# Nano to macro- polymeric particles for the release of active molecules

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Biodegradable and biocompatible polymeric particles have been widely used to encapsulate molecules that could then be released in a controlled or sustained way. This lecture will explore a range of technologies for the processing and application of particles for drug release ranging from the nano to the macro-scale sizes. Although the methodologies proposed are transversal for many pharmaceutical and bioengineering applications examples will especially focus the area of tissue engineering and regenerative medicine, in particular for bone repair. Nanoparticles can be used to deliver differentiation factors to direct the faith of stem cells. We discovered that naringin, a naturally occurring flavanone, encapsulated in nanomiceles could be internalised and released in mesenchymal stem cells, promoting the differentiation and augmenting the pro-osteogenic effect over that of free drug and standard induction methods, thus indicating the potential of this system to enhance stem cell–based bone regeneration.

Micro and macro-particles should be prepared using other methodologies. We proposed the use of superhydrophobic substrates as platforms to produce hydrogel or polymeric particles able to encapsulate molecules with a high loading efficiency. Several examples are presented in this context using natural based polymers and synthetic biodegradable polymers. The mild conditions that the particles may be formed allows for the encapsulation of living cells, extending the applicability of the technology.

Liquefied capsules are also an interesting system where drugs or cells may be encapsulated and released in a controllable fashion. We have been using the layer-by-layer technique (LbL) for the production of the multilayer shell that is enveloping the capsules. The mechanical and transport properties of the multilayers could be tuned, and the use of stimuli-responsive polymers in the construction of the shells permits to develop smarter delivery systems. The technology was also adapted to encapsulate living cells, and the resulting compartmentalized cell microfactories can be produced for distinct biomedical applications.