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EDITORIAL

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Emerging topics in microvascular research: Advancing our understanding by interdisciplinary exploration

Abstract

Historically, major advances in microvascular research have been made by integrating physiology and bioengineering approaches. This Special Topics Issue focuses on providing a spotlight on emerging areas of microvascular research, showcasing how interdisciplinary collaborations and application of novel techniques can impact our understanding of tissue-specific microvascular remodeling by integrating cell behaviors across scales. The authors in this issue investigate pericyte physiology, perturbations to uteroplacental blood flow, bone microvascular alterations in aging, molecular markers of revascularization, and microfluidic devices to mimic the lymphatic system. The articles highlight the continued importance of expanding our understanding of the microvascular system in health, and disease extends microvascular boundaries in the face of current paradigms, and illustrates how emerging leaders in the field are creating new scientific niches.

The gains in the field of microcirculatory research over the last 65 years have been tremendous. With cornerstones in medicine, physics, physiology, and engineering, work in this field has contributed to the physiological, molecular, and pathological understanding of microvascular function. The collection of review and original research articles in this special topics issue highlights emerging areas in microvascular research.[1-5] Each contribution challenges traditional dogma, provides novel rationale, identifies unique and understudied microvascular beds, and describes innovative approaches to push the boundaries and impacts of microvascular research. As our understanding increases, knowledge gaps also emerge regarding the relationships between microvascular remodeling and function in specific tissues types and scenarios that have traditionally garnered less attention. An opportunity exists to consider or re-consider these scenarios with specific emphasis on integrating cell-level interactions and applying novel technologies.

The issue begins with a review article focused on microvascular pericytes.[5] Pericytes had been a previously overlooked cell type in vascular biology, with an unknown physiological function. Recently, researchers have evaluated pericyte location, function, and clinical/therapeutic potential. These cells wrap around the microvasculature to protect the integrity of the vessel and stabilize gap junctions. In this issue, Dr. John Chappell's group provides insight into pericyte function in the local microenvironment during microvascular development, remodeling, and angiogenic sprouting.

As translational science spans from in vitro, to in vivo, to humans, transitional techniques bridging these fields (eg, dual cell culture, modeled systems, and ex vivo perfusion) provide valuable data pertaining to systemic molecular and biomechanical mediators of systemic physiology and pathology. Using the principles of engineering to study biofluidics, Dr. Jonathan Song's group presents an update on microfluidic models of lymphatic vessel function. Microscale modeling efforts, through the collaboration over many scientific fields, may continue to provide novel approaches and techniques to push the boundaries of our current scientific arsenal.[1]

Perturbations to uteroplacental vascular reactivity can have significant consequences to fetal growth and survival.[2] Coupling these outcomes with disruptions to the maternal environment during pregnancy provides the basis to support theories pertaining the Barker hypothesis and more recently Developmental Origins of Health and Disease. Dr. Phoebe Stapleton's group presents a review of the understudied uteroplacental vascular network.[2] This review illustrates how common maternal physiological and environmental exposures alter vascular homeostasis, promote uteroplacental microvascular dysfunction, and result in intrauterine or fetal growth restriction. The integration of this work showcases a negative impact on fetal health and developmental outcomes.

Advancing age impacts the function of many bodily systems including immunity and microvascular reactivity.[3] Those of advanced age are more susceptible to infection and subsequently at greater risk for disease. One theory centralizes around immunosenescence, the reduction of immune function with age, and impairment in the bone marrow microenvironment; however, the role that the bone microvasculature may play in this decline is unclear. In their primary research report, Dr. Rhonda Prisby's group evaluates and assesses

the hematological parameters associated with bone marrow ossification during aging.[3]

Finally, studies by Machado and Bates challenge traditional dogma and apply known angiogenic signaling to a common vascular pathology, ischemia.[4] These molecular studies demonstrate the potential for clinical and therapeutic applications through the dual stimulation of nitric oxide angiopoietin receptor and vascular endothelial growth factor with DII4 activation. This work provides an interesting avenue for future work in the development of angiogenic versus arteriolar genesis revascularization therapies.

Collectively, the articles in this special issues represent novel rationale and innovative approaches in emerging topics of microvascular research. These topics centralize on shifting traditional paradigms, investigating understudied cellular populations and vascular beds, and applying dogma to inform therapeutic approaches.

KEYWORDS

bone, emerging topics and microcirculation, microfluidic devices, pericyte, revascularization, uteroplacental

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CONFLICT OF INTEREST

The authors report no conflict of interest.

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