Increasing use of textile materials as Scaffolds for Tissue regeneration - a classic example of scientific innovation

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The concept of tissue engineering has been redefined with the increasing use and popularity of "Scaffolds" for tissue regeneration and the subsequent implantation of the regenerated tissue in human body.

Earlier it was conveniently described as an interdisciplinary field that applies the principles of engineering and the life sciences toward the development of biological substitutes that restore, maintain, or improve tissue function. (Langer, R., and Vacanti, J. P., Science (1993) pg. 260, 920)

But later reviewers realized the necessity of distinguishing tissue regeneration with the help of scaffolds from the conventional methods of inducing cell growth solely with the help of growth and differentiation factors.

The use of scaffolds to regenerate tissues is a sophisticated technique and presents promising possibilities to improve and revolutionize the field of medicine and healthcare in ways that were not known before. But before we proceed to discuss the wonders of scaffolds themselves, let us look at the basic definitions of regenerative medicine and tissue engineering, and most importantly, why do we need them in the first place?

When cells, tissues or organs of a human body gets damaged or diseased by sudden trauma, illness or genetic anomalies, these building blocks of a human body have to be replaced either by inducing natural cell growth or by transplantation.

Induced growth of cells to replace damaged tissues is done with the help of "growth factors"- proteins that help in differentiation and proliferation of cells; whereas transplantation is simply a technique that involves removal of a required tissue from a 'donor' and implanting it the 'receiver'.

Both procedures have helped mankind in medicine and healthcare sector for long; but these conventional procedures come with their own limitations.

Whilst stem cell growth and culture yields cells at a reasonable rate, their potential of differentiation is quite limited. In other words, though we can obtain a significant quantity of cells from two dimensional cultures, all the cells are of the same type; and hence their use is limited to simpler surgeries like skin grafts, etc.

Or stating it more simply, it's not possible to grow a complex organ like heart or bone tissue on a petri dish.

Transplantation offers an alternative for replacement of complex tissues like liver and bone marrow, but the issue of shortage of donors will always pose a constraint for wide scale application of this technique.

"Scaffolds" offer an answer to this problem. Scaffolds are matrices designed as a three-dimensional mirror image of an organ or tissue to be replaced on which cells grow and regenerate the needed tissues.

Scaffolds which are usually made of polymer and textile materials are supplied with cells that need to be regenerated, and are then placed in either a bio-reactor (in vitro) or in a human body (in vivo) to provide the environmental parameters required for cell growth.

After the polymer and textile materials have served their function as a template and the new organ has been formed, the scaffolds are absorbed into the tissues and the new construct can be used an implant.

Scaffolding provides a promising way to reconstruct complex tissues like cardiac, articular and bladder tissues. It is probably due to this degree of sophistication that scaffolds offered that has led the reviewers to redefine regenerative medicine in a new way.

For instance, Y. Ikada (September 2009) defines the regenerative medicine as follows:

1- Without Scaffolds – Cell therapy (Internal medicine)
2- With Scaffolds – Tissue Engineering (Surgery)

There are various property requirements that a scaffold has to fulfill to perform its function successfully. These include strength, rigidity, biocompatibility, large surface area to volume ratio, interconnected micro-pores (with the required pore size 100 and 500 mm), absorption kinetics and biodegradation rate, etc.

Textile technologies used for construction of scaffolds

Application	Material	Yarn structure	Fabric structure
Arteries	Polyester Dacron 56 Teflon	Textured	Weft/warp knit Straight tube bifurcation Plain woven straight tube, nonwovens
Tendon	Polyester Dacron 56 Kevlar	Low twist Filament	Plain woven narrow tape coated with silicon rubber
Hernia repair	Polypropylene	Monofilament	Tricot jersey knit
Esophagus	Regenerated Collagen	Multi filament	Plain weave
Heart valve	Polyester Dacron 56	Multi filament	Knitted velour
Patches	Polyester Dacron 56	Textured	
Sutures	Polyester Nylon Collagen	Monofilament Multi filament	Braid Woven tapes
Ligaments	Polyester Teflon Polyethylene	Multi filament	Braid
Bone and Joints	Carbon in thermo set or thermoplastic matrix	Multi filament	Woven Braid

Fibrous materials (knitted, non woven and bonded) are one class of materials that fulfill these requirements and have therefore found acceptance for use in the fabrication of scaffolds.

