

A Case of Osteoporosis

Core Concepts:

- Osteoporosis occurs when decreased bone density weakens bones and makes bone fractures more likely.
- Calcium dietary supplements are advertised as promoting bone health and preventing osteoporosis.
- There is a lack of evidence regarding the claim that calcium dietary supplements prevent bone fractures due to osteoporosis.
- Osteoporosis is a complex disease. There are very likely many risk factors for osteoporosis such as genetics, lifestyle choices, and environmental exposures.

Class Time Required:

1 -2 forty-minute class period

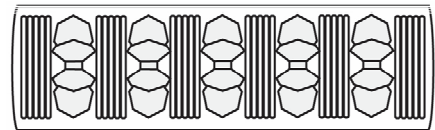
Teacher Provides:

For each student:

- 1 copy of student handout entitled **A Case of Osteoporosis**

For each pair of students: (*Note: Allow approximately 1 hour for assembling the bone models.*)

- 1 copy of the **Understanding Osteoporosis** poster. You might want to print this on colored paper.
- **Information Cards 1-8.** Cut into eight separate cards. You might want to laminate the cards if they will be used for multiple classes.
- **Normal Bone Model** - Fill a clear plastic coin tube as shown in the diagram on the right. Alternate stacks of 5 white winks with 1 white starflake bead. *NOTE: You will use 30 winks and 5 starflake beads.* Put the lid on the tube. Apply a "Normal Bone" label lengthwise to the tube. Seal with tape or glue to keep tubes closed.
- Bag containing materials for the osteoporosis bone model:
 - Empty coin tube with lid. Apply an "Osteoporosis Bone" label lengthwise to the tube.
 - 10 Starflake beads
 - 10 white winks



Ordering Information for tubes, beads, and winks:

- Quarter size clear plastic coin tubes may be ordered from <http://www.coinsupplyexpress.com/Round-Coin-Tubes-Sold-Each.html> Approximately \$0.32 each
- 7/8" white bingo winks may be ordered from https://www.gameparts.net/mm5/merchant.mvc?Screen=CTGY&Store_Code=G&Category_Code=BNGO-WNKS-78 Approximately \$11.00 per 1000
- 18 mm white starflake beads may be ordered from <https://www.consumercrafts.com/store/details/catalog/jewelry-plastic-and-acrylic-beads/06107-7-02> Approximately \$5.00 per 500

Teacher Resources:

- **What is osteoporosis? What causes osteoporosis?**
<http://www.medicalnewstoday.com/articles/155646.php>
- **NIH Osteoporosis and Related Bone Diseases National Resource Center**
http://www.niams.nih.gov/Health_Info/Bone/Osteoporosis/
- **MedlinePlus - Osteoporosis**
<https://medlineplus.gov/osteoporosis.html>
- **Clinician's Guide to Prevention and Treatment of Osteoporosis**
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4176573/>
- The Science Take-Out kit **Brittle Bones: A Density Problem** provides a more detailed hands-on activity related to osteoporosis. This kit also contains coin tubes, beads and winks to assemble the bone models.
<http://www.sciencetakeout.com/product/brittle-bones-a-density-problem/>

Suggested Class Procedure:

1. Give each student a copy of the **A Case of Osteoporosis** student handout.
2. Assign students to work with a partner.
3. Distribute the following materials to each pair of students.
 - **Understanding Osteoporosis** poster
 - **Information Cards 1-8**
 - Normal Bone model
 - Bag of materials for making Osteoporosis Bone model that contains: 10 white disks, 10 white star beads, 1 Osteoporosis Bone tube with lid.
4. Read **The Case** paragraph on page 1 aloud to the class.
5. Students use the bone models and the Information Cards 1 and 2 to complete **Part 1: Modeling Osteoporosis**. *Optional: You may provide metric rulers and balances if you would like students to determine the density of the models.*
6. Read the instructions for **Part 2: Evaluating Claims about Osteoporosis** aloud to the class. *Note: As you read, demonstrate how to do the first two claims (A and B) to show students how to handle claims that are supported and claims that are refuted. Ask students what the word “inconclusive” means.*
7. Students use the Information Cards (1-8) and the **Understanding Osteoporosis** poster to complete **Part 2: Evaluating Claims about Osteoporosis**. Suggest that one partner be responsible for finding answers on the information cards and one partner be responsible for finding answers on the poster.
8. Students answer the questions that follow the Osteoporosis Claims chart.
9. Call on several students to read their answers to the questions that follow the Osteoporosis Claims chart. **Discuss answers with an emphasis on the need for further evidence to determine if taking calcium supplements is a safe and effective way to prevent osteoporosis. Emphasize the need for further scientific research.**
10. Wrap-up discussion should reinforce these concepts:
 - It may seem logical that taking calcium supplements would build stronger bones; however, scientific research has provided evidence that this may not be true.
 - Additional research is needed to determine if dietary supplements containing calcium are effective in preventing fractures or osteoporosis.
 - Conducting controlled studies on human subjects may be difficult.

