

## Bone Transplant Worksheet

*Engineering Challenge:* You are assigned the task of working as a team of biomedical engineers to create a turkey femur prototype that could be used as a transplant. Your challenge is to use calipers to determine the exact measurements of a turkey femur, draw a sketch on graph paper, and create a prototype using various provided supplies. Your goal is to create a prototype that not only looks like a turkey femur, but is also similar in mass and density. In addition, you will use a saw to create a cross section of the femur. Using calipers, you will take the measurements of the turkey femur cross-section and use CAD software to create a 3D image to print on a 3D printer.

### Day 1: Research and Data Gathering

1. Use the calipers to measure the turkey femur.
2. On graph paper, draw to scale the turkey femur. Create several labeled drawings so that you show views from the front, back, two sides and the ends.  
*Tip:* Make sure you read the “bone diagrams” criteria in the rubric.
3. Using an electronic balance, measure the mass of the femur and record in Table 1 (below).
4. Fill a graduated cylinder half full with water. Record the volume of water in the Table 1.
5. Place the femur in the graduated cylinder; record the volume of the water + bone in Table 1.
6. Calculate the volume of the femur and record in Table 1.
7. Calculate the density of the turkey femur and record in Table 1.

Table 1				
Bone mass (g)	Water volume (ml)	Water + bone volume (ml)	Bone volume (ml)	Bone density (g/ml)

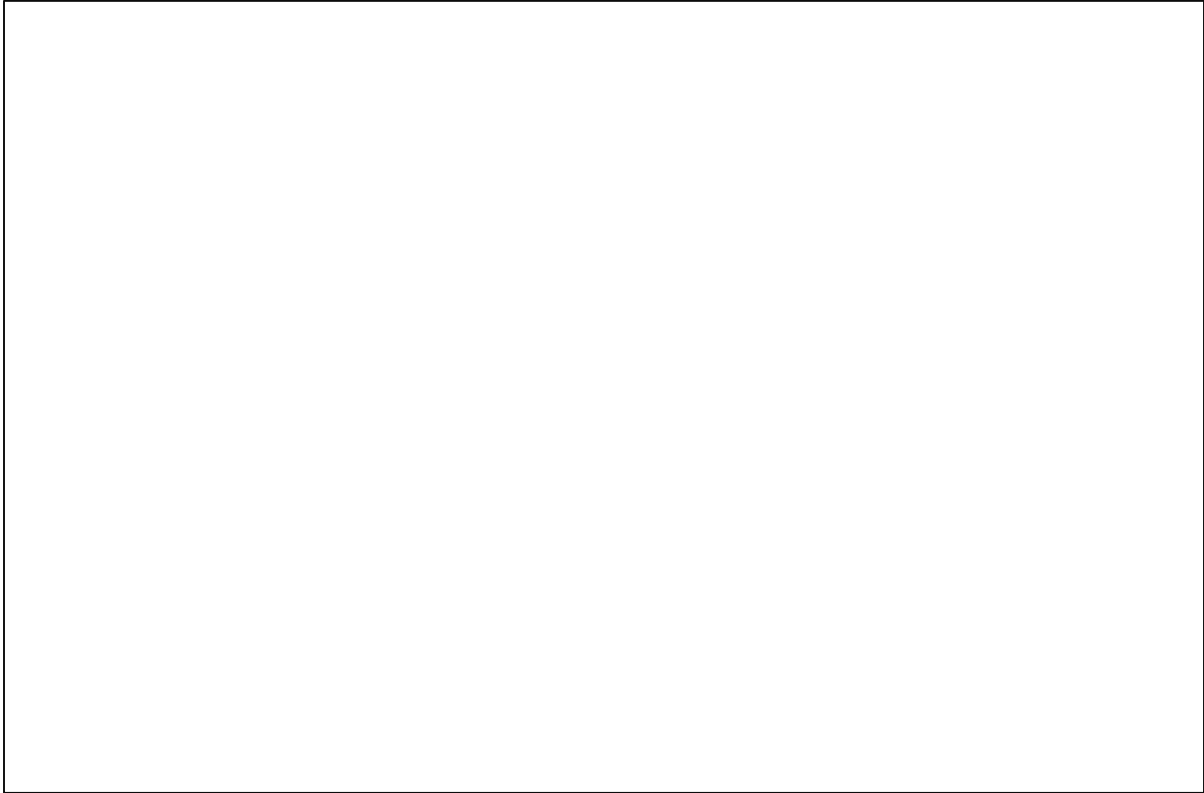
### Day 2: Design and Prototyping

1. Referring to your turkey bone drawings and caliper measurements, begin to construct a 3D prototype of the turkey femur.
2. Use the supplied materials, such as modeling clay, cardboard, straws, pipe cleaners, tape, etc. In addition, you may use other supplies with teacher approval.

Name(s): \_\_\_\_\_ Date \_\_\_\_\_ Class \_\_\_\_\_

3. In the box below, draw a rough sketch of your bone prototype indicating the materials that you will be using and where they will be used.
4. Use the rubric to guide you in this process. Your goal is to make a femur prototype that has the exact measurements of the real turkey femur. In addition, you also want your prototype to be the same mass and density as the turkey femur. Make prototype improvements, as needed.

Rough sketch



*Note:* Sketch and describe any redesign on a separate sheet of paper.

### **Day 3: Model Cross-Section via 3D Printing**

1. Using a hacksaw, cut the turkey femur shaft to obtain a cylindrical section of the bone. Now you have a bone cross-section.
2. Use calipers to measure the bone cross-section.
3. Using CAD software, design a replication (a copy) of the bone cross-section.
4. Save the design as an “stl” file.
5. Print the cross-section on the 3D printer.

