Under Construction!

Building the Best Bones for Life (Grades 6-8)

Lesson Plan

LESSON OVERVIEW:

During this lesson, students will be introduced to facts about bone, joint and muscles and discover how good nutrition and physical activity contribute to bone development and health. They will identify and describe the key nutrients and food sources important for bone health and develop a strategy for including bone building foods in their diet.

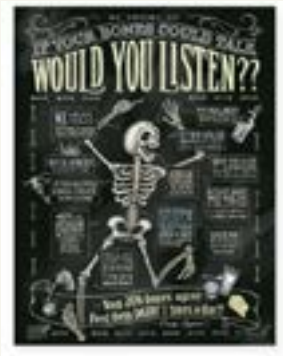
During or following this lesson, students will:

- Engage in three types of weight bearing activity.
- Measure the calcium in bones from birth to adult.
- Use Nutrition Facts labels from beverage cards to rank the bone building power of beverages.
- Identify dairy foods that are good sources of bone building nutrients.
- Devise personal "hacks" to make snacks and meals calcium-rich.
- Complete a bone-based puzzle sheet.

LESSON OBJECTIVES:

The student will:

1. Explain at least two key facts about the anatomy of bones, joints and muscles.
2. List calcium, vitamin D and protein as nutrients present in milk, yogurt and cheese that play a major role in bone health.
3. Identify two examples of how poor nutrition can contribute to bone injuries and disease.
4. Describe how weight bearing activity contributes to bone health and list at least 3 examples of activities which are considered weight bearing.
5. Evaluate a variety of beverages and rank according to overall nutrient contribution to the diet.
6. Develop a strategy for including adequate amounts of nutrient-rich dairy foods in his/her daily diet.



Lesson Materials Needed:

1. Board or flip chart
2. Think Your Drink Beverage Cards, available from the SUDIA Store at SoutheastDairy.org or EatSmart.org
3. Think Your Drink Poster
4. If Your Bones Could Talk – Would you Listen? poster, available from the SUDIA Store at SoutheastDairy.org or EatSmart.org
5. Bag of beanbag filler (white polystyrene pellets), available from craft stores, warehouse stores, or online. White flour or white cornmeal also will work in this activity.
6. Measuring cups (¼ cup and 1 cup)
7. Large plastic zip-top bags and a sharpie
8. Copies of the **Under Construction! Building the Best Bones for Life** activity sheet

ACADEMIC INTEGRATION:

- Science
- Mathematics
- Critical Thinking
- Language Arts

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Leader Background

Bones — all 206 of them — give the body the structure it needs. Some bones, like the skull and ribs, protect the brain and heart. Other bones are hooked together by joints and allow for movement and bending. The body's skeletal muscles are attached to bones and together, they facilitate movement. Muscles literally pull the bones when we move! The musculoskeletal system includes bones, muscles and joints - along with tendons, ligaments, and cartilage – all which work together to enable physical movement and activity.

Even though bone cells are hard and stiff, they are still very much alive and growing. The amount of bone tissue in the skeleton (known as bone mass) typically peaks for most people by age 30. Up to 90 percent of **peak bone mass** is acquired by age 18 in girls and age 20 in boys. This creates a short window during development to deposit mineral into the body's "bone bank." Later in life, the body begins to make withdrawals from the skeleton, potentially leading to the severe bone loss known as **osteoporosis**. A healthy lifestyle throughout the adult years serves to maintain bone mass and a healthy skeleton.

Strong bones are also important for the active or athletic student. Vitamin D may be particularly relevant in preventing stress fractures. A five year study1 of 6712 teen girls points to the importance of adequate vitamin D stores in preventing stress fractures, particularly in athletic adolescent females.

Dairy foods are integral to optimal bone health and provide a nutrient-rich package containing calcium, protein, vitamin A, vitamin D, vitamin B12, riboflavin, niacin, potassium, phosphorus, pantothenic acid and other key nutrients. Children and teens ages 9-18 require 3 servings of dairy daily but surveys show that many children and teens fall short in their consumption of dairy foods. A serving of dairy is 8 ounces or 1 cup of milk or yogurt or 1½ ounces of cheese.

Below are key facts for lesson preparation. The glossary also provides useful background for teaching this lesson.

