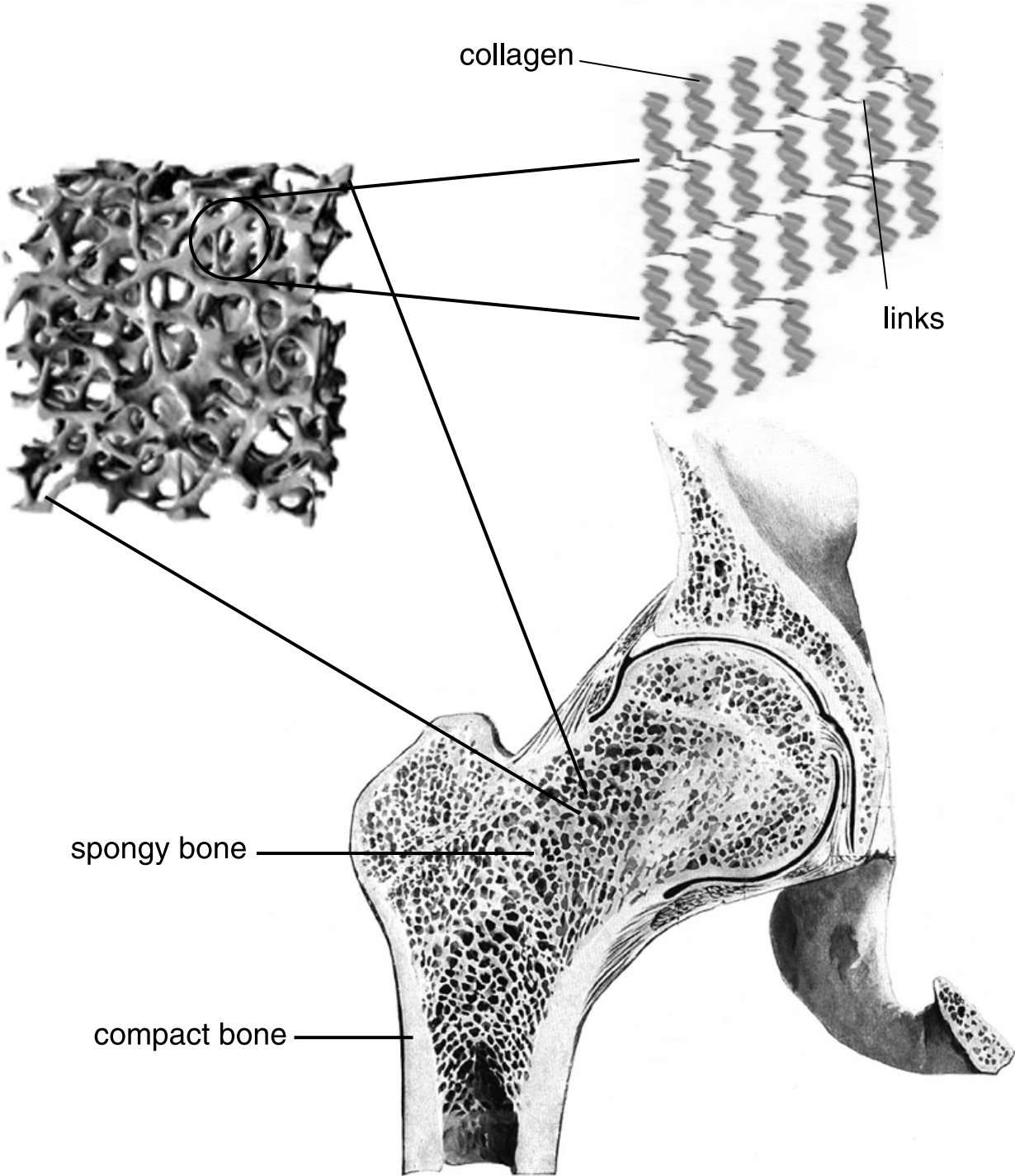


It's Alive! Or Is It?

Properties of living systems	Bone		Muscle		Skin	
	Yes	No	Yes	No	Yes	No

Why do you believe bone, muscle, and skin have been grouped together for study in this module?

