

1: The Skeletal and Muscular Systems

Unit Unit 1: Human Body Systems I - Standard: • NGSS: HS-LS1-2 (Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.)
• TEKS: §112.42(c)(12)(A) [B.12.A] — analyze the interactions that occur among systems that perform the functions of regulation, nutrient absorption, reproduction, and defense from injury or illness in animals.

Lesson Objective: You will explain how bones and muscles are structured and how they work together to support, protect, and move your body. You will compare the three types of muscle tissue and describe how the bone-muscle lever system produces controlled movement.

Your Body's Framework: The Skeletal and Muscular Systems

Three Core Concepts

1. Bones Are Living Structures

Bone grows, repairs itself, and stores calcium. Its layers — compact bone, spongy bone, and marrow — each serve a specific function beyond holding your body up.

2. Three Types of Muscle, Three Different Jobs

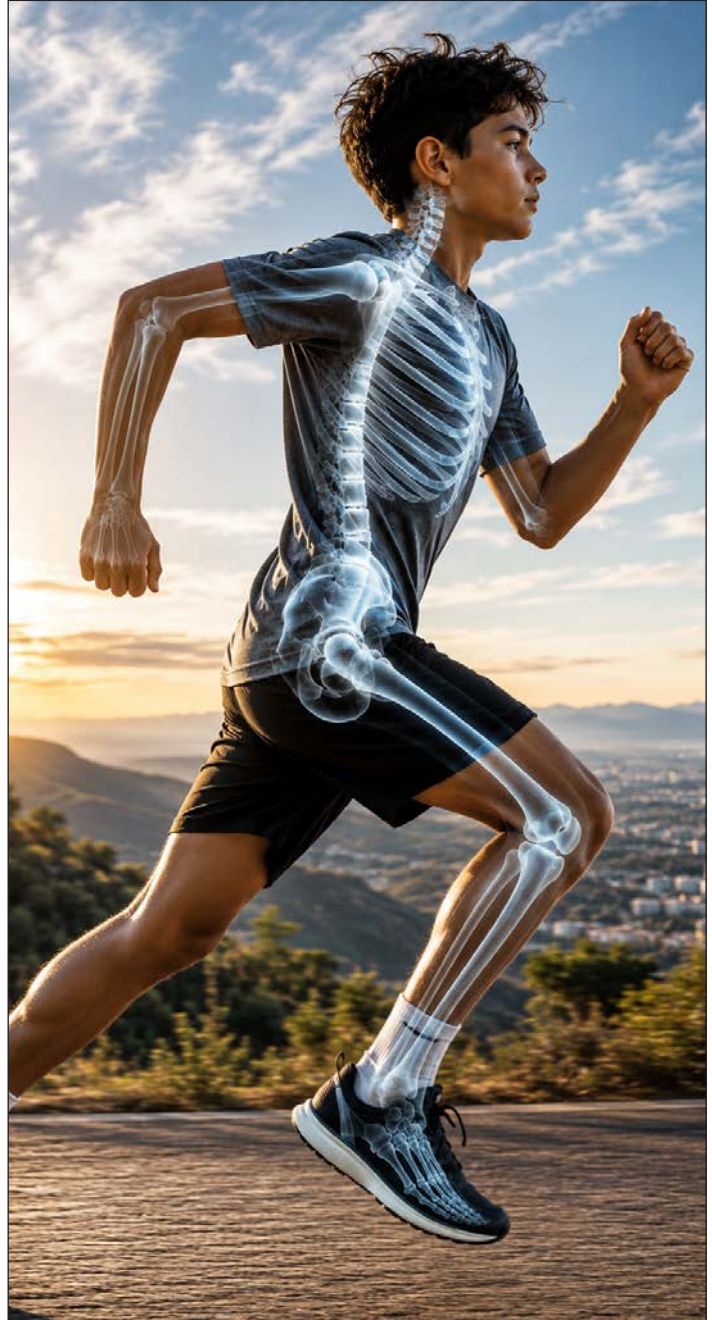
Skeletal muscle moves your body by choice. Smooth muscle runs your organs automatically. Cardiac muscle keeps your heart beating without pause.

3. Bones and Muscles Work as a Lever System

Muscles pull on bones through tendons, bones rotate around joints, and that produces movement. Damage any one part and the whole chain breaks down.

