

**Investigation of Encapsulin Nanocompartment Systems as a Scaffold for Biomaterials Synthesis in
*Rhodococcus jostii***

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With recent innovations in synthetic biology, genetically engineered microorganisms can now produce a wide variety of bioproducts, including fuels, commodity chemicals, plastics, and inorganic materials, to support a robust bioeconomy. However, challenges such as poor reaction efficiencies and toxicity often limit yields and prevent the production of desired chemicals. One strategy to overcome these challenges is to isolate biosynthetic reactions into protein compartments or cages within engineered microorganisms. Confining biochemical reactions into such cages may help increase reaction yields by bringing the reaction components closer together. At the same time, keeping the desired bioproducts inside these cages can prevent any potential toxic effects of the products, or the conversion of those products into undesired molecules. Some bacteria, such as the emerging model bioproduction bacterium *Rhodococcus jostii*, naturally produce protein cages, called encapsulin nanocompartments. The goal of this research is to identify mechanisms for engineering compartmentalized biosynthesis in this bacterial strain. This project will develop approaches to control encapsulin production by investigating the native regulation, biosynthesis, and maintenance of the encapsulin system. Gene-editing methods will be used to engineer encapsulins with novel structural properties for expanded bioproduction capabilities. As a case study, the encapsulin system will be used to biosynthesize cadmium sulfate (CdS) nanoparticles, which are semi-conducting materials used in many important optical and electronic applications. Ultimately, this work will establish encapsulin compartmentalization systems as a means of improving yields and enabling new biosynthetic routes toward next generation bioproducts and biomaterials in support of DOE's mission to build a strong bioeconomy and thus enhance our energy security.

This research was selected for funding by the Office of Biological and Environmental Research.