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Mesoporous silica nanoparticles for drug and gene delivery

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Mesoporous silica nanoparticles (MSNs) are nano-metre-sized drug carriers. They exhibit a very fascinating potential in the biomedical and pharmacological fields by acting like a drug and gene delivery system. Several researchers have engineered synthetic honeycomb-like mesoporous structures of silica (SiO2). The ordered mesoporous materials in their initial phases of development were used for catalysis application, photocatalysis and magnetism. However, in 2001, upon extensive research, it was proposed that these ordered mesoporous materials could be used as drug delivery agents. Since then, silica-based ordered mesoporous materials have undergone a reorganisational applicatory state and have attracted substantial attention from biotechnological researchers for their application as effective drug carriers.

Their structural examination further revealed a large surface area and pore volume, selective surface functionality and biocompatibility along with morphology control. The MSNs also possess an easily tunable particle size along with uniformity in their pore volume. They offer easy encapsulation of drugs, proteins and biogenic molecules. MSNs exhibit exceptionally high loading capacity for therapeutic agents and stimuli-responsive drug profiles which allows for controlled and targeted release properties when modified with polymers or proteins.

Further, the synthesis of MSNs is relatively simple, economical and an ascendible task. The good biocompatibility of these nanoparticles is on account of the usage of silica which is recognised as safe by the Food and Drug Administration (FDA). Additionally, silica nanoparticles (Cornell dots-C dots) have even received a green signal for stage 1 human clinical trials. In recent decades, the growth in MSNs as an anticancer drug delivery system has been mainly premised upon the fact that the nanoparticles can store high volumes of chemotherapeutics in their pores. They can increase the drug concentration inside the tumour tissue, hence achieving passive targeting. The pores serve as reservoirs to stockpile different molecules. Moreover, the pore size can be engineered to selectively load either hydrophobic or hydrophilic anticancer agents.

For instance, MSNs have been effective in inhibiting pancreatic cancer and in one particular research, the cytotoxic effect of camptothecin (CPT)-loaded MSNs on different cancer cell lines was observed. Growth inhibition was observed in three pancreatic cancer cell lines (Capan-1, PANC-1 and AsPc-1), one stomach cancer line (MKN45) and also in one colon cancer cell line (SW480). One research with transplastin, an inactive isomer of cisplatin, also hints at the possibility of MSNs in enhancing less potent anticancer drugs by making them more biomedically effective after suitable combinations with MSNs.

Keywords: Mesoporous silica nanoparticles(MSNs), Biomedical, Food and Drug Administration(FDA) , Anti-cancer, Pancreatic Cancer, gene delivery,Camptothecin, Cisplastin, Transplastin

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