Why This Topic Matters

The skeletal and muscular systems affect every movement your body makes. Conditions like osteoporosis, sports injuries, and heart disease connect directly to these systems — and understanding them applies to your health, your fitness, and any career path in healthcare.



Your skeleton is alive — and what you do right now is building it for the next 50 years.

Built to Move: How Your Skeleton and Muscles Power Everything You Do

Every time you catch a ball, swipe your phone screen, or stand up from a chair, two of your body's most essential systems are working in perfect sync. Your **skeletal system** and your **muscular system** operate together so smoothly that most people never think about them until something goes wrong. A broken bone, a pulled muscle, or a stiff joint can bring daily life to a sudden stop. These are not just things that happen to other people — they happen to athletes, students, and people your age every day. Understanding how these two systems work together gives you a foundation for making smarter choices about your health right now and far into the future.



Every move you make is bones, muscles, and tendons working as one.

The Skeleton: More Than Just a Frame

Most people picture a skeleton as a rigid, dry structure — something you see hanging in a science classroom. In reality, **bone** is living tissue. It grows, repairs itself, and changes throughout your entire life. The adult human skeleton contains **206 bones**, ranging from the large **femur** (thigh bone) — roughly 48 centimeters (19 inches) long in an adult — to the tiny stapes bone inside your ear, which measures just 3 millimeters (0.1 inches). Teenagers may have slightly more because some bones have not yet fully fused together.

Bone is not solid all the way through. It has two distinct layers, and each one has a job. The outer layer, **compact bone**, is dense and hard — it is the part that handles pressure, impact, and force every time you move. Just beneath it is **spongy bone**, which looks less like solid rock and more like a honeycomb or lattice. That structure keeps bones from being too heavy while still maintaining the strength your body needs. Think of it as the body's

way of building light but tough — the same principle engineers use when designing bridges and aircraft.

At the very center of certain bones is **marrow** — soft tissue that does something most people never expect from a skeleton. Marrow is where your body produces red blood cells, white blood cells, and platelets every single day. Your skeleton is not only holding you up — it is also manufacturing the blood that keeps every cell in your body alive.

Bones also serve as a mineral storage system. About 99% of your body's calcium is stored in bone tissue. When your blood needs calcium — for muscle contractions, nerve signals, and dozens of other processes — your body draws it directly from bone. Calcium is not just important for bones; it plays a role in nearly every

The adult skeleton contains 206 bones — from the 48-centimeter (19-inch) femur to the 3-millimeter (0.1-inch) stapes in the ear.

Built to Move: How Your Skeleton and Muscles Power Everything You Do

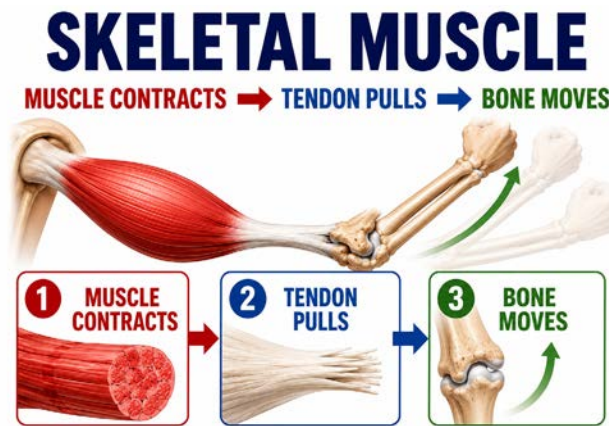
system in the body. That is why getting enough calcium and vitamin D during your teen years has a direct and lasting effect on your bone strength for the rest of your life. The choices you make about what you eat right now are shaping your skeleton for decades to come.

Three Types of Muscle — Three Different Jobs

When most people say “muscle,” they picture the kind you can flex — the bicep, for example. That type is **skeletal muscle**, and it is the only muscle under your **voluntary** control, meaning you consciously decide when to use it. Skeletal muscles attach to bones by tough, fibrous connective tissue called **tendons**. When a skeletal muscle contracts, it shortens and pulls on the tendon, which in turn pulls the bone — and that is what creates movement. You can feel skeletal muscle working every time you walk, lift something, or even blink.

