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Novel Polymer Architectures for Controlled Release Applications

Polymers are frequently utilised as carrier vehicles for the controlled release of a molecular cargo in response to programmed stimulation.[1] The use of stimuli-responsive polymers in this manner enables the release of therapeutic molecules, perfume molecules and dye molecules, amongst others, on-demand, and so has wide-reaching applicability.[2] Programmed stimuli employed to actuate the release of polymer-encapsulated payload molecules include changes in environmental temperature, pH, ionic strength, solvent polarity, electric/magnetic fields, light or the activity of (bio-)molecules.[3] An example of enzyme-mediated release of protein molecules is given in Figure 1.[4] The control afforded to the release of payload molecules from stimuli-responsive polymers extensive and can be readily altered dependent on the particular system/conditions in which the polymer is employed.

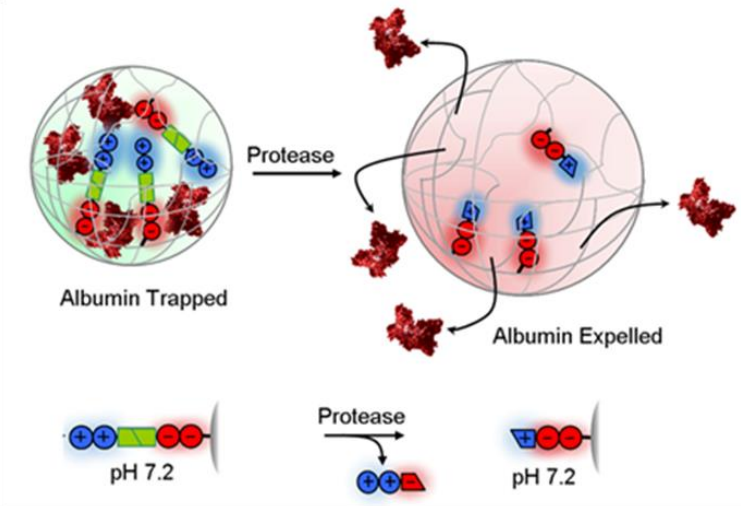

Figure 1: Protein (albunin) molecules are loaded within a polymer carrier vehicle. Upon polymer interaction with a targeted protease enzyme, the polymer dimensions increase to allow the previously entrapped protein molecules to pass out of the polymer. The albumin molecules are only released from the polymer when the polymer interacts with particular protease enzymes (the stimulation for release).

This project will focus on the development of novel stimuli-responsive polymers that will primarily be used for the delivery of drug molecules. In particular, key areas that are required to be addressed in order for the polymer-based drug delivery system to be effective include:

1) High loading of freely loaded drug molecules within the polymer carrier.
2) Polymer functionalisation to facilitate targeting towards specific tumour sites.
3) The intracellular delivery of microRNA and modified RNA.

The polymers used as the drug delivery vehicle will be biodegradable and produced by controlled polymerisation techniques to reproducibly generate drug carriers of consistent dimensions. Stimuli-responsive elements will be incorporated into the polymer design to maximise the potential application of the polymers produced. Post-polymerisation functionalisation will be done in order to furnish the polymer with elements that enable particular cell targeting and/or polymer tracking *in vivo*.

The project is varied in its nature, containing aspects of controlled polymer synthesis, biochemistry (polymer functionalisation) and biomaterials chemistry (the formation of drug delivery vehicles). In addition, a range of analytical techniques will be employed to enhance both student learning and project progression.

References

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(3) M. A. Cohen *et al*. *Nat. Mater*. **2010**, 9, 101-113.
(4) P. D. Thornton *et al*. *Soft Matter*, **2008**, 4, 821-827.

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