Peptide-based supramolecular low-molecular-weight gelators have emerged as promising materials across various fields, including healthcare, cosmetics, and bioanalysis. Their advance highlights the increasing importance of gels as foundational elements and tools in next-generation technologies. Advances in the structural, functional, and production-related aspects of peptide-based gels — combined with their biocompatibility, responsiveness to chemical modifications, and suitability for rational *de novo* design — are accelerating their adoption in pharmaceutical science, too. Among recent innovations, peptide-based nanogels have gained particular interest. These injectable, nanoscale objects are closely related to hydrogels organization in their core and are stabilized by a surfactant shell. Formulated using self-assembling ultrashort peptides (*e.g.* Fmoc-FF), they are produced through a refined top-down approach that enables precise control over particle characteristics. This optimized methodology has positioned peptide nanogels as versatile platforms for expanding the scope of gel-based applications. These formulations have demonstrated an ability to encapsulate a wide range of active pharmaceutical ingredients (APIs), such as doxorubicin, dexamethasone, short interfering RNA (siRNA), gadolinium-based contrast agents, and chemical exchange saturation transfer (CEST) agents. Their colloidal stability, capacity for drug inclusion, controlled release profiles, and selective targeting potential underline their functionality in therapeutic and diagnostic contexts. Overall, peptide-based nanogels represent a significant advance in the formulation of responsive, biocompatible delivery systems, offering new possibilities in targeted drug delivery and biomedical imaging.