

## PRESS RELEASE

### Immune cells remember their location

Researchers in Bonn use an AI algorithm to reconstruct the spatial origin of macrophages

**Bonn, March 02 – A new AI-based method reconstructs spatial information about where immune cells were originally located in an organ, even after these cells have been removed from the tissue and analyzed individually. To accomplish this, Researchers at the University Hospital Bonn (UKB) and the University of Bonn use the transcriptome, i.e., the entirety of all messenger RNA transcripts produced by genes within a cell at a given time. The work has now been published in the journal *Advanced Science* and introduces the new MERLIN algorithm.**

How do immune cells change and contribute to diseases in organs? Single-cell RNA sequencing technology has revolutionized immunological research, by revealing which genes are active in individual immune cells. "However, when cells are isolated, information about which part of an organ the cells originated from is inevitably lost. In highly structured organs such as the kidney or brain, this spatial information is crucial for understanding health and disease," says Prof. Christian Kurts, Director of the Institute for Molecular Medicine and Experimental Immunology at the UKB. He is a member of the ImmunoSensation<sup>3</sup> Cluster of Excellence and the Transdisciplinary Research Area (TRA) "Life & Health" at the University of Bonn.

### MERLIN makes the memory of immune cells accessible

"We discovered that macrophages carry a molecular memory of their local environment," explains Junping Yin, first author of the study. "Even after isolation, their gene activity still reflects which area of the kidney or brain they originate from. MERLIN makes this information accessible again."

MERLIN was developed at the intersection of immunology, nephrology, and bioinformatics. The algorithm uses machine learning to recognize characteristic patterns in gene activity that are influenced by local tissue conditions such as oxygen deficiency or salt concentration.

"From a bioinformatics perspective, it was crucial that MERLIN be trained on multiple independent datasets," says Jian Li, senior author and bioinformatician. "This allows the system to learn real biological signals. It can then be applied to completely new or previously published datasets."

The researchers were able to show that MERLIN not only works in mouse models, but also correctly predicts the spatial origin of macrophages – large specialized white blood cells – in human kidney samples. In addition, the approach was transferred to the brain, where the positions of microglia, the brain's immune cells, were successfully reconstructed.

**Chairman of the Management Board  
and Medical Director**

Prof. Dr. Uwe Reuter, MBA

Tel.: +49 228 287-10900

Fax: +49 228 287-9010900

[Uwe.Reuter@ukbonn.de](mailto:Uwe.Reuter@ukbonn.de)

**Public Relations and Corporate  
Communication**

Tel.: +49 228 287-10469

[ukb-medien@ukbonn.de](mailto:ukb-medien@ukbonn.de)

Bonn University Hospital  
Venusberg Campus 1  
Building 02  
53127 Bonn

### **MERLIN provides new insights into kidney disease**

The application to kidney disease is particularly relevant. By analyzing previously published data sets on inflammation, sepsis, ischemia-reperfusion injury occurring after transplantation, and diabetic nephropathy, MERLIN confirmed known disease mechanisms and provided new insights into region-specific immune responses and therapeutic effects. "This is a major advance for nephrology," emphasizes senior author Christian Kurts. "We see that immune responses and drug effects depend heavily on the specific region of the kidney, as we know from patient care."

The study was conducted at the UKB in the context of the ImmunoSensation<sup>3</sup> Cluster of Excellence and TRA "Life & Health" at the University of Bonn, which promote interdisciplinary research on the immune system. It also highlights the close international and national collaboration with researchers in Wuhan (China), at the University Medical Center Hamburg-Eppendorf, and at LMU Munich.

"MERLIN opens up a new dimension in single-cell research," summarizes Junping Yin. "We can re-evaluate existing data sets and gain a much more precise understanding of disease mechanisms."

**Funding:** In addition to funding from the ImmunoSensation<sup>3</sup> Cluster of Excellence at the University of Bonn, the study was supported by the German Research Foundation (DFG) within the framework of TRR 237 *Nucleic Acid Immunity* and FOR 5427 *Bacterial Renal Infections and Their Defense*, and SFB 1192: *Immune-Mediated Glomerular Diseases*.

