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Covalent Organic Frameworks for Biomedical Applications

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Nitric oxide (NO), and other gases, are utilized by the body to modulate immune responses in wound repair, tissue engineering, infection treatment and more. Much research has been spent developing materials that can deliver such gases in vivo, yet their labile nature makes delivery in a controlled fashion and with release of clinically relevant amounts problematic.

Covalent-organic frameworks (COFs) are porous polymeric materials linked by stable covalent bonds. Because of their high stability, low density, large surface area, porosity, crystalline structure and multidimensionality, COFs are able to load large amounts of gas and have been used extensively in the energy sector for gas storage. Exploiting their utility for applications in the biomedical space has been challenging, however, because most COFs are not biocompatible nor do they respond to biological stimuli, which limits controlled release capabilities.

Researchers at the Biodesign Institute of Arizona State University have developed novel COFs with biodegradable linkages. These COFs are capable of temporarily binding gas and/or drug molecules and releasing those molecules in a controlled fashion. In vivo, these loaded COFs can be used for sustained treatment of a variety of diseases and infections. The COFs are able to act intracellularly in macrophages to modulate production of proinflammatory cytokines and membrane expression of signaling proteins. In vivo testing demonstrated that these COFs can load and release anti-TB drugs in a sustained manner and reduce overall Mtb population.

These COFs represent a new class of biomaterials with degradable linkages and biocompatibility for drug delivery and therapeutic applications.

Potential Applications

- Drug delivery
- Can simultaneously release NO and small molecule drugs
- Can delivery multiple drugs intracellularly
- Therapeutics – can modify the function of immune cells (macrophages, dendritic cells, neutrophils, etc.)
- Biomineralization

Benefits and Advantages

- The COFs are stable in bodily fluid
- Biodegradable linkages
- Can release payload in a sustained and controlled manner
- Can form 2D sheets, layered on top of each other, which are crystalline in nature
- Large pore volume – able to load large quantities of drugs and gas releasing materials
- Able to release NO and therapeutics intracellularly to increase efficacy.
- Can be formulated with osteoinductive compositions to induce biomineralization

For more information about this opportunity, please see

Esrafili et al - Adv Healthc Mater - 2021

For more information about the inventor(s) and their research, please see

Dr. Acharya's departmental webpage

Dr. Acharya’s laboratory webpage