Editorial

Prebiotic Chemistry

Prebiotic chemistry research aims to uncover abiotic synthesis pathways of life's building blocks and chemical evolution scenarios towards the origin of life. Conceptual and experimental progress in the field of prebiotic chemistry leads to a deeper understanding of synthesis pathways, self-assembly conditions and self-organization processes of organic molecules and supramolecular systems and narrows the gap between chemistry and biology. Results in this field have a substantial philosophical dimension (What is life?) as well as a technological relevance for biotechnology, nanotechnology and materials science.

Several disciplines with links to organic chemistry are involved in prebiotic chemistry. These disciplines include astrochemistry, atmospheric chemistry, geochemistry, physical chemistry, systems chemistry and synthetic biology. The research field is very large, so all recent developments in prebiotic chemistry are not covered here. However, some very central topics can be identified: *synthesis* (the generation of stable building blocks of life), *complexification* (the structure of molecules, polymers, supramolecular systems and networks of chemical reactions) and *transition* (e.g. self-assembly to self-organization, catalysis to autocatalysis, arbitrary complexity to organized complexity, chemistry to biology). These central topics are investigated via both ahistorical and historical approaches to the origin and nature of life. Ahistorical approaches focus on general concepts and principles such as fundamental driving forces of self-organization and complexification, whereas historical approaches are based on experimental and analytical results leading to hypotheses for scenarios about possible environments and synthesis pathways of life's building blocks. Therefore, this special issue is designed to present reviews which exemplify all the above mentioned disciplines, central topics and approaches.

This special issue starts with a communication on the concept of Dynamic Kinetic Stability (DKS) by A. Pross, which clearly contextualizes the other contributions. The concept of DKS covers all central topics, provides a conceptual bridge between chemistry and biology and gives a compelling explanation of the fundamental driving force behind complexification from the point of view of systems chemistry.

The second contribution provided by C. Cleland is a careful analysis of contemporary theories of the origin of life. It is a helpful guide for scientists working in the field of prebiotic chemistry as it raises the awareness for conceptual confusions regarding contemporary theories of the *origin* of life: these theories divide along the same lines as theories of the *nature* of life. Her critical discussion of the genes-first theory (RNA World) and metabolism-first theory (small molecule theory) also shows how important new ahistorical approaches (e.g. the DKS theory) are, especially in respect to the central topic of “transition”.

The contribution by M. Trainer is the first historical approach in this issue. Her review on atmospheric prebiotic chemistry gives a thorough insight into the range of organic products which could have been produced by atmospheric synthesis. She also discusses the generation of organic hazes and their impact on the early Earth’s climate and prebiotic chemistry.

The fourth contribution, provided by K. Lemke, refers to the hypothesis that organic synthesis reactions at high temperatures have been highly important in prebiotic chemistry. From the perspective of physical organic chemistry and geochemistry, Lemke presents an important review on the current understanding of factors affecting the stability of small biomolecules in submarine hydrothermal systems.

The reviews provided by Trainer and Lemke shed light on the base of prebiotic chemistry at which the synthesis products – the building blocks of life – are required to be thermodynamically stable. In a later stage of prebiotic chemical evolution the rise of replicating molecules opened another kind of stability: DKS. The review by Mast *et al.* is about experiments which explore thermal gradients (which occur in deep sea hydrothermal vents) to trigger molecular evolution based on replicating molecules.

The sixth review, provided by Kazmierczak *et al*., focuses on the possible role of Ca^{2+} as a promoter of major steps in the evolution of early life. It is a wonderful example for the ongoing role of DKS in complexification after biogenesis because the evolutionary innovations induced by rising geochemical Ca^{2+} levels over geological time can be interpreted as an increase of DKS of replicating living entities.

After this, Torino *et al.* provides an intriguing overview of concepts and published research in the field of synthetic biology which aims at synthesizing primitive cell-like entities from minimal components. Such cell-like entities mimic key features of life.

The final contribution looks at prebiotic chemistry and biology from the point of view of quantum physical chemistry. It reviews important contributions of the tunnelling effect to prebiotic chemistry ranging from the base of chemical evolution to the evolution of complex multicellular life.

I would like to thank all of the contributors to this issue for their valuable and very interesting work.

