Center for Experimental Medicine and Systems Biology

Division of Cell Regulation
細胞制御研究分野

Professor	Satoshi Yamazaki, Ph.D.	教　授	博士(生命科学)	山　﨑　　聡
Associate Professor	Yosuke Tanaka, Ph.D.	准教授	博士(医学)	田　中　洋　介
Assistant Professor	Takao Yogo, M.D., Ph.D.	助　教	博士(医学)	余　語　孝　夫
Project Assistant Professor	Hyojung Jeon, Ph.D.	特任助教	博士(医学)	全　　孝　静
Project Assistant Professor	Yuko Kawano, M.D., Ph.D.	特任助教	博士(医学)	川　野　裕　子

Our studies focus mainly on investigation of stem cell biology using the hematopoietic stem cell (HSC) as a research model. Recent identification of a variety of stem cell sources including embryonic and somatic (tissue-specific) stem cells has brought about substantial progress in the field of stem cell research.

1. Quantitative phase imaging with temporal kinetics predicts hematopoietic stem cell diversity.

Yogo T, Iwamoto Y, Becker HJ, Kimura T, Ishida R, Sugiyama-Finnis A, Yokomizo T, Suda T, Ota S, Yamazaki S.

Innovative identification technologies for hematopoietic stem cells (HSCs) have expanded the scope of stem cell biology. Clinically, the functional quality of HSCs critically influences the safety and therapeutic efficacy of stem cell therapies. However, most analytical techniques capture only a single snapshot, disregarding the temporal context. A comprehensive understanding of the temporal heterogeneity of HSCs necessitates live-cell, real-time and non-invasive analysis. Here, we developed a prediction system for HSC diversity by integrating single-HSC ex vivo expansion technology with quantitative phase imaging (QPI)-driven machine learning. By analyzing the cellular kinetics of individual HSCs, we discovered previously undetectable diversity that snapshot analysis cannot resolve. The QPI-driven algorithm quantitatively evaluates stemness at the single-cell level and leverages temporal information to significantly improve prediction accuracy. This platform advances the field from snapshot-based identification of HSCs to dynamic, time-resolved prediction of their functional quality based on past cellular kinetics.

2. Progenitor effect in the spleen drives early recovery via universal hematopoietic cell inflation

Yogo T, Becker HJ, Kimura T, Iwano S, Kuchimaru T, Miyawaki A, Yokomizo T, Suda T, Iwama A, Yamazaki S.

Hematopoietic stem cells (HSCs) possess the capacity to regenerate the entire hematopoietic system. However, the precise HSC dynamics in the early post-transplantation phase remain an enigma. Clinically, the initial hematopoiesis in the post-transplantation period is critical, necessitating strategies to accelerate hematopoietic recovery. Here, we uncovered the spatiotemporal dynamics of early active hematopoiesis, “hematopoietic cell inflation,” using a highly sensitive in vivo imaging system. Hematopoietic cell inflation occurs in three peaks in the spleen after

transplantation, with common myeloid progenitors (CMPs), notably characterized by HSC-like signatures, playing a central role. Leveraging these findings, we developed expanded CMPs (exCMPs), which exhibit a gene expression pattern that selectively proliferates in the spleen and promotes hematopoietic expansion. Moreover, universal exCMPs supported early hematopoiesis in allogeneic transplantation. Human universal exCMPs have the potential to be a viable therapeutic enhancement for all HSC transplant patients.

Publications

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