

**Chief Complaint:** 14-year-old girl admitted with a broken left leg.

**History:** Nicole Michaelson, a 14-year-old girl, was skiing when she fell and broke her left leg. As she fell, her left leg got caught under the body of another skier who ran into her. An X-ray revealed that the fracture was a compound, tibial-fibular fracture just below the knee. The X-ray also revealed a torn meniscal cartilage in the knee above the fracture. The girl remained in the hospital for 14 days because of an infection of the leg in the area of skin breakage. Her immobilized leg was casted after the infection subsided. She remained in a full leg-length cast for 3 months, after which the upper portion of the cast was removed and she was allowed to start bearing weight on the leg. The bones ultimately healed, but the girl continued to have left knee swelling ("water on the knee") and pain made worse by walking. Arthroscopic examination of the knee revealed a meniscus that was still torn 6 months after her injury.

**Questions:**

1. What does the term "tibial-fibular fracture" mean?
2. What is a compound fracture?
3. Why was her injury more likely to become infected than a routine fracture of the leg?
4. Describe the microscopic features of osseous tissue that help long bones withstand lateral stress without breaking.
5. Describe the microscopic features of the osseous tissue that help long bones withstand compressive forces without breaking.
6. What features of the knee joint structure help minimize friction between the thigh bone and the leg bone?
7. Describe the changes a broken bone undergoes as it is healing.
8. How does weight-bearing influence the bone repair process you described above? (i.e. what effect does weight-bearing have on the orientation of the Haversian systems?)
9. Why did Nicole's bones heal much more quickly than her cartilage?

**Chief Complaint:** 72-year-old woman who fell on her right hip.

**History:** Margaret Donovan, a 72-year-old white female, was brought to the emergency room by her son-in-law after falling in her bathtub. She was previously in good health, despite leading a relatively sedentary lifestyle and having a 30-pack-year history of cigarette smoking. The only medication she currently takes is Inderal (propranolol) for mild hypertension. She fell upon entering the bathtub when her right leg slipped out from under her; she landed on her right hip. There was no trauma to her head, nor does she complain of right or left wrist pain. However, she reports severe pain in the right hip and upper thigh, and was unable to get up after her fall. An injection of oxymorphone hydrochloride (Numorphan) helped relieve her pain and she was taken to the radiology department for an X-ray of her right leg and hip.

**Physical Examination:** The patient was alert, oriented to time, place, and date, and was responding appropriately to questions despite being in considerable pain. There were no signs of trauma to the head, neck, torso, arms, or left leg. The right thigh and hip were extremely tender and were immobilized by a leg splint. Heart and lung sounds were normal, and abdominal sounds were reduced.

**Radiology Report:** The X-ray of the right hip revealed a complete, comminuted, intertrochanteric fracture of the right hip. No other fractures were noted in the right leg. There were also long-term osteoporotic changes in the femur, tibia, and fibula.

**Questions:**

1. What is meant by a "complete, comminuted, intertrochanteric fracture of the right hip"?
2. Draw a picture of what you think Margaret's fracture looks like.
3. The radiologist reported signs of osteoporosis. Describe the characteristics of an osteoporotic femur as seen on an X-ray. (How does it differ in appearance from a normal femur?)
4. Describe the microscopic features of osseous tissue that normally help long bones withstand lateral stress without breaking.
5. Describe the microscopic features of osseous tissue that normally help long

bones withstand compressive stress without breaking.

Surgeons performed an open reduction of Margaret's fracture, immobilizing the bones with internal pins.

6. Describe the changes that a broken bone undergoes as it is healing.
7. During her long recovery, Margaret is advised by her physician to begin weight-bearing as soon as she can. How does weight-bearing influence the process you described in question #6? (Be specific in your answer and describe what weight-bearing does to bone at the microscopic level.)
8. Aside from any effect on the healing process, why else might Margaret's physician want her to avoid a prolonged period of bed-ridden inactivity?
9. What risk factors does Margaret have for osteoporosis?
10. What parts of the skeleton (i.e. what bones) are most vulnerable to the ravages of osteoporosis?
11. Following her recovery, Margaret was placed on three medications: (A) oral calcium supplementation, (B) oral estrogen, and (C) oral alendronate sodium (Fosamax). Specifically describe how each of these medications works to treat Margaret's condition.
12. Other treatments for osteoporosis include (A) sodium fluoride and (B) calcitonin. Describe how each of these medications works to treat osteoporosis.

