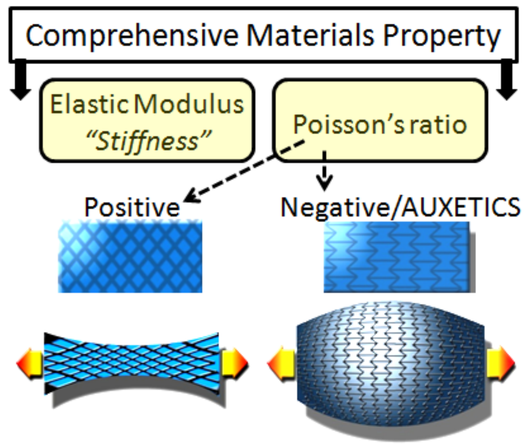
Influence of negative Poisson's ratio *(Auxetics)* on cell behavior

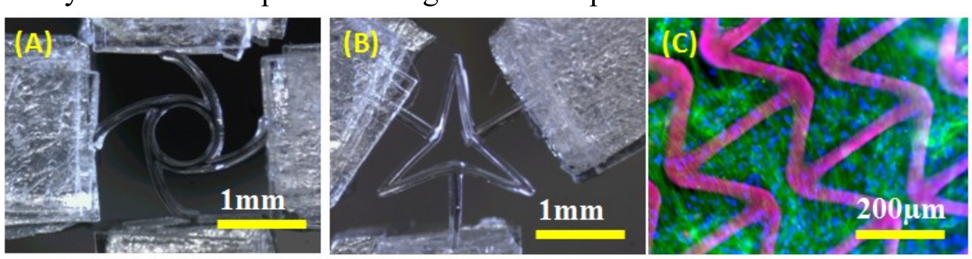
Pranav Soman, Biomedical and Chemical Engineering



Tissue engineering aims to develop biological substitutes or scaffolds with the end goal of having these replace pathological tissues. Materials property of an ideal scaffold must be tailored to satisfy the local stresses and deformations of the underlying native tissue. The ability of a biomaterial scaffold to support and transmit cell forces can be comprehensively described by two parameters, the elastic modulus and the Poisson's ratio. Thus far, alterations in elastic modulus (commonly referred to as "stiffness") have been shown to impact cells in fundamentally different ways. Typically, Poisson's ratio is assumed to be positive for all materials (~0.3 to 0.5), even though materials with negative Poisson's ratio or "auxetics" do exist in biology. Materials with positive Poisson's ratio contract when they are stretched, while "auxetic" materials expand and get fatter, when stretched.

In this work, we investigate the influence of varying negative Poisson's ratio of biomaterial scaffolds on cellular behavior. The successful execution of this project necessitates the synergetic application of methods from Materials Science, Biology, and 3D printing technologies. Firstly, Dynamic Projection printing or Nozzle-based extrusion printing will be used to manufacture scaffolds with chiral, 4-star, and re-entrant honeycomb geometries in poly(ethylene)glycol (PEG) biomaterial. Secondly, we develop custom-made micro-manipulation tool to quantify the Poisson's ratio of investigate how biaxial strains influence adhesion, proliferation, cytoskeletal organization, and differentiation of smooth muscle cells.

In the context of cell-materials interactions, Poisson's ratio has not been explored, primarily because of challenges involved in tuning the Poisson's ratio in biological scaffolds. In this work, we investigate the effect of "*Auxetics"* on cell response. Methodology developed in this work can be extended to other biomaterials and cell-types to investigate effects of altering the Poisson's ratio on a variety of cellular aspects. Tuning another important fundamental material property, the Poisson's ratio, will foster experiments and may lead to a paradigm shift in the understanding of cell-substrate interactions.



Negative Poisson's ratio or *"Auxetic"* scaffolds manufactured using poly(ethylene) glycol biomaterial: (A-B) Optical image of scaffolds with chiral and tri-star geometries. (C) Fluorescent image showing integration of human mesenchymal stem cells with re-entrant honeycomb geometry scaffold. (green=actin) (blue=nucleus)