Mesoporous Biomaterials: a Lexicon and Structured Bibliography of Reviews

Kennedy, Elizabeth

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Accessing mesoporous and nanostructured biomaterial information can be particularly time-consuming and problematic due to the interdisciplinary nature of the field. Relevant papers can be found across a broad range of journals and various key words are needed to comprehensively retrieve information. A keyword lexicon and themed bibliography of over 250 review articles from more than 100 different journals has therefore been assembled to aid students and researchers in this expanding field. Reviews dedicated to fabrication of mesoporous materials and some key characterisation techniques are grouped together. Reviews focussed on specific medical issues like biocompatibility and toxicological testing are also provided. Medical applications that have been the focus of reviews include drug delivery, cancer therapy, medical imaging, orthopaedics, tissue engineering, biofiltration, biosensing and bioanalysis. The following mesoporous materials also have had dedicated reviews on biomedical uses: silica, silicon, silicates, metallic biomaterials, metal organic frameworks, carbonaceous materials, calcium phosphates, titania, and alumina.

The academic literature, excluding textbook and textbook chapters, was searched using the lexicon shown in table 1 to capture the field, in conjunction with “review”. Searching was conducted via Google, PubMed, Scopus, Google Scholar and Web of Science.

Reviews on mesoporous materials which focussed on non-medical applications were also excluded. Reviews based on nanoscale component structures with mesoporosity, like nanotubes, were included, whilst reviews solely on solid nanoparticles were not. The reviews found have been grouped as shown schematically in figure 1, depending on whether their emphasis is on fabrication, characterisation, medical testing or specific medical uses. General reviews which featured both medical and non-medical applications have been included, but those focused solely on non-medical applications have not. Reviews which discuss the applicability of various characterisation techniques to mesoporous materials in general, or specific mesoporous materials, were included. Most of the reviews that focus on one specific mesoporous material for one specific medical application were grouped within the medical application section, rather than the corresponding dedicated material section.

Nearly 300 reviews have been collated spanning more than 100 different journals. Within each group, reviews are arranged chronologically with the most recent first. The most intensively studied mesoporous biomaterial and medical application area were found to be mesoporous silica and drug delivery respectively, both with more than 50 dedicated reviews over the last decade 2005-2015.

General reviews on mesoporous materials

2. Physicochemical properties affect the synthesis, controlled delivery, degradation and pharma-
<table>
<thead>
<tr>
<th>Biomaterial Terms &amp; Medical Properties</th>
<th>Nanoscale Morphology</th>
<th>Materials</th>
<th>Properties and Characterization</th>
<th>Medical Processing &amp; Testing</th>
<th>Medical Administration</th>
<th>Biomedical Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorbable</td>
<td>Aerocrystal</td>
<td>Alumina</td>
<td>Biochemical</td>
<td>Approval</td>
<td>Buccal</td>
<td>Bioanalysis</td>
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<td>Bioactive</td>
<td>Aerogel</td>
<td>Calcium phosphate</td>
<td>EDX</td>
<td>Bacteria</td>
<td>Excipient</td>
<td>Biofiltration</td>
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<td>Bioadhesive</td>
<td>Foam</td>
<td>Carbon</td>
<td>FTIR</td>
<td>Biodurability</td>
<td>Implanted</td>
<td>Biosensing</td>
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<tr>
<td>Biocidal</td>
<td>Hierarchical porosity</td>
<td>Carbonaceous</td>
<td>Gas adsorption</td>
<td>Biostability</td>
<td>Injection</td>
<td>Cancer</td>
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<td>Biocompatible</td>
<td>Hybrid</td>
<td>Clathrate</td>
<td>Magnetic</td>
<td>Intraosseous</td>
<td>Intramuscular</td>
<td>Cell culture</td>
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<td>Biodegradable</td>
<td>Mesopore</td>
<td>Gold</td>
<td>Mechanical</td>
<td>Clinical</td>
<td>Intraosseous</td>
<td>Dental</td>
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<td>Graphene</td>
<td>Microscopy</td>
<td>Cytotoxicity</td>
<td>Intratumoral</td>
<td>Drug delivery</td>
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<td>Mesoscopic</td>
<td>Hydroxyapatite</td>
<td>NMR</td>
<td>Endotoxin</td>
<td>Intravenous</td>
<td>Gene delivery</td>
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<td>Mesosstructured</td>
<td>Metal</td>
<td>Optical</td>
<td>Genotoxicity</td>
<td>In-vitro</td>
<td>Imaging</td>
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<td>Metal oxide</td>
<td>Porosimetry</td>
<td>Haemolysis</td>
<td>In-vivo</td>
<td>Immunoisolation</td>
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<tr>
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<td>MOF</td>
<td>Raman</td>
<td>Histopathology</td>
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<td>Orthopaedic</td>
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<td>SAXS</td>
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<td>SEM</td>
<td>Inflammatory</td>
<td>Oral</td>
<td>Proteomics</td>
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<td>Parenteral</td>
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<td>Nanoporous</td>
<td>Silicon</td>
<td>TEM</td>
<td>Regulation</td>
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<td>Surgical</td>
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<td>Nanostructured</td>
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<td>Regulatory</td>
<td>Pulmonary</td>
<td>Theranostics</td>
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<td>Silicon nitride</td>
<td>Thermo-porometry</td>
<td>Sterilization</td>
<td>Subcutaneous</td>
<td>Therapeutic</td>
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<td>Titania</td>
<td>XPS</td>
<td>Testing</td>
<td>Topical</td>
<td>Therapy</td>
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<td>Porous</td>
<td>Zeolite</td>
<td>XRD</td>
<td>Toxicity</td>
<td>Transdermal</td>
<td>Tissue engineering</td>
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<tr>
<td>Tissue compatible</td>
<td>Xerogel</td>
<td>Zirconia</td>
<td>Zeta potential</td>
<td>Toxicology</td>
<td>Vascular</td>
<td>Wound repair</td>
</tr>
</tbody>
</table>


Reviews on fabrication techniques


Reviews on characterisation techniques


10. The complexity of mesoporous silica nanomaterials unravelled by single molecule mi-

**Reviews on toxicity and biocompatibility**

8. The toxicological mode of action and the safety of synthetic amorphous silica – a nanostructured material. C. Frujitter-Polloth. Toxicology. 294 (2-3) 61-79 (2012).
Reviews on mesoporous silica, organosilicas and silicates


Reviews on mesoporous silicon


Reviews on mesoporous carbon and carbonaceous materials


Reviews on mesoporous calcium phosphates


5. Calcium phosphate ceramic systems in growth factor and drug delivery for bone tissue engineering: a

**Reviews on mesoporous metals, metal oxides and metal organic frameworks**


**Reviews on drug delivery**


Reviews on Medical Imaging and Theranostics


Reviews on cancer detection and therapy


Reviews on Tissue Engineering & Cell culture


**Reviews on biofiltration, biomolecule immobilization & bioanalysis**


