

Role of Textiles in Stem Cells and Medicine

Gokarneshan N

Formerly Professor and Head, Department of Textile Chemistry, SSM College of Engineering, Komarapalayam, Tamil Nadu, India

Corresponding author

Gokarneshan N, Formerly Professor and Head, Department of Textile Chemistry, SSM College of Engineering, Komarapalayam, Tamil Nadu, India

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Textiles act as the foundational 3D scaffolds for tissue engineering and stem cell therapies. By mimicking the body's natural extracellular matrix (ECM), synthetic and natural fabrics provide the vital structural and electrical cues required for stem cells to adhere, grow, and differentiate into specific replacement tissues.

Biomedical textiles are transforming regenerative medicine and stem cell research by bridging the gap between raw cellular material and functional human tissue. Their primary roles and applications include:

Stem Cell Scaffolding

Textiles engineered at the micro- and nanoscale provide a 3D architecture with optimized porosity. This structure allows stem cells to migrate, receive nutrients, and multiply, ultimately directing them to differentiate into organ tissues like cardiac muscle or bone.

Electrical and Mechanical Stimulation

Conductive or piezoelectric textile materials can transmit electrical currents. This is particularly critical in cardiology, where electrical stimuli help stem cells differentiate into synchronized, beating cardiac myocytes.

Biotextile Implants

Commercial fabrics—such as those discussed by the Wilson College of Textiles—are widely utilized for internal repairs. Woven, knitted, and braided textiles provide high tensile strength for load-bearing tissues like ligaments and tendons, and can act as structural meshes for hernia repair and vascular grafts.

Smart Wearable Therapy

Beyond implants, “smart” textiles integrated with nano-carriers can be worn to enable controlled drug delivery, slowly releasing medication or antimicrobials directly to a wound site.

Drug Delivery and Wound Care

Alginate, chitosan, and collagen-based textile dressings help retain moisture and promote fibroblast activity for healing chronic wounds and severe burns.

Silk fibroin (SF) and synthetic polymers are widely combined to engineer advanced biomaterials. Blending them overcomes the mechanical and swelling limitations of standalone proteins, creating highly customizable, biocompatible scaffolds used for stem cell culture, tissue regeneration, and targeted drug delivery.

Key Benefits of the Combination

Tailored Mechanics & Degradation: While SF offers strength, biocompatibility, and controlled breakdown, synthetic polymers (e.g., polylactic acid or polycaprolactone) provide structural integrity and varying degradation rates.

Optimized Microenvironments: The synergy mimics the native Extracellular Matrix (ECM), providing stem cells with chemical and topographical cues needed for adhesion, proliferation, and specific differentiation.

Versatile Processing: The materials are readily processed into 3D printable bioinks, electrospun nanofibrous meshes, and responsive hydrogels.

Common Synthetic Polymers Used

Poly(lactic-co-glycolic acid) (PLGA) & Poly(lactic acid) (PLA): Often blended with SF for bone and cartilage tissue engineering due to their excellent mechanical strength and safe, predictable degradation.

Polycaprolactone (PCL): Paired with SF to build flexible yet robust scaffolds, frequently used for vascular, bone, and neural tissue regeneration.

Poly(ethylene glycol) (PEG) & Poly(vinyl alcohol) (PVA): Blended or cross-linked with SF to create hydrogels with tunable swelling properties and hydro-retention,

Primary Clinical and Medical Applications

Bone & Cartilage Repair: SF-synthetic composites seeded with mesenchymal stem cells are used to bridge critical bone defects and regenerate articular cartilage.

Neural & Cardiac Patch Engineering: The structural and conductive properties of these blends support stem cell

differentiation into neurons or cardiomyocytes for spinal cord injury and heart tissue repair.

Wound Healing & Skin Grafts: Electrospun SF-synthetic mats act as artificial skin substitutes, promoting stem cell recruitment and rapid tissue repair.