Bone Up on Tissue Engineering

Author(s)
Bethany Vice and Nick Harth

Subject(s)
Biology - Tissue Engineering

Grade Level
10th

Duration
2-3 60-minute sessions

Rationale (How this relates to engineering)
This lesson relates the activities in a biology classroom (study of organs, organ systems, dissections) to innovative engineering applications of tissue engineering.

Activity Summary
Students will be introduced to the concept of tissue engineering. They will work in groups to test the strength of a model bone and then modify the model to see if strength can be improved.

Objectives
1. Students will be able to explain the relevance of tissue engineering.
2. Students will be able to describe the basic process of tissue engineering.
3. Students will be able to describe the general steps in the research process.
4. Students will be able to identify errors in the research process.
5. Students will be able to relate general biology concepts to recent scientific advances.

Standards

Science (Grade 10)

Science and Technology - Understanding Technology
- Cite examples of ways that scientific inquiry is driven by the desire to understand the natural world and how technology is driven by the need to meet human needs and solve human problems.
- Describe examples of scientific advances and emerging technologies and how they may impact society.
Scientific Inquiry – Doing Scientific Inquiry
- Present scientific findings using clear language, accurate data, appropriate graphs, tables, maps and available technology.
- Draw conclusions from inquiries based on scientific knowledge and principles, the use of logic and evidence (data) from investigations.

Scientific Ways of Knowing – Science and Society
- Investigate how the knowledge, skills and interests learned in science classes apply to the careers students plan to pursue.

Mathematics
- Students pose questions and collect, organize, represent, interpret and analyze data to answer those questions. Students develop and evaluate inferences, predictions and arguments that are based on data.

Background Knowledge
Students should have the general background of animal systems.

Materials Required
8.5” x 11” Sheets of paper
Tape
Paper clips
Styrofoam cups
Coins
Scale

Activities
Day 1
(10 min) Introduction – Have students stand beside/behind their desk.

Start the lesson by reading the introduction on the student handout. Make sure the students understand the piece. Go over words that may be unfamiliar to them. (Hopefully some will ask to sit down, don’t let them!)

Ask them what is going on while they are standing.
- What different tissues are involved in this process? (My class had been dissecting animals, so I asked them to refer to their dissections.) Bone, muscle, nerves, etc.
- What is holding you up as you stand? Think of how much you weigh and what is holding that weight up.

Tissues serve different purposes.
- What is the purpose of bone? Support, structure
- Do you know how much stress a bold can withstand? Why would it be important to know how much weight a bone can withstand?
Activity – The students are going to test a bone model. The model is made of paper. Show the students how to make their model. Have supplies available for the students and allow them to setup their own test station. The students can be creative when developing their test station.

Parts 1 & 2
Follow directions as on the student handout.
Collect student data in a spreadsheet for use the next day.

Day 2
(15 min) Allow students time to review the work on their handouts from the previous day. Encourage them to talk about the questions with their group. Make sure you have all of the data collected in the spreadsheet.

(30 min) Discuss data collected from previous day. Have a graph of the data projected (or on a handout) and allow the students a few minutes to analyze it. Get their feedback. Does the data look like it should? What is right or wrong about it? What should it look like?

Was the paper a good model for a bone? If available, pass around animal bones for the students to look at. Talk about the bone not being solid and how the paper is a reasonable model. This discussion may continue into the use of models in science.

Review the questions in the handout with the students. Some topics may have already been covered in previous discussion.

(15 min) Video – This video is approximately 7 minutes in length. Can be found at <http://www.pubinfo.vcu.edu/secretsofthesequence/showdetail.asp?id=51>

Before the Video – Tell students to look for and record the 4 steps that are used to engineer new tissues.
- Extract the cells from either a donor or the patient
- Build a scaffold for the cells to grow on
- Supply nutrients and oxygen to the cells
- Grow cells on the scaffold until the scaffold dissolves at the point where there is enough tissue structure for the cells to continue to grow and attach to themselves

After the video go over the student questions.

What is the goal of tissue engineering?
Tissue engineering is about restoring, repairing, and maintaining organs.

What is the difference between tissue engineering and genetic engineering?
Tissue engineering involves the restoring, repairing, and maintaining organs. Genetic engineering is the manipulation of the genetic code. Tissue engineering could utilize genetic engineering to accomplish certain objectives.

What is the tissue that researchers believe is the easiest to grow and why?
Cartilage because they do not need a great deal of oxygen, can receive nutrients by diffusion, and they do not need much of a vascular supply.
Assessment of Student Learning
Handout with questions pertaining to the different aspects of the lesson.

Assessment of the Activity
Student feedback form.

Acknowledgements
A significant portion of this lesson was adapted from Virginia Commonwealth University – Secrets of the Sequence, <http://www.pubinfo.vcu.edu/secretsofthesesequenve>