

What's Included?

Unit Planning

- State & NGSS Standards document
- Unit Pacing Guide for 50 min classes
- Vocabulary terms for prefix/suffix work
- Differentiation ideas for honors students and virtual students ***Digital links for virtual learning found here**
- Honors assignment list

Notes

- 31-slide Skeletal System PowerPoint presentation
- Cornell Notes Pages
 - Fill-in-the-blank (5 pgs)
 - Editable versions of all Cornell notes
- Doodle Notes (9 pgs)
 - Guide to Using Doodle Notes
 - Doodle Note Keys & Examples

Activities

- Candy Compact Bone Modeling Activity (1 pg)
- Bone Bingo (1 pg + 69 slides)
- Body Proportions Activity (3 pgs)
- Joint Action Activity (3 pgs + 2 reference pgs)
- Skeletal System Disease Infographic Activity (4 pgs)
- Answer Keys for all activities

Student Pages

- This folder contains duplicate copies of every student page. They are in order according to the pacing guide for QUICK PHOTOCOPYING if you are using the pacing guide as is.

Extensions

- Digging Deeper: Bone Markings & Mapping* (2 pgs)
- Digging Deeper: Fractures (2 pgs)
- Skeletal Homeostasis (1 pg)
- Data Analysis: Bone Density in Space* (1 pg)

*Honors Options

Review and Assessment

- Editable Task Card Review (20 cards) with answer sheet
- 4 bone labeling diagrams- full skeleton, skull, long bone anatomy, joint anatomy (with answer keys and premade quizzes)
- Bone Structure Quiz through Google Forms
- Skeletal System Test (paper)- both Honors and Regular versions with answer sheets

Unit Planning:

NGSS and State Standards Document

If your state isn't listed, contact me by email (support@suburbanscience.com) and I'll help you figure out which ones are covered!

Included Resources by Folder:

What's Included?



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- 31-slide Skeletal System PowerPoint Presentation
- Cornell Notes Pages (5 pgs)
- Editable Cornell Notes (5 pgs)
- Cornell Notes Keys (5 pgs)
- Doodle Notes Pages (9 pgs)
- Guide to Using Doodle Notes
- Doodle Note Keys & Examples (18 pgs)

Activities

- Candy Compact Bone Modeling Activity (1 pg)
- Bone Bingo (1 pg + 69 slides)
- Body Proportions Activity (3 pgs)
- Joint Action Activity (3 pgs + 2 reference pgs)
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*Honors Options

Review and Assessment

- Editable Task Card Review (20 cards) with answer sheet
- 4 bone labeling diagrams- full skeleton, skull, long bone anatomy, joint anatomy (with answer keys and premade quizzes)
- [Bone Structure Quiz through Google Forms](#) (Make a copy of this file to your Drive. Do NOT assign to students using this link.)
- Skeletal System Test (paper)- both Honors and Regular versions with answer sheets

Student Pages

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Supplementary Resources

- Analyze Halloween skeletons for accuracy (find cheap skeletons at Target, Walmart, etc.)
- If your school has a disarticulated skeleton, students can work to put it together correctly.
- Make models of bones with clay- works particularly well for vertebrae ([example](#))
- [Video: Skull Bones Mnemonic](#)
- [Anatomy Arcade: Whack-A-Bone Identification Practice Game](#)
- [Bone Composition Lab: Bend-A-Bone](#)
- [Case Study on Paget's Disease](#)

Materials Needed

- General classroom use: colored pencils, markers, and crayons, index cards for prefixes and suffixes
- Candy Compact Bone Lab: Pull-n-peel Twizzlers, Nerds or other small candy, Swiss Rolls
- Digging Deeper- Fractures: whole carrots (enough for every pair of students to have 2-3)
- Body Proportions Lab: tape measures, calculators

Not included:

Skeletal System Unit Guide

Standards:

Topic:	State:	Standards:
Physiology of Bones	OH	AP.SM.2 Processes of the skeletal system include hematopoiesis, ossification and bone growth and remodeling.
	CO	Standard V, Objective 2 -Compare and contrast compact and spongy bone and the location and function of each.
	IN	APA.1 Develop a model to illustrate the structure, development, growth, and function of compact and spongy bone.
	UT	Strand 5, Standard -Identify the roles of osteocytes.
Joints	FL	None
	OH	AP.SM.2 Joints can be classified as fibrous, cartilaginous, or synovial.
	CO	Standard V, Objective 2 -Identify the types of cartilaginous joints.
	IN	APA.3 -Identify and describe components of the skeletal system.
Diseases of the Skeletal System	UT	Strand 5, Standard -Describe and differentiate the roles of osteocytes.
	FL	None
	OH	AP.SM.2 Homeostasis of the skeletal system involves the regulation of bone mass and bone structure.
	CO	Standard V, Objective 2 -Describe the role of osteocytes in bone structure.
	IN	None
	UT	Strand 5, Standard -Identify the roles of osteocytes.
	FL	None

*Note: NGSS is a registered trademark that developed the Next Generation product, and do not endorse it.

Standards:

Choosing Standards:

Although many states use NGSS, there are some states that do not. I worked hard to find other state standards, but if yours are not addressed, please send me an email at support@suburbanscience.com and I can help you determine which of your state standards are covered in this unit. Thank you!

NGSS for the Unit:

- HS-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- HS-LS1-3: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Skeletal System Unit Guide

Topic:	State:	Standards:
Structure of Bones and Bone Cells	OH	AP.SM.2 The skeletal system is composed of bones, cartilage, joints and ligaments. Bones make up most of the skeleton. There are four main cell types that compose bone tissue, each with a specific function: osteogenic cells, osteoblasts, osteocytes, and osteoclasts. The microscopic anatomy of compact bone includes osteons. Bones are classified by their shape. The structure of a typical long bone can be explored. Specific bones of the skeleton can be studied by their subdivisions: the axial skeleton and the appendicular skeleton. Cartilage is found in areas of the nose, ears, ribs and joints. The skeletal system provides support for the human body, protects soft organs, allows for movement due to attachment of muscles, stores minerals and fat and forms blood cells.
	CO	Standard V, Objectives 1-3 -Identify the five functions of the skeletal system. -Compare and contrast compact and spongy bone and the location and function of each. -Differentiate the axial and appendicular skeletons.
	IN	APA.1.2 -Develop a model to illustrate the structure, development, growth, and function of compact and spongy bone. -Evaluate the general macroscopic characteristics of a typical long bone, then locate and identify individual bones and bone features.
	UT	Strand 5, Standards 1-5.7-8 -Identify the general functions of the skeletal system. -Identify the roles of the following in bone growth and ossification: osteoblasts, osteocytes, osteoclasts. -Describe the features of a long bone. -Identify the four shapes of bones with characteristics and examples of each. -Describe and locate the following bone markings: Foramen, meatus, sinus, condyle, tuberosity, trochanter, tubercle, process. -Contrast the axial and appendicular skeletons. -Locate the following bones: mandible, maxilla, zygomatic, frontal, parietal, occipital, sphenoid, ethmoid, hyoid, temporal, clavicle, scapula, sternum, ribs, pubic bone, femur, patella, tibia, fibula, tarsals, metatarsals, phalanges, humerus, ulna, radius, carpals, metacarpals, vertebrae.
	FL	SC.912.L.14.12-14 -Describe the anatomy and histology of bone tissue. -Distinguish between bones of the axial skeleton and appendicular skeleton. -Identify the major bones of the axial and appendicular skeleton.