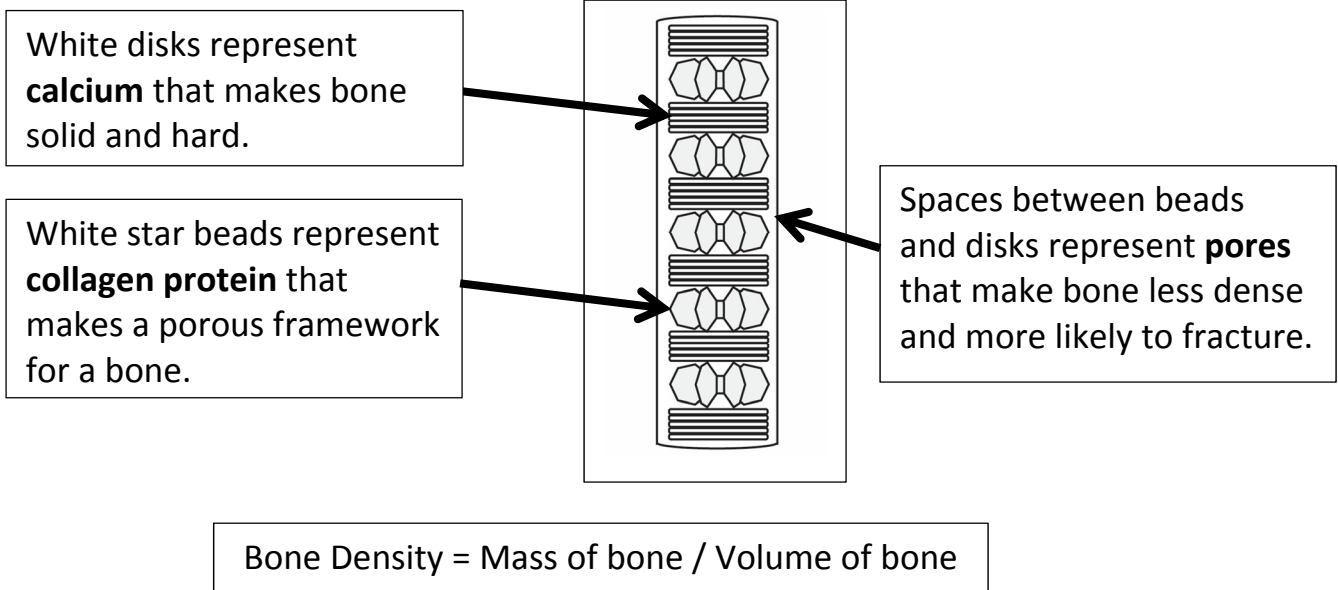
11. Optional Extension: Ask students how they might conduct an experiment to test the claim that taking calcium supplements increases bone density and prevents osteoporosis.
12. Optional Extension: Assign one of the New York Times articles below to be read for homework. You could have students read the articles online or provide printed copies of the articles.

- **Thinking Twice About Calcium Supplements**
<https://well.blogs.nytimes.com/2013/04/08/thinking-twice-about-calcium-supplements-2/>
- **Studies Show Little Benefit in Supplements**
<https://www.nytimes.com/2016/11/15/well/eat/studies-show-little-benefit-in-supplements.html>
- **Long and Short of Calcium and Vitamin D**
<http://www.nytimes.com/2011/01/25/health/25brody.html>

Ask students to write a list of the three most important or interesting things that they learned from the assigned article, or write a position statement on whether they would recommend taking calcium supplements. They should be prepared to read what they wrote to the class.

Note: Students are more likely to focus on thinking and writing if they know they may be asked to read what they wrote.

