Development of an Enzyme-Bioink for the 3D Printing of Functional Materials

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The field of 3D bioprinting still faces big challenges on the road to printing major full functional tissues and organs. One of them is adding functionality to the newly formed tissue for replicating the exact native biochemical environment.

Enzymes represent a highly attractive class of bioactive agents for applications in tissue engineering. The enzymes' specificity and selectivity enable them to react with target molecules only, and their *in vivo* biocatalytic processes makes them highly biocompatible. Hence, in contrast to their toxic and side-effect-prone drug alternatives, enzymes evolve as ideal candidates for adding functionality in biomaterials.

However, the difficulty in the application remains in delivering enzymes to the targeted site in adequate amounts for a long time. In previous studies, enzymes are rarely used as bioactive agents in the field of 3D bioprinting and are only physically entrapped or loosely injected inside the hydrogel. This results in low retention within the biomaterial scaffold and short-term effects of the enzymes.

Here, we present the development of a biocatalytic enzyme bioink for extrusion-based bioprinting by covalently attaching enzymes to the bioink scaffold in one quick crosslinking step. The enzymes become an integral part of the network and demonstrate higher stability inside the gel leading to an increased concentration and prolonged catalytic activity than solely physically entrapping the enzymes inside the hydrogel. Being able to 3D print this enzyme bioink, this opens up a novel cytocompatible biocatalytic bioink for precise and controlled applications at a targeted site within a three-dimensional structure.