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Unit Overview Page

plus

Supplementary Resource Ideas and Materials Lists

Editable Pacing Guides

	Day	Intro	Instruct	Assess	Homework
Joints	7	Prefix/suffix flashcards: • femor-	<ul style="list-style-type: none"> Skeletal System PPT- Section 5 Cornell Notes (Movement of the Appendicular Skeleton) Bone Bingo for students that need review Honors: Digging Deeper: Bone Mapping 	<ul style="list-style-type: none"> Cornell Notes summaries Informal discussion and questions Informal check of bone identification accuracy during Bone Bingo 	Honors: Finish Digging Deeper: Bone Mapping
	8	Review prefix/suffix flashcards	<ul style="list-style-type: none"> Joints Activity Diagrams- Skeleton, Skull, & Joint 	<ul style="list-style-type: none"> Informal discussion and questions Check for accuracy on diagrams- no grade necessary 	
Diseases of the Skeletal System	9	Review prefix/suffix flashcards or play Bone Bingo	<ul style="list-style-type: none"> Skeletal System Disease Infographic Activity (need computers) 	<ul style="list-style-type: none"> Informal questioning during infographic worktime Student planning pages (simply observe for progress) 	
	10	Review prefix/suffix flashcards or play Bone Bingo	Finish Disease Infographics	Infographic grading rubric	Finish Disease Infographics if not finished
Review	11	Review prefix/suffix flashcards or play Bone Bingo	<ul style="list-style-type: none"> Collect Disease Infographics Task Card Review 	<ul style="list-style-type: none"> Observe during Informal discussion 	
Assess	12	Review notes for test	Skeletal System Test	Formative	

Using this Pacing Guide as is? You can print all the student pages in order from the "Student Pages" tab.

The daily topic coincide with the previous standards document.

Lesson planning is now quick and easy!

Skeletal System Unit Pacing Guide

	Day	Intro	Instruct	Assess	Homework
Structure of Bones and Bone Cells	1	Students add to prefix/suffix flashcards: • epi-, peri-, -physis	<ul style="list-style-type: none"> Skeletal System PPT- Section 1 & Section 2 Cornell Notes (Intro to the Skeleton & Microscopic Anatomy of Bone) 	<ul style="list-style-type: none"> Cornell Notes summaries Informal discussion and questions 	
	2	Prefix/suffix flashcards: • osteo-, trabecul-	<ul style="list-style-type: none"> Candy Compact Bone Lab Materials: Pull-n-peel Twizzlers, Nerds or other small candy, Swiss Rolls Diagram of Long Bone With extra time, look at a virtual slide of compact and spongy bone at histologyguide.org. 	<ul style="list-style-type: none"> Informal check of accuracy in bone lab model & diagram Have students find features on virtual slides 	
Physiology of Bones	3	Prefix/suffix flashcards: • -clast-, -blast-	<ul style="list-style-type: none"> Skeletal System PPT- Section 3 Cornell Notes (Bone Formation & Remodeling) Skeletal Homeostasis 	<ul style="list-style-type: none"> Cornell Notes summary Informal check of student accuracy on Homeostasis page Informal discussion and questions 	
	4	Review flashcards	<ul style="list-style-type: none"> Digging Deeper: Fractures Materials: whole carrots (enough for every pair of students to have 2-3) Honors: Bone Density in Space 	<ul style="list-style-type: none"> Informal discussion and questions 	Honors: Finish Bone Density in Space All: Study for Quiz
Joints	5	Honors: Collect and/or check homework Prefix/suffix flashcards: • inter-, crani-, cephal-	<ul style="list-style-type: none"> Online Quiz (need computers) Skeletal System PPT- Section 4 Cornell Notes (Axial Skeleton) 	<ul style="list-style-type: none"> Cornell Notes summaries Informal discussion and questions 	
	6	Review prefix/suffix flashcards	<ul style="list-style-type: none"> Complete Body Proportions Lab Materials: tape measure, calculators 	<ul style="list-style-type: none"> Informal check of student comprehension and calculations during lab 	

Coincide with State Standards document in Unit Planning Folder

*Bold items must be photocopied.



This icon is found on the top right corner of Honors pages for easy identification.

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Differentiation Ideas for:

- Student Interest
- Student Ability
- Teaching Pace
- Teaching Environment (Virtual, in-class, or hybrid)

Differentiation

Teaching Environment

Virtual or Hybrid students

Digital Options:

- Links for PowerPoints
- Digital Students pages using Google Slides™ for students to type on
- Digital Doodle Notes™
- Virtual bone tissue slides can be found on [Histology Guide](#).
- For the **Body Proportions Lab**, students working from home can measure their body proportions and those of their family members.
- For the **Joints Activity**, students working from home can come up with their own motions rather than choosing motion cards in class.
- Bone Bingo is best completed in class. With virtual students, using the [Whack-A-](#)

All found on the following page.

Honors Assignment List


Although there are no official education standards for what makes an "honors" class,

honors assignments generally provide one of three options:

- Greater depth of knowledge
- Additional critical thinking
- More independent work

In this unit, you can find some additional assignments used to increase the knowledge for honors students. **These can certainly be used for all students also be helpful for extra credit, homework, or sub days if you need them.** Because answers to these assignments are often less straightforward, I regrading for completion and then **discussing the answers** to make sure the

Assignment	Type of work	Skills addressed
Data Analysis: Bone Density in Space	Math Extension	Interpretation of raw data graphs (Excel option incl)
Digging Deeper: Bone Mapping	Greater depth of knowledge	Additional vocabulary, & of instruction

All honors assignments are designated by a  in the top right corner identification.


For additional skill-work in pathology or for students thinking of going into the field, I also use my Anatomy case studies. There is one for each body system require critical thinking, research, and allow students to integrate topics body system to another.

[Click here to see the Case Studies](#)

Differentiation

Student Ability

Advanced students

- Honors options are included in the student pages. These can be given to a whole advanced class or individual students, as needed. They are marked with the  icon.
- To identify additional bones besides those on the PowerPoint

s (found in the Notes folder)

n-the-blank notes on the right side leaving only questions for a ent note-taking experience.

mary and allow students to come up with their own.

quizzes, use the option without the word bank and/or grade on res.

idents to use prefix/suffix flashcards on the test.

rs" tests that don't have word banks for the diagrams and nal short answer questions.

k altogether may work well for students that have trouble y or have home situations that don't allow for work outside of count for the extra class time needed to complete all

o students during labs and answer questions as they complete students may need to have each lab answer discussed and day rather than grading the labs for accuracy.

minated for these students in order to simplify material.

s (found in the Unit Planning folder)

he-blank style of notes for these students so they can focus on ss on summarizing.

the-blank summary see if students can come up with the

Differentiation

Differentiation is a key component to any unit. Here are some tips for differentiating based on student interest, ability and teaching environment.

Student Interest/Choice

- Both Cornell notes and Doodle Notes™ are included in this unit. Although most of my students preferred the Doodle Notes™, they may not resonate with everyone. Some students may prefer the structure of the Cornell notes.
- Students can choose the disease topic of their choice for the skeletal disease activity. Some may have a topic that is not listed and it is helpful to allow students to follow those interests.
- For the **Candy Compact Bone** activity, students can easily make models with clay or dough rather than candy, if they prefer. If you already have the modeling clay, it may also be cheaper than purchasing candy.
- When discussing fractures, students with an interest in the medical field or EMS may want to pursue first aid training further. There are online courses through the Red Cross or local certification courses that are easily found through an internet search.
- When discussing bone density in space, students that are interested in the space field may want to investigate [other research studies](#) conducted on the International Space Station.

Cornell Notes

OR

Doodle Notes

The Axial Skeleton

What are the 2 major sections of the skeleton?

What bones are found within the axial skeleton?

What is the structure of the vertebral column?

The vertebral column extends from the skull to the pelvis. It provides support and protection for the brain and spinal cord. It is composed of 26 vertebrae and 9 sacral segments. The vertebrae are divided into cervical, thoracic, lumbar, and sacral regions. The cervical vertebrae are the neck vertebrae, the thoracic vertebrae are the chest vertebrae, the lumbar vertebrae are the lower back vertebrae, and the sacral vertebrae are the sacrum. The sacrum is a triangular bone formed by the fusion of five sacral vertebrae. The coccyx is a small tailbone at the bottom of the spine.

The skull is divided into the cranium and the facial bones. The cranium is the part of the skull that houses the brain. The facial bones are the part of the skull that forms the face. The skull is composed of 22 bones. The cranium is composed of 8 bones and the facial bones are composed of 14 bones. The skull is protected by the meninges and the cerebrospinal fluid.

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Vertebral Column

Label the sections of the vertebral column in the boxes.

