DIGS-BB SUMMER SCHOOL
Biological Making of Materials 2023

TECHNISCHE UNIVERSITÄT DRESDEN

HANDS-ON SESSION

Molecular mechanisms of material formation by microalgae

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Organisms are incredibly adept at producing materials with complex, species-specific morphologies and extraordinary properties from organic and inorganic building blocks. Among the most remarkable organisms in this respect are unicellular algae from the groups of diatoms and coccolithophores. Diatoms biosynthesize intricately nano- and micropatterned silica cell walls, and coccolithophores an extracellular casing composed of cellulose-based organic scales as well as calcified scales with complex-shaped calcite crystals. The biomolecular machineries and mechanisms by which diatoms and coccolithophores biosynthesize and shape mineralized and non-mineralized materials are largely elusive.

Achieving a fundamental understanding of the mechanisms underlying the bio-morphogenesis of materials by organisms, requires (i) detailed knowledge of the biomolecules that guide these processes, and (ii) experimental techniques for the functional analysis of these biomolecules. To this end, we have developed for these algae protocols for the isolation and biochemical characterization of diatom cell walls and coccolithophore scales, tools for genetic manipulation, and genome and transcriptome datasets and fluorescence microscopy. This has enabled proteomic, glycomic, and comparative genomic and transcriptomic approaches to identify, localize and functionally characterize the biomolecular toolkits that diatoms and coccolithophores use for materials formation.

The tutorial will include:

- Isolation of biominerals and cellulose scales from diatoms and coccolithophores
- Extraction of diatom biosilica and scale-associated soluble biomolecules
- Chromatographic fractionation of the soluble biomolecules
- Visualization of fluorescently-tagged proteins within biominerals or insoluble organic matrices by TIRF microscopy
- Analysis of the soluble organic biomolecules by gel electrophoresis and staining