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MWP – Young Researcher Abstract 2025

Project title: Protein-Based Platform for Cellulose Biofunctionalization	
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Abstract (approx. 200 words)**:**

My research advances the use of cellulose by expanding its functionality without chemical modification. While native cellulose is biodegradable and abundant, its low reactivity limits its ability to bind biomolecules (enzymes, antibodies, DNA probes, etc.), constraining its use in biotechnology. As a result, industries rely on modified cellulose derivatives such as cellulose acetate and nitrocellulose, which enable biomolecule attachment but compromise biodegradability. This is common in biomanufacturing, where large volumes of such materials are used to immobilize biomolecules in the production of pharmaceuticals, food ingredients, and consumer goods. These supports are non-biodegradable and ultimately accumulate in landfills.

To address this challenge, I modify cellulose with proteins—not chemicals. I computationally designed a novel protein and produced it in genetically engineered bacteria. It has two domains: one binds to cellulose, the other captures tagged biomolecules. When applied to native cellulose, the protein forms stable yet reversible linkages, allowing biomolecules to be attached and removed on demand. The system is fully biodegradable and compatible with nanofibers and commercial papers.

This work unites the functionality of biomolecules with the structural versatility and sustainability of cellulose. In doing so, it positions forestry-derived materials as a platform for innovation in biotechnology, biomedicine, biosensing, and beyond.

Key words: Protein Engineering, Biofunctionalization, Cellulose Modification