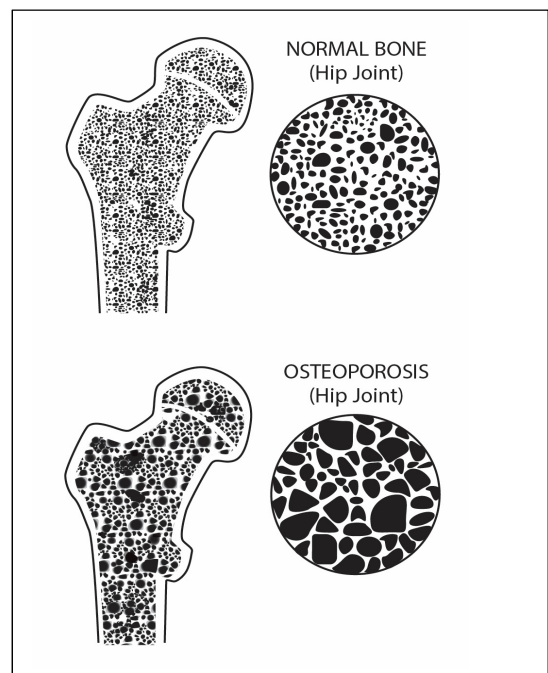
Information Card 1: Key to Bone Models



Information Card 2: What is Osteoporosis?

Osteoporosis is a disease in which bones become less dense and more porous. Bone density decreases because the bones contain less calcium and have more pores. As bone density decreases the bones weaken and are more likely to fracture (break). Approximately one in two women and one in four men age 50 or older will break a bone due to osteoporosis.

Osteoporosis is often called a silent disease because people cannot feel their bones weakening. Breaking a bone is often the first sign of osteoporosis. Bones in the spine, hip, wrist, pelvis, and upper arm are particularly at risk of fracture in people with osteoporosis. Bone fractures from osteoporosis can result in complications such as stooped (bad) posture, decreased mobility, and permanent pain.

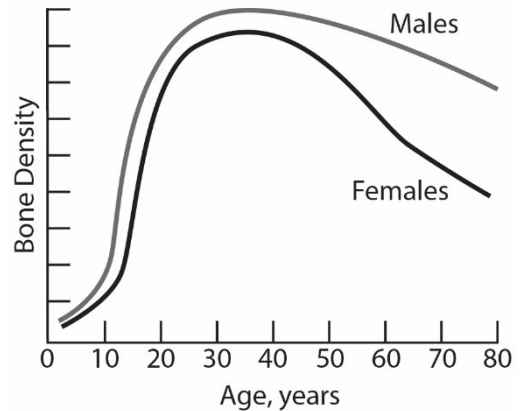


White = bone tissue (calcium and collagen protein)
Black = pores that make bone less dense

Information Card 3: Osteoporosis Causes

Bone is a type of living tissue. Like other tissues in the body, bone constantly repairs and renews itself.

- During childhood and young adulthood, bone density increases because bone building activity is greater than bone breakdown activity.
- After about the age of 35, bone density decreases because bone breakdown activity increases and/or bone buildup activity decreases.



Osteoporosis occurs when the body loses too much bone tissue, makes too little bone tissue, or both. Women have a higher risk for osteoporosis because their rate of bone loss increases when their estrogen (female hormone) levels decrease as they get older. Men are less likely to develop osteoporosis because they tend to have larger and stronger bones. Also, bone loss in men begins later in life and advances more slowly.

Information Card 4: Dietary Supplement and Osteoporosis

IMPORTANT FACTS YOU SHOULD KNOW

Calcium is the primary mineral responsible for strong bones.* Our absorbable formula provides Vitamin D to support calcium metabolism and immune health.* Adequate Calcium and Vitamin D throughout life, as part of a well-balanced diet, may reduce the risk of osteoporosis.

These statements have not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease.

No Gluten, No Yeast, No Wheat, No Milk or Milk Derivatives, No Lactose, No Sugar, No Preservatives, No Artificial Flavor, No Sodium.

WARNING: If you are pregnant, nursing, taking any medications, or have any medical condition, consult your doctor before use. Discontinue use and consult your doctor if any adverse reactions occur.

Keep out of reach of children. Store at room temperature. Do not use if seal under cap is broken or missing.

Manufactured and distributed by Vitasafe, Inc. 111 SW Main Street, Any Town, CA XXXXX

**LIQUID FILLED
ABSORBABLE**

**Calcium
1000 mg**

plus

**1000 IU
Vitamin D₃
PER SERVING**

Bone Health *

**60 Softgels
Dietary Supplement**

DIRECTIONS FOR ADULTS, TAKE ONE SOFTGEL DAILY, PREFERABLY WITH A MEAL. As a reminder, discuss the supplements and medications you take with your health care providers.

