

## Chapter 43 Project

### No Bones About It

#### Project Goal + Timeline

The musculoskeletal system is essential for the body's movements and many of its processes. Notably, bones support the body and protect its vital organs. As such, proper maintenance of bone health is critical to an active and healthy lifestyle. In this project, you will consider different disorders that disrupt bone health and predict the effect of potential treatments designed to affect bone homeostasis. You'll work with a partner to make your predictions. Then, you'll check your predictions against the literature to see what the actual effects of the treatments are. This project should take between one and two hours to complete.

#### Directions

Whether it is from injury, insufficient diet, genetic disposition, or aging, a failure of bone homeostasis can have major impacts on one's health and quality of life. Osteoporosis is one condition that results from a failure of bone homeostasis. In osteoporosis, the creation of new bone does not occur quickly enough to keep up with the removal of old bone. This imbalance may occur due to the body's failure to form new bone, the body's removal of too much of the old bone, or a combination of both processes. Osteoporosis causes bones to become porous, weak, and brittle, such that they are much more likely to break in response to a minor fall or impact. Risk factors for osteoporosis include age, sex (more common in females), hormonal imbalances, certain autoimmune conditions, insufficient calcium and vitamin D, a sedentary lifestyle, and smoking.

Bisphosphonates are one potential treatment for conditions of altered bone homeostasis. Bisphosphonates are a group of drugs that preferentially bind to calcium ions. As a result, they are rapidly absorbed into new bone. When liberated from the bone, bisphosphonates attach to and enter osteoclasts. Bisphosphonates inhibit the activity of osteoclasts and can cause the death of these cells.

1. What is the function of osteoclasts?
2. Based on your answer to Question 1, why might bisphosphonates be helpful in treating osteoporosis?
3. What general prediction can you make about the effect of bisphosphonates on bone homeostasis?

Imagine you are designing a series of experiments to test the effect of bisphosphonates on different conditions. First, you'll investigate the effects of bisphosphonates on osteoporosis. Divide patients with osteoporosis into the treatment groups described in Table 1. Work with your partner to complete the table with your predictions for how each treatment will affect bone strength, integrity, and resistance to fractures as well as how each treatment will affect blood calcium level.

**TABLE 1: Predictions of Effects of Bisphosphonates on Osteoporosis**

| Dietary Calcium | Bisphosphonate Treatment | Prediction for Bone Health | Prediction for Blood Calcium |
|-----------------|--------------------------|----------------------------|------------------------------|
| Low             | None                     |                            |                              |
| Low             | High                     |                            |                              |
| High            | None                     |                            |                              |
| High            | High                     |                            |                              |

Next, perform a literature search to locate at least two studies that investigated the effects of treatment with bisphosphonates on osteoporosis. Provide the article author(s), title, publication year, and journal title in Table 2.

**TABLE 2: Sources for Effects of Bisphosphonates on Osteoporosis**

|                  | Article 1 | Article 2 |
|------------------|-----------|-----------|
| Author(s)        |           |           |
| Title            |           |           |
| Publication Year |           |           |
| Journal Title    |           |           |

- Summarize the findings in the articles you found. What do the studies indicate about how bisphosphonates affect osteoporosis?
- Compare the findings in the articles to your predictions in Table 1. Were your predictions supported or not supported by the studies? Were any of the findings in the studies surprising?
- A sedentary lifestyle is a risk factor for osteoporosis, and physical activity is recommended to help prevent osteoporosis. Propose a mechanism through which physical activity helps prevent osteoporosis.

Next, you decide to investigate how bisphosphonates affect recovery from a fracture in patients without osteoporosis. Divide patients with fractures into the different groups described in Table 3.

- Describe the stages in the recovery from a fracture. In what way(s) may treatment with bisphosphonates affect this process?

Complete Table 3 with your predictions for how treatment with bisphosphonates and calcium would affect fracture healing (including the degree of repair and the shape and function of repaired bone) and blood calcium level.

**TABLE 3: Predictions of Effects of Bisphosphonates on Fracture Healing**

| Dietary Calcium | Bisphosphonate Treatment                               | Prediction for Fracture Recovery | Prediction for Blood Calcium |
|-----------------|--------------------------------------------------------|----------------------------------|------------------------------|
| Low             | Only in the first two months after fracture            |                                  |                              |
| Low             | From the third month to the sixth month after fracture |                                  |                              |
| High            | Only in the first two months after fracture            |                                  |                              |
| High            | For all six months after fracture                      |                                  |                              |

Next, perform a literature search to locate at least two studies that investigated the effects of treatment and timing of treatment with bisphosphonates on fracture recovery. Provide the article author(s), title, publication year, and journal title in Table 4.

**TABLE 4: Sources for Effects of Bisphosphonates on Fracture Recovery**

|                  | Article 1 | Article 2 |
|------------------|-----------|-----------|
| Author(s)        |           |           |
| Title            |           |           |
| Publication Year |           |           |
| Journal Title    |           |           |

8. Summarize the findings in the articles you found. What do the studies indicate about how bisphosphonates affect recovery from a fracture?
9. Compare the findings in the articles to your predictions in Table 3. Were your predictions supported or not supported by the studies? Were any of the findings in the studies surprising?

As you've seen, both the process of bone recovery after a fracture and treatment with bisphosphonates can reduce the amount of calcium in the blood. A reduction in calcium affects the muscular system.

10. Describe one way that calcium is involved in muscle contraction.
11. Considering your response to Question 10, how will a reduction in calcium likely affect muscle contraction?

### Project Materials

- Project worksheet
- Pen or pencil
- Computer with internet access

### Student Checklist

- ☐ Complete predictions for osteoporosis experiment (Table 1)
- ☐ Locate two sources for effect of bisphosphonates on osteoporosis (Table 2)
- ☐ Complete predictions for fracture experiment (Table 3)
- ☐ Locate two sources for effect of bisphosphonates at fracture recovery (Table 4)
- ☐ Complete all questions