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2D DNA nanoporous scaffold promotes osteogenic differentiation of pre-osteoblasts

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Biofunctional materials with nanomechanical parameters similar to bone tissue may promote the adherence, migration, proliferation, and differentiation of pre-osteoblasts. In this study, deoxyribonucleic acid (DNA) nanoporous scaffold (DNA-NPS) was synthesized by the polymerization of rectangular and double-crossover (DX) DNA tiles. The diagonally precise polymerization of nanometer-sized DNA tiles (A + B) through sticky end cohesion gave rise to a micrometer-sized porous giant-sheet material. The synthesized DNA-NPS exhibited a uniformly distributed porosity with a size of 25 ± 20 nm. The morphology, dimensions, sectional profiles, 2-dimensional (2D) layer height, texture, topology, pore size, and mechanical parameters of DNA-NPS have been characterized by atomic force microscopy (AFM). The size and zeta potential of DNA-NPS have been characterized by the zeta sizer. Cell biocompatibility, proliferation, and apoptosis have been evaluated by flow cytometry. The AFM results confirmed that the fabricated DNA-NPS was interconnected and uniformly porous, with a surface roughness of 0.125 ± 0.08035 nm. The elastic modulus of the DNA-NPS was 22.45 ± 8.65 GPa, which was comparable to that of native bone tissue. DNA-NPS facilitated pre-osteoblast adhesion, proliferation, and osteogenic differentiation. These findings indicated the potential of 2D DNA-NPS in promoting bone tissue regeneration.

Keywords: 2D DNA nanoporous scaffolds (DNA-NPSs); Bone tissue regeneration; Pre-osteoblasts; Rectangular and double-crossover (DX) DNA-tiles.

Biography

Baig, MMFA is a registered Pharmacist and did a PhD in Chemistry. His recent research interest is designing nanomaterials for Biomedical Engineering, Mechano Pharmacology, Developmental Biology, Structural Biology, and Neuroscience. He got his post-doctoral training in Nanomedicine at the Faculty of Dentistry, The University of Hong Kong. His postdoctoral work was focused on designing DNA-based functional & bio-active nanomaterials to apply in Restorative Dentistry, Oral Microbiology/ Oncology, Regenerative Therapeutics, Stem Cells Research, Drug Delivery, and Molecular Pharmaceutics. He got a Ph.D. degree in Chemistry (Therapeutical Biochemistry) from the School of Chemistry and Chemical Engineering, Nanjing University (NJU), China. During his Ph.D., he worked on DNA Nanotechnology, Nano-Therapeutics, Biosensing, Bio-imaging, Diagnostics, and Cellular Biophysics. Previously, He received his Doctor of Pharmacy (PharmD) and MPhil (Pharmaceutical Chemistry) degrees from the Faculty of Pharmacy, Bahauddin Zakariya University (BZU), Multan, Pakistan; where he learned about Biochemistry, Phytochemistry, Pharmacognosy, Biotechnology, Polymers, Organic, Medicinal, Bio-analytical, and Material Chemistry.

His research work mainly focused on the construction and function of DNA nanomachines, which are cutting edge and challenging topics. He designed and constructed unique DNA molecular tension probes using a short circular DNA nanotechnology technique and functionalized these probes with fluorophores, gold nanoparticles, small molecular drugs, and peptide ligands. He achieved nano-specific precision in organizing plasmonic nanoparticles on the nano DNA frameworks to achieve plasmon resonance effects. My work on the DNA nanomachines provided an efficient mechanism of fluorescence resonance energy transfer that realizes the bio-imaging, and detection of biological events, and functions of the biomolecules.

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