The mechanical environment inside and outside the cell is not the result of a single component. Most, if not all, matrix gels are heterotypic in that they are assembled networks of differing polymers systems. In material science, it is known that for interpenetrating networks if the fibres are similar, then the resultant hybrid material exhibits properties, which are an average of the two networks (see Figure 1). Multiple materials with different mechanical regimes act together and form the necessary toolbox for transportation, communication and other cell tasks. The presence of a second (or third) semi-flexible network can completely change the properties of the first; for instance, a gel can become many times stronger, tougher or more responsive. Interpenetrating or composite networks of simple synthetic gels have been studied, but for the much more relevant biological materials, very little is known partly because these biological materials are experimentally difficult to study.

This project is about understanding how the material properties of collagen and fibrin are modified by the presence of the polyisocyanide (PIC) gel to be able to make strain stiffening tunable hybrid biomaterials for controlled cell growth. The questions we need to answer are:

- How are fibrin and collagen gel properties modified by the interpenetrating network?
- What would occur if the PIC-gel were modified with CAKQAGDV, a fibrin binding protein? Or with HVWMQAPGQGC a known collagen binding protein.
- Could the strain-stiffening properties of PIC be altered by the addition of strain stiffening nanocellulose? Nanocellulose is a novel material, which is also been observed to exhibit biomimetic properties but unlike fibrin/collagen is fully synthetic and has significantly different stiffness, allowing greater regimes of strain stiffening to be accessed.

**PROJECT PLAN**

1. Study the strain stiffening and material properties of fibrin/PIC and collagen/PIC mixtures. Understand the interaction between interpenetration networks. Use the results as a basis for modeling studies.
2. Investigate the changes in material properties as a function of PIC-peptide/fibrin binding density. Investigate the changes in stiffness and strain stiffening as a function of crosslinking density and altered pore size.
3. Synthesize and study the material properties of functionalized PIC gels in the presence of nanocellulose materials (In collaboration with the group of Prof. Darren Martin). By this, develop a fully synthetic matrix whose materials properties can extended to larger strain stiffening regions.
4. In collaboration with Dr. C. Storm (Technical University Eindhoven, NL) and Dr P. Kouwer (Radboud University Nijmegen, NL) model the above experimental data. By this, develop a model, which will give an understanding of the precise relationship between the different molecular parameters and the materials properties, allowing a fully TUNABLE matrix to be developed for the cell growth.
THE CANDIDATE
Strong background in organic synthesis and/or physical organic chemistry
Experience with proteins
Polymer characterization
Rheology, protein modification