Bone Structure

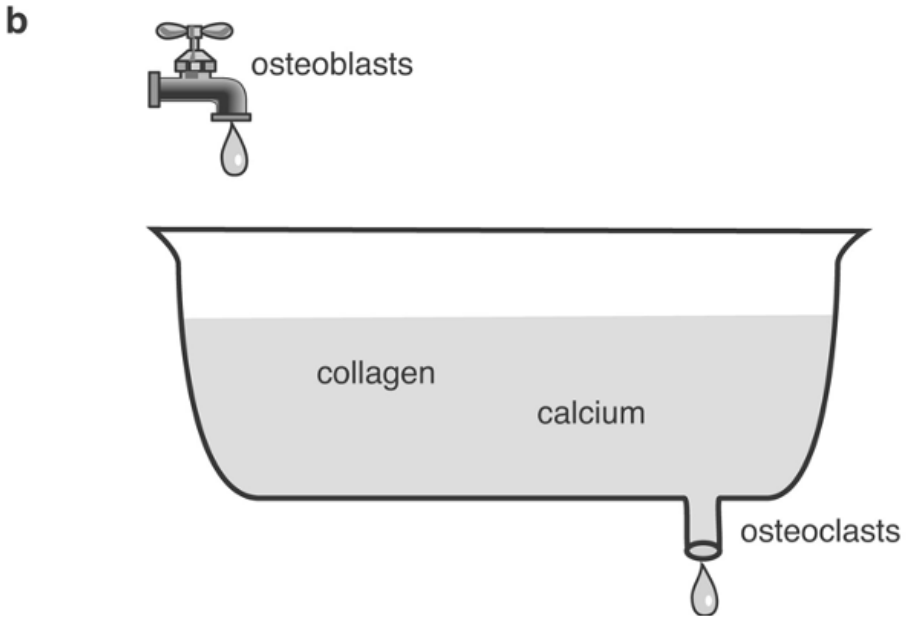
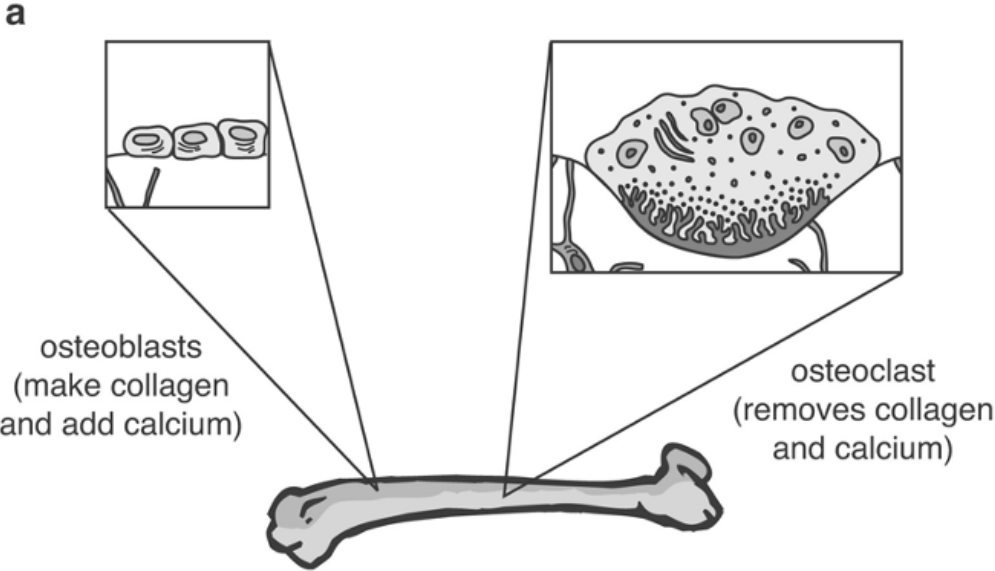


