

Inside the Skull: Exploring Bone Marrow and Brain Dynamics with Intravital Imaging

WEBINAR
OCT 8 | 11:00 AM EDT



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Special Joint Webinar

DATE: October 8, 2026 (Thursday)

TIME: 17h00 CEST

DURATION: 25min (Prof. Koh) + 25min (Prof. Kim) + 10min (Q&A)

Register Page

What happens at the interface between the skull, immune system, vasculature, and brain? And how can we visualize these interactions from the skull to the deep brain?

This joint webinar will feature **Prof. Bong Ihn Koh (Yale School of Medicine)**, author of the paper **“Adult skull bone marrow is an expanding and resilient haematopoietic reservoir,”** and **Prof. Pilhan Kim (KAIST)**, who will introduce advanced **intravital imaging approaches for visualizing brain dynamics**. Together, the sessions will explore new perspectives on the dynamic biology of the skull and brain.

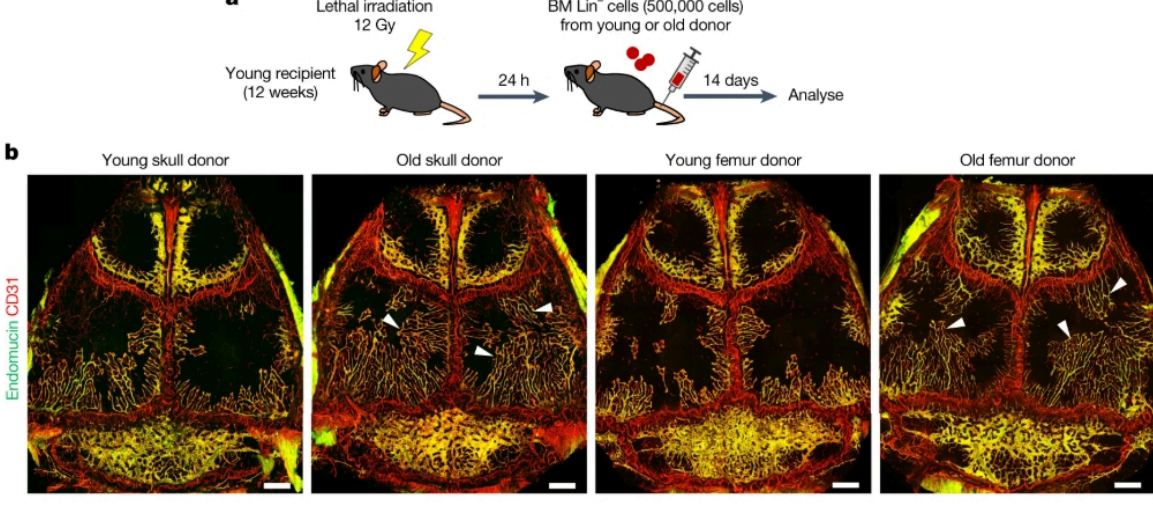


Figure 3a,b. Regulation of calvarial vessels by haematopoietic cells
Adapted from Koh et al., Nature 636, 172–181 (2024)

Session 1: Functional specialization of craniofacial bone marrow vasculature

Prof. Bong Ihn Koh will present his recent publication, *“Adult skull bone marrow is an expanding and resilient haematopoietic reservoir.”* highlighting the unique vascular and immune characteristics of the calvarial bone marrow and its role in neuroimmune communication between the skull and the central nervous system (CNS). The presentation will explore how specialized bone marrow vasculature supports **haematopoiesis**, **immune cell trafficking**, and **CNS surveillance**, with a focus on the functional heterogeneity of craniofacial bone marrow.

Session 2: From Skull to Deep Brain: Exploring Brain Dynamics with Intravital Imaging

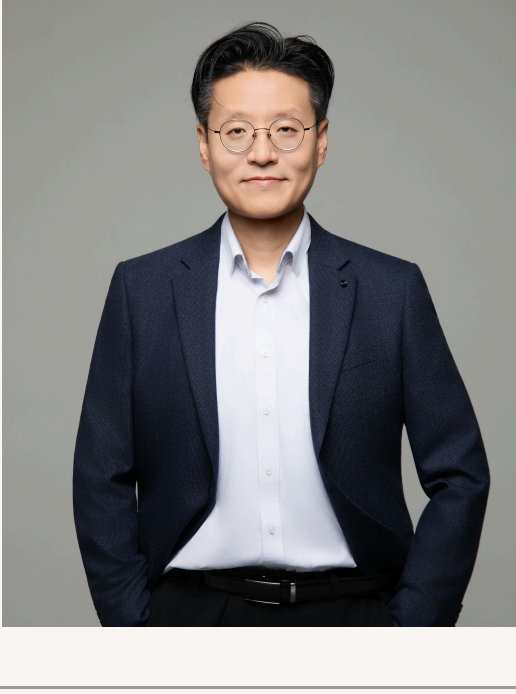
Prof. Pilhan Kim will introduce cutting-edge intravital imaging approaches for exploring brain dynamics from the skull to deep brain regions. His session will highlight how **two-photon and confocal microscopy** enable real-time visualization of neuronal, vascular, and cellular dynamics in the living brain, featuring **cranial imaging windows**, **deep brain imaging**, and **awake imaging** for longitudinal studies of brain physiology and cellular interactions.