CERVICAL

THORACIC

LUMBAR

SACRAL

COCYX

What is different about the sacrum from the other vertebrae?

These vertebrae fuse during adolescence.

Transfer your knowledge from the previous lesson to this one. Provide a summary of the vertebral column.

Every student page also comes in a **digital** version on Google Slides

Virtual, hybrid, or absent students can stay right on track!

Intro to the Skeleton

What are the functions of the skeletal system?

1. Support- Bearing the weight of the body
2. Protection- Encasing essential organs (ex: ribcage)
3. Movement- Joints provide movement for bones
4. Storage- Storage of minerals to be released into the bloodstream; storage of fat in yellow bone marrow
5. Manufacturing- production of red & white blood cells from red bone marrow

How are bones classified?

Bones are a solid matrix of living cells and fibers surrounded by calcium deposits.

Bones are classified by their shape.

What are the anatomical features of a long bone?

Long bones have 2 basic regions:

- Diaphysis: shaft, long part of bone
- Epiphyses: ends of bone

Between these layers is a thin layer of internal cartilage called the epiphyseal plate (growth plate).

The ends of the epiphyses are covered with an external layer of cartilage called articular cartilage, which provides smooth movement of joints and cushion from shock.

In the diaphysis of the long bone, a hollow medullary cavity is found.


Red bone marrow fills the cavity in young people.

Age causes the red marrow to be replaced with fatty yellow bone marrow.

It is within the bone marrow that new blood cells are produced (called hematopoiesis).

Summary

The skeletal system provides many functions for the body. Bones are classified by shape and have a specific structure with bone marrow in the center of the diaphysis and articular cartilage surrounding the epiphyses.



Intro to the Skeleton

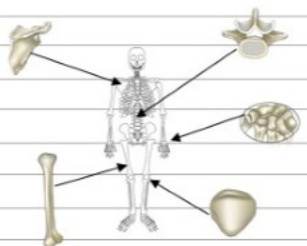
What are the functions of the skeletal system?

1. Support- Bearing the weight of the body
2. Protection- Encasing essential organs (ex: ribcage)
3. Movement- Joints provide movement for bones
4. Storage-
5. Manufacturing-

How are bones classified?

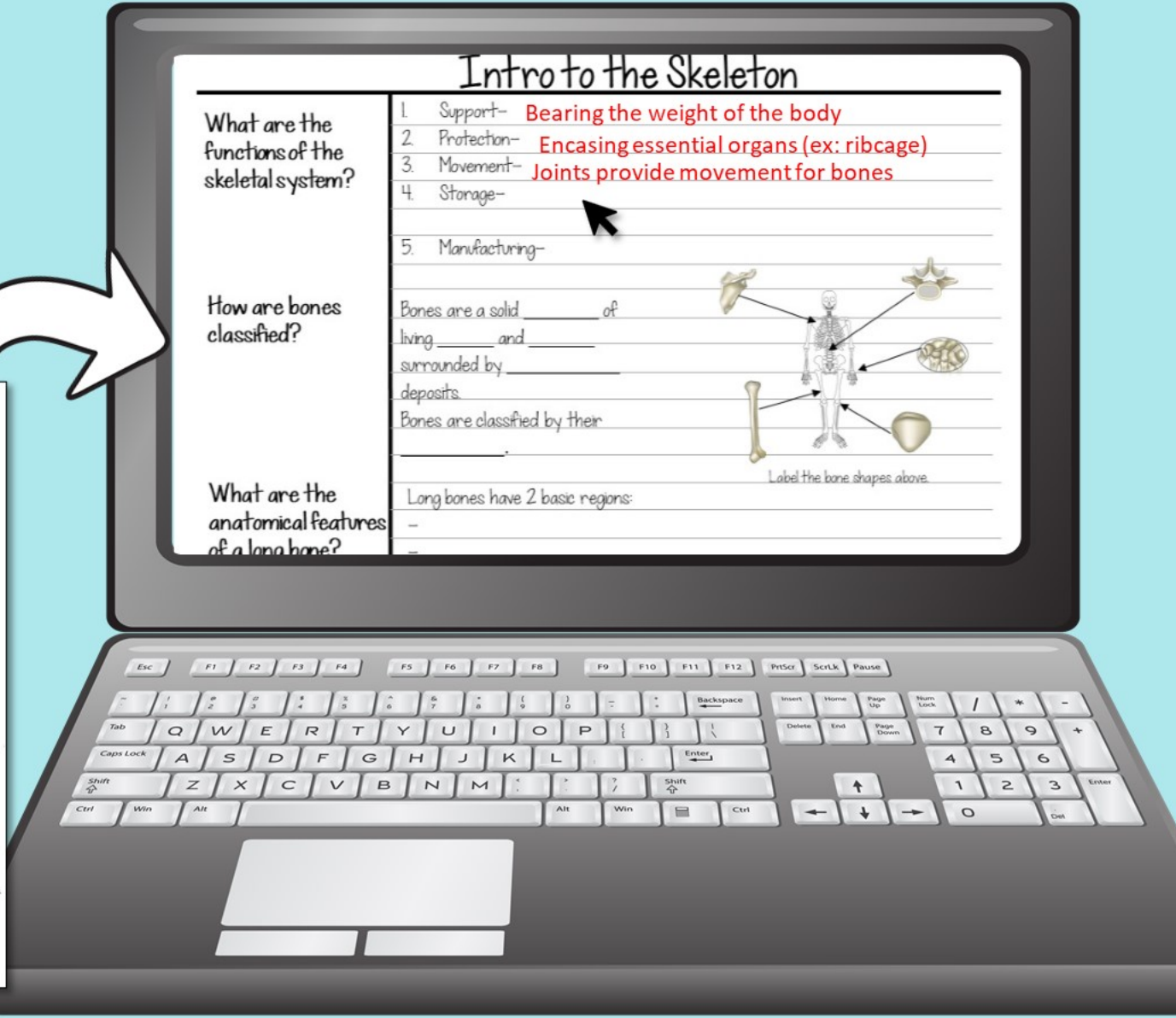
Bones are a solid _____ of living _____ and _____ surrounded by _____ deposits.

Bones are classified by their _____.



Label the bone shapes above.

Long bones have 2 basic regions:



Can be used in Google Classroom, Microsoft OneDrive or many other platforms!

Greek and Latin Roots for Medical Terminology Practice

Anatomical Prefixes/Roots/Suffixes:

Term	Definition
-blast	immature cell, germ cell
crani-	skull
clast-	breaking down
cephal-	head
epi-	upon
femor-	femur
inter-	between
osteo-	bone
peri-	surrounding, around
-physis	growth
trabecul-	little neck

Skeletal System

Using Prefixes/Suffixes in your Classroom:

Why study prefixes and suffixes at all?

The basis of scientific terminology comes from Latin & Greek. By teaching science students Latin & Greek prefixes, suffixes and root words, they can learn to dissect new scientific terms when they come across them in news articles or textbooks. This is a great way to train our students to be scientifically literate adults. Even if they don't remember all the facts they've memorized in this class, they can interpret scientific information from the media and from their own doctors.

How can you use them in class?

- **How I do it:**
 - **Beginning of the year:** I ask students to bring in a stack of 300 3"x5" index cards. I always have a few extra on hand for students that forget or can't afford them, although they're fairly inexpensive.
 - **Beginning of (almost) every class:** I write any prefixes and suffixes that are relevant to that day's topic on the board along with the definition. Students record the prefix/suffix on one side of an index card and the definition on the other. If there aren't any terms for that day, students can review the terms they already have written down.
 - **On test day:** I add approximately two scientific words to the end of every unit test. These are words that relate to the unit but are not ones we have discussed in class. Students must use the prefixes/suffixes we've studied to interpret the meaning of the new term. For on-level or advanced classes, I recommend not letting students use their index cards on the test, but for low-level students, it may be beneficial to allow it.