Master 2.1

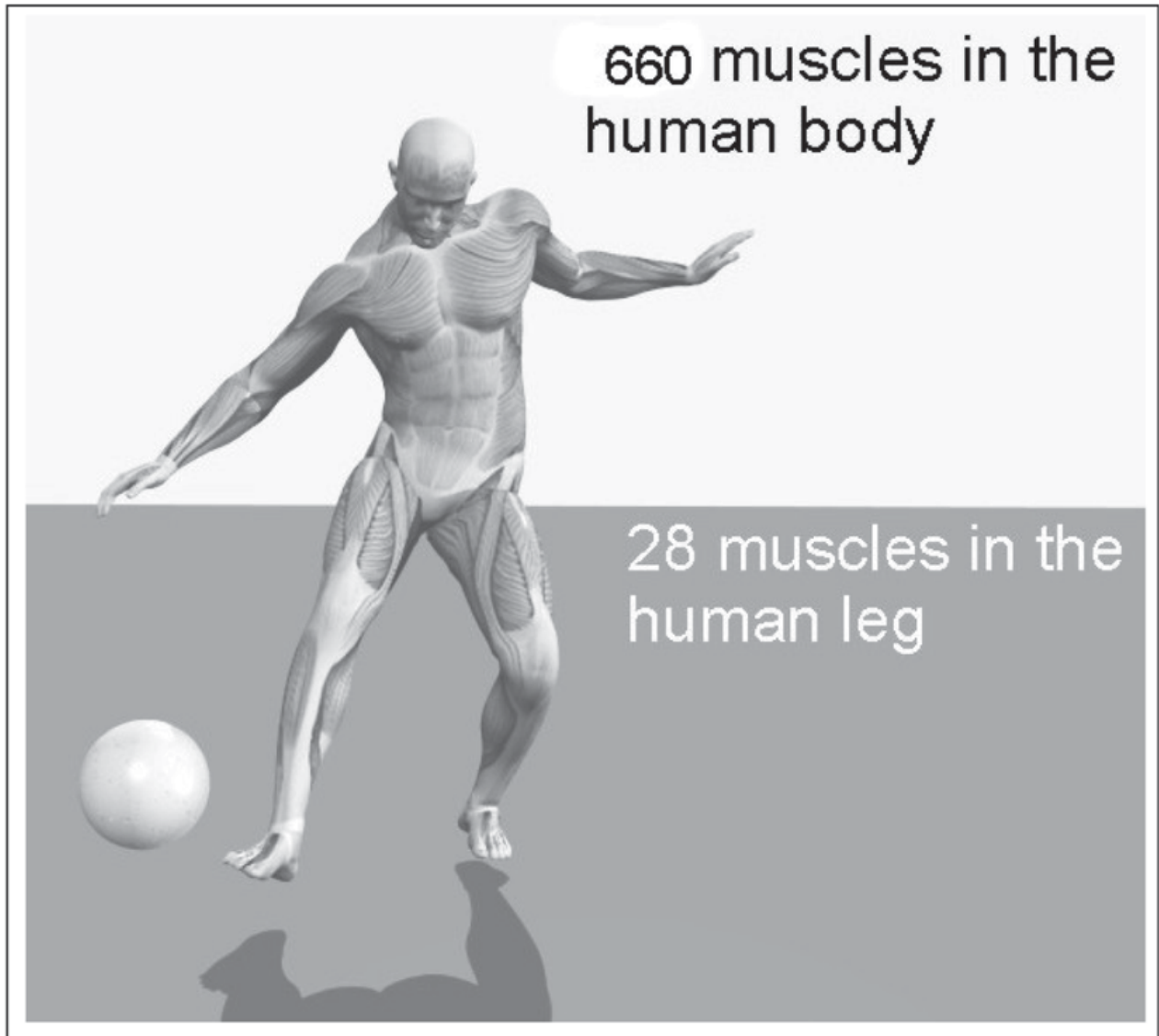
Testing the Pasta Model

1. Use your ruler to move two desks or tables (of the same height) 20 centimeters apart.
2. Sort out two groups of pasta, each containing 20 pieces.
3. Use rubber bands to bundle one group of pasta; leave the other group unbundled.
4. Bend two paper clips and attach weights to them. Each paper clip should hold about 200 grams.
5. Place the bundled pasta between two desks so that each end rests on about the same amount of desk.
6. Carefully hang one of the paper clips with weights from the center portion of the pasta.
7. Use a ruler to measure the distance from the desks to the lowest portion of the sagging pasta. Record the measurement on a piece of paper.
8. Remove the bundled pasta and place the 25 pieces of unbundled pasta between the desks as before.
9. Carefully hang one of the paper clips with weights from the center portion of the pasta.
10. Use a ruler to measure the distance from the desks to the lowest portion of the sagging pasta. Record the measurement on a piece of paper.