MEET-THE-EXPERT



Bong Ihn Koh, Ph.D.
Assistant Professor, Department of Comparative Medicine at Yale Stem Cell Center, Yale School of Medicine

Prof. Bong Ihn Koh studies **vascular biology** and specialized **stem cell niches** in **craniofacial bone marrow**, focusing on their roles in **neuroimmune communication**, **hematopoiesis**, and **tissue regeneration**.



Pilhan Kim, Ph.D.
Professor, Graduate School of Medical Science and Engineering, KAIST

Prof. Pilhan Kim specializes in **in vivo imaging** and **intravital microscopy**, developing advanced **two-photon and confocal imaging techniques** to enable real-time visualization of cellular dynamics and disease mechanisms.

Article

Adult skull bone marrow is an expanding and resilient haematopoietic reservoir

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The bone marrow microenvironment is a critical regulator of haematopoietic stem cell self-renewal and fate¹. Although it is appreciated that ageing, chronic inflammation and other insults compromise bone marrow function and thereby negatively affect haematopoiesis², it is not known whether different bone compartments exhibit distinct microenvironmental properties and functional resilience. Here we use imaging, pharmacological approaches and mouse genetics to uncover specialized properties of bone marrow in adult and ageing skull. Specifically, we show that the skull bone marrow undergoes lifelong expansion involving vascular growth, which results in an increasing contribution to total haematopoietic output. Furthermore, skull is largely protected against major hallmarks of ageing, including upregulation of pro-inflammatory cytokines, adipogenesis and loss of vascular integrity. Consistent rapid and dynamic changes to the skull vasculature and bone marrow are induced by physiological alterations, namely pregnancy, but also pathological challenges, such as stroke and experimental chronic myeloid leukaemia. These responses are highly distinct from femur, the most extensively studied bone marrow compartment. We propose that skull harbours a protected and dynamically expanding bone marrow microenvironment, which is relevant for experimental studies and, potentially, for clinical treatments in humans.

Niche microenvironments composed of multiple cell types and molecular signals regulate the self-renewal and the ultimate fate of haematopoietic stem cells (HSCs) in bone marrow^{3,4} (BM). The skull, a flat bone encasing the brain, develops via intramembranous ossification and fundamentally differs in both composition and remodeling from long bones, which undergo endochondral ossification during development and sustain load-bearing mechanical stress^{5,6}. The thin and flat mouse calvarium, the main component of the skull roof, has been successfully used as a platform for the imaging of HSC dynamics^{7,8}. Potential functional differences between BM compartments, such as those in long and flat bone, however, remain little understood. It has been shown that HSCs are homogeneously distributed throughout calvarium and long bone (mainly diaphysis and epiphysis) under homeostatic conditions, whereas chimerism is more transplanted with congenic haematopoietic stem and progenitor cells (HSPCs) in initially higher focal calvarium and epiphysis relative to diaphysis⁹. The discovery of designated channels between the calvarial BM and the bone marrow of the meninges indicates that skull BM acts as a haematopoietic reservoir for meningeal and central nervous system immunity^{10,11}. Ageing causes an overall decline in haematopoietic function, with compromised lymphopoiesis and a bias toward dysfunctional myelopoiesis¹². Again, it remains unknown whether all BM compartments are equally affected by ageing processes and therefore collectively contribute to haematopoietic decline. Here we show that calvarial BM is fundamentally different to the BM in long bones. Calvarial BM continuously expands during adulthood, is resistant to most major hallmarks of BM niche ageing, and gradually increases its systemic haematopoietic contribution throughout adult life and ageing. Our work also establishes that BM compartments exhibit unexpected functional differences, with implications for a range of physiological conditions such as pregnancy and ageing, as well as pharmacological treatments and disease settings.

Skull BM expands during adult life

To characterize changes in calvarial BM throughout adult life, we collected skulls from young adult (9–14 weeks, hereafter referred to as ‘young’), middle-aged (31–37 weeks), old (52–75 weeks) and geriatric (95 weeks) mice. Initial stereoscopic observations showed that blood-filled structures, representing blood vessels and surrounding BM, occupy only limited areas of the dorsal and parietal bone in young adults, whereas interpericardial bone is mostly filled by blood vessels (Fig. 1a). Although angiogenic growth of blood vessels is normally confined to

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