

# STIMULI-RESPONSIVE DRUG DELIVERY SYSTEMS

Drug delivery systems based on lipid nanostructures that respond to a range of stimuli to release the drug 'on demand'. Potential to replace multiple injection treatment regimens with more convenient and patient friendly non-invasive release for disease. Diseases such as macular degeneration are particularly suited to this technology.

- **Enable controlled, on demand release of drug in response to stimulus**
- **Proof of concept established for a range of stimuli including near infrared light, heat, magnetic field and enzymatic and biochemical triggers**
- **Reversible changes in the lipid nanostructure allow switching between 'on' and 'off' states, enabling release of multiple doses of drug at therapeutically meaningful time points**
- **Slow release of drugs using lipid nanostructures has been demonstrated clinically.**

## THE CHALLENGE

On exposure of some lipids to physiological fluids, structures form that are capable of controlling the release of incorporated drug molecules at very different rates, from essentially no release, to fast release.

The structures form as a consequence of the packing of the lipids. By controlling the packing it is possible to alternate between the different structures to switch drug release 'on' and 'off' (Fig.1). Incorporation of different stimuli into the lipid systems enables them to be used as drug delivery 'switches' (Fig.2).

Different lipid structures provide different release rates. Monash has developed methods to switch between different structures to harness their on-off drug release behaviour.

Age-related macular degeneration (AMD) is a critically important disease with up to 20% of the population over 50 developing symptoms eventually leading to loss of vision. AMD is most commonly treated with anti-VEGF drugs, administered by intravitreal injection every 6-8 weeks. This treatment is unpleasant and imposes a personal, financial and lifestyle burden on patients, leading to poor compliance.

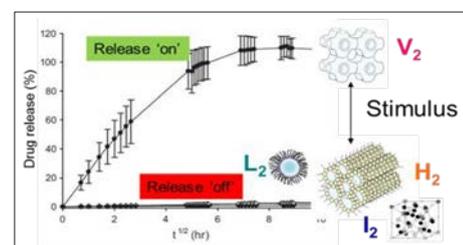
Patient acceptance of intravitreal treatment of AMD would be greatly enhanced by reducing the frequency of injections to every six to twelve months. The on-demand release of the Monash lipid systems is being developed with this goal in mind. Following a single injection, the lipid nanostructure would be activated by the ophthalmologist using a clinical laser system to release drug when required. This non-invasive activation procedure is expected to be fast and have minimal risk of infection or other side effects.

## THE TECHNOLOGY

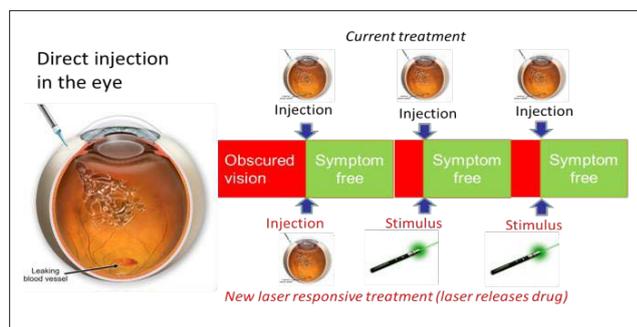
Researchers from the Monash Institute of Pharmaceutical Sciences have developed lipid nanostructure drug delivery systems. Using a range of non-invasive stimuli, these systems can be activated to release a dose of drug 'on demand'.

The Monash drug delivery technology has application in a range of diseases requiring frequent injection of drugs, such as administration of anti-VEGF agents in AMD and administration of hormone treatments in cancers and endocrine diseases.

Diseases such as macular degeneration are particularly suited to this technology, where a highly selective light stimulus can be used to initiate changes in the lipid nanostructure to release the active ingredient only when required, reducing injection frequency while maintaining clinical control of therapy.



**Figure 1:** Alternating between different structures to turn drug release 'on' and 'off'.



**Figure 2:** The on-demand release behaviour of the Monash lipid nanostructures will enable a single injection loaded with multiple doses of drug, which releases a unit dose of drug after non-invasive activation.

## THE OPPORTUNITY

Monash seeks partners with drugs that would benefit from its stimuli-responsive drug delivery technology, to progress development through preclinical studies and into clinical trials.

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