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Living implant fortified with active therapeutics and well organized stem cells for regenerative nanomedicine

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Recently, we have reported an active nanostructured collagen implant reinforced with human stem cells for bone regeneration. In our group, we have reported smart hybrid materials equipped with nanoreservoirs of therapeutics and stem cells spheroids. This unique nanotechnology strategy is used to entrap, protect, and stabilize therapeutic agents into polymer coatings acting as nanoreservoirs enrobing nanofibers of implantable membranes. Upon contact with cells, therapeutic agents become available through enzymatic degradation of the nanoreservoirs. As cells grow, divide, and infiltrate deeper into the porous membrane, they trigger slow and progressive release of therapeutic agents that in turn stimulate further cell proliferation. This constitutes the first instance of a smart living nanostructured hybrid membrane for regenerative medicine. The cell contact-dependent bioerodable nanoreservoirs described here will permit sustained release of drugs, genes, growth factors, etc., opening a general route to the design of sophisticated cell-therapy implants capable of robust and durable regeneration of a broad variety of tissues.

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Challenges to nanoscience and nanotechnology: Intriguing nanosize effect and nanotime effect

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We first introduce a novel nanosize concept and a novel "nanotime" concept along with reviewing a series of novel phenomena and novel techniques related to nanosize effect and ultrafast process, which were recently discovered in our lab or were reported in literature. In these concepts, for the first time we are able to account for the non equilibrium, amorphous-like, and nonlinear nature of the current nanoscience and nanotechnology. In particular, we demonstrate that the structure instabilities of materials occur when a material system is limited to a space within a scale that is comparable to atomic distance. Such a nanosize effect is crucially dependent only on the nanosize, but also on nanoshape or nanocurvature (including positive nanocurvature and negative nanocurvature). We also demonstrate that the structure instabilities of materials occur as well when the exchange of external energy with materials is limited to a time within a scale that is comparable to atomic vibration period. Such a "nanotime" effect can give rise to either soft mode or instability of atomic vibration in a condensed matter. The new concepts are very meaningful for control over fabrication and energetic beam processing of low dimensional nanostructures and nanodevices, especially for several potential applications related to nanoparticles, nanocavities, carbon nanotubes and nanowires. The new concepts have similarly important implications for chemistry, biology, and medicine as demonstrated by immerging new findings about nanocavities and nanolaser irradiation. In particular, in biology and medicine, there are widespread research interests either in using nanocavity (shell-core) structure to design and build biology composites, biosensors, drug deliverer, and protein structures or in nano surgery via ultrafast nanolaser processing, both being operative at the molecular level dealing with the concepts put forward herein.

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