Crani-

Uses in your Classroom:

Helpful tips for using cards:

- Always have a master list of the terms you've given out or keep your own set of notecards. It may be helpful to have students write the date in the top corner of the card. This allows absent students to copy the terms they missed when they return.
- Starting class with these terms is a great way to give yourself a few more minutes to get organized. Students can always review their index cards or quiz each other if you need a few more minutes.
- Students will need some way to keep the cards organized- put them on a ring, rubber band them together, or keep them in a bag.
- Students add to these index card stacks throughout the year without removing terms. The course builds on itself, so it's always beneficial to review terms from previous units as well as the current unit. You may find that some terms are duplicated from one unit to another. No need to have students write the same term twice.
- For advanced students, you may want to have them look up the definition in a textbook rather than providing it to them.

Be sure to mention these prefixes and suffixes again as they come up in class. Using the terms in context is the best way for students to recognize and remember them.

Prep sub plans:

Students can type the terms into Quizlet or a similar site and quiz themselves.

Students can make up scientific terms (real or not) and have other students interpret the meaning of the term.

Use a blank bingo board (provided on the next page) and have students fill in the definitions for the current or past unit in any blank. The sub can call out a prefix or suffix and students mark off the definition until someone wins bingo.

*This is another important reason to have a master list or set of cards for all the terms students have already learned.

A great way to encourage scientific literacy and prepare students for higher level science courses.

Highly Visual PowerPoint Presentation

31 editable, fully-animated slides

What are the functions of the skeletal system?

Support

- Bearing the weight of the body

Protection

- Encasing essential organs
- Ex: ribcage heart & lungs

Movement

- Joints provide movement for bones

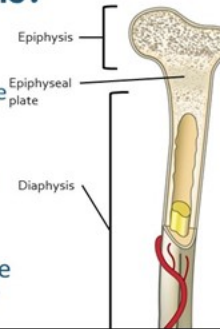
5 Functions of the Skeletal System

Manufacturing

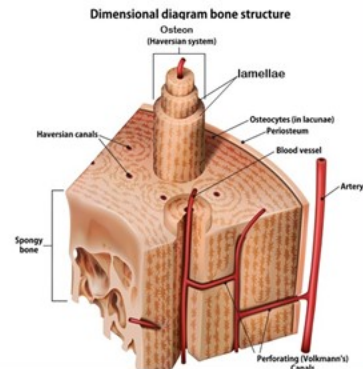
- Production of red & white blood cells from red bone marrow
- Called **hematopoiesis**

What are the anatomical features of a long bone?

- Long bones have 2 basic regions:
 - **Diaphysis**- shaft, long part of bone
 - **Epiphyses**- ends of bone
- Between these layers is a thin layer of internal **cartilage** called the **epiphyseal plate** (growth plate)
- The ends of the epiphyses are covered with an external layer of cartilage called **articular cartilage** which provides smooth movement of joints and cushion from shock.



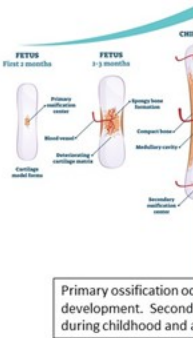
bone is made of cylinders called osteons. The osteons are arranged in concentric circles called lamellae. The lamellae surround a central canal called the Haversian canal, which contains blood vessels and nerves. The Haversian canals are connected by perforating (Volkmann's) canals.



Sample Slides

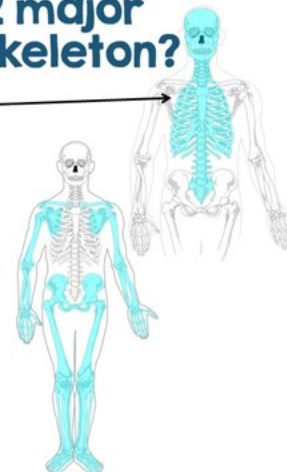
How is bone formed?

- An embryo's skeleton is made of **cartilage**.
- Near the third month of embryo development, **osteoblasts** begin to secrete **mineral** deposits that replace the **cartilage**. The osteoblasts then mature into **osteocytes**.
- This process of incorporating **calcium** & **minerals** into **cartilage** to become bone is known as **ossification**.



What are the 2 major sections of the skeleton?

- **Axial skeleton**-
 - Central axis of the body
 - Skull, ribs, sternum and vertebrae (80 bones)
- **Appendicular skeleton**-
 - Pectoral & pelvic girdles
 - Bones of the arms, legs, pelvis, and shoulders (126 bones)



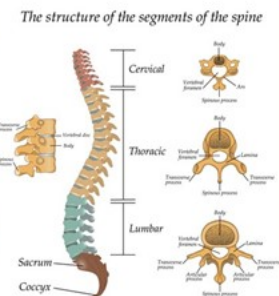
What is the structure of the vertebral column?

The vertebral column extends from the skull to the pelvis. It provides support and protects the spinal cord running through it.

The vertebral column consists of **33** vertebrae at birth, the 5 sacral vertebrae and 4 coccygeal vertebrae of the coccyx **fuse** in **adulthood**. The remaining vertebrae are separated by **intervertebral discs** that provide **cushioning** and absorb **shock**.

Vertebral column counts:

- Cervical vertebrae (7)
- Thoracic vertebrae (12)
- Lumbar vertebrae (5)
- Sacral vertebrae (5 fused)
- Coccyx (4 fused)



Two note-taking styles are included:

Cornell Notes

Microscopic Anatomy of Bone

Where are spongy bone and compact bone found?

How do spongy and compact bone differ?

What are the types and functions of specialized bone cells?

The outer layer of bone is made of tough connective tissue called periosteum. It is the location of muscle, attachment and bone repair. Beneath the periosteum is a thick layer of compact bone. At the ends of long bones the spongy bone layer is beneath the compact bone.


Spongy bone is a lattice of trabeculae ("little beams") that are found along lines of stress for perfect resistance from compression. Between the trabeculae are spaces filled with marrow or blood vessels.

Compact bone is arranged in cylinders called osteons. Osteons are arranged in concentric circles called lamellae. These lamellae surround a central (or Haversian) canal that contains blood vessels and nerves. The central canals are connected by perforating (Volkman's) canals running perpendicularly.


	Osteocytes	Osteoclasts	Osteoblasts
Function:	• mature bone cells • make up most of bone structure	• break down bone	• produce new bone

Canaliculi connect all bone cells, allowing them to receive nutrients and remove wastes.

Summary: Spongy bone contains large spaces while compact bone is made of column-shaped osteons. Specialized bone cells build and destroy bone, while canaliculi keep the bone cells connected to nutrients.



Label the trabeculae and osteons in the images above.



Label the canaliculi.

Doodle Notes

Cancellous (Spongy) Bone

TRABECULAE: "little beams"
The calcified portion of spongy bone that forms to resist the force of compression.

The holes in spongy bone are filled with bone marrow and blood vessels.

OSTEON: The unit of compact bone. Long cylinders surrounding a central canal. Perforating (Volkman's) canals run perpendicularly.

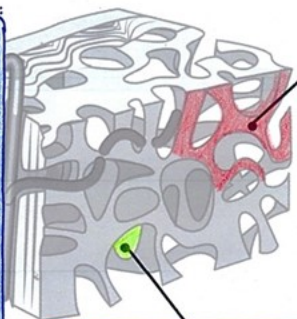
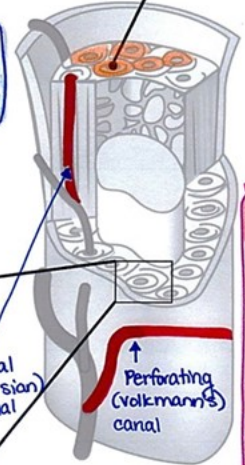
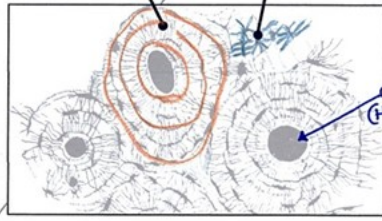
CANALICULI: Connect bone cells, allowing them to receive nutrients and remove waste.

CONCENTRIC LAMELLAE: cylinders of calcified matrix surrounding a central (Haversian) canal.

