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Steering Complex Reaction Networks with Minerals

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Introduction: Modern chemistry approaches to the Origin of Life are typically targeted to exploring the constrained synthesis of prebiotically plausible specific molecules or reaction pathways, or to produce biomolecules. Uncontrolled multicomponent condensation reactions of simple building blocks and the exploration of molecular networks are typically avoided due to the expectation of runaway combinatorial explosion, producing an analytically-intractable, undifferentiated, mess.[1,2] However, these combinatorial explosions can be tamed, and perhaps even controlled, by small changes to the reaction environment – i.e. by the addition of different minerals.

Our recent work has shown that environmental changes (salts, minerals, mixing histories) can programme the condensation of the same amino acids to produce consistently different compound mixtures, with different structural and functional properties.[3] Furthermore, we demonstrated for the first time that simple minerals can program the differentiation of distinct functional ensembles of different molecules from a classic primordial soup model whereby the simple precursor chemicals exhibited to spark discharge conditions.[4] This work therefore shows that the untargeted mixture first approach allows the formation of networks of reactions that generate of diversity from fixed sets of starting materials, and shows that differentiation of product mixtures can occur in the wider environment without the need of biological machinery.

[1] Benner S A, Kim H J & Carrigan M A (2012) *Accounts of Chemical Research* 45: 2025-2034. [2] Schwartz AW (2007) *Chemistry & Biodiversity* 4:656-664. [3] Rodriguez-Garcia M *et al.* (2015) *Nature Communications* 6:8385. [4] Surman, AJ *et al.* (2017) *In Preparation*.

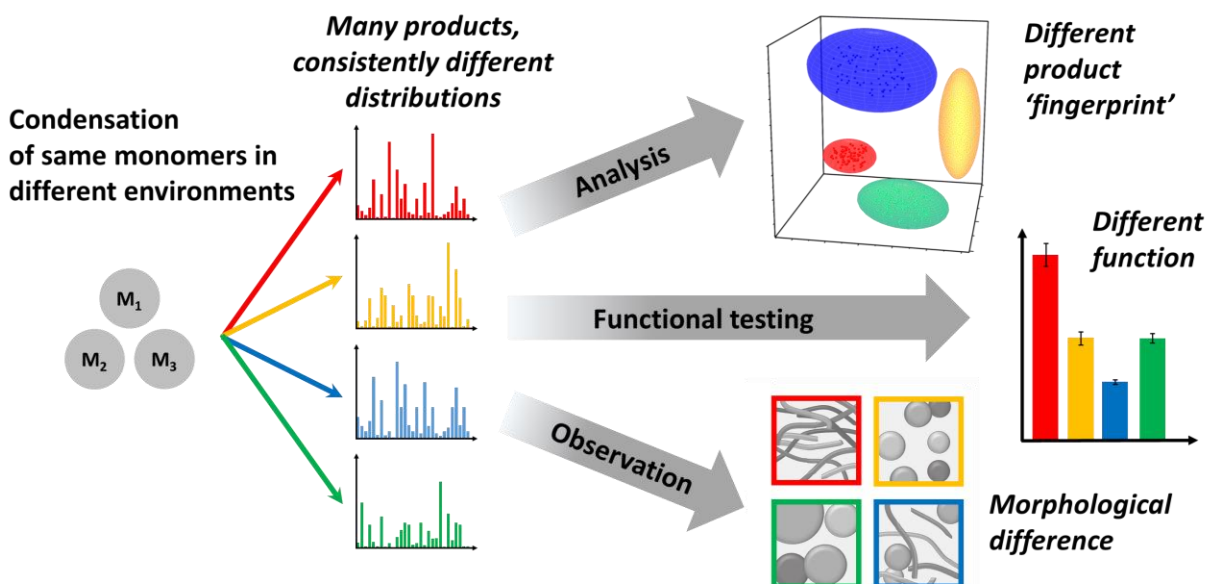


Figure 1 – *Uncontrolled condensation reactions make a mess, but can be steered:* Reactions where polyfunctional building blocks yield combinatorial explosions can be steered by different environmental conditions to give different product distributions with consistently different structural and functional properties.