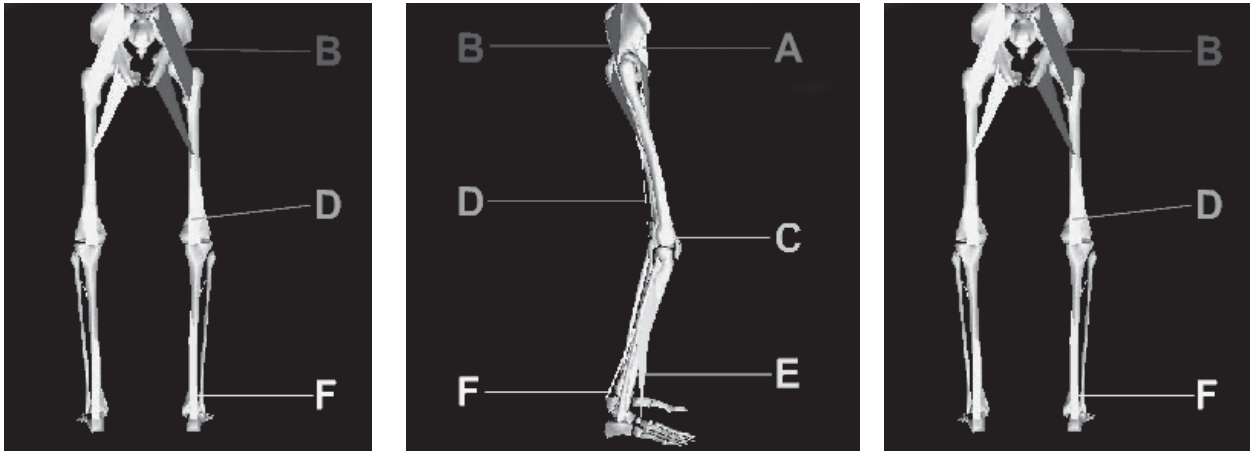
Bone in Balance



Muscles



Anatomy of a Kick Results



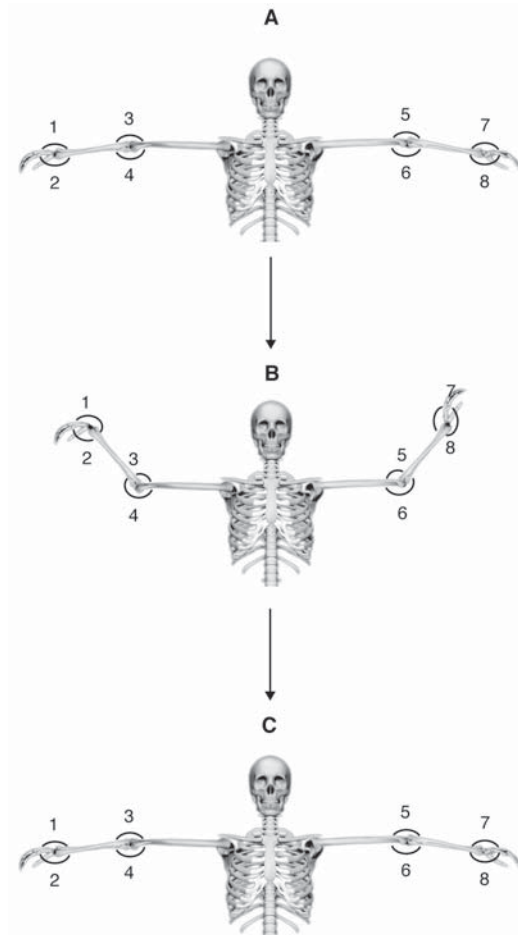
- Fill in the table and answer the question below to show what you have learned about muscles. In the “Muscle Group” column on the right, write the order in which the muscle groups function to produce the kicking motion you are investigating.

Muscles Matter!

Attachment (From where to where)	Movement (Which body part moves how)	Muscle Group (Identified by letter)
		1.
		2.
		3.
		4.
		5.
		6.

- Which muscle groups work in opposing pairs?

Relax! I'm Contracting



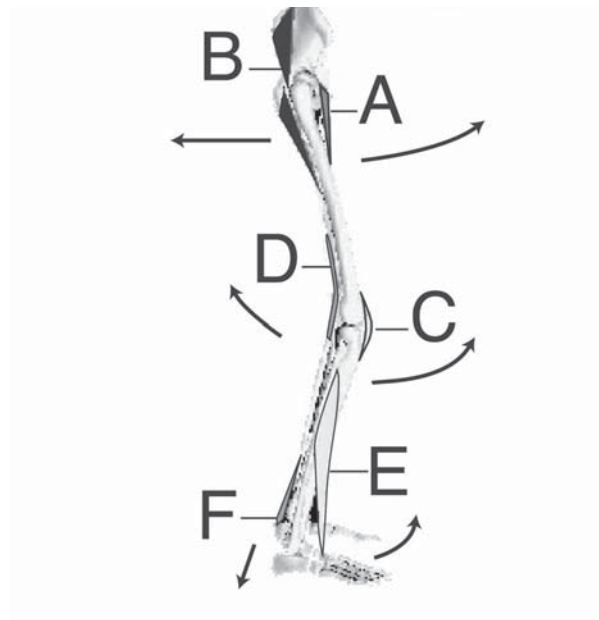
Movement from Panel A to Panel B

Muscle	Contracting or Relaxing?
1	
2	
3	
4	
5	
6	
7	
8	

Movement from Panel B to Panel C

Muscle	Contracting or Relaxing?
1	
2	
3	
4	
5	
6	
7	
8	

Muscle Group Sequence

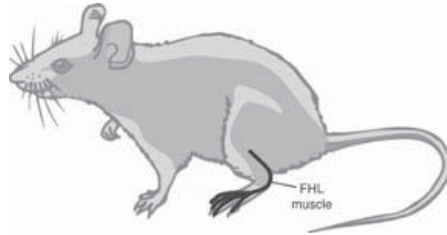


1. Write the order in which the muscle groups function to produce the kicking motion you are investigating.

Muscle group (identified by letter)
1.
2.
3.
4.
5.
6.

