

## Chapter 1 - Guided Notes Answer Key

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### Three Most Important Concepts

Concept 1: Bones are living tissue with multiple layers; they grow, repair themselves, store calcium, and produce blood cells in the marrow.

Concept 2: There are three types of muscle — skeletal (voluntary), smooth (involuntary, in organs), and cardiac (involuntary, in the heart) — each with a distinct function.

Concept 3: Bones and muscles work together as a lever system, with muscles pulling on bones via tendons and joints acting as the fulcrum to produce movement.

### Fill-in-the-Blank

1. compact
2. marrow
3. Skeletal
4. blood pressure
5. joints

### Matching

|                |   |
|----------------|---|
| Cardiac muscle | B |
| Compact bone   | C |
| Spongy bone    | D |
| Tendon         | A |
| Smooth muscle  | E |

### True | False

1. T — The article states: “bone is living tissue. It grows, repairs itself, and changes throughout your entire life.”
2. F — The article states cardiac muscle “contracts automatically like smooth muscle,” meaning it is not under voluntary control.
3. T — The article states: “About 99% of your body’s calcium is stored in your bones.”
4. T — The article states: “Skeletal muscles attach to bones by tough, fibrous connective tissue called tendons.”
5. F — The article states the adult skeleton contains 206 bones; teenagers may have slightly more because some bones have not yet fused.

### Application Question

Beyond support, bones produce blood cells in the marrow and store about 99% of the body’s calcium. The body draws on that calcium reserve for muscle contractions, nerve signals, and other processes.

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### Fill in the Table

| Muscle Type                   | Key Characteristic or Function                                                                |
|-------------------------------|-----------------------------------------------------------------------------------------------|
| Skeletal Muscle               | The only muscle under voluntary (conscious) control; moves limbs and body                     |
| Smooth Muscle                 | Involuntary; lines organs and blood vessels; regulates digestion and blood pressure           |
| Cardiac Muscle                | Found only in the heart; contracts automatically at typically 60–100 times per minute at rest |
| Skeletal Muscle — Attached By | Tendons (tough, fibrous connective tissue)                                                    |
| Cardiac Muscle — Location     | Found only in the heart                                                                       |

### 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 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 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

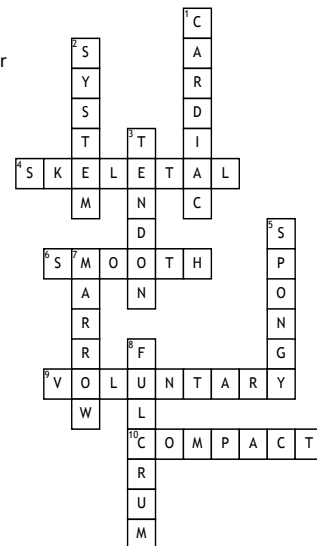
2. The framework of bones and joints that supports and protects the body, produces blood cells, and stores minerals like calcium. \_\_\_\_\_ Skeletal \_\_\_\_\_

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. \_\_\_\_\_



## Chapter 1 - Hypothetical & DV|IV Answer Keys

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### Hypotheticals: Built to Move — The Skeletal and Muscular Systems

Sample answers — accept other reasonable responses grounded in the article.

#### Hypothetical 1 — The Tendon Injury

- a) Tendons attach skeletal muscle to bone and transfer muscle force to produce movement.
- b) Without the tendon, the muscle's force has no path to the bone — movement stops even with a healthy muscle.
- c) All three components must be intact; damage to any one part breaks the lever system.

#### Hypothetical 2 — The Resting Heart Rate

- a) Cardiac muscle; it is involuntary and not under conscious control.
- b) Typically 60–100 beats per minute at rest.
- c) Lifestyle affects how efficiently cardiac muscle functions, even though it operates automatically.

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### IV|DV Analysis Sheet — The Skeletal and Muscular Systems

Accept other reasonable CVs and predicted outcomes grounded in the article.

#### Scenario 1 — Calcium and Bone Density

- IV: Daily calcium intake (mg|day)
- DV: Bone density at end of study
- CV 1: Age of participants | CV 2: Study duration
- Predicted Outcome: Higher calcium intake will produce greater bone density; teen-year nutrition permanently affects bone strength.

#### Scenario 2 — Resistance Load and Muscle Fatigue

- IV: Clothespin resistance level (standard vs. high)
- DV: Squeezes per minute
- CV 1: Trial duration (1 minute) | CV 2: Rest time between trials
- Predicted Outcome: High-resistance group will fatigue faster and complete fewer squeezes per minute.

#### Design Your Own — Sample Answer

- Hypothesis: If a teenager does more weight-bearing exercise per week, then their bone density will be higher, because the article's case study shows active teens built measurably denser bones.
- IV: Amount of weight-bearing exercise per week
- DV: Bone density
- CV 1: Age | CV 2: Daily calcium intake
- Measurement: Bone density scan at start and end of study; compare the difference.

## Chapter 1 - Reflection Questions & Data Analysis Answer Keys

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### Reflection Questions: Built to Move — The Skeletal and Muscular Systems

Sample answers — reflection questions are open-ended; accept any response that shows thoughtful engagement with article concepts.

#### Reflection 1 — Personal Relevance

I did not realize my diet right now is directly shaping my bones for the next 50 years. The article says calcium and vitamin D during the teen years have a permanent effect on bone strength. I probably need to take that more seriously instead of waiting until I am older.