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Graphical Abstracts

Current Organic Chemistry, **2013**, *Vol. 17, No. 16* **1702**

Dynamic Kinetic Stability (DKS) as a Conceptual Bridge Linking Chemistry to Biology

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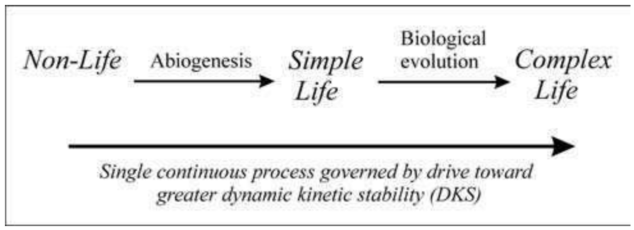

Current Organic Chemistry, **2013**, *Vol. 17, No. 16* **1704**

Conceptual Challenges for Contemporary Theories of the Origin(s) of Life

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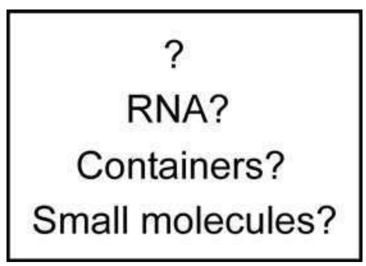

Current Organic Chemistry, **2013**, *Vol. 17, No. 16* **1710**

Atmospheric Prebiotic Chemistry and Organic Hazes

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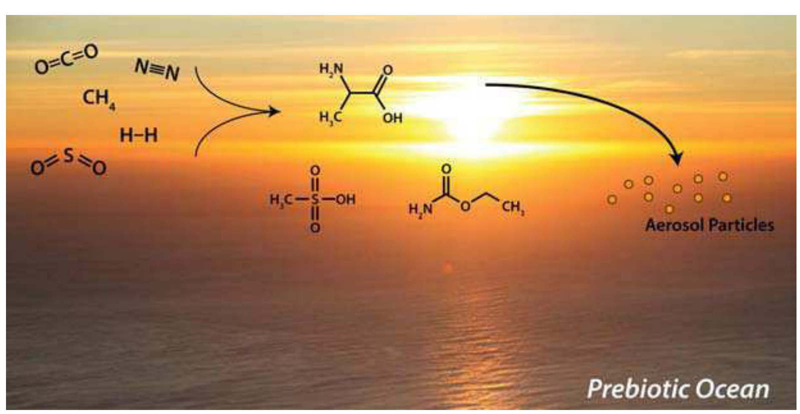

***Current Organic Chemistry*, 2013, *Vol. 17, No. 16* 1724**

The Stability of Biomolecules in Hydrothermal Fluids

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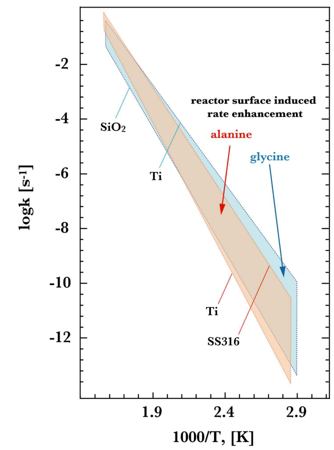

***Current Organic Chemistry*, 2013, *Vol. 17, No. 16* 1732**

Could Thermal Gradients Drive Molecular Evolution?

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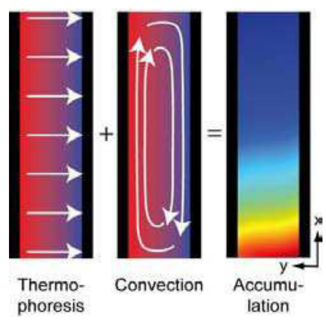

***Current Organic Chemistry*, 2013, *Vol. 17, No. 16* 1738**

Calcium in the Early Evolution of Living Systems: A Biohistorical Approach

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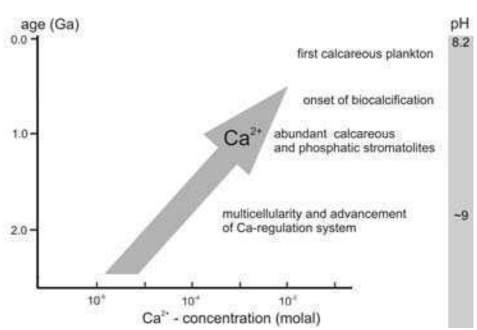

Current Organic Chemistry, **2013**, *Vol. 17, No. 16* **1751**

Piecing Together Cell-like Systems

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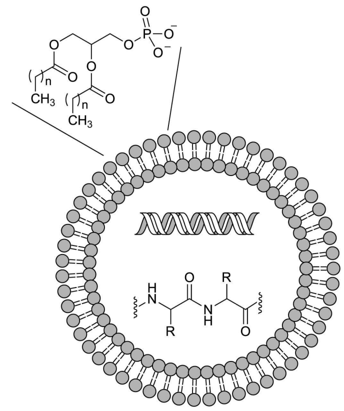

Current Organic Chemistry, **2013**, *Vol. 17, No. 16* **1758**

Quantum Tunnelling to the Origin and Evolution of Life

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