Bioreactors as a Means to Tissue Engineer Normal Cardiovascular Function

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Cardiovascular disease has a high risk and is continually increasing in many countries every year. In fact the amount of patients with heart disease has a higher fatality rate of those with cancer. Throughout history different methods of cardiovascular treatments have been applied. Treatments varying from the pharmaceutical aspect (such as blood thinners and medications to control cholesterol and lipids) to new procedures such as: valve replacements, quadruple bypass, stents, inflatable balloons and even new imaging techniques. All of those are excellent procedures but how efficient are they? There are perhaps better methods used or have been considered. These methods are ones that involve tissue engineering or better yet tissue engineering using a bioreactor.

Tissue engineering (sited by Jean Ruel and Genevieve Lachance) is the manipulation of molecular and biological cells. These cells are then created into tissues. Then the tissues are used to replace bad tissues. Once the tissues are ready to be embodied into the heart they have shown physiological qualities such as blood flow, and pressure. Studies have been demonstrated that cultured tissues or engineered tissues have an accurate simulation of physiological functions and mechanical properties.

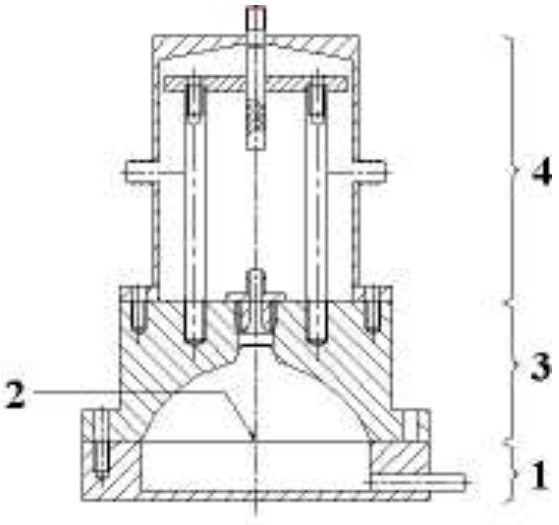
Several groups across the world have tried bioreactors. A bioreactor is a vessel that is used to carry out chemical processes that involves organisms derived from such organisms. To sum it up the bioreactor takes tissues to cultivate more tissue. These bioreactors are processed either as aerobic or anaerobic (depends on oxygen or not for growing stages). Bioreactors allow precise and continuous control of tissue cultures. The goal of using these bioreactors is to provide an environment that accurately mimics the natural cardiovascular conditions.

Bioreactors used for cardiovascular usages are modified from ordinary Bioreactors. The reason being is pulsatile flow is driven by a pump. This flow is exerted by positive pressures. This flow is only exerted of positive pressure. A cardiac cycle a positive pressure is only exerted by a fluid force which as a slightly higher counterbalance force from a vacuum. Regular bioreactors have "dead space" or dead angles in lower compartments of the chambers. These dead angles would result in non-uniform fluid flow. If this happen for cardiovascular cultures, non-uniform blood flow would eventually lead to blood clots.

A generic bioreactor design (shown) is of a versatile compact design of acrylic-plastic. It consists of 4 main compartments. In compartment 1 is an air chamber filled with pulsated by an air pump which mimics the beat of the cardiac cycle. The second compartment is a silicon diaphragm which differentiates like a heart beat. Blood and nutrients are placed in compartment 3. Finally in the 4th compartment is a secured chamber where the tissue-engineered cultures are grown

To enhance the efficiency of growing cultures, two outlets are placed within the air pressure compartment which keeps a consistence pulsatile flow. There is also a one way valve which is located between the pressure chamber and the perfusion chamber which will prevent any sort of back flow

This particular bioreactor contains several interchangeable parts in the perfusion chamber. These parts are then further divided into 2 other parts. The first is categorized as artery-parts for different diameters of the different arteries. The second category is for heart valves. These two categories are used depending on what will be grown. Since bioreactors are versatile for different things only one specific set of tissues is grown at once.



In conclusion the optimal goal for these bioreactors is to spatially uniformly distribute cells, to maintain desired gases and nutrients in cultured medium and to expose developing tissue to appropriate physical stimuli. Restoring normal cardiovascular function after significant trauma has been a goal of humankind since the earliest days of medicine. The use of these bioreactors to re-grow vital heart tissue brings us much closer to that goal, and will hopefully open the door to full cardiovascular recovery in time.

Sources:

- "A New Bioreactor for the Development of Tissue-Engineered Heart Valves ." Ruel , J. , Lachance , G. Annals of Biomedical Engineering. April 2009 Volume: 37
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