Your body also runs two other types of muscle automatically, without any conscious effort from you. **Smooth muscle** lines the walls of your internal organs — your stomach, intestines, and blood vessels. It contracts slowly and steadily, pushing food through your digestive system and adjusting the width of blood vessels to help regulate blood pressure. You never feel it working, but it never stops. Without smooth muscle, basic functions like digesting a meal or maintaining circulation simply would not happen.

That idea — a muscle working automatically and without rest — leads to the most remarkable example of all. **Cardiac muscle** is found only in the walls of your heart. It is strong and striated like skeletal muscle, but it contracts automatically like smooth muscle — no conscious command required. Cardiac muscle never takes a break. From before you are born until the moment you die, it contracts typically 60–100 times per minute at rest, every hour of every day. Together, all three muscle types keep your body moving, your organs processing, and your blood circulating at the same time.



The Lever System: How Motion Actually Happens

Movement does not happen simply because a muscle contracts. It happens because muscles and bones are arranged as a mechanical **lever system**. A lever is any

rigid structure that rotates around a fixed point — that fixed point is called a **fulcrum**. In your body, bones act as the levers, joints act as the fulcrums, and muscle contractions provide the force that drives the whole system.

Think about bending your arm at the elbow. Your bicep muscle contracts and pulls your forearm bone upward. The elbow joint is the fulcrum, the forearm is the lever, and the load is whatever you are carrying —

*Cardiac muscle contracts
60–100 times per minute at rest
and never stops from birth to death.*

Built to Move: How Your Skeleton and Muscles Power Everything You Do

whether that is a phone or a backpack. It is a simple, elegant system that your body runs hundreds of times a day without you noticing.

Muscles almost always work in **opposing pairs**. When the bicep contracts to bend the arm, the tricep on the back of the upper arm relaxes. When you straighten the arm, the tricep contracts and the bicep relaxes. This back-and-forth coordination is what allows smooth, controlled movement in both directions. Training both muscles in a pair equally is important — imbalances between opposing muscles are a common cause of injury.

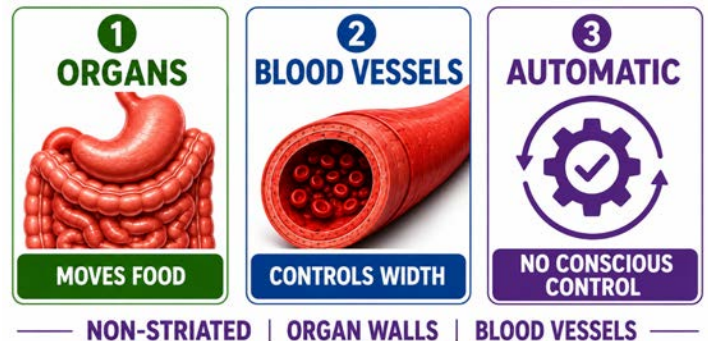
Tendons are what make this system complete. They have very little stretch compared with muscles, which is exactly the point — they act like cables, transmitting the full force of a muscle contraction directly to the bone with minimal energy loss. When a tendon is torn or damaged, movement shuts down even if the muscle itself is perfectly healthy, because the force has no path to travel.

Case Study:

Building Stronger Bones Before 25

Bone density — how compact and strong your bone tissue is — peaks between ages 25 and 30. After that, most people gradually lose more bone than they build. A study tracking young women over 10 years found that those who performed weight-bearing exercise — like running, gymnastics, or strength training — during their teen years had measurably denser bones than those who did not, even decades later. The teens who stayed active were building what researchers call **bone capital** — a reserve that protects against **osteoporosis** and fractures well into adulthood. This research makes clear that

SMOOTH MUSCLE WORKS AUTOMATICALLY



bone health is not something to think about later in life. That window is open right now.

How to Apply

- **Eat calcium-rich foods** during your teen years to build strong bones while your skeleton is still developing.
- **Weight-bearing exercise** — like running, hiking, or strength training — builds bone density before it peaks in your mid-twenties.
- **Know your muscle types:** skeletal muscle is voluntary, smooth muscle runs your organs automatically, and cardiac muscle keeps your heart beating non-stop.
- **Protect your tendons** — they transmit all muscle force to bone, and a tear can shut down movement even when your muscles are fine.
- **Opposing muscle pairs** work together — training one side of a joint without the other creates imbalances that lead to injury.