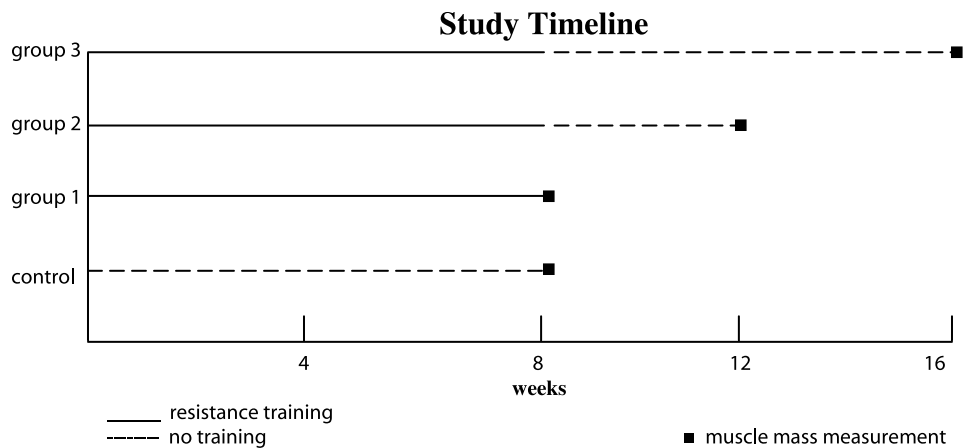
2. Which muscle groups work in opposing pairs?

Rat Resistance Training Study



This study investigates the effect of performing resistance training and stopping training on the muscle mass of rats. Resistance training is exercise that causes your muscles to pull and push against a force. In this study, the resistance training involved rats carrying weights up a ladder.

Rats were divided into two groups. Five rats in the control group did no training for 8 weeks and then had their muscle mass measured. Fifteen rats performed resistance training for 8 weeks. The resistance training consisted of rats climbing a ladder with weights attached to their tails. Training was conducted twice a day every 3 days. Weight was increased gradually during the 8 weeks of training. After the 8 weeks of training, five of the rats, called group 1, had their muscle mass measured. Another five rats became group 2 and received no training for 4 weeks, and then had their muscle mass measured. The remaining five rats became group 3 and received no training for 8 weeks, and then had their muscle mass measured.



At the times indicated on the chart, the mass of one leg muscle of the rats was measured. This muscle is known as the flexor hallucis longus (FHL). The FHL is located on the back of the lower leg and across the bottom of the foot. This muscle flexes the foot and toes in rats.

1. Plot the average mass of the FHL muscle for each rat group (from Master 4.2, *Muscle Data*) on Master 4.3, *Graph Template*.
2. Follow the instructions on the worksheet (Master 4.4a, *Resistance Training Study Worksheet and Graph Template*) and calculate the increase in muscle mass for each of the training groups.
3. Plot the increase in muscle mass on the second graph template (Master 4.4b).