Materials used for constructing scaffolds include a family of aliphatic polyesters: Poly (glycolic acid) (PGA), poly (lactic acid) (PLA), and their copolymers poly (lactic acid-co-glycolic acid) (PLGA).

Other than the synthetic materials, natural macromolecules are also widely employed in scaffold fabrication. These include collagen which is a fibrous protein and also silk. The table summarizes the textile technologies that are used for construction of scaffolds.

Textile materials and technologies have long seized to serve solely the purposes related to apparel and other conventional product requirements. Their use has been extended to a large area of modern technology such as technical textiles, nanotechnology and composites.

Textiles, in the form of scaffolds, have a potential of providing solutions to many problems in medical and healthcare sector. An exciting new technique of preparing scaffolds through electrospinning of textile materials is also attracting attention of scientists and industrialists, because of its potential to offer greater strength requirements. The world of invention knows no bound, and textile materials, in the form of scaffolds, are a classic example of scientific innovation.

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Textile machinery offers interesting careers: A Forum with the French textile students

The French Textile Machinery Manufacturers' Association, UCMTF, once again brought together the students from the four French universities which train engineers for the textile industries. The goal was to further enhance relations with the students and to review the careers offered to them both in France and worldwide.

The forum was organized on the campus of l'ENSISA (Ecole Nationale Supérieure d'Ingénieurs Sud Alsace) located in Mulhouse. Students from ENSAIT (Roubaix), ITECH (Lyon) and the textile department of HEI (Lille) joined. More than 250 manufacturers, teachers and students participated.

Despite the economic crisis, the French manufacturers' dynamism is obvious. To get even stronger when investments will recover, they are increasing their R&D and marketing budgets. The thirty companies which make up UCMTF achieve a turnover of nearly € 1 billion, ranking sixth in the world. They employ directly or indirectly more than 8,000 people and over 90% of their sales are exported to more than a hundred countries all over the world.

Bruno Ameline.

Marc Brabant.

Presenting these figures, Bruno Ameline, chairman of UCMTF, emphasized that the textile machinery market is still dominated by the European manufacturers for historical reasons of course, but mainly thanks to their commitment to answer their customers' needs, to provide machinery for developing new products and/or for optimizing the production processes.

After the welcome speech of Bruno Ameline, Marc Brabant, the president of UCMTF's education commission and Gérard Binder, the CEO of ENSISA, Gildas Minvielle of IFM (Institut Français de la Mode / French Fashion Institute) analyzed the state of the textile industry and the main trends which are shaping its future. He explained how the textile industry was one of the first industrial sectors to face the globalization process and how it adapted itself to this new environment. The students expressed their realism about the challenges and their hopes for new products, particularly in the industrial fabrics sector.

Three panel discussions were an opportunity for the UCMTF members to present their strategies and their new machines:

- Combing- Spinning- Yarn processing- Weaving: Participating companies: N. Schlumberger, RITM, Petit, Superba, Stäubli.
- Nonwovens: Participating companies: Asselin-Thibeau, Laroche, Rieter Perfojet.
- Finishing and air engineering: Participating companies: Alliance, Roussselet, Dollfus & Muller, AESA.

Later, Claude Levy-Rueff introduced a study made with the machinery manufacturers which shows the importance of the return on investment in the customers' decisions, the costs savings in energy consumption being particularly important.

He also reported on the SECURIVET conference which took place last June in Paris. It showed that the protective garment sector is still a growing industry which offers multiple careers opportunities to textile engineers.

This introduced a round table on today's and tomorrow's job opportunities for textile engineers. Five alumni of different ages, presented their own careers, the know how and the inter-personal skills required for one's own success.

Speakers.

Students.