Teens who did weight-bearing exercise in high school had measurably denser bones decades later.

1: The Skeletal and Muscular Systems - Guided Notes

Three Most Important Concepts

Write each concept in your own words using what you learned from the article.

Concept 1: _____

Concept 2: _____

Concept 3: _____

Main Concept Overview

Fill in each blank using the word bank below.

Word Bank: blood pressure — compact — joints — marrow — skeletal

1. The outer layer of bone, called _____ bone, is dense and built to handle pressure and force.
2. At the center of certain bones is _____, where red blood cells, white blood cells, and platelets are produced.
3. _____ muscle is the only type under your voluntary, conscious control.
4. Smooth muscle controls the diameter of blood vessels and helps regulate _____.
5. In the body's lever system, _____ act as the fulcrum, or pivot point.

Matching

Match each term on the left to the correct description on the right. Write the letter in the blank.

- | | |
|----------------------|---|
| _____ Cardiac muscle | A. Fibrous connective tissue that attaches muscle to bone |
| _____ Compact bone | B. Muscle found only in the heart; contracts automatically |
| _____ Spongy bone | C. Dense outer layer of bone built to withstand force |
| _____ Tendon | D. Lightweight inner bone layer with a lattice-like structure |
| _____ Smooth muscle | E. Involuntary muscle that lines organs and blood vessels |

1: The Skeletal and Muscular Systems - Guided Notes

True | False

Write T for True or F for False in the blank next to each statement.

- 1. _____ Bone is living tissue that can grow and repair itself.
- 2. _____ Cardiac muscle is under your voluntary control.
- 3. _____ About 99% of your body's calcium is stored in your bones.
- 4. _____ Tendons attach muscles to bones.
- 5. _____ The adult human skeleton contains exactly 200 bones.

Fill in the Table

The three types of muscle tissue each have unique characteristics.

Use the article to complete the right column.

Muscle Type	Key Characteristic or Function
Skeletal Muscle	
Smooth Muscle	
Cardiac Muscle	
Skeletal Muscle — Attached By	
Cardiac Muscle — Location	

Application Question

Your friend says bones are just a hard frame that holds your body up. Using what you learned in the article, explain two other jobs that bones do besides providing support.

1: The Skeletal and Muscular Systems - Independent | Dependent Variable

Independent and Dependent Variable Analysis Sheet Built to Move — The Skeletal and Muscular Systems

Quick Reference

Term	What It Means
Independent Variable (IV)	The one factor the scientist deliberately changes in an experiment.
Dependent Variable (DV)	What the scientist measures — the outcome that results from the change.
Controlled Variable (CV)	Everything kept the same throughout the experiment so the test stays fair.

Section 2 — Scenarios for Analysis

Directions: Read each scenario carefully. Identify the independent variable (IV), dependent variable (DV), and two controlled variables (CV). Then write one sentence predicting what you think will happen based on what you know about the skeletal and muscular systems.

Scenario 1 — Calcium and Bone Density

Researchers want to know whether the amount of calcium in a teenager’s daily diet affects their bone density. They study 50 teenagers over two years, tracking calcium intake in milligrams per day and measuring bone density at the end of the study period. All participants are the same age and follow the same daily schedule — the only thing that differs is how much calcium each one consumes.

IV: _____

DV: _____

CV 1: _____

CV 2: _____

Predicted Outcome (1 sentence): _____

1: The Skeletal and Muscular Systems - Independent | Dependent Variable

Scenario 2 — Resistance Load and Muscle Fatigue

A physical education class tests how quickly hand muscles fatigue under different resistance levels. Students squeeze a clothespin — either a standard model or a high-resistance model — as many times as possible in one minute. The number of squeezes per minute is recorded across five consecutive trials, with a 30-second rest between each trial. Each student uses the same hand and squeezes at a steady pace — the only difference is the resistance level of their clothespin.

IV: _____

DV: _____

CV 1: _____

CV 2: _____

Predicted Outcome (1 sentence): _____

Section 3 — Design Your Own

Directions: Read the biology question below. Write a testable hypothesis using the “If... then... because...” format. Then identify the IV, DV, two CVs, and describe how you would measure the DV in one sentence.