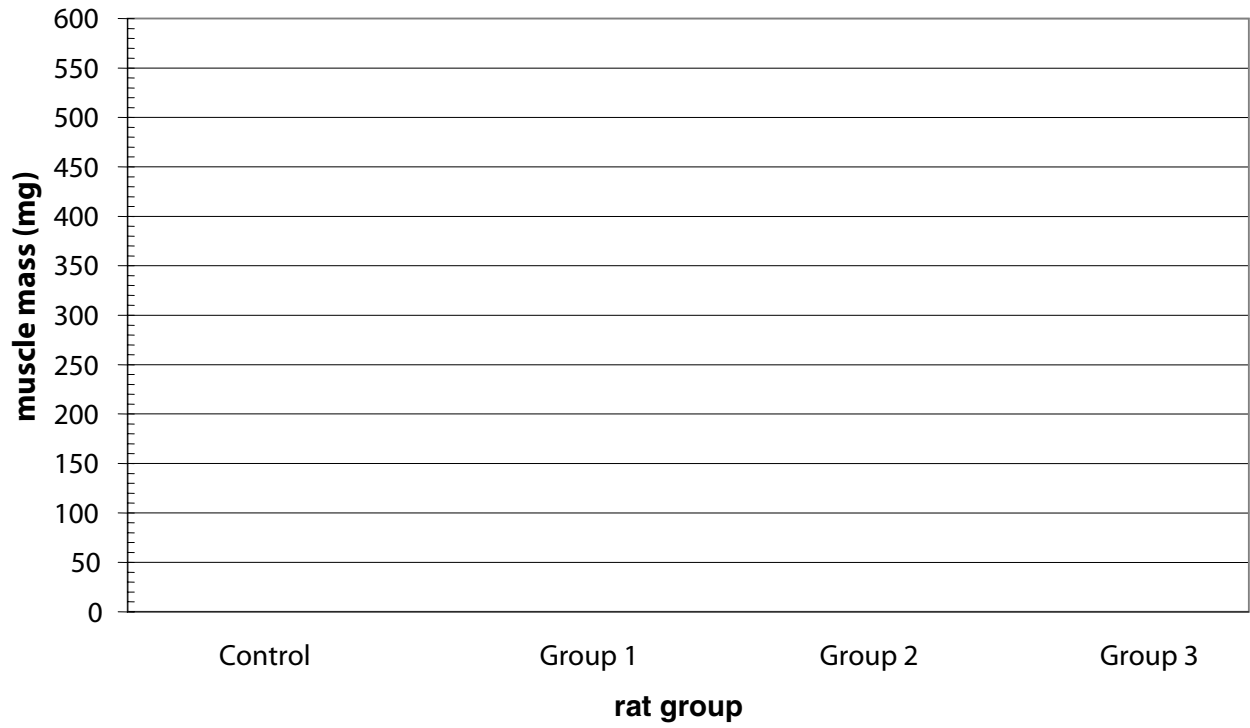
Muscle Data

Average Mass of FHL Muscle in Rats

Rat group	Average muscle mass (mg)
Control group	463
Group 1 8 weeks of resistance training	544
Group 2 8 weeks of resistance training, then 4 weeks of no training	531
Group 3 8 weeks of resistance training, then 8 weeks of no training	508

Graph Template

Average Mass of FHL Muscle in Rats



Resistance Training Study Worksheet and Graph Template

1. Use this formula and the example below to calculate the change in muscle mass* as a percentage for each training group as compared with the Control Group.
2. Plot the values from the last column on the graph template.

$$\% \text{ muscle mass increase} = \frac{\text{Training Group Mass (G)} - \text{Control Group Mass (C)}}{\text{Control Group Mass (C)}} \times 100\%$$

Example:

Training Group mass (G) = 600

Control Group mass (C) = 463

$$\% \text{ muscle mass increase} = \frac{600 - 463}{463} \times 100\% = 30\%$$

$$600 - 463 = 137$$

$$137 \div 463 = 0.30$$

$$0.30 \times 100\% = 30\%$$

Training Group (G)	G - C	÷ C	× 100% = % muscle mass increase
Group 1	___ - 463 =	___ ÷ 463 =	___ × 100 = ___
Group 2	___ - 463 =	___ ÷ 463 =	___ × 100 = ___
Group 3	___ - 463 =	___ ÷ 463 =	___ × 100 = ___

*All units in milligrams.

Resistance Training Study Worksheet and Graph Template

Percent Muscle Mass Increase in Training Groups over
Control Group



Description of Milk Study



This study examines how drinking milk affects the results of physical exercise. Thirty healthy teenagers were divided into two groups. One group drank three servings of milk each day, while the second group drank three servings of orange juice each day. The orange juice did not contain extra calcium. Both groups of teenagers then participated in a 12-week program of resistance training. Resistance training is exercise that causes your muscles to pull and push against a force. Examples of resistance training include weight lifting, push-ups, pull-ups, or using exercise machines. During and after the training, the teenagers from both groups had their strength tested (how much weight they could bench press). They also were X-rayed to estimate the amount of minerals in their bones.

Data from Milk Study

Juice Group

	Week 0	Week 6	Week 12
Bench press (kg)	49	53	60
Percent increase in bone minerals	0.00	0.54	1.26

Milk Group

	Week 0	Week 6	Week 12
Bench press (kg)	49	54	60
Percent increase in bone minerals	0.00	1.42	2.48

Description of Sports Study

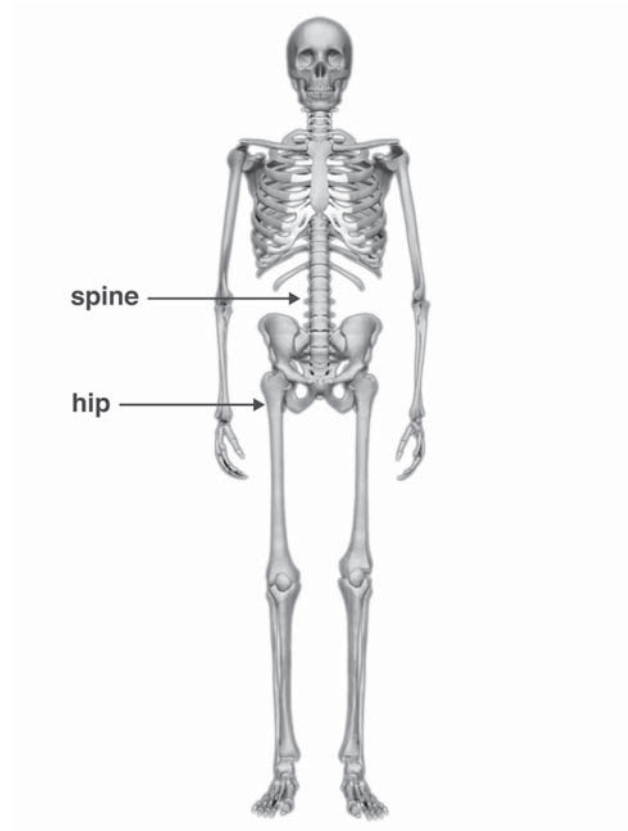
This study examines the effects of playing different sports on the mineral content of bone.

