

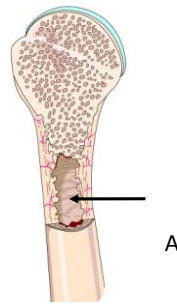
**Question No. 1 of 10**

**Instructions:** (1) Read the problem and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.




**Question #01**

1. What part of the long bone in the image below is labeled with the letter A?



- (A) Articular cartilage
- (B) Epiphysi
- (C) Periosteum
- (D) Medullary cavity
- (E) Epiphyseal cartilage

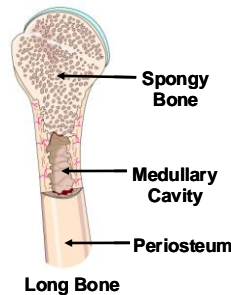


**Feedback**

- A. Incorrect!  
The articular cartilage is located on the end of a long bone where it articulates with other bones.
- B. Incorrect!  
The arrow is pointing at the medullary cavity, which is in the diaphysis.
- C. Incorrect!  
The periosteum is located on the outside of the compact bone.
- D. Correct!  
The arrow is pointing at the medullary cavity.
- E. Incorrect!  
The epiphyseal cartilage is located in the epiphysis, at the end of a long bone.



**Solution**



Compact bone wraps around the spongy bone and is called compact because of the minimal free space, as compared to spongy bone. Compact bone gives the bone its smooth, white appearance. In a leg bone, for example, the shaft of compact bone transmits the applied stresses on the bone. Spongy bone makes up the ends of long bone, known as the epiphysis, as well as being located deep in the bone interior. Spongy bone can transmit forces that are placed on the bone from different angles, and the trabecular meshwork can transmit forces across the bone. Within the trabecular meshwork is the red bone marrow, which is the site of blood cell formation. Within the medullary cavity is the yellow marrow, which is an important energy reserve.

**(D) Medullary cavity**

## Question No. 2 of 10

**Instructions:** (1) Read the problem and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.



### Question #02

**2.** A bone biopsy reveals an abnormality in the bone matrix. Based on the makeup of bone matrix, which of the following statements is correct?

- (A) The bone matrix, which is only located in the periosteal layer of bone, was the site of the abnormality.
- (B) The hydroxyapatite crystals, which are a major component of bone matrix, are abnormal.
- (C) The zinc oxide that makes up half of the hydroxyapatite crystals in bone matrix was deficient in the sample.
- (D) Calcium phosphate, which only accounts for 2% or less of the weight of bone, is deficient in the sample.
- (E) Bone matrix, which usually accounts for only a small percentage of the weight of bone, is abnormally increased in the sample.



### Feedback

A. Incorrect!

The bone matrix is located in the compact bone.

B. Correct!

Hydroxyapatite crystals are a major component of bone matrix.

C. Incorrect!

Hydroxyapatite crystals are made up of calcium phosphate and calcium hydroxide.

D. Incorrect!

Calcium phosphate accounts for the majority of the weight of bone, approximately 66%.

E. Incorrect!

Bone matrix accounts for the majority of the weight of bone.



### Solution

Bone matrix is made up of hydroxyapatite crystals. Hydroxyapatite crystals are made from the interaction between calcium phosphate and calcium hydroxide. Inorganic compounds, such as calcium salts, sodium and magnesium, are incorporated into these crystals to strengthen bones. Calcium phosphate accounts for approximately 66% of the weight of bone. In comparison, approximately 33% of the weight of bone is from collagen fibers. Cells in bone, such as osteocytes, account for 2% or less of the weight of bone.

**(B) The hydroxyapatite crystals, which are a major component of bone matrix, are abnormal.**

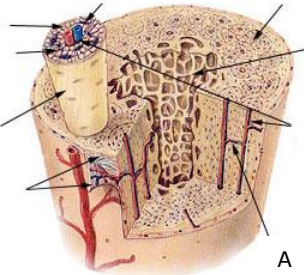
**Question No. 3 of 10**

**Instructions:** (1) Read the problem and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.



**Question #03**

**3.** Which component of bone is labeled with the letter A in the image below?



(A) Periosteum  
(B) Volkmann's canal  
(C) Osteon  
(D) Trabeculae  
(E) Canalliculi



**Feedback**

A. Incorrect!  
The periosteum is located on the outside of the compact bone; the letter A is identifying a Volkmann's canal.

B. Correct!  
The letter A is identifying a Volkmann's canal, which connects the individual osteons.

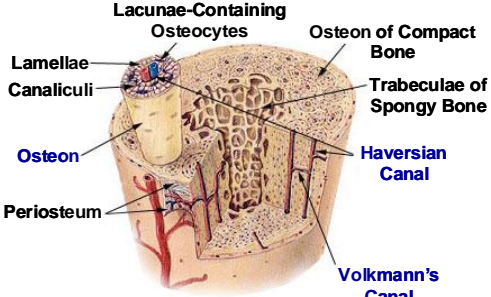
C. Incorrect!  
While the canal labeled with the letter A connects osteons, the arrow is not actually pointing at an osteon.