Sally C., age 22, has been shopping with her mom at the mall. Sally is wearing her favorite high-heeled sandals. As Sally and her mom head down the sidewalk to their car, Sally reaches the curb and notices a bright purple convertible. Distracted by the car as it passes by, Sally stumbles on the curb's edge and falls down. Her mother helps her up and Sally tries to walk but realizes her left ankle is in great pain. Her mother assists her to the car and Sally comments that this is the worst sprain she has ever had.

When they reach home, Sally's pain has not subsided and a large "goose-egg" swollen area has emerged on the lateral surface of the left ankle. Sally applies an ice pack to her ankle and props her foot up for about thirty minutes. The pain continues and the swelling increases. Sally's mother drives her to the emergency room of the community hospital.

An X-ray of Sally's ankle reveals a fracture in the distal fibula, just above the lateral malleolus. An orthopedic surgeon, Dr. Johnson, is called to treat Sally's injury. The surgeon explains to her that her fracture must be "set" and describes it as a closed, transverse fracture. Dr. Johnson proceeds to set the fibula and apply a cast, and based on her age and good health, he predicts that she will need the cast for about four to six weeks.

Sally is told to continue her activities as best she can. Sally returns to work in two days wearing her walking cast. Exactly four weeks later, Dr. Johnson removes Sally's cast; she feels a small bump just above the lateral malleolus. Dr. Johnson tells Sally that the bump is normal after a fracture, and that it will gradually disappear. About eight months later, Sally notices that the bump is gone. She now wears walking shoes when she is in a hurry, and is no longer distracted by unusual cars.

1. What is a sprain?
2. Which bones comprise the ankle?
3. What motion most commonly causes a sprained ankle?
4. What is causing the swelling and pain in the injured area?
5. Describe the location of the fibula and the lateral malleolus.
6. Name the classifications of fractures that can occur in the ankle region.

7. What is the purpose of a cast?
8. What bone structures must be present in order for the bone to heal properly?
9. What was the “bump” that Sally felt on her ankle?

Here's the synopsis:

Your 80 year-old great aunt, Persis, was placing a canning jar on the top shelf of her pantry when she stepped awkwardly off the stool and twisted her leg at the hip. She felt a sharp pain in her hip and, after collapsing to the floor, found she could no longer stand. She was taken to the emergency room where an X ray showed that the neck of her femur was fractured. More detailed X ray images revealed reduced bone mass in the head and neck regions of the injured femur, in the ends of other long bones of the body and in the vertebrae. Surgery was necessary to repair the fractured femur and a biopsy of the bone tissue indicated that the composition of the osteoid was normal. Healing of the fractured femur is proceeding slowly.

1. What organ(s) is (are) involved?
2. What primary tissue type is involved?
3. What specific type of tissue is affected?
4. What specific types of cells produce the normal microanatomy of the tissue?
- 5a. What is the significance of your great aunt's age and gender?
- 5b. What normally happens to the microanatomy of the specific tissue you

identified as it ages?

6. What age-related alterations in the activities of the cells you identified cause this change in microanatomy?

7. What is the significance of your great aunt being a woman?

8. What disease caused the abnormal anatomical symptoms and led to the fracture?

Underline one: Osteoporosis or Paget's disease (osteitis deformans)

9. What aspects of the above description help you distinguish these two possibilities? Explain.

#### CASE STUDY-Osteoporosis: Scenario A

I've always been told that calcium is important for strong, healthy bones. My mom says that as long as I drink milk, I won't develop osteoporosis. Is this correct? Is there anything else I can do to protect myself?

#### SCENARIO A: Marissa

Marisa, a petite, Caucasian, 15-year-old, just learned this morning that her 55-year-old grandmother, with whom she has lived since the death of her parents, was diagnosed with osteoporosis after visiting her doctor because of chronic hip and wrist pain. For the past year, Marisa's life has been one tragedy after another. Her happily married parents were killed in a car crash nine months earlier on the way home from their 16th anniversary surprise party. Her boyfriend of two years moved to a different state a few months back and ended their relationship shortly after. To make things worse, her first year in high school was disastrous. Not only did she fail algebra, she didn't make the soccer team, as she had hoped. Marisa's grandmother lives far from where Marisa used to, and because she is an only child, Marisa often finds herself feeling lonely and on the brink of depression. The only person she feels she can count on besides her

grandmother is her best friend, Tara. She told Tara about her grandmother's disease as soon as she found out. Marisa has no idea what osteoporosis is or what it does to the body. All she knows is that her grandmother is the only close living relative she has and she can't fathom losing another loved one.

Ultimately, you must address the specific type of therapy, if any, that Marisa's grandmother might use and the risks and benefits of her choice.