Compact Bone

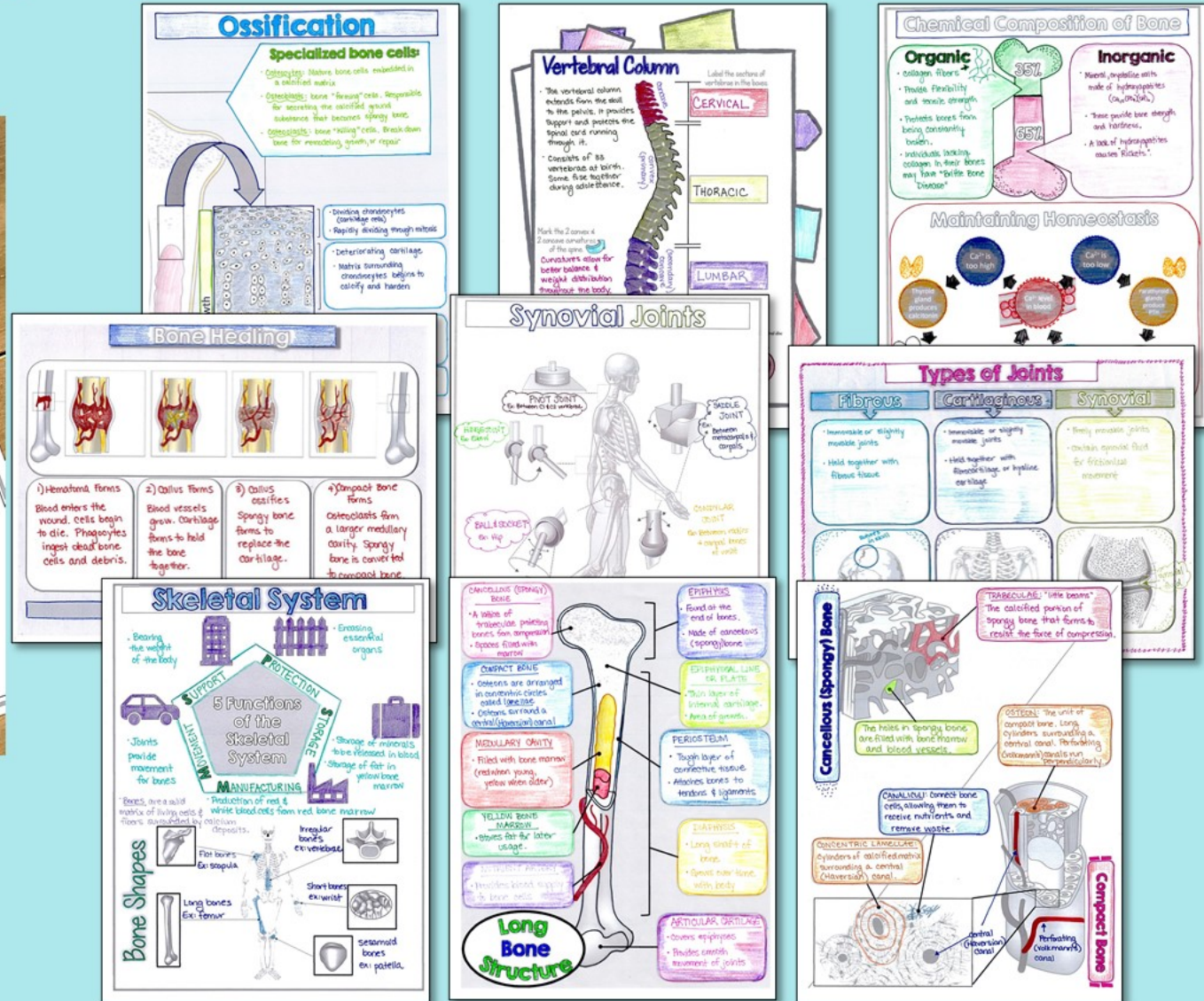
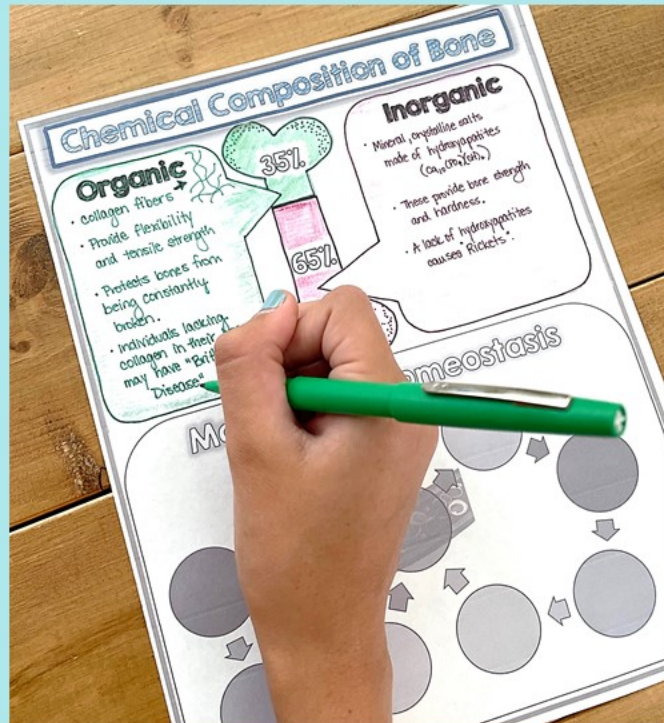
central (Haversian) canal

Perforating (Volkman's) canal

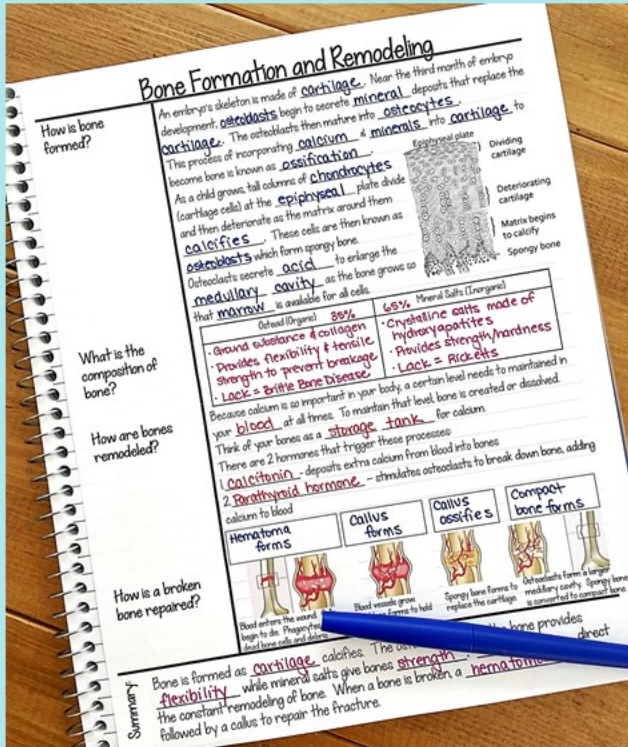
Both coincide perfectly with the presentation for error-proof notes!

9 pages of Doodle Notes



Doodle Notes™ increase student focus and memory-
and they're great fun!
A guide for using them in your classroom is included.

5 pages of Cornell Notes



Big
concept
questions

Content
summary for
each page

Movement of the Appendicular Skeleton

What bones are found within the appendicular skeleton?

How do joints differ structurally?

There are 3 structural types of joints:

	Fibrous	Cartilaginous	Synovial
Description	<ul style="list-style-type: none"> Immovable or slightly movable Held together by fibrous connective tissue 	<ul style="list-style-type: none"> Immovable or slightly movable Held together by cartilage 	<ul style="list-style-type: none"> Highly movable Contain synovial fluid for frictionless motion
Example	Between bones of the skull	Between vertebrae	Knee, elbow

What is the structure of synovial joints?

A joint capsule filled with synovial fluid surrounds the end of the bones.
A synovial membrane and articular cartilage line the joint cavity.

How do ligaments and tendons differ? Ligaments = attach bone to bone
Tendons = attach muscle to bone

Label the following types of joints on the image:
pivot joint, ball & socket joint, saddle joint, gliding/plane joint, hinge joint, condylar joint

Summary: The appendicular skeleton consists of the pelvis, legs, and arms. The bones of the skeleton are connected by joints, which vary in structure and function. Synovial joints are the most moveable and can provide a range of movements based on the shape of the bones involved.