A total of 41 college students participated in the study. They were divided into four groups:

- _____ Control group: students who get very little exercise
- _____ Group 1: students who play basketball or volleyball
- _____ Group 2: students who swim
- _____ Group 3: students who play soccer or run short-distance track

After completing their playing season, students were X-rayed to estimate the amount of minerals in their bones. Bone-mineral measurements were made at two locations: the spine and the hip (see the following).

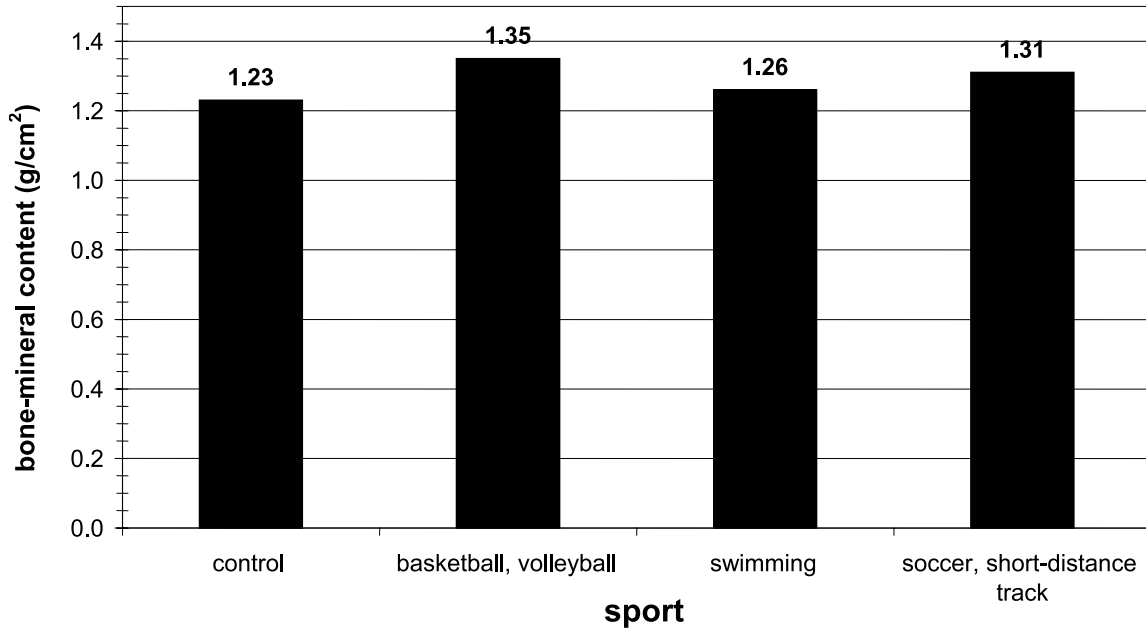
Use your knowledge of exercise and bone to rank the four different groups in the study with respect to their bone-mineral content. The group with the highest level of bone minerals should be labeled "1," while the group with the lowest level of bone minerals should be labeled "4." Write your rankings in the spaces next to the group descriptions above.



