Integrating creative thinking into biomaterials education: A first year bioengineering seminar module to teach how to design musculoskelatal bioengineering systems for regenerative purposes.

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Statement of Purpose: Choosing a major in their freshman year is usually a challenge for incoming students. The department of Bioengineering at Penn State University offers a First-Year Seminar where different areas of bieongineering are introduced to freshmen through in-class presentations. This year we evaluated a pilot module within the first-year seminar class to introduce a specific bioengineering subtopic and allow them flexibility to create their own solution to a given bioengineering problem.

Methods: The seminar module involved two sections and each had a two hour classroom time. During the first section students were taught musculoskeletal regenerative engineering strategies with special focus on tendon regeneration. The second section was a hands-on session where a group of four to five students worked to build a tendon stretch bioreactor from custom fabricated pieces capable of applying cyclic strain on artificial scaffold materials . In order to design a flexible platform that allowed students to design unique solutions we first started with two simple machine ideas that would create a non-linear sinusoidal stretch on given elastic materials (Figure 1). All the parts were designed and machined using the machine shop at Penn State University Bioengineering Department. All materials have been selected to be non-toxic, and clear to allow visibility of the final configuration. Gears, acrylic sheets, polysulfone and Teflon rods were purchased from McMasterCarr (Robinsville, NJ). The technical drawings of the bioreactor pieces were drawn using SolidWorks (Waltham, MA). As a representative artificial elastic scaffold, different rubber materials were tested before the hands-on module and a synthetic rubber scaffold material with high elastic strength and an ability to stretch longer distances was chosen. During the design and development phase, at least 5 different solutions (total number of groups in the class) were verified possible given the pieces available.

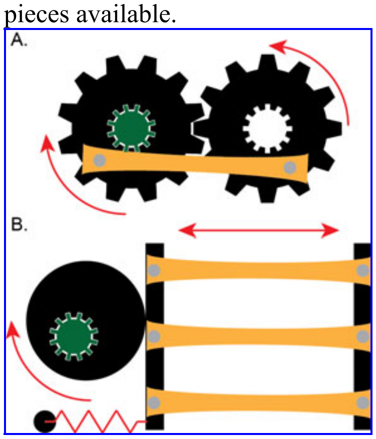

Figure 1.Two simple machine sketches intended to create a linear stretch through A) stretching the material via two concentric gears, B) a rotating cam and spring system.

Figure 2. Tendon Bioreactor setup Kit.

Results: Students created at least two solutions per group for the tendon stretch project. 3 of the designs are out of what we have designed towards and all were unique to each group. Students enjoyed both the classroom session and hands-on session. Both of the sessions were interactive and informative. Students were given a simple problem set that asked them to calculate the spring constant for a tendon with given boundary stretches and loads. All the students solved the question set and brought to the classroom before the hands on module started. Before hands-on module started, a brief introduction about the need for a tendon stretch bioreactor was discussed in the classroom and preceded with the hands on module. Thirty minutes were given to each group to solve the problem and assemble the motor to their setup to see if their solution was working or not.

Conclusions:

In this study a classroom module was designed and implemented to create awareness to Musculoskeletal Regenerative Engineering with a special focus on tendon stretch bioreactor design. Students were encouraged to;

- Ask questions to critically analyze current strategies.
- Learn about the structure function relationships when designing a Musculoskeletal Bioengineering System.
- Create Tendon Bioreactor prototypes each of them unique per group.
- Enjoy while doing all of the above.

References:

A Youtube video for the project can be found following the link below:
http://www.youtube.com/watch?v=_zpDy9ExcHU&feature=plcp