Biomolecular Condensates Research 2025 1(1):1-2
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Editorial

From Chaos to Order: Charting the New Landscape of Biomolecular Condensates

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It is with immense excitement and a profound sense of purpose that we announce the official launch of *Biomolecular Condensates Research* (BCR), a dedicated, international, open-access journal poised to serve a field that is redefining the very principles of cellular biology. As the founding Editor-in-Chief, I am honored to welcome you to this new platform—a home for a scientific revolution in progress.

For decades, a fundamental question has intrigued biologists: how do the billions of molecules within a cell achieve their exquisite coordination, creating order from chaos to orchestrate life? A revolutionary answer has emerged in the principle of biomolecular phase separation. This concept posits that cells utilize fundamental physical laws to drive the self-assembly of proteins and nucleic acids into dynamic, membraneless compartments known as biomolecular condensates.

The journey of this field has been nothing short of explosive, a "three-act play" that I have been privileged to witness and participate in from its very beginning. Act One (2009-2014), the foundational period, began with the seminal observation that P granules in C. elegans behave like liquid droplets [1]. This was powerfully consolidated in 2012 by the groundbreaking work from my Ph.D. mentor, Professor Pilong Li, and his colleagues, who first established that multivalent interactions are the core driving force behind protein liquid-liquid phase separation (LLPS) [2]. This discovery provided the mechanistic key that unlocked the field, and I was fortunate to have embarked on my decade-long journey in this field at its inception.

Act Two (2015-2017) saw an accelerated development, where the principle was rapidly applied to core biological questions, revealing the universal importance of condensates in transcription, signaling, and RNA metabolism. We now find ourselves in Act Three (2018-present), a comprehensive eruption of discovery, where the focus has pivoted from asking "what is it?" to "what does it do, and how can we intervene?". An analysis of the literature, including a database our group has compiled of nearly 10,000 publications, confirms this stunning exponential growth. This rapid maturation has created an urgent need for a specialized venue to publish high-quality, impactful research. *Biomolecular Condensates Research* is founded to be that venue.

My own research has focused on how phase separation provides a new layer of regulation over the most fundamental of cellular processes: the organization and expression of our genome. We have begun to understand how condensates

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operate in distinct modes—for instance, compacting heterochromatin in a "with" model versus activating genes on euchromatin in an "on" model [3, 4]. We have uncovered how pioneer transcription factors like FOXA1 can form condensates that act as "solvents" to unpack repressed chromatin [5], and how histone variants can leverage phase separation to exquisitely remodel the genome during reproduction [6].

Crucially, the focus is increasingly turning to the dark side of phase separation: its dysregulation in disease. A unifying theme is emerging where the delicate balance of condensation goes awry—either through "loss-of-function," where essential condensates fail to form, or "toxic gain-of-function," where aberrant, often solid-like aggregates emerge. My group's work has shown how Rett syndrome mutations can cripple the phase separation capacity of MeCP2, leading to a loss of chromatin organization [7], and how mutations in FOXA1 impair its pioneering function, contributing to cancer [5]. Furthermore, our forthcoming work reveals how mutations in proteins like MID1 can trigger a "Scaffold-Dissociated Aberrant Condensation" (SDAC), leading to a toxic gain-of-function that drives neuronal apoptosis.

These insights present profound challenges and exhilarating opportunities. To truly advance, we must systematically map the entire landscape of "Phase separation-associated Disease Proteins" (PADPs) and develop innovative tools for precise intervention, such as the programmable nIDR "dissolving tool" we are currently developing.

Biomolecular Condensates Research is founded to be the catalyst for this next wave of discovery. Our mission is to be the premier platform for both fundamental and translational studies. We seek to publish studies that:

• Uncover novel principles of phase separation and the physical chemistry of condensate biology.

• Systematically identify new condensate-forming biomolecules and their roles in health and disease, leveraging both computational and high-throughput experimental approaches.

• Elucidate the molecular mechanisms by which condensates regulate cellular processes, from transcription and chromatin architecture to signaling and immunity.

• Bridge the gap between basic science and clinical application, by exploring the pathological consequences of aberrant phase separation and developing novel diagnostic and therapeutic strategies.

We are building a world-class editorial board and invite leaders in the field to join us in this endeavor. The era of the condensate is here. It offers a new logic for understanding the cell—a logic of "order from chaos" that drives life's most essential processes. We stand at the threshold of translating these fundamental principles into tangible solutions for devastating human diseases. On behalf of the entire team at Auber Scientific Publishing, I cordially invite you to join us on this exciting journey. Submit your best work to *Biomolecular Condensates Research* and help us build the home for a revolution.

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