POLYMORPH SELECTION: DECIPHERING BIOCHEMICAL CONTROLS ON CALCIUM CARBONATE MINERALIZATION

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Biomineralization describes the processes by which living organisms form minerals from their localized chemical environments. These processes have significant implications for the origin of life, materials science, energy development, and the emerging area of geomedicine. Of all biogenic minerals, calcium carbonates ($CaCO_3$) are the most diverse and extensive, presenting an excellent medium for the study of biomineralization. Calcium carbonate may be selectively deposited by organisms as one of six polymorphs, or forms of $CaCO_3$ that differ in crystallographic structure and thermodynamic stability. Specific mechanisms through which this control is achieved, however, remain unclear.

Evidence suggests that biomineralization processes can be strongly influenced by organic molecules in the environment of nucleation. These molecules may alter the energy landscape of biomineral precursors, affecting crystal structure, morphology, growth rate, and possibly polymorphism. Recent work in our group links the presence of biologically important peptides to the regulation of biomineral growth kinetics. Similar biomolecules will be utilized to elucidate a relationship between biomolecule functional group chemistry and mineral polymorphism.

In new research, calcium carbonate will be grown in a peptide-free environment as well as in solutions where peptide fragments containing acidic, neutral, or basic residues have been added. The resulting crystallites will be identified with scanning electron microscopy (SEM). Both nuclear magnetic resonance (NMR) spectroscopy and molecular modeling will be utilized to study the mechanism of polymorph selection by developing a basic picture of hydration dynamics in the growth environments of the experiments.

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