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Biomedical Applications of Nanostructured Metal-organic Frameworks

Ayesha Sohail *

Department of General Surgery, Christian Medical College, Vellore, India

Short Communication

Metal–organic Frameworks (MOFs) are being miniaturised in order to integrate these materials into strategic applications such as sensing and medication delivery. This new family of nanoscaled MOFs (nanoMOFs), which combines the intrinsic features of porous materials with the benefits of nanostructures, is projected to outperform traditional bulk crystalline MOFs in some circumstances. The advantages of MOF miniaturisation have previously been done to be effective in the field of biomedicine, not only because it has a substantial influence on the choice of administration method, but also because it influences there *in vivo* fate, and therefore their toxicity and/or activity. The goal of this review is to look at how to make nanostructured MOFs and how they can be used in biomedical applications.

In the last decade, the area of hybrid ordered porous materials has expanded fast, not only as a result of the ever-increasing number of different structures and compositions, but also as a result of significant attempts to add new or improved capabilities. Metal–organic frameworks, also known as porous coordination polymers, are a type of hybrid inorganic–organic solid that is made up of inorganic secondary building units and easily tuneable polycomplexant organic linkers with permanent porosity [1]. Because of their regular and wide porous structure, their primary potential applications in the early phases of the field were storage and separation of fluid mixes. Energy storage, sensors, magnetic and electronic devices, heterogeneous catalysis, and biomedicine have all lately been added to the list of applications.

The downsizing of MOFs has sparked a lot of attention in order to use them in strategic applications like sensing or medication delivery. This new class of nanoscaled MOFs (nanoMOFs) is projected to improve the performance of traditional bulk crystalline MOFs in some circumstances by combining the intrinsic features of porous materials with the benefits of nanostructures [2]. The advantages of MOF miniaturisation have previously been demonstrated to be effective in the field of biomedicine, not only because it has a substantial influence on the choice of administration method, but also because it controls there *in vivo* fate, and hence their toxicity and/or activity.

When using nanoparticles (NPs) as nanocarriers, for example, the large (external) surface area of NPs may promote not only greater bioactivity but also effective surface modification, enabling circulation, targeting characteristics, and enhancing chemical and colloidal stability [3,4]. These characteristics, in particular, determine their *in vivo* fate. As a result, particles smaller than 500 nm normally enter cells by endocytosis, whereas larger particles are more likely to be phagocytosed. It is also known that particle size influences splenic and renal clearance: particles bigger than 200 nm are more likely to be removed via the splenic filtration system, whilst particles less than 10 nm are cleared via the kidney's filtering system [5].

Finally, the size has a significant impact on the duration spent circulating in the bloodstream, affecting the interaction with the endothelium and, ultimately, their biodistribution. Particles smaller than 250 nm, for example, have a greater cross-section through the leaky endothelium (i.e. extravasation), making them helpful for tumour targeting. Finally, depending on the desired capabilities, these nanomaterials must meet a number of requirements, including minimal toxicity, good blood compatibility, low immunogenicity, adjustable degradation, and, in many cases, appropriate mechanical properties [6].

The focus of this review is on nanostructured MOF preparation and biological applications. We'll go over all of the many synthetic methods that have been described so far, as well as the shape and surface engineering steps that are required for biomedical applications [7]. In nanomedicine, bigger particles (>500–1000 nm) are frequently termed nanoparticles, despite the preferred definition of a nanomaterial, which is widely regarded as materials within the 1–100 nm range (at least one dimension and for 50% of the particles in the numerical size distribution). As a result, we'll use the term nanoparticle to refer to both submicronic (1000 nm) and nanometric (1–100 nm) particles.

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***Address for Correspondence:** Ayesha Sohail, Department of General Surgery, Christian Medical College, Vellore, India; E-mail: Sohail.a@cmc.edu*

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