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Review Article

Nanotechnology for tissue engineering: Need, techniques and applications

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ABSTRACT

Tissue engineering is very fast growing scientific area in this era which is used to create, repair, and/or replace cells, tissues and organs by using cell and/or combinations of cells with biomaterials and/or biologically active molecules and it helps to produce materials which very much resembles to body's native tissue/tissues. From tissue engineering current therapies got revolutionised and life quality of several millions patient got improved. Tissue engineering is the connecting discipline between engineering materials science, medicine and biology. In typical tissue engineering cells are seeded on biomimicked scaffold providing adhesive surfaces, then cells deposit their own protein to make them more biocompatible, but unable to vascularise properly, lack of functional cells, low mechanical strength of engineered cells, not immunologically compatible with host and Nutrient limitation are a classical issue in the field of tissue and tissue engineering. Through the article we will understand the technology involved, need and application of nanobiotechnology based tissue engineering.

1. Introduction

Tissue engineering is very fast growing scientific area in this era and used to create, repair, and/or replace cells, tissues and organs by using cell and/or combinations of cells with biomaterials and/or biologically active molecules and helps to produce materials which very much resembles to body's native tissue/tissues. Tissue engineering is the connecting discipline between engineering materials science, medicine and biology.[1] In typical Tissue engineering cells are seeded on biomimicked scaffold providing adhesive surfaces, and then cells deposit their own protein to make them more biocompatible, but unable to vascularise properly, lack of functional cells, low mechanical strength of engineered cells, not immunologically compatible with host and Nutrient limitation are a classical issue in the field of tissue and tissue engineering.[2] "Novel biomimetic scaffold" and "Modern technology" been developed for more accuracy on positioning and viability, complexity, interaction etc., using micro and nanotechnology for production and analytical control through tools.[3] Micro and nanotechnology are providing them simple substrate for adhesion and proliferation and active agents for their growth. Nanofabrication techniques, materials science, surface, micro and nano-patterning in tissue engineering

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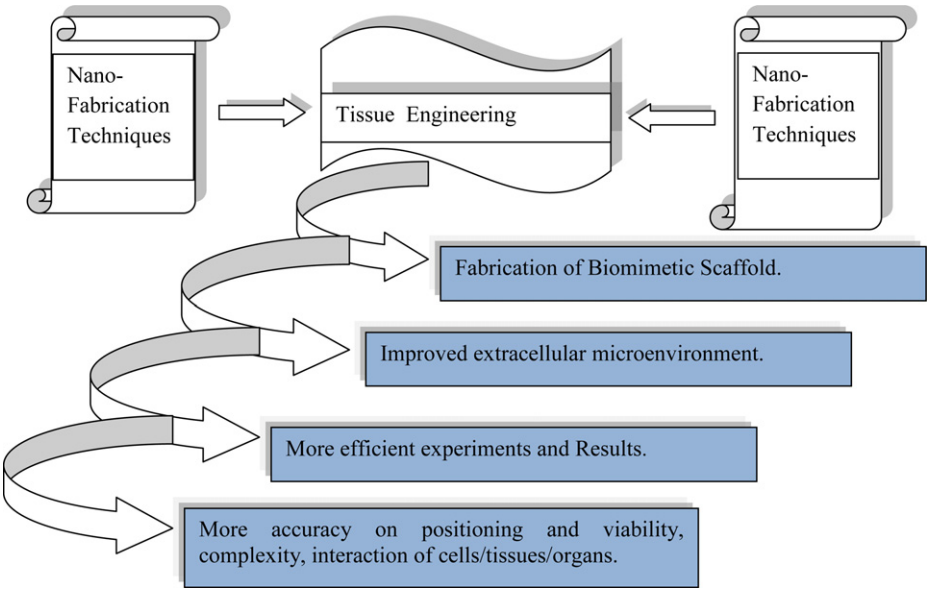

Fig. 1 – Schematic representation of benefits of using micro and nanofabrication for tissue engineering.

helps in providing best microenvironment where cells have to grow.[4]

2. Tissue engineering from nanotechnology

There are several benefits of using micro and nanofabrication techniques for tissue engineering (Fig. 1). Nanotechnology can be used to create nanofibers, nanopatterns and controlled-release nanoparticles with applications in tissue engineering, for mimicking native tissues since biomaterials to be engineered is of nanometre size like extracellular fluids, bone marrow, cardiac tissues etc.[5]

2.1. *Electrospun nanofibers*

It is the tools for form biomimic scaffold, and used for bone, cardiac muscle tissue engineering. To guide cell orientation and form blood vessel-like structures aligned poly(L-lactic-co-ε-caprolactone) nanofibres were used.[6] Using poly(lactic- co -glycolide) and poly(L-lactic acid) scaffolds neural stem cells were studied[7] and these fibres are able to control scaffold function i.e. biomimicked the adhesion surface, also nanofibres with core–shell structure were used for "Controlled Release" of encapsulated molecules.[8]

2.2. *Nanotextured substrates for tissue engineering*

Various nanostructures found naturally in the body (Fig. 2). Basement membrane for adhesion and affects other cellular behaviour is of 5–200 nm[9] (Fig. 3). Chemically cell density increases when poly(lactic-co-glycolide) nanosurface is treated with NaOH.[10] E-beam lithography is useful in nano tissue engineering.[11] Nanotechnology helps to improved regulation of cell adhesion and vascularisation e.g. compatible epithelial basement membrane like structure formed from carbon nanotube in osteoblast cells adhesion also nanofibres on glass as substrate used for same but earlier one is more efficient.[12]

2.3. *Self-assembled nanomaterials*

Methods for inducing self assembly in tissue engineering are biomimetic coating, electrolytic deposition (ELD) and pH induction and many materials used such as peptide amphiphile (PA), hyaluronan, chitosan, and apatite/amelogenin.[5,13] Sheets/fibres of self assembled peptides formed because of hydrophobic and hydrophilic regions and further assembly is because of charge shielding in the form of hydrogels.[5,14] High aspect ratio nanofibres in 3D self assembled fibres are made possible by using PA which is used in controlled release of bone morphogenetic protein–protein but having less cell–cell

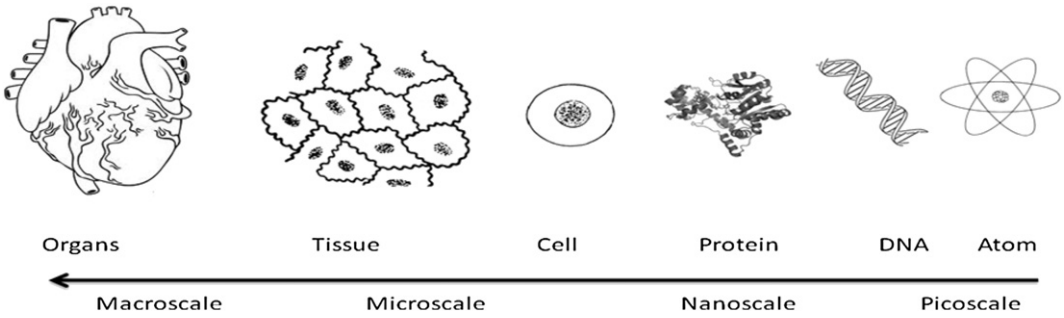

Fig. 2 – Size scale of various biological structures.