Project ID: 341

Senior Division

Microbiology

David He
Westview High School
Gr. 10

Utilizing Genetically Engineered Ocean Bacteria to Degrade Microplastics

AWARDS:

American Academy of Pediatrics Climate Change and Health Committee - SR Div Honorable Mention
American Chemical Society - San Diego - 1st Place
Society of American Military Engineers - San Diego Post - Senior Division 2nd Place
Torrey Pines Docent Society - Senior Division Honorable Mention
WateReuse Association - San Diego Society - Winner
CSEF Qualified

The idea of using biological enzymes to degrade microplastics has been around for many years, especially as plastics have grown to become an increasingly larger and larger issue. I decided to take a previously discovered enzyme, Polyurethenase Esterase A (PueA), and engineer it into a bacterium that thrived in the ocean, *Alteromonas Macleodii*.

Procedure: A plasmid was first created on Benchling and Snapgene using enzyme sequence on NCBI, and the parts were ordered from IDT. The plasmid was created by assembling a Level 0 plasmid through Gibson Assembly, a Level 1 plasmid (with a mobilization factor) through Golden-Gate Assembly, and then conjugating the plasmid into Alteromonas. To check if plastic degradation was occurring, genetically engineered PueA Alteromonas was implemented into an artificial sea-water medium, along with strips of polyurethane plastic.

Results: The plasmid with the final engineered L1 plasmid did indeed fluorescence green in Alteromonas, demonstrating expression of the PueA enzyme in a laboratory environment. However, compared to the wild-type controls, there was no noticeable degradation (measured with FTIR Spectroscopy) of the Polyurethane Plastic with the PueA enzyme in the artificial sea-water medium. This occurred in both no-glucose and glucose mediums. This was likely due to differences in the form of polyurethane plastic between the original study and ours.

Conclusion: The PueA protein was implemented into and secreted by the genetically engineered Alteromonas into the environment. However, it did not create any noticeable degradation in the Polyurethane. Another protein, Tcur, is currently under testing using the same experimental conditions.

Project ID: 342

Senior Division

Microbiology

Jihoo Hyun

Canyon Crest Academy

Gr. 9

Creating Paper with Bacterial Cellulose: Toward the Sustainable Production of Bioplastic

AWARDS:

San Diego Chapter - American Society of Materials International - Senior Division 2nd Place

Deforestation stands as a critical concern, prompting an exploration of sustainable alternatives to conventional paper production. This study investigates bacterial cellulose as a viable material for paper-like material creation. Bacterial cellulose, derived from non-pathogenic bacterial species, boasts structural advantages and environmental compatibility. Through the isolation and culture of Acetobacter xylinum, this research outlines a method for producing cellulose fibers with nano-fibrous structures. Methodologies involve bacterial isolation and culturing, bacterial cellulose production, and synthesis of paper-like filaments. Results demonstrate enhanced tensile strength and comparable usability akin to traditional paper. These findings suggest a promising avenue for sustainable paper production, albeit with potential variations in production processes. Future refinements and scalability assessments could bolster this eco-friendly approach to address deforestation challenges in the paper industry.

Project ID: 343
Senior Division
Microbiology

Mason Raymond
Steele Canyon High School
Gr. 10

Resistance of Multi-pathway Inhibitors and Antibiotics Combating Staphylococcus epidermidis

AWARDS:

BD "Advancing the World of Health" - Senior Division 3rd Place
CSEF Qualified

The threat of antibiotic resistance has grown dramatically in the past decades, with studies suggesting that antibiotic resistance may lead to tens of millions of deaths in the near future. One particular genus of bacteria susceptible to antibiotic resistance is Staphylococcus, with its forms as *S. aureus* and *S. epidermidis* being most notable for their deadly threat. However, many bacterial inhibitors have been discovered to be effective against these species, originating both from organic plants and from minerals. In this study, the goal was to more clearly analyze how *Staphylococcus epidermidis* builds resistance to antibiotics, and to find alternatives with less resistance. Results showed a statistically significant decrease in zones of inhibition of chloramphenicol, while negligible changes in punicalagin and colloidal silver. Additionally, a fifty-fifty mixture of punicalagin and colloidal silver created a larger zone of inhibition than either individually, possibly indicating an additive effect. Further studies should be conducted, however this data is promising for developing antimicrobials by optimizing these inhibitors to combat antibiotic resistance.