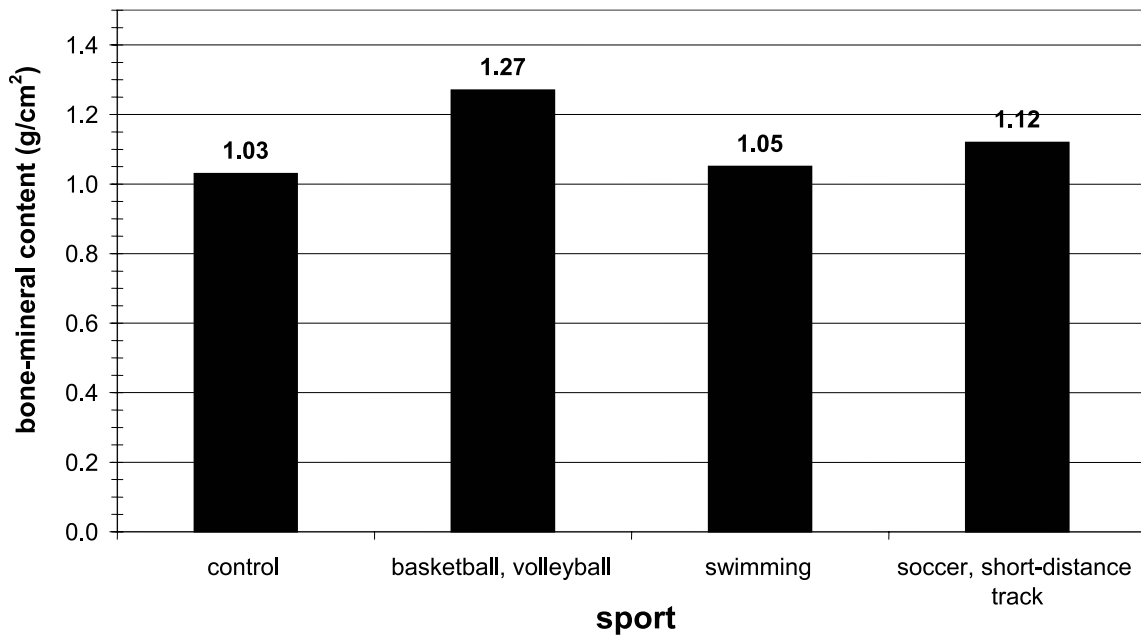
Master 5.3

Data from Sports Study

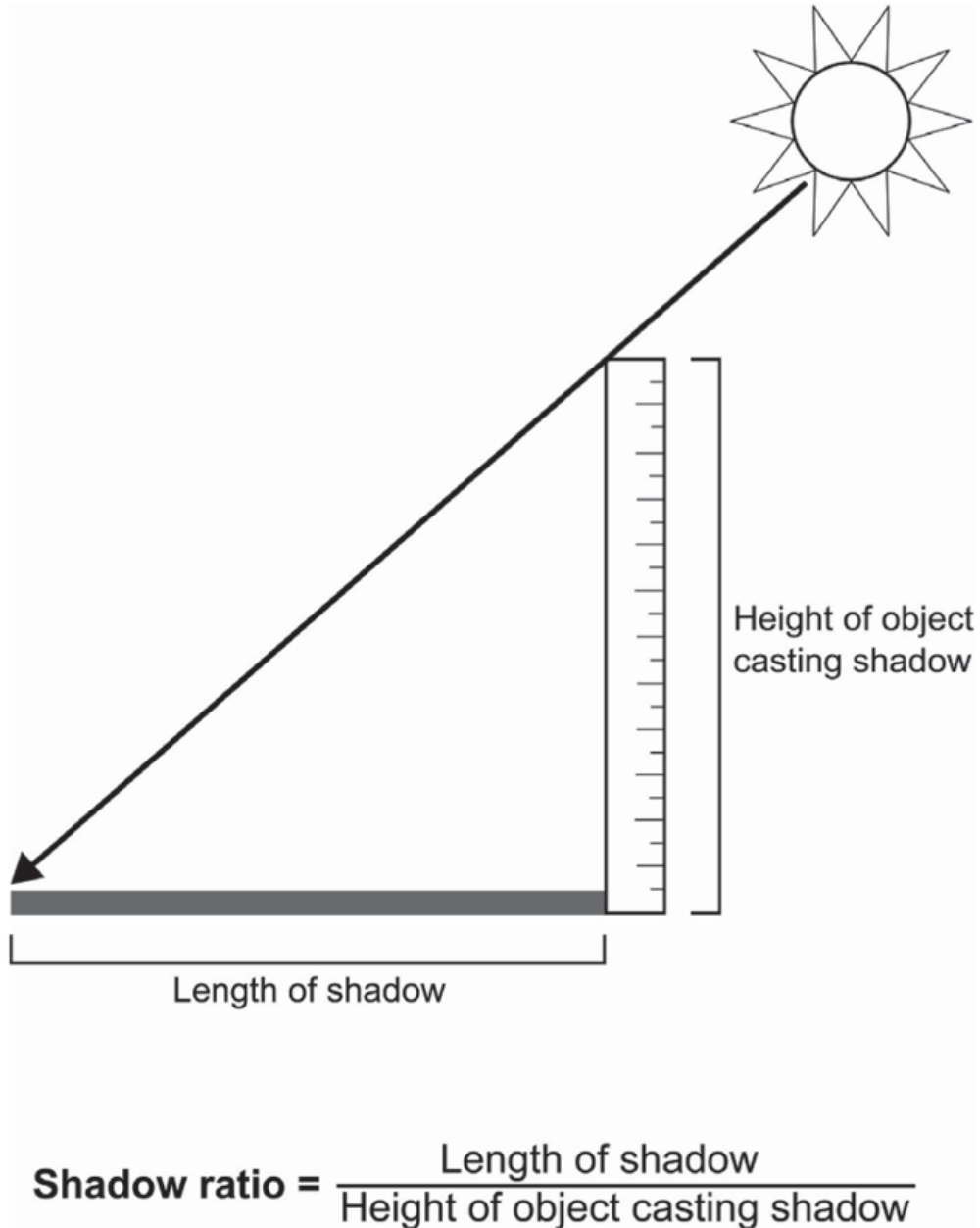
Bone-Mineral Content of Spine by Sport



Bone-Mineral Content of Hip by Sport



Calculating the Shadow Ratio



Outline for Health Recommendations

Question	Bone	Muscle	Skin
What is it made of?			
What does it do?			
How does it work?			
How do our behaviors affect it?			
How do we keep it healthy?			