**Publication:** Junping Yin et al.: Predicting Macrophage Spatial Localization from Single-Cell Transcriptomes to Uncover Disease Mechanisms; *Advanced Science*; DOI: 10.1002/adv.202410924  
<https://advanced.onlinelibrary.wiley.com/doi/full/10.1002/adv.202410924>

#### **Scientific contact:**

Prof. Christian Kurts

Institute for Molecular Medicine and Experimental Immunology

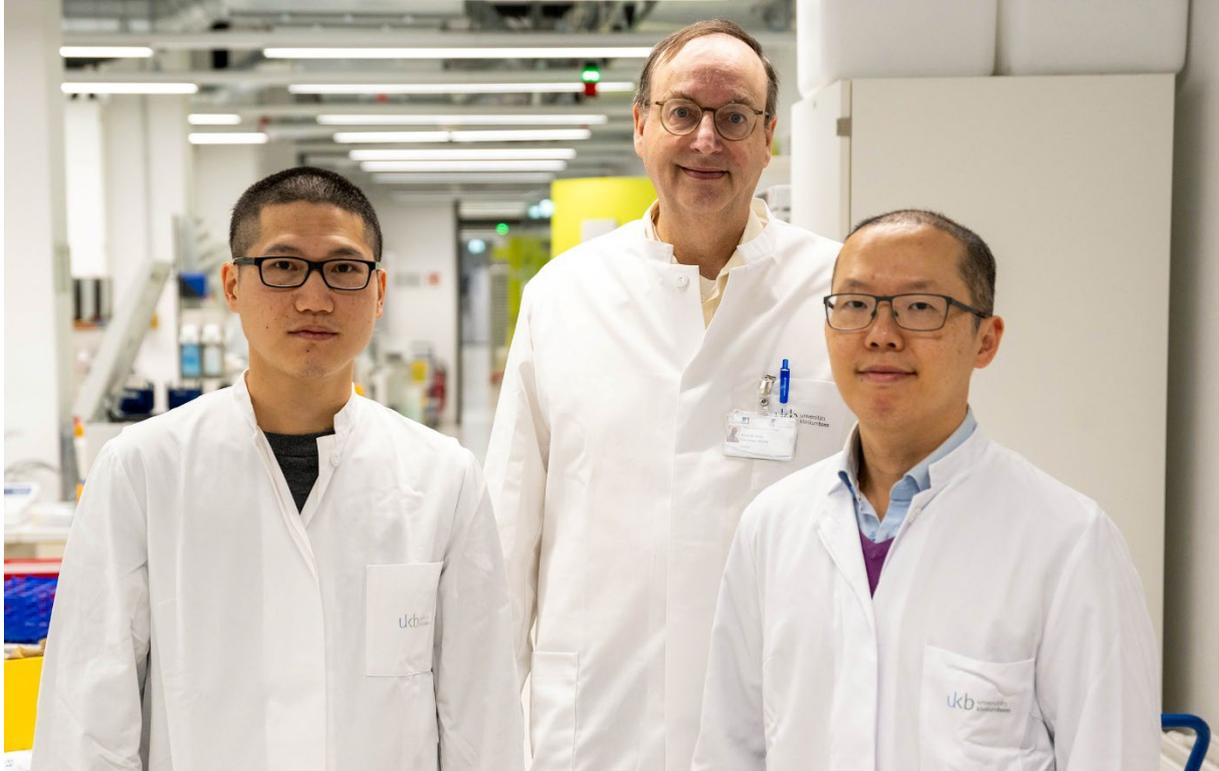
University Hospital Bonn

ImmunoSensation<sup>3</sup> and TRA & Life and Health Clusters of Excellence, University of Bonn

Email: [ckurts@uni-bonn.de](mailto:ckurts@uni-bonn.de)

**Image**

**material:**



**Caption: Immune cells remember their location:**

(from left) Junping Yin, Prof. Christian Kurts and Jian Li use an AI algorithm to reconstruct the spatial origin of macrophages.

**Picture credits:** University Hospital Bonn (UKB) / Alessandro Winkler

**Press contact:**

Dr. Inka Väth

Deputy Press Officer at the University Hospital Bonn (UKB)

Public Relations and Corporate Communication at UKB

Phone: (+49) 228 287-10596

E-mail: [inka.vaeth@ukbonn.de](mailto:inka.vaeth@ukbonn.de)

**About the University Hospital Bonn:** As one of Germany's leading university hospitals, Bonn University Hospital (UKB) combines excellence in medical care and research with high-quality teaching. Every year, UKB treats more than half a million outpatients and inpatients. Around 3,500 students are enrolled in medicine and dentistry, and over 600 individuals receive training in healthcare professions annually. With around 9,900 employees, UKB is the third-largest employer in the Bonn/Rhein-Sieg region. In the „Focus hospital rankings“, UKB is rated the top university hospital in North Rhine-Westphalia and has the second-highest case mix index (an indicator of treatment complexity) of all university hospitals nationwide. In 2024, UKB secured nearly €100 million in third-party funding for research, development, and teaching. For the fourth consecutive year, the F.A.Z. Institute recognized UKB as both “Germany's Training Champion” and “Germany's Most Desirable Employer.” For current figures and further information, please refer to the annual report at: [geschaeftsbericht.ukbonn.de](https://www.ukbonn.de/geschaeftsbericht)