- Calcium is the primary mineral in bone and 99% of the calcium in the body is located in bones and teeth.
- Calcium in naturally occurring foods such as dairy is more bioavailable – meaning the body can more easily absorb and utilize the calcium. Calcium supplements and calcium-fortified foods and beverages are less bioavailable.
- In addition to adequate calcium intake, eating a well-balanced and varied diet is also needed to build a strong skeleton. Vitamins A, D, and K, phosphorus, magnesium, protein and many other nutrients contribute to bone building and overall good health.
- Lactose intolerance does not mean dairy-free. For those individuals who have difficulty digesting lactose, drinking lactose-free milk, consuming small amounts of milk at a time and choosing lower lactose dairy foods such as aged cheese and yogurt are proven options for dealing with this intolerance.
- According to the American Academy of Pediatrics[2] paper on **Optimizing Bone Health in Children and Adolescents:**

– "Dietary sources of calcium should be recommended in preference to calcium supplements, not only because of the improved bioavailability of dietary sources of calcium, but also primarily to encourage lifelong healthy dietary habits."
– "The replacement of milk in the diet by soda can prevent adolescents from achieving adequate calcium and vitamin D intake, and because soda consumption has no health benefit, it should be avoided."
– "Milk alternatives, such as soy- or almond-based beverages, may have a reduced amount of bioavailable calcium per glass, even when fortified with calcium."

Teaching the Lesson

1. Class Discussion

Begin the lesson by finding out what students know about bone health. Ask students the following questions and write their answers and ideas on the board or flip chart.

- What are some of the important functions of bone in our body (possible answers: give us structure; protect our brain, heart, lungs, spinal cord; coordinate with joints and muscles for movement; small bones in middle ear play a role in hearing)
- What factors are important for the development of a healthy skeleton (possible answers: calcium, vitamin D, protein, overall good nutrition, weight bearing exercises).
- What are the best sources of calcium that are most usable to your body? (answer: the calcium found in milk, yogurt and cheese)
- How many servings of dairy are needed by pre-teens and teens? (answer: 3 servings daily).
- What's a serving? (answer: 1 cup milk or yogurt, 1 ½ oz. cheese).
- How does the body get adequate vitamin D? (answer: either from a few minutes of sunshine daily or from fluid milk, fortified yogurt or other fortified foods)
- Have any of you heard of the disease osteoporosis? Can anyone explain why it is called "a pediatric disease with geriatric consequences?" (answer – peak bone mass is attained primarily in the teen years and if the skeleton is not as strong as it can be, it places an individual at risk for bone-thinning osteoporosis later in life)
- Can anyone think of other reasons to develop a healthy skeleton during the teen years (possible answers: to reduce the risk of stress fractures and to support the body during sports and physical activities)

2. Weight Bearing Activity

Explain to students the definition of a weight bearing activity (muscles and bones working against gravity like in running). Ask students to think of 3 activities that are weight bearing and can be done in place in the

classroom. Next, ask them to stand up and spend 3 minutes engaging in these activities. Using a timer or stop watch, have them switch to the next activity after 1 minute. Examples include walking or jogging in place, hopping, marching, jumping, "air" jump roping, dancing, or moving with small weights. *Note: The next three activities can be done simultaneously by different small groups with students rotating between activities.*

3. Measuring Calcium in Bones

Break class into small groups of 3-5 students *(note: may want info in this section also designed as a separate sheet to place on table where activity is taking place)*. On the table, you will find a bag filled with white pellets (or white flour or white cornmeal), which represents the calcium in bones. You will use the measuring cups to measure the amount of calcium in the bones of a healthy skeleton at different ages and stages by following the directions below.

- A newborn baby has about ¼ cup of calcium in their bones. Measure ¼ cup of pellets and place it in a bag and label it "newborn."
- A 10 year-old has about 4 cups of calcium in their bones. Measure 4 cups of pellets and place it in a bag and label it "10 year-old."
- A 15 year-old has about 9 cups of calcium in their bones. Measure 9 cups of pellets and place it in a bag and label it "15 year-old."
- An adult has about 11 cups of calcium in their bones. Measure 11 cups of pellets and place it in a bag and label it "adult."
- Interesting fact: An adult with osteoporosis may have as little as 6.5 cups of calcium in their bones.