Each page is **editable**.
Add and delete text, questions, and summaries
to meet the needs of your students.

Includes 5 Activities

- Candy Compact Bone Modeling
- Bone Bingo Game
- Bone Proportions Activity
- Joint Action Activity
- Skeletal System Disease Infographic Activity

Candy Compact Bone

Teacher Instructions:

In this activity, students will make a model of a compact bone using candy.

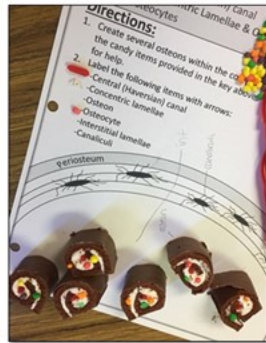
Students should have either a textbook or the Skeletal System PowerPoint to use as a reference.

If necessary, other candies can be used.

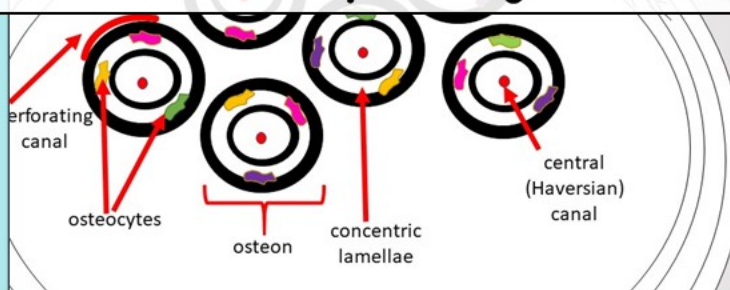
To save money, the Swiss Rolls can be cut in thirds before class begins.

A photographic example provided here. (The licorice is threaded through the Swiss Roll to represent the central Haversian canal.)

An answer key is provided below:



Bone Modeling Sample Page



Bone Bingo

Bone Bingo Game Sample Page & Slides

		FREE		

Fun activity for
working on bone
identification!

Part 3:
Re-record your height in the table below. Then, using a measuring tape, measure your head circumference and record it in the table below. Your head circumference is the distance all the way around your head. If your measuring tape is not flexible, you can wrap a piece of string around your head and measure the length of the string. You may want to have someone else measure it for you. Now, compare your head circumference to your height. A typical head circumference is 33% or one third of someone's height. Find your percentage by using the following formula:

$(\text{Head circumference} \div \text{height}) \times 100 =$

Write the answer in the last space

Height	
Head circumference	
Head %	

Part 4:
Take measurements for at least measurements below.

Femur %	Index %
Wingspan Ratio	

Body Proportions Student Instructions

Background:

The length and width of your bones generally makes up the proportions of your body. Although we're all different, it turns out that our bodies are quite similar. In this activity, you'll see how close your body proportions are to the average.

Part 1:

Using a measuring tape, measure your height and record it in the table below. You may want to have someone else measure it for you. You can measure in inches or centimeters, but whatever units you choose should be consistently used for all measurements in this lab.

Next, measure the length of your femur. Since you can't see your femur, estimate the length by

Body Proportions Activity Sample Pages

Re-record your height in the table below. Using a measuring tape, measure your wingspan and record it in the table below. You may want to have someone else measure it for you. Your wingspan is the distance from the tip of your middle finger to the tip of your other middle finger when your arms are outstretched like a cross.

Now, determine the ratio of your wingspan to your height. A typical wingspan is nearly equal to height. Find your ratio by using the following formula:

$(\text{Wingspan} \div \text{height}) =$

Write the answer in the last space on your table.

Height	
Wing span	
Wingspan/Height =	

Skeletal System Disease Infographic Student Planning Page

Research Notes:

Sources:

Joints Activity

Throwing a baseball

Moving to

Joints Activity

Name: _____

Directions: Pick up a card. Act out the motion described on the card. The rest of the class will guess the motion and write down the bones and types of joints used in that motion.

Joint Action Activity Sample Pages

Chewing gum

Joints used: _____

Joints used: _____

Activity: _____

Activity: _____

Bones used: _____

Bones used: _____

Joints used: _____

Joints used: _____

Activity: _____

Activity: _____

Bones: _____

Joints: _____

Infographic Grading Rubric

Teachers are blank to encourage you to think about creative ways to WOW your teacher!

Approaching Standard	Meets Standard	Above Standard
Uses space, lettering, and colors that confuse information or does not clearly or accurately communicate.	Information is enhanced through use of space, lettering, and colors. • 3+ colors • Main title • headings	
Graphics are confusing or do not meet minimum requirements for	Graphics are carefully chosen and include a minimum of • 1 graph or chart	
	Infographic includes all required elements: • 10-15 words • 10-15 words • 10-15 words	
	Infographic uses 10-15 words correctly and consistently or used incorrectly.	Infographic demonstrates excellent and knowledgeable use of 10 vocabulary words that are on a appropriate level.

Comments:

Skeletal System Disease Infographic Student Instructions

An **INFOGRAPHIC** is a visual representation of information. They present information clearly and concisely. They can also communicate data, patterns and trends.

TASK: Make an infographic to communicate information about your disease or disorder.

STARTING YOUR INFOGRAPHIC:

1. Go to Canva.com or a similar visual creation website. (You can do this simply in PowerPoint, as well.)

2. Browse a free account to find more examples.
3. Select the templates for infographics to get ideas or simply start your own from scratch.

REQUIREMENTS:

1. Create an infographic to communicate
2. Use the following requirements for the infographic:

- Symptoms of the disease
- Treatment of the disease
- 10 scientific or vocabulary words (erythrocyte, etc.)
- 3 separate blocks of information
- Your name

SAMPLE PROJECT:

This is an example of an "A" project. It includes the above requirements as well as extra graphics, charts, and sections where appropriate. Remember, you must communicate thorough information in a concise way. This may mean going above the minimum requirements.



Disease Infographic Activity Sample Pages

Extension Pages

2. Draw a detailed illustration of your chosen bone below.



Digging Deeper: Bone Mapping Student Instructions



Objective: Learn terminology for bone markings and identifying features.

Instructions:

Part 1: Research

1. Use your textbook or the internet to find the definitions of the following bone terms:

- Condyle-
- Foramen-
- Fossa-
- Head-
- Meatus-



- Process-
- Sinus-
- Trochanter-
- Tubercle-
- Tuberosity-

Part 2: Map a Bone

1. Choose one bone from the following list:

Frontal bone of skull

Femur

Rib

Mandible

Ischium

Temporal bone of skull

Scapula

Humerus

Radius

Temporal bone of skull

4. Occasionally, fractures will cause a bone fragment to protrude through the skin. This is called an open or compound fracture. What do you think is an additional concern for individuals with this type of break?



Open / compound

Part 2: Splinting

Watch the following video: <https://www.youtube.com/watch?v=9rQ6PPAPA4I>
Then, answer the questions that follow.

Digging Deeper: Fractures Student Instructions

Objective: Students learn the types of common bone fractures and how to properly provide first aid to an individual with a bone fracture.

Instructions:

Part 1:

1. Review the chart below showing several common types of bone fractures.

Transverse	Oblique	Comminuted	Avulsed	Spiral	Greenstick
The fracture line is perpendicular to the shaft of the bone.	The fracture line is on an angle through the bone.	The bone is broken into three or more pieces.	A tendon or ligament pulls a fragment of bone away.	The bone is broken in a spiral pattern due to twisting.	The bone is bent, but not broken all the way through.
Blunt trauma applied to the bone.	Blunt trauma applied to the bone.	High velocity trauma or falls from great heights.	Indirect force to the bone or twisting motion.	One extremity is twisted while the other is moving.	Very frequently caused by falls, especially in children.
Ex: sports injuries	Ex: sports injuries	Ex: sports injuries	Ex: sports injuries	Ex: sking	

Greater depth of knowledge, scientific literacy, & critical thinking

2. Use your textbook or the internet to find the definitions of the following bone terms:

Which one required the least force?