#### Reflection 2 — Societal Impact

Bone health education should be required because the window for building bone density closes in the mid-twenties. Most students have no idea their habits right now have lifelong consequences. Schools already teach nutrition, but connecting it to bone science makes it concrete and urgent.

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### Data Analysis: Muscle Fatigue and Resistance Load

Accept other reasonable answers that reference the data and connect to article concepts.

IV: Resistance level | DV: Squeezes per minute

**Q1:** 15 squeezes/min (Trial 3, High Resistance column)

**Q2:** The high-resistance group dropped from 28 to 6 squeezes per minute — a steep decline of 22. The low-resistance group dropped only 8 (52 to 44). Higher resistance caused much faster fatigue; the rate of decline increased with resistance across all groups.

**Q3:** Higher resistance forces skeletal muscle to generate more force per contraction, depleting capacity faster. This matches the article's point that skeletal muscle is voluntary and fatigable, unlike cardiac muscle, which never stops.

**Teacher note:** Students often assume the 30-second rest fully restores muscle — the data shows it does not. Extension: What would Trial 6 look like for the high-resistance group?

# Chapter 1 - Lecture Notes

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## Teacher Lecture Notes: Built to Move The Skeletal and Muscular Systems

**Lesson Focus:** Bone structure and function, three muscle types, the bone-muscle lever system.

### Opening the Lesson

- Ask students what they think bones are made of. Most will say “calcium” or “minerals.” Use this to pivot: bone is living tissue, not just a mineral scaffold.
- Ask if anyone has ever broken a bone or knows someone who has. Brief discussion — then connect: healing happened because bone is alive.
- Establish the big idea early: the skeletal and muscular systems do not work in isolation. They are one integrated movement machine.

### Concept 1: The Skeleton — Structure and Function

- The adult skeleton has 206 bones. Teenagers may have slightly more because some bones have not yet fused — growth plates are still active during high school years.
- Bone has layers: **compact bone** (dense outer shell, handles compressive force), **spongy bone** (lightweight lattice interior, adds strength without bulk), and **marrow** (soft core in long bones — red marrow produces blood cells; yellow marrow stores fat).
- The femur is approximately 48 centimeters (19 inches) in adults and is the strongest bone in the body. The stapes in the ear is only about 3 millimeters (0.1 inches) — smallest bone in the body.
- Emphasize that bones are a **mineral reservoir**: about 99% of the body’s calcium is stored in bone tissue. The body draws on this constantly — for nerve signals, muscle contractions, and dozens of other functions.
- Teen nutrition point: calcium and vitamin D during adolescence have a permanent effect on bone strength. This is not abstract — it applies directly to students’ lives right now.
- Bone density peaks between ages 25 and 30. The teen years are the most important window for building “bone capital.”

### Concept 2: Three Types of Muscle

- Begin with what students already know: the muscles they can flex (skeletal). Then build out to smooth and cardiac.
- **Skeletal muscle**: voluntary, striated, attached to bone via tendons. Controls all deliberate movement — walking, lifting, writing. Fatigues with use.
- **Smooth muscle**: involuntary, found in organ walls and blood vessels. Moves food through the digestive system, controls blood pressure by adjusting vessel diameter. Students cannot feel it working.
- **Cardiac muscle**: involuntary, found only in the heart. Has properties of both skeletal (striated, strong) and smooth (automatic). Contracts typically 60–100 times per minute at rest. Never stops throughout a person’s lifetime.
- Key contrast for students: skeletal muscle tires out; cardiac muscle does not.
- Tendons connect skeletal muscle to bone. They have very little stretch compared with muscle fibers — they act as force-transfer cables. A torn tendon ends movement even when the muscle is intact.

### Concept 3: The Bone-Muscle Lever System

- Define a **lever**: a rigid structure that rotates around a fixed point (the **fulcrum**).
- In the body: **bone = lever**, **joint = fulcrum**, **muscle contraction = force**.
- Use the elbow curl as a class demo. Students can do it at their desks. Ask: where is the fulcrum? (elbow joint) What is the lever? (forearm) What provides force? (bicep)
- Introduce **opposing muscle pairs**: bicep and tricep. One contracts while the other relaxes. This is how all controlled limb movement works — it is not a single muscle doing all the work.
- Reinforce the tendon role: the force generated by a muscle is only useful if the tendon transmits it to the bone correctly. This explains why tendon injuries are so debilitating.

### Case Study: Bone Capital

- Share the study finding: teens who engaged in weight-bearing exercise had measurably denser bones even decades later.
- Weight-bearing exercise examples: running, gymnastics, soccer, hiking, strength training — not swimming or cycling (those are lower-impact on bone).
- Connect: students in their teens are in the prime bone-building window. After 30, net bone loss begins for most people.

### Discussion Questions

1. If bone is living tissue, what does that tell us about how the body might respond to a fracture — and why might healing take weeks instead of hours?
2. Smooth muscle keeps your digestive system moving and your blood vessels regulated. What might happen if smooth muscle stopped working in just your blood vessels?
3. A patient has a completely intact bicep muscle but cannot bend their elbow after an injury. What part of the lever system was most likely damaged, and how does that explain the loss of movement?
4. Bone density peaks in your mid-twenties. If a person spent their teen years mostly sedentary and eating a low-calcium diet, what are the likely consequences by the time they are 60?
5. Cardiac muscle contracts about 60–100 times per minute at rest, never stopping. How is it physically possible for a muscle to work that continuously without fatiguing the way a bicep does?