8 Investigating Biomechanics

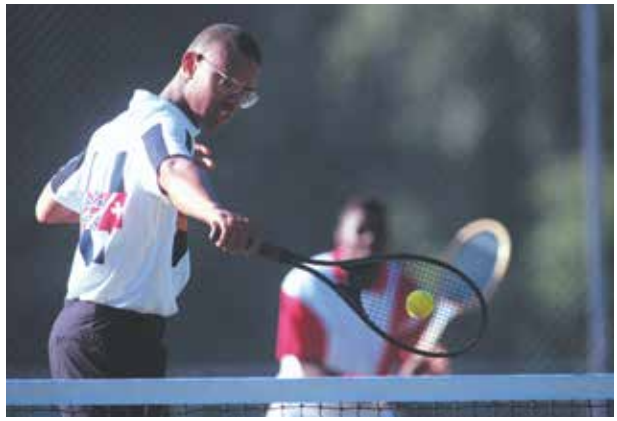
LABORATORY

ALTHOUGH ENGINEERS FOLLOW certain steps to design devices, they can find inspiration for creative solutions in a variety of places. One way bioengineers approach problems is to observe the structures in nature that perform the function they are trying to design. **Biomimicry** is a field of engineering dedicated to mimicking or copying the biological motions or structures of living organisms. It is an approach to innovation that imitates nature's patterns and strategies. The evolution of animals, plants, and microbes over billions of years provides inspiring solutions to a variety of problems seen by species of all kinds in nature, such as movement, protection, and energy use.

In this activity, you will look at the structure and function of a chicken wing by dissecting it. By studying the biomechanics of the wing, you will be better prepared in the next activity to design an artificial arm that works in a similar way.

GUIDING QUESTION

How does the structure of an arm or wing affect its function?



Studying the structure and function of a bird's wing (left) helped engineers design the first airplanes. The human arm (right) inspired the development of prostheses.

MATERIALS

For each pair of students

- 1 raw chicken wing
- 1 medium or large pair of pointed dissection scissors
- 2 pairs of forceps
- 1 dissecting tray
- 1 toothpick
- 1 hand lens
- paper towels

SAFETY

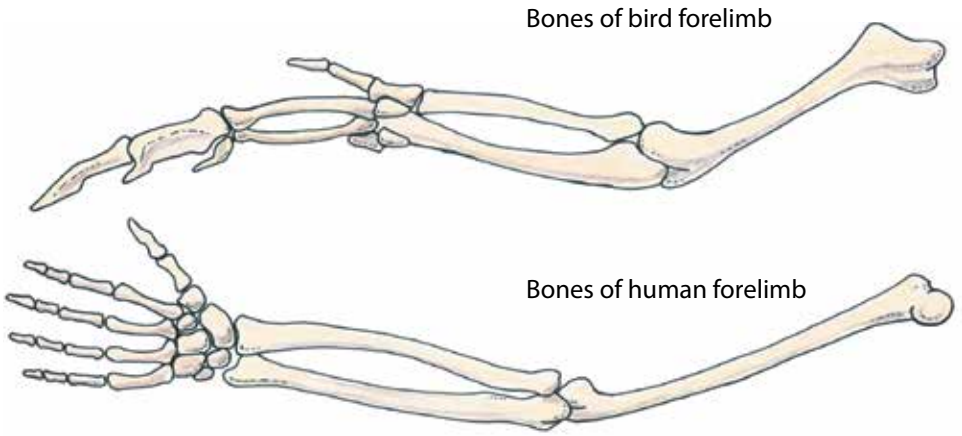
Only one person may dissect at a time—take turns. Keep your fingers out of the way of sharp implements. Do not eat or drink in class. Be very careful not to touch your mouth, nose, or eyes when you are working on the dissection. Wash your hands thoroughly with soap and hot water after completing the dissection.

PROCEDURE

Part A: Comparing the Chicken Wing to the Human Arm

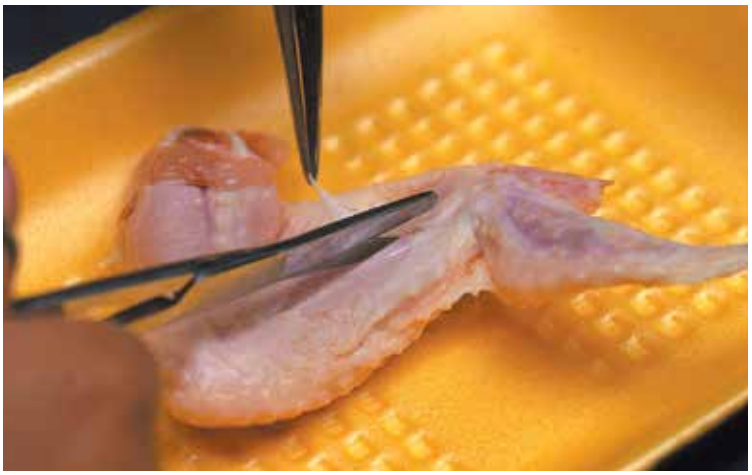
1. Locate the following structures in your arm:

shoulder joint	one upper arm bone
elbow joint	thumb
wrist joint	finger bones
two forearm bones	



Step A: Make a small cut in the skin.

Step B: Insert the tip of the scissors into the small cut.



Step C: Cut the skin along the bone without cutting the muscle.

2. Examine the whole chicken wing.
3. Without cutting yet, feel the wing. Use your fingers to find structures on the chicken wing similar to the human arm structures listed in Step 1.

Part B: Dissection

4. Turn the wing so the inside is facing up. Use your forceps to pinch up the skin, and make a small cut with your scissors, as shown in Step A.
5. As shown in Step B, insert a scissor blade into the cut so that it is parallel to the bones. Be careful that you don't cut through the muscle under the skin.
6. As shown in Step C, cut the skin and peel it away from the muscle, using your forceps and scissors to help you. Expose both major joints of the chicken wing. Observe the tendons, blood vessels, and muscle. **Tendons** are the shiny strips of tissue that connect muscles to bones.

7. Use your forceps to pull on the tendons individually. When muscles contract, they pull on the tendons, so when you pull on a tendon, you are modeling the action of a wing muscle (Steps D and E).

   Try to get a part of your chicken wing to "wave" back and forth by pulling on the tendons attached to two opposing muscles.

Step D: Use your forceps to pull on the tendon.

8. Cut through the muscles until one of the lower wing bones is clearly visible.
9. Bend the bone with your fingers until it breaks. Note how resistant the bone was to bending.
10. Examine the inside of the chicken bone. Use a toothpick to explore the texture of the center of the bone, which is the location of the marrow.

Step E: Move the chicken wing. Observe the chicken's "hand" moving toward the lower "arm."

11. Set the chicken wing on the tray so that you can see all the structures.
12. Wash your hands thoroughly with soap and hot water. Don't touch the chicken after you wash your hands.
13. In your science notebook, draw a labeled diagram of the chicken wing. Include the tendons and the structures you located in Step 6.
14. In your notebook, describe what you had to do to make the wing move in opposite directions. Record your observations of the inside of the chicken bone.

15. Follow your teacher's directions for disposing of the chicken wing and for final cleanup. Wash your hands when you are done.

ANALYSIS

1. How are human arms and chicken wings similar? How are they different?
2. What evidence did you find that would help to explain how birds move parts of their wings back and forth? Draw a diagram showing muscles and tendons to help explain your answer.
3. Describe how the structure of bird bones allows them to be both lightweight and strong.
4. Now that you know the internal structures of bird bones, would you change your bone prototype from the "Artificial Bone Model" activity? If so, describe how and why. If not, explain why not.