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A review on Impact of Nanotechnology in Induced Pluripotent Stem Cells

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Nanotechnology is the study of mini structures that are nearly having size of 0.1 to 100 nm. Now, nano medicine is a new field of science and technology. Nano particles has huge application in protein, peptide delivery, cancer and drug delivery helpful. Applications of varied nano systems in cancer therapy like carbon nano tube, dendrimers, nano crystal, nano wire, nano shells etc. are given. The advancement in nano technology helps in the treatment of neuro degenerative disorders like Parkinson's disease and Alzheimer's disease. There are applications of nano technology within the treatment of tuberculosis, the clinical application of nanotechnology in operative dentistry, in ophthalmology, in surgery, visualization, tissue engineering, antibiotic resistance, immune response. The aim of this text is to research the present trends and impact of nanotechnology in induced pluripotent stem cells (iPSCs). The iPSCs are considered together of the potential cell sources for tissue engineering applications thanks to their self-renewal and differentiation abilities. However, the key to know their full potential in tissue engineering requires a deep understanding of the iPSCs biology and their cellular interaction with three-dimensional (3D) scaffolds, which support and regulate the cellular growth and performance, in conjunction with signaling molecules. At the cellular and molecular level, nano-scale features play a crucial role in controlling cell behavior and other physiological functions of iPSCs.

Quantum dots (Qdots) are nano-scale crystals that emit light and are comprised of atoms from groups II-VI of the table, usually incorporating cadmium. With the help of quantam dots we can visualize cells than certain other techniques like dyes, due to their photostability and longevity. This also allows their use for studying cellular dynamics while the differentiation of stem cells is ongoing. Qdots have a shorter diary to be used with stem cells than SPIO/MRI and have only been utilized in vitro thus far, due to the need for special equipment to track them in whole animals.

Bone is a natural nanocomposite made up of organic (collagen) and inorganic (hydroxyapatite (HA)) components arranged in a hierarchical structure ranging from nano- to macro scale. As from the nanostructures we will get a way better approximation to the native bone architecture, thereby nanomaterials offer a platform to recapitulate the organization of natural ECM for the event of functional bone tissue constructs. Patient specific bone substitutes can be produced using nanoscale biomaterials and iPSCs technology for variety of bone reconstructive treatments.

Genetic controls, using DNA or siRNA (not to be confused with miRNA), is emerging as a useful gizmo for controlling cellular functions in stem cells, particularly for guiding their differentiation. Nanoparticles are often wont to replace the traditionally used viral vectors, like retroviruses, which are implicated in causing complications in whole organisms like inducing mutations resulting in cancer. Nanoparticles offer a less costly, more easily producible vector for transfection of stem cells, with a lower risk of immunogenicity, mutagenicity, or toxicity.

Stem cell helps in regulation of physiology, controls proliferation, and ultimately governs lineage specification. Cells have particular shapes that optimize completing specific cellular functions: neurons have long bodies to efficiently deliver signals which will span the whole length of the human figure, where adipocytes are spherical to store lipids. From a developmental view point, signals from the stem cell niche induces conformational changes which then influence tissue structure and purpose.

Topography plays a key role in cell maintenance and performance. Nanoscale architecture has grooves, ridges, pits, and pores in vivo; for instance, proteins within the ECM are usually arranged during a fibrous manner with these topographical properties. These fibrillar networks are approximately 10-100 nanometers but can be several microns, and the bone marrow contains numerous nanoscale pores that provide additional cues for stem cells. Nanotopography is vital because cells receive signals through specific binding sites that integrins recognize, and integrin signaling is controlled through nanoscale ECM-cell interactions. Surface features as small as 10 nm have the power to influence cell adhesion. When cells bind to integrins, tyrosine kinase and phosphatase signaling is activated, and both are important for cell fate and organic phenomenon. Through these biophysical cues, somatic cell adhesion and cytoskeleton organization are regulated, thus cell decisions regarding proliferation, migration, elongation, cell alignment, polarization and differentiation are impacted. Studies using MSCs determined that the nanoscale topography potentially acts through spatial control of ligands and regulatory factors, and act as the interplay between physical and biochemical cues determine cell morphology and phenotype. Topography may be a powerful tool since, not only is cytoskeleton tension altered like in cell shape experiments, but also entire molecular arrangement and dynamic organization of cellular adhesion mechanisms are affected.

Nanoparticles are promising tools for brand spanking new biomedical techniques, due to their small size and skill to penetrate cells. As research advances still increase our knowledge of the factors controlling somatic cell functions, it's likely that new applications for nanoparticles, together with stem cells, will be discovered. While the evidence suggests that some applications will turn out to be more useful, or safer, than others, there is vast potential for using nanoparticles to enhance and improve stem cell technologies.