Supplement Facts

Serving Size: 1 SoftGel
Servings Per Container 60

Amount Per Serving	% Daily Value	
Calories	15	
Calories from Fat	10	
Total Fat	1 g	2%***
Vitamin D (as D3 Cholecalciferol)	1,000 IU	250%
Calcium (as Calcium Carbonate)	1,000 mg (1.0 g)	100%

***Percent Daily Values are based on a 2,000 calorie diet

Other Ingredients: Soybean Oil, Gelatin, Glycerin, Soy Lecithin. **Contains <2% of:** Beeswax, Sorbitol, Titanium Dioxide Color.

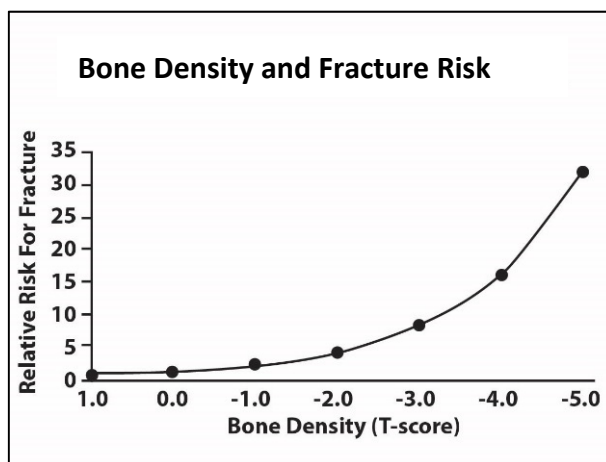
Quality Guaranteed Lab Tested

Laboratory tested to meet strict quality control standards for potency, purity and disintegration. 100% Quality Guaranteed.

Information Card 5: Osteoporosis Diagnosis and Risks

A bone density test can be used to diagnose osteoporosis. People with osteoporosis have low bone density. The graph on the right illustrates the association between bone density and bone fractures.

A decrease in bone density can occur for a number of reasons such as lack of physical activity, lack of calcium, and reduced hormone (estrogen and testosterone) levels. Smoking, excessive alcohol use, and certain medicines also lead to decreased bone density. People with a family history of osteoporosis are more likely to experience osteoporosis as they get older.



Information Card 6: Calcium and Osteoporosis

Information from the US Food and Drug Administration (FDA)*

Everybody needs calcium to build and keep strong bones and for normal body functioning. It is important to eat enough calcium during childhood and young adulthood when bones are growing and bone density is increasing. High bone density at the end of childhood decreases a person's risk for developing osteoporosis later in life. As an adult, the calcium you eat helps you to keep the bone mass you developed when you were growing.

Calcium (Recommended Daily Allowance)

Age	Female	Male
Birth to 6 months	200mg	200mg
Infants 7 - 12 months	260mg	260mg
Children 1 - 3 yrs	700mg	700mg
Children 4 - 8 yrs	1000mg	1000mg
Children 9 - 13 yrs	1300mg	1300mg
Teens 14 - 18 yrs	1300mg	1300mg
Adult 19 - 49	1000mg	1000mg
Adult 50+ yrs	1200mg	1000mg

Source: <http://ods.od.nih.gov/factsheets/list-VitaminsMinerals>

Foods that are good sources of calcium include dairy products such as milk, yogurt and cheese, and dark green leafy vegetables, such as kale and turnip greens. There are also some foods that have added calcium, such as calcium-fortified orange juice and grapefruit juice. Calcium supplements may provide an additional source of calcium.

*Modified from: <http://www.fda.gov/ohrms/dockets/dockets/05n0413/05n-0413-ref0001-full-info-handout.pdf>

Information Card 7: Calcium and Osteoporosis

Information from the US Preventative Services Task Force, 2013*

The US Preventative Services Task Force concludes that the current evidence is insufficient to assess the balance of the benefits and harms of calcium supplementation for the prevention of fractures in men or women. Evidence for the benefits and risks of calcium supplementation is lacking, of poor quality, or conflicting.

Information from the British Medical Journal, 2015**

In summary, our analyses indicate that calcium supplements have small inconsistent benefits on fracture reduction. Because some studies have shown that taking calcium supplements increases the risk of heart attack and stroke, the benefits of calcium supplements may be outweighed by cardiovascular risks. These results suggest that clinicians, advocacy organizations, and health policymakers should not recommend increasing calcium intake for fracture prevention, either with calcium supplements or through dietary sources.

