The main objective of this project is to gain a better understanding of the evolution, diversity, and functional significance of stereom microstructures in echinoderms, particularly focusing on the triply periodic minimal surface (TPMS) microfabrics found in the calyces of fossil crinoids. TPMS structures are highly ordered, making them valuable materials for bionic applications. Three major TPMS types, including the primitive, gyroid, and diamond structures, have been observed in natural systems. While stereom microstructures resembling the primitive surface have been known in echinoderms for some time, the diamond-type (D-TPMS) microstructures have only recently been recognized.

This project aims to analyze the stereom microstructure in the Paleozoic and Mesozoic crinoid calyces using well-preserved materials in order to investigate how their microstructural designs have changed over time. The project seeks to answer important questions such as when D-TPMS originated in crinoids, whether it evolved independently or had a single origin, what factors drove its temporal distribution among crinoids, and whether it carries any phylogenetic signals.

It has been hypothesized that D-TPMS may have arisen independently in distantly related echinoderm clades or that it may be a more widespread trait that emerged during periods of increased predation pressure. These hypotheses will be explored by examining temporal trends of D-TPMS in fossil crinoids, particularly during intervals associated with increased predation pressure such as the Middle Paleozoic Marine Revolution and the Mesozoic Marine Revolution.

A secondary objective of the project is to investigate the formation mechanisms of D-TPMS microstructures. This will be done through Mn-labeling experiments performed on the living knobby starfish *Protoreaster nodosus*. By studying the formation of these complex microstructures, insights into their morphogenesis can be gained, which is of great value to the materials science community.

The project's last goal is to assess the effectiveness of D-TPMS against abrasion. This will be done by comparing ossicles with similar size and chemical composition but having different stereom microstructures. The project will test predictions that echinoderms with D-TPMS should be more resistant to abrasion compared to those lacking these structures. Experimental tests using a tumbling barrel will be conducted to evaluate these hypotheses.