

Engineering Biology to Do Chemistry

Outline of this session:

- discussion of the use of the traditional toolkit to create new biomolecular materials
- discussion of nano-scale and nano-strength
- exploration of the bacteriophage library

Introduction

Associate Professor of Biological Engineering (BE) and Material Science and Engineering (DMSE) Angela Belcher is interested in the development of biological mechanisms and materials for the fabrication and self-assembly of new nano-materials.

Development of Biomolecular Materials

The emerging field of bioengineering lies at the interface of chemistry, biology, materials science, and biotechnology. The bioengineer integrates knowledge from these disparate fields in the development of new biomolecular materials.

Biomolecular materials are designed through the use of the traditional biologist's and chemist's toolkits. Engineers draw from the creations of mother nature and from their previous inventions. This slide shows nature's different types of shells and the materials they are composed of. In class, we looked at some of the shells pictured and discussed how different materials, calcium carbonate and protein among them, are involved in their make-up.

The biologist's and chemist's toolkits, consisting of fundamental methods and procedures, can be used to devise new rational designs that produce a particular desired effect, identify parts that may need change, devise an algorithm or model, among other things. Biotechnology lies in the manipulation and engineering of biology and chemistry to create something useful. The question then becomes, to what extent can we manipulate or evolve natural systems to suit our needs?

We rarely think of the world in nanometers. This slide puts in perspective just how small a nanometer really is. An atom is 0.1 nm, a string of DNA is 1 nm, followed by a Petri dish, a human thumb, a cow. The circumference of the MIT dome is 15 billion nm. This slide shows the comparison of different types of cell parts, organelles, and sheets. Even the strongest materials in nature are derived from tiny, minute particles. The strength of some of the strongest things in nature are composed on the microscopic scale.

This slide proposes the mechanism of protein mediated crystal growth. The top pictures show the individual tablets of CaCO_3 that make up the shell. The bottom pictures show the protein layers in-between the protein tablets. Evolution has already created certain natural machines, such as ribosomes to produce protein. Our goal is to try to capture the essence of the molecular machine and build new machines to make inorganic as well as organics materials.

The presence of molecules with or without the DNA linker can be indicative of where or not something is diseased.

Nanocircuits are built using device physics, material science, and DNA chemistry.