3. Another way to describe fractures is complete, meaning the bone is broken all the way through, and incomplete, when the break is only partially through the bone. Which fracture on the chart is an incomplete fracture?

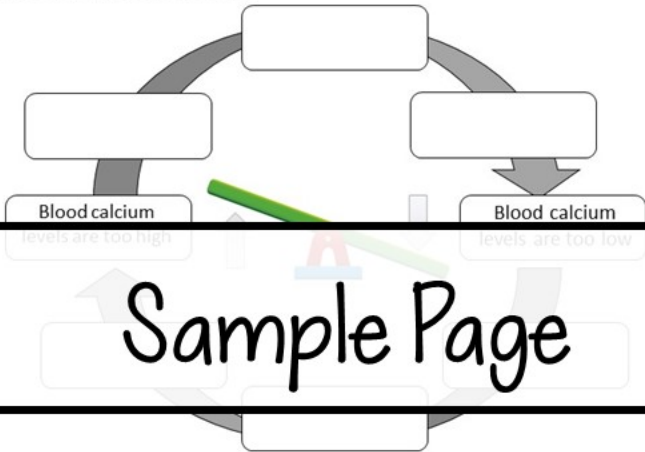
Extension Pages

Skeletal Homeostasis



Calcium Balance

Almost every cell in your body uses calcium in some way. It is used in the movement of muscles and the transportation of electrical impulses through the nerves. The level of calcium in the blood is closely regulated by hormones. Excess calcium is stored in the bones and teeth for future use, if necessary. The two hormones that regulate blood calcium levels are calcitonin, which is produced by the thyroid and is used to lower blood calcium levels, and parathyroid hormone (PTH), which is produced by the parathyroid glands and can raise blood calcium levels.



Sample Page

Discussion Questions:

1. Fill in the following statements on the cycle above: *parathyroid glands release PTH, calcium from blood is absorbed into bones, blood calcium levels increase, blood calcium levels decrease, calcium from bones is absorbed into blood, thyroid gland produces calcitonin*
2. Specialized cells called osteoblasts build bone, while osteoclasts destroy bone. Which of these cells would be used in association with the release of calcitonin? Why?
3. "Bones are static, dead structures within the body." Explain why this statement is false.

Data Analysis: Bone Density in Space

One of the major obstacles to long-term space flight is the loss of bone density in astronauts. For a short-duration space flight, bone loss may be minimal but as long-duration space flights become more common, it becomes a serious health concern. In the microgravity environment of space, astronauts often lose 1%-2% of their pre-flight bone density. To combat this threat, astronauts on long-duration flights to the International Space Station exercise about 2.5 hrs per day using resistance bands to simulate weight-bearing activities.

The table below shows the bone density loss of the upper and lower body in ten astronauts during a range of space flight durations.

Individual	1	2	3	4	5	6	7	8	9	10	Avg

Data Analysis: Bone Density in Space

Teacher Instructions

This activity provides students with raw data from hypothetical astronauts. Students will use this data to calculate means, analyze trends, and graph two sets of data.

Options:

1. **Paper Option-** Students without access to Microsoft Excel can

complete this activity on paper and graph the data on the graph

provided. Digital Option- Students with access to Microsoft Excel can

complete this activity on a computer and graph the data on the graph

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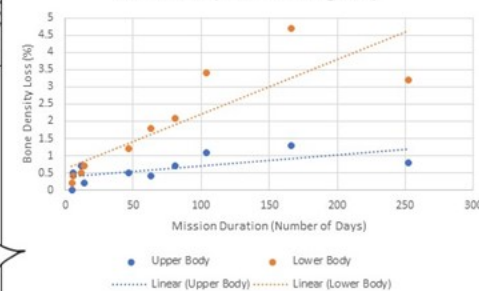
complete this activity on a computer and graph the data on the graph

provided. Digital Option- Students with access to Microsoft Excel can

Math Extension with optional Excel graphing instructions

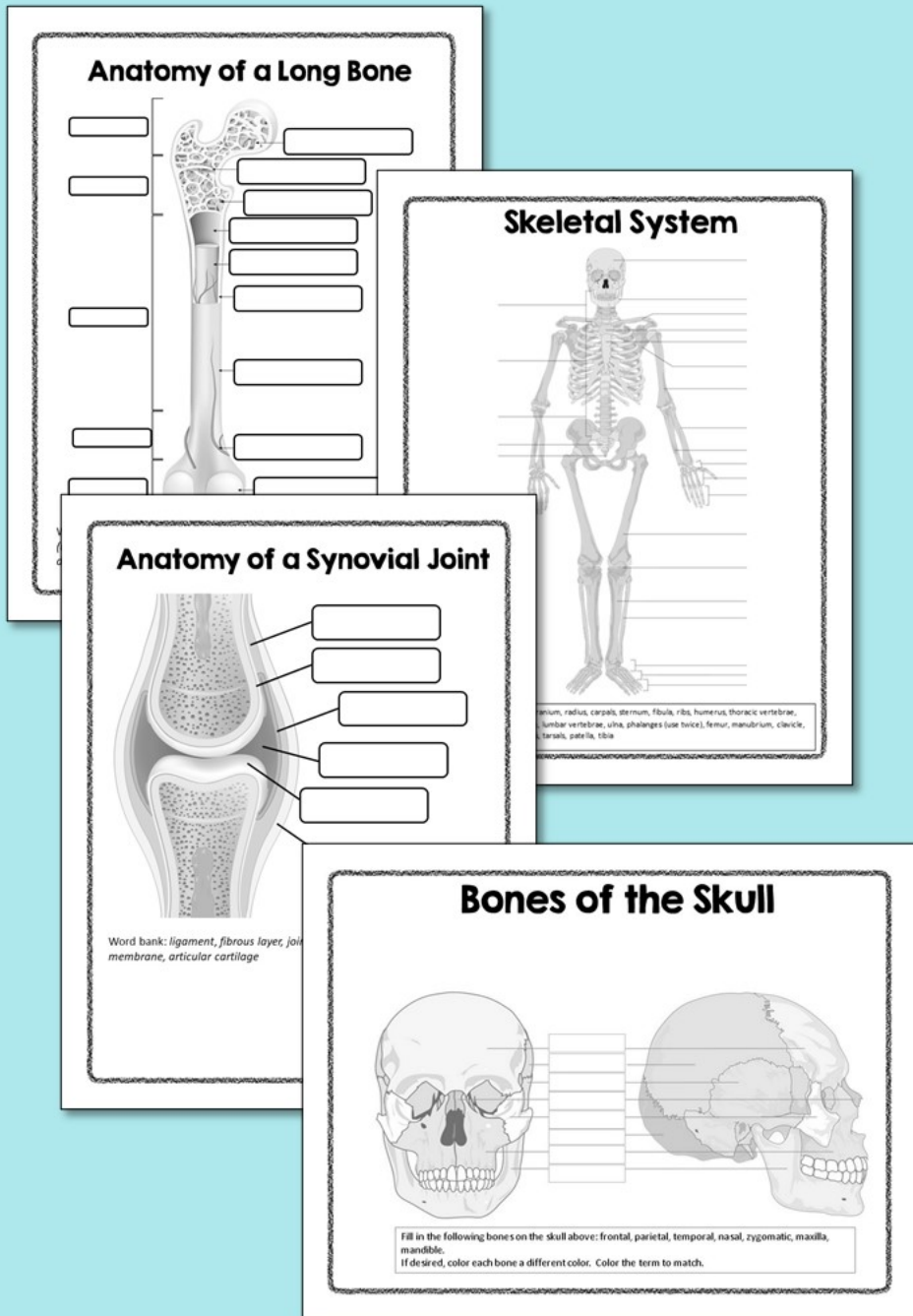
1. Select the data in the "Bone Density Loss in Microgravity" spreadsheet and copy it to the clipboard.
2. Select "Insert" then choose to create a "Scatterplot" graph (the one with dots). A graph should appear on the page.
3. Right click on the graph and choose "Select Data". Click "Add Series".
4. When prompted, choose "Series Name" to be "Upper Body".
5. Right click on the graph again and edit the "Series Name" to be "Lower Body".
6. Left click on the graph and then click on the "Trendline" button.
7. Click on a blue dot. Select "Trendline" in the dropdown menu.
8. Click on an orange dot and repeat the "Trendline" step.
9. Your graph is now complete! Share with your teacher.

