Microfluidics in Nanomedicine

Microfluidics is a recent advance in formulation science that is a superior method for the synthesis of uniform nanoparticles for drug delivery and related applications where colloidal systems are utilized. Using microfluidics, small volumes of liquid reagents are rapidly mixed in microchannels in a highly controlled manner to form tunable nanomedicines for tailored drug delivery. The reproducibility of the technique is a desirable feature to meet the demands of the pharmaceutical regulatory requirements. Commercially available microfluidics systems are now available to enable production at relevant scales for manufacturing applications. Coupling the microfluidics systems to advanced analytical methods such as microscopy, spectroscopic techniques and X-ray diffraction enables enhanced understanding of particle formation mechanisms and structure.

This special thematic issue of *Pharmaceutical Nanotechnology* highlights recent state-of-the-art advances in the utilization of microfluidics for the design of nanomedicines. Particle formation and *in situ* particle functionalization are a focus, with studies on polymer and lipid-based particles being a feature. This special issue also illustrates the breadth of approaches and applications that are possible with this microfluidics technology. The contributions in this special issue include a review by Streck and Hong *et al.* [1] that covers the foundations of the types of microfluidics mixers used in the pharmaceutical context, key considerations for the production of both lipid and polymer systems and outlines process-related variables that influence nanoparticle properties. The important feature of batch-to-batch consistency was investigated by Poller *et al.* [2] for PLGA nanoparticles, with the addition of albumin to the aqueous phase being identified as a strategy to assist in tuning nanoparticle physicochemical properties. Solid lipid nanoparticles are the focus of an article by Anderluzzi *et al.* [3] that draws on the considerable experience in the Perrie lab for using microfluidics to produce lipid nanomedicines in a high-throughput and scalable process. The use of microfluidics to produce stimuli-responsive nano drug delivery systems is highlighted in the paper by Hong *et al.* [4] who have applied the technique to the fabrication of cubosomes. Analysis using small angle X-ray scattering revealed that the internal structure of the cubosomes was influenced by the processing conditions. The use of plant extracts for their therapeutic effect is becoming increasingly interesting in human medicine. Vu *et al.* [5] present research formulating the antioxidant compound rutin into PLGA nanoparticles as a strategy to improve the low oral bioavailability. In this paper, the authors compared a traditional bulk production method with microfluidics and conclude that microfluidics results in more uniform nanoparticles with higher entrapment of rutin compared to a bulk method.

The Editors extend their gratitude to the authors for their interest and contributions to this timely special theme issue. We also thank the reviewers for their time and expertise for provide an appraisal of the manuscripts and their comments to help improve the quality of the submissions.

It is hoped that this special theme issue on Microfluidics in nanomedicine may stimulate new endeavours in this area and encourages adoption of this technique as a superior production method to synthesise nanomedicines.

**REFERENCES**


