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Editorial: Biological stimuli-responsive smart materials

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Editorial on the Research Topic
Biological stimuli-responsive smart materials

Introduction

Along with economic development, healthcare and lifestyle progresses have been intensively focused, developing a huge desire to investigate new medical devices or treatment approaches. The fundamental of new medical devices or treatment methods is advanced biomaterials, and interactions between the human body and materials play a prominent role. The targeted polymers have been synthesized to modify implants with functional coatings and design fine materials (such as nanorods, filled and hollow microspheres) in order to regulate the cell behavior and promote the tissue regeneration (Roberts et al., 2018; Park et al., 2019; Wilson et al., 2019). Although the *smart* characteristic is vital in certain situations, these biomaterials are far from intelligent and cannot respond or adjust their performance according to the environment. As an instance, the drug carriers must recognize tumor tissues for delivering the drug to cancer cells without harming in the vicinity of normal cells (Zhang et al., 2019).

So far, several smart materials have been designed having the physical stimuli such as magnetic field, temperature, mechanical stimuli, electric field, light, ultrasound, chemical stimuli such as reduction and pH (Ghamkhari et al., 2018; Massoumi et al., 2019; Saraei et al., 2019; Khanizadeh et al., 2020), or biological stimuli such as glucose antigen and enzyme for regenerative medicine. Smart materials have many properties including the response to prolonged blood circulation, controlled drug release, ON-OFF switch activities, raised diagnostic accuracy, ability to generate specific stimuli, enhanced tumor accumulation, and therapeutic efficacy (Rezaei et al., 2021). Smart materials such as nanomaterials [e.g., gold nanoparticles (AuNPs), graphene, carbon nanotubes (CNTs), *etc.*], hydrogels, quantum dots (QDs), have been vastly employed in the biomedical applications (Stuart et al., 2010; Howes et al., 2014; Wei et al., 2017; Guo et al., 2020).

Repotente et al. biosynthesized the AuNPs through reducing chloroauric acid by lactic acid isolated from the probiotic *Lactobacillus* acidophilus. The surface analyses approved a size range of 4–15 nm for the prepared nanoparticles. Investigation of cytotoxicity and apoptosis of synthesized AuNPs showed that they are toxic against human lung cancer cells (A549) and human breast adenocarcinoma cells (MCF7). Nuclear damage was evident, but only MCF7 cells underwent apoptosis. Notably, AuNPs showed a non-toxic effect against a normal cell line, i.e., myoblasts. AuNPs were absorbed by the cells and presented in the cytosol, so they showed selectivity towards the used breast and lung cancer cells. Potential clues to cancer chemotherapy and targeted delivery in human breast and lung cancers can be obtained through the results of the current research.

The loading of polymeric micelles in injectable thermosensitive hydrogels with rapid distribution in the vaginal walls improves the bioavailability of the drug and provides a suitable therapeutic efficiency for the drug delivery systems. A core/shell polymeric micelle containing clotrimazole and silver nanoparticles (AgNPs) was developed by Hosseinzadeh et al. The combination of clotrimazole and AgNPs had a synergistic effect and increased the antifungal properties of the drug delivery system. A thermosensitive hydrogel system with silver polymer micelles with favorable properties may be suitable for the treatment of vaginal candidiasis.

Bone tumors are deadly and incurable diseases damaging the large areas of bon. Traditional therapies combining surgery, chemotherapy, and radiation have demonstrated their limit of efficacy, motivating efforts to develop new therapeutic methods. On the other side, the development of biomaterials renders the innovative options for bone tumor treatment. Suitable biomaterials are capable of simultaneously providing tumor therapy and promoting bone regeneration. Zhang et al. reviewed the recent progresses in achieving new strategies for bone tumor treatment by biomaterials, focusing on the innovative scaffold design. They also discussed the nanomaterials that can help the drug delivery or hyperthermia therapy to kill bone tumor cells.

In another research work, Cheng et al. manufactured a thermoforming film loaded with hydrogen peroxide as a clear aligner and studied the system efficacy on teeth blenching and its prominent impact on shear bonding strength for attachment. They demonstrated that the application of an aligner film loaded gel as a drug carrier was feasible and the thermoforming film featuring the sustained release of hydrogen peroxide had an acceptable bleaching effect on isolated teeth and had no significant influence on the shear bonding strength for attachment. This new type of film has potential clinical value, which is conducive to further exploration of this type of films.

Author contributions

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Conflict of interest

Author RS was employed by Sarvaran Chemie Pishro Company (S.C.P).

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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