D. Incorrect!  
The trabeculae are located in the interior where the spongy bone is.

E. Incorrect!  
The canalliculi are small passages that connect the osteocytes.



**Solution**



**Compound and Spongy Bone**

Bone matrix includes specialized structures, known as osteons, which are long, narrow cylinders containing both Haversian and Volkmann canals. Within the osteon are numerous lacunae. Inside the lacunae is a single osteocyte (bone-forming cell) surrounded by the lacuna, which the osteocyte produced. Osteocytes communicate with each other through passages, called canalliculi. Haversian canals surround blood vessels and nerves inside the bone. Volkmann's canals connect the individual osteons to each other and to the periosteum. The periosteum provides the blood supply and houses the osteoclasts for bone resorption.

**(B) Volkmann's canal**

### Question No. 4 of 10

**Instructions:** (1) Read the problem and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.



#### Question #04

**4.** A question on an exam asks you to contrast spongy bone with compact bone. Which of the following statements would be correct to include in the answer?

- (A) Spongy bone contains many interwoven spaces.
- (B) Spongy bone is heavier and denser than compact bone.
- (C) Spongy bone is lighter and does not contribute at all to the overall strength of bone.
- (D) Even though there are differences between spongy bone and compact bone, both contain a trabecular meshwork.
- (E) There is almost no difference between spongy bone and compact bone.



#### Feedback

A. Correct!  
Spongy bone contains many interwoven spaces; compact bone does not.

B. Incorrect!  
Spongy bone is lighter and contains more open spaces than compact bone.

C. Incorrect!  
Although spongy bone is lighter, it is still strong enough to contribute to the overall strength of the bone.

D. Incorrect!  
Only spongy bone is made up of a trabecular meshwork.

E. Incorrect!  
There are differences between spongy bone and compact bone, including the density, weight, strength, location and proportion of the overall bone.



#### Solution

One of the biggest differences between compact bone and spongy bone is the arrangement of the trabeculae. Spongy bone contains many spaces interwoven with the trabeculae. Spongy bone is lighter than compact bone and, overall, it provides for a lighter bone for easier mobility. Even though the spongy bone is lighter and contains an open meshwork, it is still strong and contributes to support function.

**(A) Spongy bone contains many interwoven spaces.**

### Question No. 5 of 10

**Instructions:** (1) Read the problem and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.



#### Question #05

**5.** During the histological examination of a bone tissue sample, a defect is noted in a cell that is present in both an immature, undifferentiated state and as a mature cell. What is the cell type that is defective and what is its precursor cell type?

- (A) The defective cell is an osteoclast that differentiates from an immature bone cell.
- (B) The defective cell is an osteoblast that differentiates from an osteoprogenitor cell.
- (C) The osteocytes in the sample are defective, as are the osteoclasts from which they differentiate.
- (D) The osteoprogenitor cells and the osteocytes from which they differentiate are abnormal in the sample.
- (E) The periosteum cells are abnormal, as are the osteoprogenitor cells they differentiate from.



#### Feedback

A. Incorrect!

Osteoclast cells differentiate from the same stem cell that produces monocytes and neutrophils.

B. Correct!

Osteoblasts, which are mature cells, differentiate from an immature osteoprogenitor cell.

C. Incorrect!

Osteocytes differentiate from an osteoblast.

D. Incorrect!

The osteoprogenitor cells differentiate into a mature osteoblast cell.

E. Incorrect!

The periosteum contains osteoprogenitor cells that go on to differentiate into osteoblasts.



#### Solution

Within the periosteum of bone are cells that eventually differentiate into osteoblasts, known as osteoprogenitor cells. These cells are induced to differentiate into osteoblasts by growth factors and as part of the repair process after bone damage, such as a fracture. Osteoprogenitor cells are considered immature cells that mature when they differentiate into osteoblasts. Osteoclasts differentiate from the same stem cells that produce monocytes and neutrophils. An osteoblast is similar to a fibroblast, except they express specific genes for bone formation. If the osteoblast becomes encased in bone matrix, they differentiate into osteocytes.

**(B) The defective cell is an osteoblast that differentiates from an osteoprogenitor cell.**

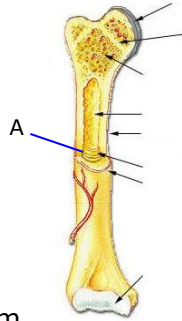
**Question No. 6 of 10**

**Instructions:** (1) Read the problem and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.



**Question #06**

**6.** In this image of a long bone, what is the letter A labeling?



- (A) Endosteum
- (B) A layer of bone tissue that provides attachment points for tendons.
- (C) Spongy bone.
- (D) Articular cartilage.
- (E) A layer of bone tissue that is located only in irregular bones.