Biology Question: Does the amount of weight-bearing exercise a teenager does each week affect their bone density?

Hypothesis — Write your prediction using the format: **If... then... because...**

IV: _____

DV: _____

CV 1: _____

CV 2: _____

How would you measure the DV?

(Write 1 sentence describing what you would observe or record.)

1: The Skeletal and Muscular Systems - Reflection Questions

01

How might knowing that your bone density is still building during your teen years change the way you think about your daily habits?

Think about specific things you do — or do not do — every day. What factors does the article say affect bone development during adolescence?

02

Should bone health education be a required part of school physical education? Why or why not?

Think about when bone density is built and how long the effects last. Who has access to this information and who does not?

1: The Skeletal and Muscular Systems - Data Analysis

Muscle Fatigue and Resistance Load Grip Squeezes Per Minute at Three Resistance Levels Over Five Trials

Trial	Low Resistance (squeezes min)	Medium Resistance (squeezes min)	High Resistance (squeezes min)
1	52	41	28
2	49	36	21
3	47	31	15
4	45	27	10
5	44	23	6
<i>Independent Variable: Resistance level of the clothespin</i> <i>Dependent Variable: Number of squeezes completed per minute</i>			

A student tested how quickly her hand muscles fatigued at three different resistance levels. She squeezed a clothespin as many times as possible during each one-minute trial, resting 30 seconds between trials. The number of squeezes per minute was recorded for each trial.

Analysis Questions

Question 1 — Basic Interpretation

How many squeezes per minute did the student complete during Trial 3 at high resistance?

Question 2 — Pattern Identification

Describe how the number of squeezes changed from Trial 1 to Trial 5 for the high-resistance group. How does that compare to the low-resistance group?

Question 3 — Application

Based on the data, what does this table suggest about how resistance level affects skeletal muscle fatigue? How does this connect to what you learned about how skeletal muscles work?

1: The Skeletal and Muscular Systems - Hypotheticals

Scenario 1: The Tendon Injury

A high school sprinter tears her Achilles tendon three weeks before the state championship. Her calf muscles are completely healthy and undamaged. Doctors confirm the muscle itself is fine, but she still cannot push off the ground to run.

- a) What is the function of a tendon in the muscular system?
- b) Why can the sprinter not run even though her muscles are not damaged?
- c) What does this injury reveal about how bones, muscles, and tendons depend on each other?

Scenario 2: The Resting Heart Rate

A student measures her resting heart rate and gets 72 beats per minute. Her older brother, who does not exercise, gets 88 beats per minute. Both are sitting quietly, and neither is sick — the only real difference between them is their lifestyle and activity level.

- a) What type of muscle controls the heartbeat — and is it under voluntary control?
- b) According to the article, what is the typical resting heart rate range for cardiac muscle?
- c) What does the difference in their heart rates suggest about how lifestyle affects cardiac muscle function?

1: The Skeletal and Muscular Systems - Vocabulary

TERM	DEFINITION
Cardiac Muscle	
Compact Bone	
Fulcrum	
Marrow	
Skeletal Muscle	
Skeletal System	
Smooth Muscle	
Spongy Bone	
Tendon	
Voluntary Muscle	

The Skeletal and Muscular Systems

E P V C I S K E L E T A L S Y S T E M C L V J R
P T F B C S I S C V I H H Y U E E W B G P W B Q
M B D N O L I J M J R Q X V N X I T Z E Z I R D
J U N S M E J A D O E X R P Y U F C P V C Q E T
T A D N P R C S W P O G W T B Z C P W K V K S H
S G D P A H P D N Z Y T X G A Q X S M Y O R Z H
B K H N C U W R S X D L H H V S A F E T L R V K
I H S M T U D E F P Z L K M P Z N I C T U S P A
J R V A B G A N H W O B A C U S V Q Q S N X J F
C Y R R O Z X C S F J N E A Z S S Q G G T E I I
H K E R N D T E E W S B G H A Z C V H Z A B Z G
F H C O E G R E S J N Y Q Y K U M L Y J R G V S
Q V A W I M U S L S G H J D B D D R E C Y H P A
G K R P U T C F V B C S J U I O K T H L M O A A
Z T D J T Y K O N F V J J T U E N F Z K U O B H
W G I X A F P Z M Y L M Q S K S X E T K S V N J
E A A N T Y K K D F U L W B M W Z P E Y C C A G
W D C S K E L E T A L M U S C L E E N D L L Z U
E P M K M Z F E H B U N X G E S X C D A E T X T
I Q U D S H K K B X H X K Y I V M Z O K R P Z M
Z J S G J G K M M W F U L C R U M B N O W X V Y
P Q C K Y I X V Y E K K K C C T U S F I Y E Z E
X W L V M A V P O T H I L J M N E O L J A T B P
Z T E B A V O F Y M B C X R X E L K W E R L T R