*Modified from: <https://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/vitamin-d-and-calcium-to-prevent-fractures-preventive-medication>

** Modified from: <http://www.bmj.com/content/351/bmj.h4580>

Information Card 8: Teens and Osteoporosis

If you think that osteoporosis is something that teens don't need to worry about...think again. Experts are concerned that the lifestyle choices that today's teens are making may result in an "osteoporosis epidemic" when they reach old age. The greatest amount of bone building occurs before age 18. Therefore, the best time to reduce the risks of osteoporosis and low bone density comes during the teenage years.

It may be difficult for teens to think about how osteoporosis may affect their lives when they are 60, 70, 80, or 90 years old. Many of the factors that increase teens' chances for osteoporosis are things that cannot be changed, such as genes, age, or gender. However, there are things that teens can do to reduce their risk for osteoporosis when they get older.

UNDERSTANDING OSTEOPOROSIS

A. What is Osteoporosis?

Osteoporosis is a bone disease that makes bones weaker and more brittle because they are less dense. Osteoporosis increases the risk of bone fractures.

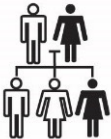
B. What Causes Osteoporosis?

Bone tissue is constantly being formed and broken down. Osteoporosis occurs when bone loss is greater than bone building.

E. Risk Factors

 Calcium and vitamin D deficiency


 Smoking

 Family history

 Getting older

 Alcohol

 Inactive lifestyle

 Thin and/or small frame

 Corticosteroids and anti-seizure medications

 Women, especially post-menopausal

 Medical conditions that weaken calcium absorption

 **Low testosterone levels (men).**
 **Low estrogen levels (women)**

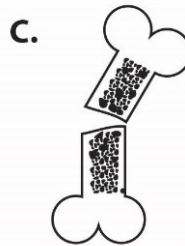
I. Over **40 MILLION** people in the United States either already have osteoporosis or are at high risk for developing osteoporosis due to low bone density.

D. Symptoms

- Brittle Bones
- Back Pain
- Height Loss
- Bad Posture



Healthy Bone
Strong Bone
More Dense



Osteoporosis
Brittle Bone
Less Dense

F. Diagnosis

Bone Density Test

- Recommended for people 50 and over
- Simple Test
- Takes 10-15 minutes



G. Treatment


Follow your doctor's recommendations.

 Take calcium and vitamin D supplements.

 Eat dairy and dark leafy and green vegetables.

 Take prescribed medications.

H. Prevention

 Take calcium and vitamin D supplements.

 Eat dairy products and dark leafy and green vegetables daily.



Limit alcohol intake.



Stop smoking.



Walk or jog regularly.

J. **1 in 2 women** and **1 in 5 men** over 50 will fracture a bone due to osteoporosis. **25%** of those who fracture a hip die within six months of the injury.

K. In women over 45, osteoporosis accounts for more days spent in the hospital than many other diseases, including diabetes, heart attack and breast cancer.

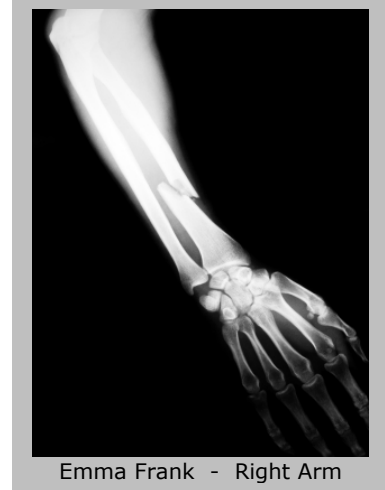
L. DUE TO PREVIOUS LACK OF FOCUS ON BONE HEALTH, THE NUMBER OF HIP FRACTURES IN THE UNITED STATES COULD BE **TRIPLED BY 2020.**

A Case of Osteoporosis

The Case:

Emma broke her arm when she fell during track practice. This was the third time that Emma had a bone fracture (break) so her doctor suggested that she get a bone density test.

Emma was shocked to hear that the bone density test showed that her bone density is lower than normal for a teenage girl. Emma's doctor warned her that she is at increased risk for developing osteoporosis when she gets older.



Part 1: Modeling Osteoporosis

Make a model to help Emma understand how the bones of someone with osteoporosis are different from normal bones.