Questions to Consider:

- Astronauts who spend more than 180 days in space lose about 20% of their bone mass. If a typical adult has 11 cups of calcium in their bones, how much would that person have after 6 months in a space ship? (answer: 8.8 cups)
- What do you think is the biggest factor in the bone loss that an astronaut experiences? (answer: lack of weight bearing activity caused by the lack of gravity in space).
- The Recommended Dietary Allowance for calcium for children ages 4 to 8 is 1000 milligrams per day. At age 9, the RDA for daily calcium changes. Do you think it goes up or down? Explain. (answer: it increases to 1300 milligrams/day to accommodate your more rapidly growing bones).

4. Beverage Comparison Activity

Break class into small groups of 3-5 students. Explain that students will be using the "Think Your Drink" beverage cards to identify the most naturally nutrient-rich beverages that best contribute to bone health. They will do this in three steps: *(note: may want info in this section also designed as a separate sheet to place on table where activity is taking place)*

- Using the Nutrition Facts label, identify all the beverages with at least 300 or milligrams of calcium/

serving. You will only use these cards for the next step.

- Next, identify the beverages that have **naturally occurring** calcium. Our bodies can better use the calcium that is already present in foods and beverages. Look at the ingredient list to see if the beverage is fortified with an added calcium compound such as calcium carbonate, calcium phosphate, calcium lactate, or tricalcium phosphate. Discard the cards that contain beverages with added calcium.
- For the remaining cards, use the **"Added Sugars"** line indented below the **"Total Sugars"** line on the Nutrition Facts label to identify beverages with 12 grams or less added sugar/serving. At the end of the activity, students should have 9 cards that meet the above criteria.

Additional Beverage Card Questions:

- Review the bar graphs on the reverse side of the cards and identify at least 3 beverages that contribute all of the following key nutrients: protein, vitamin D, calcium and potassium.
- Use the cards to find at least five beverages which contain more than 20 grams of **added sugar*** per serving.
*The Dietary Guidelines advise a limit of 50 grams of added sugar daily. This does not include the naturally occurring sugar in dairy, fruits and vegetables.

5. Write About It/Talk About It – Calcium Hacks

Break class into small groups of 3-5 students. Ask that the group assign one student as the recorder and another as the "reporter." The reporter will give a brief summary to the rest of the class when finished *(note: may want info in this section also designed as a separate sheet to place on table where activity is taking place)*.

- What is a calcium "hack?" It's a clever way to add some calcium to your diet that you may have not considered. Here are some calcium hacks you may want to try at home:
  - When making oatmeal at home, skip the H_20 and use milk instead to prepare your oatmeal. You will get a more satisfying protein and calcium-rich bowl of oats.
  - A sprinkle of cheese, please! Add cheese to all kinds of dishes for added flavor and calcium.
  - Make a savory dip for veggies or salads by combining Greek yogurt or cottage cheese, garlic and herbs such as dill, basil or oregano.

Dairy For Today:
Strong bones are important for the active or athletic student. Reduce your chance of stress fracture by consuming vitamin D rich dairy foods every day.

Dairy foods also contain a big package of nutrients that help build, repair and maintain your body as it grows. Milk, yogurt and cheese provide calcium, protein, vitamin A, vitamin D, vitamin B12, riboflavin, niacin, potassium, phosphorus, pantothenic acid and several other key nutrients.

Dairy For Tomorrow:
Your body can only build bone when you are young. By the time you reach the ripe old age of 30, your skeleton will be as strong as it ever can be. A good diet and weight bearing exercise such as running and jumping will help to prevent the bone-thinning disease known as osteoporosis.

- Now, it's your turn. As a group, brainstorm more calcium hacks using milk, cheese or yogurt. Each group member should come up with at least one hack.
- Report to the class on your hacks, highlighting one hack from each member of the group.
- Set a goal to include more calcium-rich dairy foods in your daily diet.

6. Complete Activity Sheet

Ask students to complete the "Under Construction! Building the Best Bones for Life" activity sheet, using the If Bones Could Talk poster and the knowledge they acquired during this lesson.

Going Further Resources

The Southeast United Dairy Association, Inc.

