Smart Drug Delivery Systems for Treatment of Tissue-Associated Diseases

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Abstract

Tissue engineering is one of the most challenging research topic practically covering all the classes of materials, from metals, ceramics and composites especially for hard tissue engineering to polymers and composites for soft tissue engineering. There are many diseases associated with the soft and hard tissues, including infections, cancers or just hardly healing wounds.

In many cases, the treatment is associated with the use of drug delivery systems and for an efficient treatment a stimuli-responsive delivery is required. Stimuli responsive drug delivery systems can be also used in personalized therapy because, by externally applied stimuli, the release rate can be enhanced and, in most cases, the biological activity is a dose-dependent function. Certainly, internal stimuli are also able to tune the delivery rate, pH, temperature, enzyme, ionic strength and concentration of specific ions are some of the mostly-used internal stimulus which can be considered when designing drug delivery systems.

This presentation will be mainly focused on presenting some relevant examples related to the smart drug-delivery systems for bone cancer treatment, infected skeletal muscle as well as skin regeneration/ healing.

Considering the nature of the bone, COLL/HA composite materials will be considered for bone cancer treatment [1]. Starting from this composite base, additional components can be added to develop a smart drug delivery system of the specific cytostatics, the main aim being to develop smart release, with externally applied control. Certainly, the use of magnetite meets all the criteria to be added in these supports, being stable, biocompatible and can be easily activated by externally applied electromagnetic field (200-300kHz).

In the case of the soft-tissue related infections and injuries, the support is mostly polymeric (collagen, cellulose, polycaprolactone, etc.) while the different natural and synthetic antimicrobial agents such as antibiotics, nanoparticles, polyphenols, essential oils, etc. are used [2-4]. In all infections, regardless the nature of the tissue, antioxidant and antimicrobial activity are both welcome and there are several essential oils, bee-derived products (complex mixture of components) or pure polyphenols, etc. which are already used for this purpose. Worth mentioning that skin treatment is usually facile, being good access to the injury but, in the case of deeper soft tissues the use of triggering factors is essential in assuring personalized medicine.

The influence of the electric-stimuli will be presented for the Polycaprolactone/ Bismuth Ferrite and PLA/GO Microfibrous Scaffold loaded with quercetin. It can be noticed that the supports can be electrically triggered, the electric field parameters, especially the frequency, being a promising parameter to control the delivery rate. In the case of PLA/GO-Quercetin, two different frequencies were used and the release rate increased 6000 – 8000 times for 10Hz and 700 – 800 times faster for 50Hz. Additional optimizations will be necessary to get an increase of the delivery rate of only tens fold and in this way, a more controllable DDS can be obtained avoiding “burst-like” delivery when the electric field is applied.

In conclusion, the drug delivery systems are increasingly used in treatment and, with a proper design, these DDSs can be used in a personalized treatment approach, the delivery profile being controlled by internal or external triggering.

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Figures

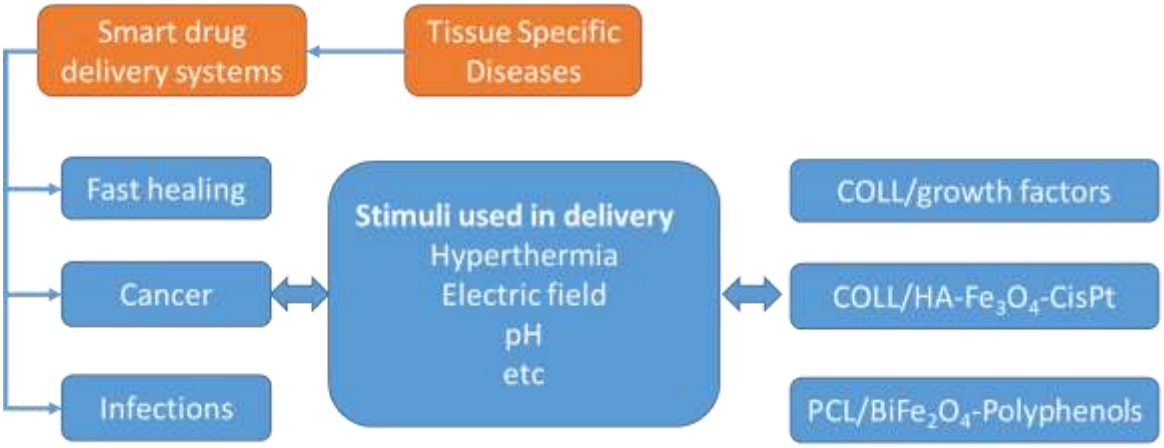

Figure 1. Smart drug delivery systems for tissue engineering