How do we make DRUGS work more EFFECTIVELY?
Using MULTI-FIELD BEHAVIOURS OF SMART GEL SYSTEMS to improve DRUG DELIVERY efficiency
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Drug delivery
Drug delivery (Figure 1) is the process of delivering pharmaceuticals to produce a therapeutic effect in the human body.

Controlled release
Controlled drug delivery aims to control the duration of the action of the drug and drug concentrations in the human body, in addition to targeting the drug to particular locations by overcoming certain tissue and cellular barriers.

Controlled release mechanism
Controlled release is obtained by responding to small changes in environmental conditions such as temperature, pH, ionic strength, salt type, solvents, electric fields, magnetic fields, light or pressure. Figure 2 illustrates how hydrogel networks release drugs by swelling in the high pH region, by-passing the stomach barrier. Figure 3 shows a schematic of the hydrogel microstructure.

Environmental responsive gels
Stimulus-sensitive, smart gels such as hydrogels are good candidates for controlled drug release agents. Hydrogels are networks of molecules or monomers with cross-linked long chains that can protect drugs from harsh environments. When hydrated, hydrogels can contain as much as 99% fluid by weight and can swell or shrink dramatically to modify drug release rates.

The challenge
It is critical to model the swelling response in order to predict drug release from the hydrogel systems. However, such mathematical modelling of drug release from coupled multi-field networks is very limited.

Our aim
This project investigates the multi-field behaviours of gel systems, including swelling and shrinkage, by mathematical modelling and numerical simulations, verified by experimental data.

Implication
The mathematical modelling and numerical simulation of smart gel systems can be applied to the control of other biological systems or processes such as bioseparation, biosensors, artificial muscles, artificial corneas, and actuators for adaptive structures.