Final Year Project Showcase Batch-2021
Year 2025

Department of Biomedical Engineering Name of Programme:Biomedical Engineering		
1	**Project Idea**	Fabrication of Polymer Engineered Herbal Biomaterial for Cardiovascular Graft Intervention Development of a cardiovascular graft using a novel blend of **PVA, chitosan, and thyme extract** to enhance **biocompatibility, mechanical strength, and antibacterial properties**. The graft films were fabricated using solvent casting and tested for structural, physical, and biological properties. This project provides a **cost-effective and herbal-engineered solution** for cardiovascular interventions, especially in **small-diameter vessels**, aiming to reduce infection risk and improve healing outcomes.
2	**Process**	The process involved the fabrication of a cardiovascular graft material using a novel blend of Polyvinyl Alcohol (PVA), Chitosan (CS), and thyme extract. This included preparation of polymer and herbal solutions, casting films with varying thyme concentrations (1%, 2%, 3%), and characterizing them via SEM, FTIR, tensile testing, pH, swelling/degradation, and antibacterial analysis.
3	**Outcome**	The outcome was the development of membranes suitable for cardiovascular grafts. CPT-1 showed best surface wettability, CPT-2 demonstrated balanced pH, while CPT-3 had strongest antibacterial activity. These confirm the film's potential for safe, biocompatible vascular implantation.
4	**Evidence (Theoretical Basis)**	This work integrates PVA (mechanical strength), chitosan (biocompatibility), and thyme (antibacterial and anti-inflammatory activity). Theoretical basis includes biomaterials and herbal science literature supporting improved performance in tissue engineering, confirmed through FTIR, SEM and other experimental tests.
5	**Competitive Advantage or Unique Selling Proposition** This project improves cardiovascular grafts by reducing infection, improving biocompatibility, and optimizing surface properties for endothelial growth. It aligns with SDG 3 (Good Health and Well-being), especially in infection-prone, low-resource settings. It opens niche markets for herbal-loaded vascular implants.	
a	**Cost reduction of existing Product**	This herbal-polymer cardiovascular graft is fabricated using relatively low-cost, accessible materials like PVA, chitosan, and thyme extract, which are significantly less expensive compared to commercial synthetic grafts made from advanced polymers like ePTFE or Dacron. The process avoids the use of costly high-end fabrication techniques (e.g., electrospinning or 3D printing at this

		stage), making it a **cost-effective alternative**, especially in regions with limited healthcare budgets.
b	**Process Improvement which leads to superior product or cost reduction, efficiency improvement of the whole process** (e.g. What is the issue is current process and what improvement you suggests)	Current synthetic grafts, especially for small-diameter vessels, suffer from **thrombogenicity, poor endothelialization, and risk of infection**. This project addresses these limitations by: Incorporating **thyme extract** with antibacterial and anti-inflammatory properties to reduce infection risks. Achieving **optimal mechanical properties** and **surface hydrophilicity** for better cell adhesion and compatibility. Enhancing **biointegration** through a simple solvent casting process that ensures structural uniformity and functional performance. This results in **superior biocompatibility and antimicrobial performance**, which improves the overall success rate of graft surgeries.
c	**Attainment of any SDG** (e.g. How it is achieved and why it is necessary for the region)	This project aligns strongly with **SDG 3: Good Health and Well-being**, by addressing a leading cause of mortality — cardiovascular diseases — with a **safe, effective, and biocompatible vascular graft**. It further supports **SDG 9: Industry, Innovation and Infrastructure** by introducing a novel product in the biomedical field with potential for commercial development, especially in developing regions like Pakistan.
d	**Expanding of Market share** (e.g. how it expand and what is the problem with the current market	This project targets a **niche market** that remains underserved: • Patients in **developing countries** who require low-cost, infection-resistant grafts. **Surgeons and hospitals** looking for alternatives to synthetic grafts that fail in small-diameter applications. • **Biomedical startups** aiming to launch herbal/biopolymer hybrid solutions
e	**Capture new market (**e.g. Niche market or unaddressed segment**)**	• The project caters to **a new, emerging segment** in biomedical devices: **herbal-engineered implants**. There is growing global interest in natural, plant-based solutions that promote healing with minimal side effects. This graft system leverages **thyme extract's antibacterial and anti-inflammatory properties** to offer an innovative product in the cardiovascular graft market. It addresses gaps in the market for: **Patients allergic or resistant to conventional antibiotics.**

		• **Rural hospitals and low-resource settings** where infection control is critical. • **Consumers and institutions favoring herbal-based therapeutic technologies.**
f	**Any Environmental Aspect** (e.g. carbon reduction, energy-efficient, etc.)	This graft uses **biodegradable, eco-friendly materials** (chitosan from shellfish waste, herbal thyme extract, water-based processing) and avoids hazardous chemicals, aligning with environmentally conscious healthcare manufacturing. Also, the **solvent casting method** used in this project is low-energy compared to high-tech alternatives like electrospinning, reducing **carbon and energy footprints** of production. Thus, the project encourages a **greener, sustainable medical innovation pathway**.
g	**Any Other Aspect**	**Customizability:** The concentration of thyme extract can be tailored (1%, 2%, 3%) depending on the clinical requirement — either prioritizing biocompatibility, pH neutrality, or antimicrobial strength. **Educational & Research Value:** This project lays the foundation for future exploration into **plant-based bioengineering** and has potential extensions into wound healing, tissue scaffolding, and drug delivery. **Scalability & Localization:** The use of **locally available** thyme and minimal-lab equipment ensures that the project is **scalable in low-income countries**, promoting **self-reliant healthcare innovation**.
6	**Target Market** (Industries, Groups, Individuals, Families, Students, etc) Please provide some detail about the end-user of the product, process, or service	Target users include hospitals, cardiovascular surgeons, biomedical device manufacturers, and patients needing bypass grafts. It is particularly useful in low-income regions needing cost-effective, infection-resistant implant materials.
7	**Team Members (Names & Roll No.)**	Ramsha Khan_BM-21051, Hafsa Ali_BM-21059, Ifra Amir_BM-21060, Hafsa Fatima_BM-21084
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