Bone Physiology:

1. Describe bone physiology and the bone remodeling cycle. Be sure to emphasize the two types of bone tissue and the roles of osteoblasts and osteoclasts.
2. Explain the relationship between calcium and bones.
3. Explain how the body controls calcium levels in the bones and blood. Be sure to describe the roles of parathyroid hormone (PTH) and calcitonin in detail.
4. Explain specifically how osteoporosis affects the bone matrix and the normal bone remodeling cycle.
5. Discuss what scientists know about the genetics behind osteoporosis.
6. List as many risk factors for this disease as you can, both controllable and uncontrollable.
7. What are the symptoms or telltale signs of osteoporosis?

## CASE STUDY-Osteoporosis: Scenario B

### Question:

I've always been told that calcium is important for strong, healthy bones. My mom says that as long as I drink milk, I won't develop osteoporosis. Is this correct? Is there anything else I can do to protect myself?

### Jeremy

Jeremy, a lanky, 19-year-old college sophomore, has recently become interested in weightlifting thanks to his friend, Sebastian. He wants to improve his physique, strength, and self-esteem, and impress his girlfriend. Jeremy has been taking asthma medication since the age of seven and he hopes the exercise will also help to improve his condition, which seems to have slightly worsened over the years. Throughout high school, Jeremy was always teased for being crawny. Once he entered college, he wanted to put the past behind him. He soon

discovered alcohol and its ability to bring people together. Jeremy drank more than his share freshmen year and had a belly to show for it. Over the summer, he met Sebastian at his restaurant-catering job. Jeremy immediately noticed how muscular Sebastian was and asked him if he lifted weights. The two soon developed a friendship and became gym buddies, and Sebastian recommended a personal trainer for Jeremy. Jeremy returned to school in the fall in better shape and promised himself to cut down on the drinking. His personal trainer had told Jeremy that he had small bones for a guy and alcohol would only aggravate the problem. Perhaps he should follow his lead and start taking steroids to bulk up. Jeremy wondered what he meant and intended to ask his biology professor.

Ultimately, you must consider if Jeremy's activities will have any impact on his chances of developing osteoporosis and the risks and benefits of his behavior. Place your notes on your left page for the questions you are covering.

1. Explain why calcium is vital to bone health.
2. What foods are good sources of calcium?
3. Discuss the importance of Vitamin D to calcium absorption.
4. Discuss calcium supplementation and the recommended daily dosages.
5. Discuss the effects of sodium, caffeine, and alcohol on calcium levels in the body.
6. Explain what peak bone mass is and its relationship to osteoporosis.
7. Describe the types of exercise that help prevent osteoporosis. Why?
8. What are steroids? What are they used for?
9. Explain how long-term use of steroids may increase risk for osteoporosis.

## CASE STUDY-Osteoporosis: Scenario C

### Question:

I've always been told that calcium is important for strong, healthy bones. My mom says that as long as I drink milk, I won't develop osteoporosis. Is this correct? Is there anything else I can do to protect myself?

Eleanor

Eleanor, a 45-year-old perimenopausal woman, is considering hormone replacement therapy mainly to prevent osteoporosis. Lately, she has been

experiencing severe hot flashes and nausea. In addition, her back has been sore on and off. Eleanor has smoked for the past 20 years and has a family history of breast cancer and heart disease. Although she vows every New Year to quit her costly habit, she has yet to follow through completely. Two years ago, Eleanor's mother underwent a double mastectomy after her struggle with breast cancer. The experience was a slap in the face for Eleanor and she vowed to take better care of herself. Aside from smoking, she eats healthier now and doesn't drink. Her husband is an avid walker, and every morning before work they both walk around the park with Tosha, the family Labrador. Everywhere she turns, Eleanor is reading about hormone replacement therapy (HRT) and women's health. Although she worries how her body will respond to HRT, she doesn't want to risk her bone health like her 58-year-old neighbor, Janice. Janice refused her doctor's advice about taking HRT a few years back and now walks with a cane. Eleanor has lately felt the pressure building to make a decision about HRT. She wants to stay healthy for her husband and 25-year-old son, Chad, but is unsure of the consequences of HRT. She's heard that it might have some bad effects.

Ultimately, you must address the question troubling Eleanor -- should she start hormone replacement therapy -- considering the risks and benefits of her choice.

1. Define "perimenopausal."
2. Explain how menopause affects a woman's hormonal levels.
3. Explain how estrogen affects calcium levels in bones.
4. Explain how smoking affects estrogen levels. How does this in turn affect calcium levels?
5. What is HRT? Who is it intended for?
6. Based on medical studies, what are the pros and cons of HRT?
7. Describe at least four other options (drugs) available to men and women to help prevent and/or treat osteoporosis.