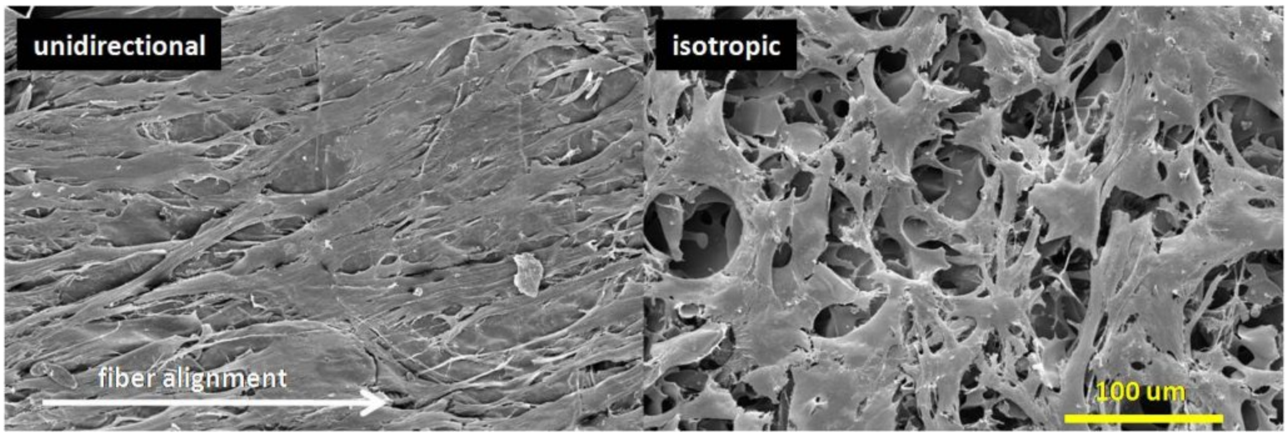
Silk patches to repair hearts

The heart is a very sensitive organ. Once it's "broken", it doesn't quite function the same way again. Biologically speaking, a common way of getting your heart broken is when you suffer a heart attack. When the oxygen supply to the heart is blocked, it is inevitable that the heart tissues affected, which have high oxygen demand, will die. A patient who suffers through a heart attack may have a second chance in life, however the dead heart tissue will result to a host of physiological problems that ultimately lessens the patient's quality of life and puts them at risk for heart failure. By itself, the heart has a hard time regenerating its own tissue.



Cell morphology on aligned (unidirectional) and non-aligned (isotropic) scaffolds.

With the advent of tissue engineering, a solution currently being explored is making a patch-like device that can be applied to the site of injury at the heart and help regenerate the dead heart tissue. Recently, silk patches made using unidirectional freezing have been proposed as a good base material to achieve this purpose. Using a gentle process that simply involves a special freezing regimen and freeze-drying, silk patches with aligned fibers can be made easily. Being a biodegradable material, the silk patch is foreseen to degrade naturally inside the body as it proceeds to regenerate normal tissue. Furthermore, the degradation products of silk are simply harmless peptides and amino acids, making it a good material to utilize. The special freezing regimen is attained by using molds which have a highly conductive copper base and an insulating body on all the other sides. This allows the ice crystals to grow longitudinally in a single direction into pillar-like shapes. It is important to note that as a solution made of water and silk (or any other material) freezes, the water and the silk go through a phase separation as only the water turns into ice. This means that as the ice crystals grow, the silk is concentrated into the spaces in between the ice pillars. Once freezing is completed, freeze-drying is done to turn the ice directly into water vapor, leaving the resulting aligned structure of the silk undisturbed. What's left after the entire process is a silk patch with aligned fibers, reminiscent of the alignment in native heart tissue. This is in fact the main advantage of this process, as it attains alignment without the use of harsh chemicals or complicated steps. Gelatin was combined with silk to improve the cell adhesion properties of the patch. The optimum amount of gelatin to be added was determined by testing the different mechanical, chemical and cellular compatibility properties of different compositions of silk and gelatin. It was concluded that a 20% gelatin and 80% silk was enough to attain improved cell adhesion without sacrificing mechanical properties. Furthermore, cells grown on the aligned patch were shown to respond to the alignment by aligning themselves along the fibers. The results indicate a potential of using these silk patches for regenerating heart tissue and other aligned tissues as well.

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Anisotropic silk fibroin/gelatin scaffolds from unidirectional freezing.
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