Bone Density Loss in Microgravity



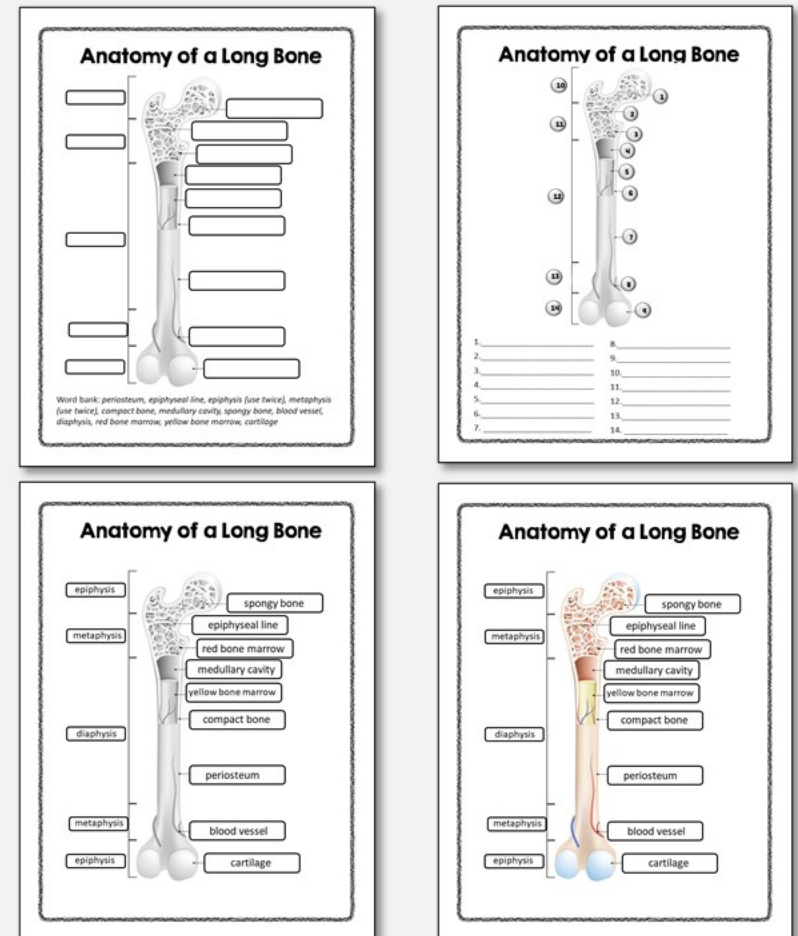
Excel answer key also provided for teacher use.

Anatomical Diagrams



Each diagram comes in 4 versions:

1. Fill-in the blank
2. Numbered quiz
3. Labeled black & white
4. Labeled color




24 Editable Task Cards for Review

1 Name the 5 functions of the skeletal system. Which two are accomplished by bone marrow?

2 The humerus would be classified as what shape?

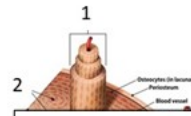
3 Name the following portions of a long bone.



4 What thin layer covers the ends of a long bone?

5 In a long bone, describe where you would find spongy bone.

6 Name these compact bone structures.



7 Describe how osteoblasts and osteoclasts work together to remodel bone.

8 In the process of _____, cartilage incorporates minerals such as _____ to harden into bone.

Sample Task Cards

Using Editable Task Cards 🍏

How to set-up:

1. Print the cards on cardstock or paper.
2. Cut the pages so that each card is separate. If you'd like to use them in future years, it may be worth laminating them to protect them from student writing and other damage.
3. Place each task card at a seat around the room.
4. Students will rotate to each seat until all cards are finished. Answers are recorded on

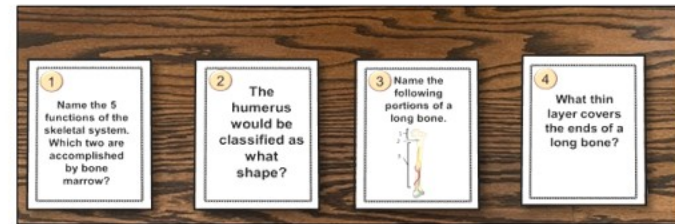
their "Task Card Answer Sheet" or notebook paper.

*TIP: It is important to have a timer. Usually 1-2 minutes is appropriate. Without a timer, students will get backed up while rotating and chaos will ensue. ©

Teacher Tips

Modifications:

- These task cards are editable so you can change the text on any card.
- There are additional cards at the end of the document for adding questions. Be sure to add the correct number, as well!
- If moving around your room isn't possible, you can have students pass the cards in one direction.
- Other options:
 - Students can use notes or not depending on the level of memorization you expect prior to reviewing.
 - Students can work in pairs, which adds confidence.



Assessments

Editable Online Quiz through Google Forms

Bone Structure and Physiology Quiz

Sample Quiz Questions
(blurred on preview to prevent cheating)

	True	False	Both	None	Not sure
Long bone	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Short bone	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Irregular bone	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
sesamoid bone	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Flat bone	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3. What name is given to the long, middle section of a long bone?

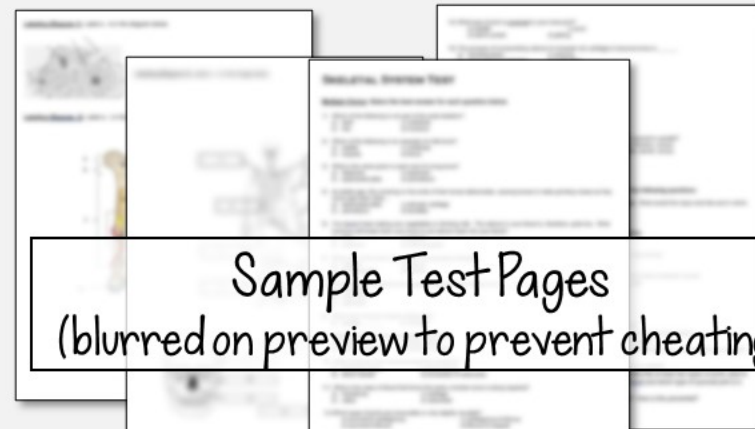
☐ Diaphysis

- 9 multi-part questions
- Fully editable
- Answer key included for automatic grading

Editable Unit Test

- 19 multiple choice questions
- 8 matching questions
- 2 Greek/Latin term questions
- 3 labeled diagrams
- 9 free response questions

Two Versions: Honors & Regular



Sample Test Pages
(blurred on preview to prevent cheating)

SKELETAL SYSTEM TEST

Name: _____

Multiple Choice

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

12. _____

13. _____

14. _____

15. _____

16. _____

17. _____

18. _____

19. _____

Matching

20. _____

21. _____

22. _____

23. _____

24. _____

25. _____

26. _____

27. _____

Free Response

Labeling

Diagram 1

A. _____

B. _____

C. _____

D. _____

Labeling

Diagram 2

A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

G. _____

H. _____

I. _____

J. _____

K. _____

L. _____

M. _____

N. _____

O. _____

Student answer
sheet & answer keys
included
(both fully editable)

I'd love to hear from you!

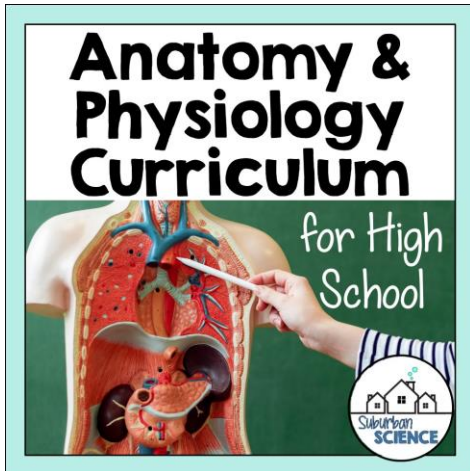
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You can also follow me on TpT or social media:



Sincerely,
Anne from Suburban Science

