Life Science
Lab Activity

Name ______________________

Date ____________ Period ________

Designing a Bone – Tissue Engineering*

Objectives
As a result of doing this activity, you should be able to:

- State the three principle ingredients needed for successful tissue engineering.
- Develop a design for a bone.
- Discuss the value of tissue engineering over conventional medical practices.
- Understand why stem cell research is considered controversial.

Introduction – Tissue Engineering
Repairing damaged tissues is often a challenge with questionable results. Battlefield surgeons have often struggled to repair serious tissue injuries. Imagine you are a military doctor in the burgeoning field of tissue engineering. A soldier is brought in from the battlefield with serious facial damage. Part of the patient's lower jaw has been shattered by a bullet. Traditional methods of dealing with this injury would leave a misshaped jaw and plenty of scar tissue. You are encouraged that new techniques in tissue engineering may provide a better solution. In the operating rooms of the near future, doctors will be able to reconstruct a patient's jaw by growing new rejection-free tissues to replace the damaged ones.

Here's how tissue engineering works. Three components are needed for successful tissue engineering.

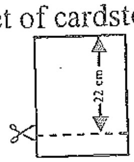
1. Develop a suitable substrate upon which the new tissue will grow. This substrate is called a ***scaffold***. Intense research is being done in the development of various scaffolds that will support the growth of different types of tissue. Although this may seem simple, the ideal scaffold should deteriorate at the same rate it is being replaced by the new growing tissue. Bone scaffolds must be similar in porosity as real bone. In some instances the density of the bone being produced is different in different parts of the same bone, so the scaffold should be designed to reflect this density difference.
2. Harvest ***stem cells*** from the patient. Stem cell research is a controversial area, especially if the research involves the harvesting of **embryonic** stem cells. A recent encouraging discovery has shown that adult stem cells can be harvested from doing liposuction. Stem cells can be found among the fatty material that is removed during this procedure. Harvesting adult stem cells is far less controversial than obtaining stem cells from human embryos.
3. If stem cells are simply put on a scaffold in the lab, they will not grow. The stem cells must be induced to grow and differentiate into the appropriate tissue. A tremendous amount of research is going into the development of ***chemicals*** (usually hormones) that will stimulate the stem cells to grow into the correct tissue.

The uses of tissue engineering seem limitless. Burn victims could be covered with their own new skin, and organ transplant patients would not have to compromise their immune systems with drugs that fight organ rejection. In theory it should be possible to grow a brand new heart from the stem cells of a cardiac patient.

Materials

Sheet of Cardstock	Scissors	10 cm of Scotch Tape
Metric Ruler	Weights	Scale

Procedure
1. Get a sheet of cardstock and cut off a piece that is 22 cm long.



*Adapted from: *An Education Outreach Manual in Tissue Engineering*, Pittsburgh Tissue Engineering Initiative, ©2002.

2. You and your lab partner are to design a bone that resists bending with the following criteria:

   A. It must be 22 cm long.

   B. It must be too large in diameter to fit in a 2 cm^2 hole and small enough to fit into a 3 cm^2 hole.

   B. A pencil must be able to be stuck at least 5 cm in each end. (Therefore, the ends must be hollow.)

   C. You may use only 10 cm of tape.

   D. You may include the scrap cut off piece in your design.

3. Have your bone tested by your teacher according to the following rules:

   A. Suspend the bone between two supports that are 12 cm apart.

   B. Hang a container with 2 kg of weight in it. (To qualify for competition, your bone must support at least 2 kg in weight.)

   C. You should not drop the bucket handle onto the bone. Lower it gently and then let the bucket hang for a quick count of two.

   D. Continue to add weight until the bone fails.

   E. Record the last weight that didn't cause the bone to fail.

4. Record your results in the spaces below.

   Maximum weight our bone supported ______________ Heaviest weight in class ______________

Analysis

1. What was the bone design like that held the most weight?

   ____

2. How did your bone design do in comparison with the rest of the class?

   ____

3. Do you think there still could be a better design than the one that won the class competition today? Explain.

   ____

4. Why shouldn't organ rejection be a problem when a patient is treated with engineered tissues?

   ____

5. Keeping it short, what are the three components for a successfully engineered tissue?

   1.______________________________

   2.______________________________

   3.______________________________

6. What is it about stem cell research that is controversial? That is, what makes some people upset about it?

   ____

   ____

7. How do you feel about embryonic stem cell research? Should research be done in this area? Why or why not?

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