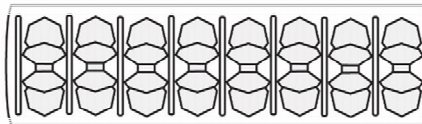
1. Observe the model of Normal Bone and read **Information Card 1**. Do not open the Normal Bone model.
2. Read the description of bones in someone who has osteoporosis on **Information Card 2**.
3. Use the materials in the bag to make a model of **Osteoporosis Bone**. The osteoporosis bone model should look different from the normal bone model. *Hint: Not all pieces need to be used. Use just enough to fill the tube.*

Materials provided:

- 10 white disks
- 10 star beads
- 1 Osteoporosis Bone tube with lid

4. Draw or describe your model in the space below.

Sample osteoporosis bone model



5. Compared to the normal bone, does the osteoporosis bone model you made have more or less calcium? Explain how Emma could tell from looking at your model and Information Card 1.

It has more calcium. Emma could tell because it has more white disks.

6. Compared to the normal bone, is the osteoporosis bone model you made more or less porous? Explain how Emma could tell from looking at your model and Information Card 1.

It is more porous. Emma could tell because it has more space between the beads and disks.

7. Explain how you could test your Osteoporosis Bone model to determine whether it was more dense or less dense than the Normal Bone model. *Hint: Use the information on Card 1.*

The two bone models are the same size and shape so they have the same volume. Simply weigh the two models. If the osteoporosis model weighs less than the normal bone model, it is less dense. OR Students may calculate the volume and weigh the models. Then they would use the equation provided on Information Card 1.

Part 2: Evaluating Claims about Osteoporosis

The **Osteoporosis Claims** chart below lists some claims that Emma heard about osteoporosis. Emma was **skeptical** about some of the claims. She wanted to know if there was evidence to support these claims.

Skeptical: Having or expressing doubt about a claim or a statement.

1. Use the **Information Cards (1-8)** and the **Understanding Osteoporosis** poster to evaluate the claims about osteoporosis.
 - For the Information Card column, write the number of at least one Information Card that provides evidence to support or refute (not support) the claim. You may use cards more than once.
 - For the Poster column, write the letter of at least one section of the poster that provides evidence to support or refute (not support) the claim. You may use a section more than once.
 - For the Conclusion column, indicate whether the evidence supports the claim, refutes the claim, or is inconclusive.

Osteoporosis Claims	Sources of Evidence		Conclusion (Supports, Refutes or Inconclusive)
	Information Card (card number)	Poster (section letter)	
A. Osteoporosis occurs when the body loses too much bone tissue, makes too little bone tissue, or both.	3	B	Supports
B. Males do <u>not</u> need to worry about bone fractures caused by osteoporosis.	2 or 3	J	Refutes
C. The best time to reduce the risks of osteoporosis comes during the teenage years.	8	No evidence on poster	Supports
D. As bone density increases, bones become weaker and more likely to fracture.	2	A or C	Refutes
E. According to calcium supplement labels, the FDA has evaluated the use of calcium supplements as a way to prevent osteoporosis.	4	No evidence on poster	Refutes
F. Having a family member with osteoporosis increases the risk of osteoporosis.	5	E	Supports
G. Changes to lifestyle and diet can reduce a person's risk of developing osteoporosis later in life.	5, 6, or 8	H or E	Supports
H. Taking calcium supplements reduces the risk for bone fractures due to osteoporosis.	6 supports 7 refutes	H or M supports	Inconclusive

2. Should Emma and other teens take calcium supplements to prevent osteoporosis and bone fractures when they get older? Support your answer with specific evidence from the Information Cards, poster, and bone models.

Student answers may vary. If they cite Card 6 and the poster, they may say that she should take supplements. If they cite Card 7 they should say that there is insufficient evidence that calcium supplements prevent osteoporosis or bone fractures.

3. If Emma does not want to take calcium supplements, what are two actions she could take to improve her bone health? Support your answer with specific evidence from the Information Cards, poster, and bone models.

Student answers will vary and may include eating dairy products and dark leafy vegetables, limiting alcohol intake, stopping smoking, and walking or jogging regularly.

4. Emma is concerned that the Understanding Osteoporosis poster is out-of-date. How should the poster be revised to include the evidence on Information Card 7?

Student answers will vary but most will suggest that section H be revised to remove the take calcium supplements.

5. Do you think that you might be at risk for osteoporosis? Explain why or why not?

Student answers will vary and may include lifestyle factors listed on the poster and/or family history of osteoporosis.