- Nutrition Worksheets & Lesson Plans: High School/Middle School (http://southeastdairy.org/teacher-resources/)
- Fuel Up to Play 60 (http://southeastdairy.org/schools/fuel-up-to-play-60/)

Dairy Council of California

- Visit the Milk and Bone Health page of the Dairy Council of California to access the following fact-filled articles: (http://www.healthyeating.org/Milk-Dairy/Health-Benefits-of-Milk/Milk-and-Bone-Health.aspx)
  - Are Milk and Calcium Good for Your Bones?
  - Building Strong Bones Over Time
  - What Role Does Protein Play in Bone Health?
- Calcium Quiz (http://www.healthyeating.org/Healthy-Eating/Healthy-Eating-Tools/Calcium-Quiz.aspx)
- TeenBeat Activity Calculator (http://www.healthyeating.org/Healthy-Kids/Kids-Games-Activities/TeenBEA.aspx)

National Dairy Council

- Printable Food Models from all food groups, including Nutrition Facts Label Information (https://www.nationaldairycouncil.org/search-results?q=food%20models)

Washington State Dairy Council

- Free Downloads (https://nutrition.eatsmart.org/collections/handouts-info-sheets)

References

1. Sonneville KR, Gordon CM, Kocher MS, Pierce LM, Ramappa A, Field AE. Vitamin D, calcium, and dairy intakes and stress fractures among female adolescents. Arch Pediatr Adolesc Med. 2012;166(7):595–600 (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3654657/)

2. Optimizing Bone Health in Children and Adolescents (http://pediatrics.aappublications.org/content/pediatrics/134/4/e1229.full.pdf)

3. Bone Health, Summary from Micronutrient Information Center, Linus Pauling Institute (http://lpi.oregonstate.edu/mic/health-disease/bone-health)

4. Kids and Their Bones: A Guide for Parents (https://www.niams.nih.gov/health_info/bone/bone_health/juvenile/default.asp)

5. Busy bones, Arizona State University School of Life Sciences, Ask a Biologist. (https://askabiologist.asu.edu/bone-anatomy)

6. Are Milk and Calcium Good for Your Bones?
   Building Strong Bones Over Time
   What Role Does Protein Play in Bone Health?
   (http://www.healthyeating.org/Milk-Dairy/Health-Benefits-of-Milk/Milk-and-Bone-Health.aspx)

7. The Power of Protein: More Than Muscle Building
   (http://www.healthyeating.org/Portals/0/Documents/Health%20Wellness/White%20Papers/ThePowerOfProtein.pdf)

8. Mangano KM, Sahni S, Kerstetter JE. Dietary Protein is Beneficial to Bone Health Under Conditions of Adequate Calcium Intake: An Update on Clinical Research. Curr Opin Clin Nutr Metab Care. 2014 Jan;17(1):69-74.

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Glossary

Bioavailability: A measure of how well nutrients from food are used by the body. This includes digestion, absorption, metabolism and the use of nutrients for normal body functions. For instance, the calcium in dairy products is highly bioavailable whereas the calcium contained in alternative beverages and some leafy greens is less bioavailable.

Calcium: The most abundant mineral in the body, calcium is needed for the development and maintenance of healthy bones and teeth. Calcium is the primary mineral in bone and 99% of the calcium in the body is located in bones and teeth. The remaining 1% is in the blood stream and plays many vital roles, including blood pressure regulation, muscle cell contraction and cell communication.

Nutrient: Substances found in food that our bodies need to live, grow and stay healthy. The six classes of nutrients are carbohydrates (including fiber), proteins, fats, vitamins, minerals, and water. There are more than 40 different nutrients with many different functions that are required for good health.

Nutrient-Rich: A nutrient-rich food refers to a food that contains substantial amounts of vitamins, minerals, protein and fiber in relatively few calories. The five MyPlate food groups, including dairy foods, fruits, vegetables, grains, and protein foods are considered nutrient-rich.

Osteoporosis: A bone disease characterized by bone mineral loss and low bone density, resulting in porous bones that are fragile and break easily. It is sometimes referred to as a pediatric disease with geriatric consequences because peak bone mass is primarily accrued during childhood and adolescence. According to the National Osteoporosis Foundation, an estimated 54 million U.S adults are at risk for osteoporosis and low bone mass.

