Name: Date:

HANDS-ON ACTIVITY

Modeling Joint Movement

The sea urchin is an echinoderm, an invertebrate animal with spiny skin. It lives exclusively in water. Its almost spherical body is covered in spines, which provide protection. Some of the spines are thick, some are flat and resemble flower petals, and still others have needles at their tips. Often, these tips contain poisonous sacs that can be used to deliver painful stings to predators.

The spines of the sea urchin provide a way for the animal to move. As one spine is stimulated, it bends and produces a similar movement in neighboring spines. A spine is able to move because it is attached to the central body with a unique ball-and-socket joint. Joints are usually associated with some kind of movement.

The sea urchin is not the only animal that has joints. Vertebrates with a skeletal system have joints, or places where two bones meet. Different types of joints allow for different types of movement.

Scientists, doctors, and engineers have studied the mechanics of the various joints observed in living organisms. These naturally existing devices for movement have inspired applications as varied as steering mechanisms in automobiles, airplane wings, tools, and medical instruments.

DEFINE AND DELIMIT

Describe a problem related to joints and movement that bioengineers might want to solve. Write a problem statement explaining the problem and describing the most important criteria and constraints for its solution.

SUGGESTED MATERIALS

- balls, rubber or plastic
- cardboard
- cardboard tubes, paper-towel or toilet paper
- clay
- craft sticks
- dowels
- electrical wire
- glue
- paper
- metal cans
- plastic wrap
- paper clips
- paper cups, 3 oz
- polystyrene foam
- rubber bands, assorted sizes
- scissors
- soda bottles, plastic
- sponge
- tape
- wire
- wood pieces (blocks)

DESIGN AND TEST

1. Brainstorm what materials or methods might be needed to create a prototype.
2. Develop a plan for designing and testing a prototype. Consult with your teacher to make sure that the conditions you have chosen are appropriate.
3. Write out a description of your plan, and draw a diagram of your prototype. As you develop the plan, take the following steps:
   - Decide what methods and materials you will use.
   - Decide how you will test whether your prototype meets the criteria.
   - Select the materials and technology that you will need from those provided by your teacher.
   - Decide what safety procedures are necessary.
4. Have your teacher approve your plan.

5. Obtain the necessary materials and set up any apparatus you will need.
6. Build your prototype.
7. Test your prototype to determine whether it meets the most important criteria for an effective solution. Consider tradeoffs you can make to meet the criteria more fully.

OPTIMIZE

Share your model with other teams. Demonstrate your prototype and explain how it meets the criteria you defined. Elicit other teams' feedback on your design. Use their observations and feedback to improve your prototype and test it again as many times as necessary.

COMMUNICATE

1. In the space below, draw a labeled diagram of your prototype.

2. Did your prototype meet the most important criteria for a solution to the problem? What constraints limited your design, and what tradeoffs did you make? Explain your answers.