Voluntary Muscle

Spongy Bone

Smooth Muscle

Skeletal System

Skeletal Muscle

Compact Bone

Cardiac Muscle

Tendon

Marrow

Fulcrum

The Skeletal and Muscular Systems

Across

4. The only type of muscle under your voluntary, conscious control; it attaches to bones by tendons and produces body movement. ____

Muscle

6. Involuntary muscle found in the walls of internal organs and blood vessels that works automatically to move food and regulate blood flow. ____

Muscle

9. A muscle whose contractions you consciously control, such as the bicep or tricep used when bending or straightening the arm. ____

Muscle

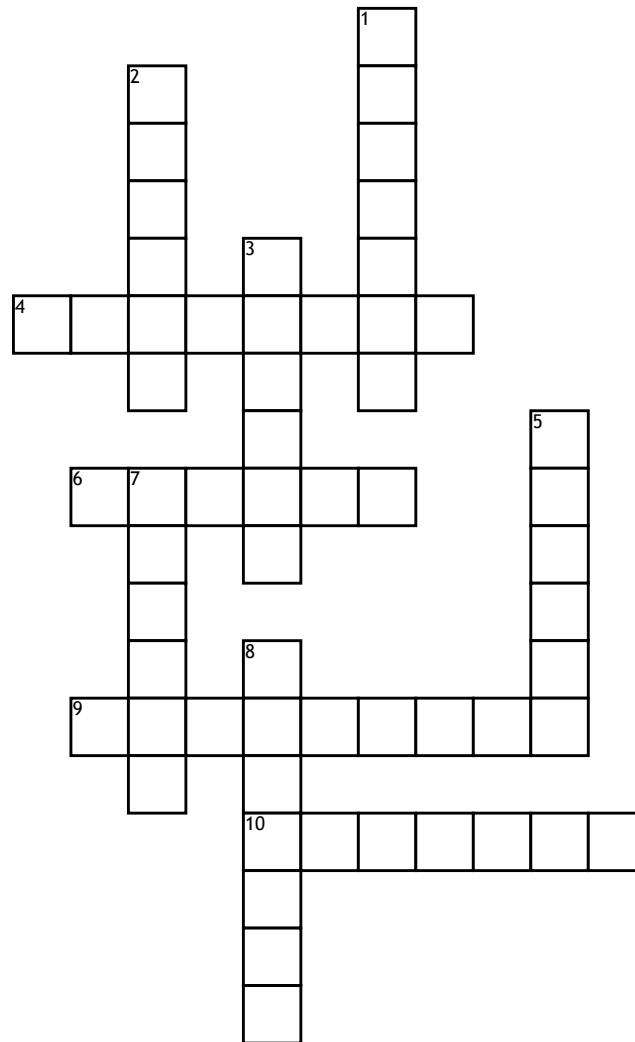
10. The dense, hard outer layer of bone that gives the skeleton its strength and ability to handle pressure and force. ____

Bone

Down

1. A type of muscle found only in the heart that contracts automatically and never stops, keeping blood pumping throughout your life. ____

Muscle



2. The framework of bones and joints that supports and protects the body, produces blood cells, and stores minerals like calcium.

Skeletal ____

3. Tough, fibrous connective tissue that attaches skeletal muscle to bone and transmits the force of a muscle contraction to produce movement.

5. The lightweight inner layer of bone with a lattice-like structure that provides strength without adding excessive weight.

____ Bone

7. The soft tissue found at the center of certain bones where red blood cells, white blood cells, and platelets are produced.

8. The fixed pivot point around which a lever rotates; in the body, joints serve as the fulcrum in the bone-muscle lever system.