Peak Bone Mass: The point at which bones have reached their maximum lifetime strength and density. The amount of bone tissue in the skeleton (known as bone mass) typically peaks for most people by age 30. Up to 90 percent of peak bone mass is acquired by age 18 in girls and age 20 in boys, which makes youth a critical time for building bone through optimal nutrition and physical activity.

Protein: Provides the building blocks needed for growth, replacement and maintenance of body tissues and structures, including bone.

Vitamin D: Known as the "sunshine vitamin" because your skin can react with sun rays to form vitamin D. The best food source is milk, which is convenient since vitamin D helps your body use calcium.

Weight Bearing Exercise: Weight-bearing means your muscles and bones are working against gravity. Activities such as walking, jumping, running, soccer, tennis, basketball, weight lifting and karate are examples of weight-bearing activities.

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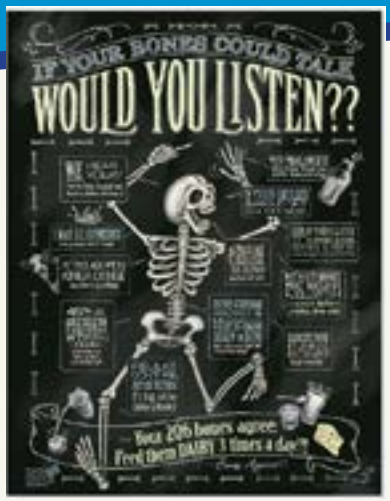
Lesson Activity



Directions: To complete this activity, use the information you learned and refer to the "If Your Bones Could Talk, Would You Listen?" poster to fill in the blanks with the correct answer from the word bank. When you are finished answering the questions, use the numbered letters in the boxes to uncover the hidden message on the next page.

Word Bank

adolescence
calcium
humerus
malleus
yogurt
osteoporosis
phalanges
skeleton
vertebrae
weight

1. (10 X 20) + 6 = the number of bones in your [ ][ ][ ][ ][ ][ ][ ][ ] (29 42 6 14)
2. [ ][ ][ ][ ][ ][ ][ ] (37 24 23 15) and vitamin D work together to build strong bones.
3. 45% of your adult skeleton is formed during [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ] (28 26 4 20)
4. Walking your dog is a great example of a [ ][ ][ ][ ][ ][ ] (31 2 39 34 16) - bearing exercise.
5. It's not that funny, but the long bone in your upper arm is [ ][ ][ ][ ][ ][ ][ ] (25 12 17 13)
6. [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ] (27 43 21 19 41 8 10 18) is a pediatric disease with geriatric consequences.
7. Natural sources of calcium are found in milk, [ ][ ][ ][ ][ ][ ] (5 1 22 35) and cheese!
8. You use your [ ][ ][ ][ ][ ][ ][ ][ ][ ] (11 33 32) when you play the piano or text your friend.
9. The bones that protect your spinal cord are called [ ][ ][ ][ ][ ][ ][ ][ ][ ] (3 38 36 9)
10. The [ ][ ][ ][ ][ ][ ][ ] (40 30 7), incus and stapes are the 3 tiny bones found in the middle ear.

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Building the Best Bones for Life (Grades 6-8)

Lesson Activity *(continued)*

Hidden Message

1	2	3	4		5	6	7	8		9	10	11	12	13		14	15	16	17	18	19	20	21	–	22	23	24	25		f				
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30	11	28		31	32	23	33	34	35		9	36	37	38	23	11	39		40	41	3	42	43	!						

TRY THIS AT HOME!

Blues Buster Blueberry Peach Smoothie

This Blues Buster Blueberry Peach Smoothie is served in a bowl. You can also top it with low-fat granola, fresh blueberries, diced peaches and a dash of cinnamon.

Yield: 3 (8-ounce) servings (24 ounces)

Ingredients:

8 ounces low-fat vanilla Greek yogurt
3/4 cup frozen blueberries
3/4 cup frozen peaches
1/2 cup low-fat milk
2 tablespoons honey
1 cup ice cubes

Directions: Combine yogurt, fruit, milk, honey and ice in a blender. Blend until smooth and frothy.

Source: Laura Marbury, MS, RD, LD, (http://southeastdairy.org/swap-straw-spoon/)