* etc.

 Society: <http://www.imeta.science>  
Publisher: <https://wileyonlinelibrary.com/journal/imeta>  
iMeta: <https://wiley.atyponrex.com/journal/IMT2>  
Submission: iMetaOmics: <https://wiley.atyponrex.com/journal/IMO2>  
iMetaMed: <https://wiley.atyponrex.com/journal/IMM3>

 [iMetaScience](#)  
 [iMetaScience](#)

 [office@imeta.science](mailto:office@imeta.science)  
[imetaomics@imeta.science](mailto:imetaomics@imeta.science)  
 [Promotion Video](#)

Update  
2026/3/30