**Feedback**

A. Correct!  
The letter A is identifying the endosteum in this image.

B. Incorrect!  
The periosteum, located on the outside of bone, provides the attachment points for tendons.

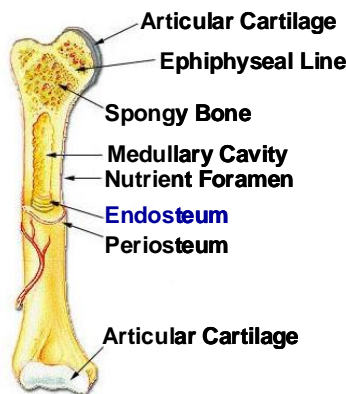
C. Incorrect!  
The spongy bone in this image is primarily located in the ends of the bone, the epiphysis.

D. Incorrect!  
The articular cartilage is located on the ends of the bone.

E. Incorrect!  
The letter A indicates the endosteum, which is present in long bones, as depicted in the image.



**Solution**



The endosteum is similar to the periosteum in structure, but it is located in the lining of the medullary cavity and it covers the trabeculae of the spongy bone. This layer can be used as an energy source during long periods of malnutrition.

**(A) Endosteum**

## Question No. 7 of 10

**Instructions:** (1) Read the problem and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.



### Question #07

**7.** Bone contains a number of markings that are unique surface markings and shapes. Which of the following statements about bone markings is correct?

- (A) Bone markings are just remnants of bone growth and development and serve no specific purpose.
- (B) Bone markings are only for articulation with other bones.
- (C) A fossa or sulcus is a shallow depression or groove in a bone.
- (D) A condyle is a small passageway in a long bone.
- (E) A trochanter extends the angle of a bone.



### Feedback

A. Incorrect!

Bone markings are surface features that play a functional role in the skeletal system.

B. Incorrect!

Bone markings are for articulations with other bone, as well as passageways for blood vessels, etc.

C. Correct!

A fossa or sulcus is a shallow depression or groove in a bone.

D. Incorrect!

A condyle is a projection or ridge for the articulation with other bones.

E. Incorrect!

A trochanter is a projection that provides an attachment point for a tendon or ligament.



### Solution

The following is a general description of some common bone markings, including their general function: (1) Process and Ramus – an elevation of projection that extends the bone, making an angle, (2) Trochanter, Tuberosity or Tubercle – large or small projections from the bone that provides tendon or ligament attachment points. (3) Head, Neck or Condyle – large or small projection or ridge. Processes formed for articulation with other bones. (4) Fossa or Sulcus – a shallow depression or groove in a bone, and (5) Foramen or Fissure – an opening for blood vessels, a passageway through the bone matrix.

**(C) A fossa or sulcus is a shallow depression or groove in a bone.**

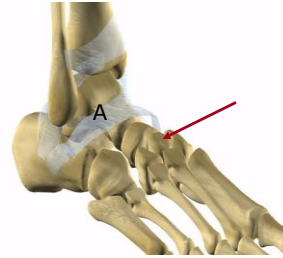
**Question No. 8 of 10**

**Instructions:** (1) Read the problem and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.



**Question #08**

**8.** The bones of the human body can be categorized into 6 different groups. What type of bone is labelled with the letter A in the image below?



- (A) Sesamoid bone.
- (B) Flat bone.
- (C) Pneumatized bone.
- (D) Short bone.
- (E) Carpal bone.



**Feedback**

A. Incorrect!

Sesamoid bones are small bones that develop in a tendon; the patella is an example.

B. Incorrect!

A flat bone is a broad, flat-shaped bone, such as the bones that make up the roof of the skull.

C. Incorrect!

A Pneumatized bone contains many air pockets and hollow regions, such as the ethmoid bone in the skull.

D. Correct!

The letter A does indicate a short bone; examples include the bones of the ankle (tarsal) and wrist (carpal).

E. Incorrect!

The carpal bones are an example of a short bone; however, the letter A in the image indicates the tarsal bone of the ankle.



**Solution**

All the bones of the body can be classified into 6 groups, based on their structure, including size and shape. The different groups are: Flat Bones – including the bones of the roof of the skull and the sternum; Long Bones – including bones of the upper and lower limbs; Sesamoid Bones – including the patella bone of the knee joint; Short Bones – including the bones of the wrist (carpal) and the ankle (tarsal); Irregular Bones – including the vertebrae of the spinal column and a few bones in the skull; and Pneumatized – such as the ethmoid bone, contain numerous air pockets and hollow regions. These bones have numerous articulations with other bones. For example, the ethmoid bone articulates with more than 10 different bones.

**(D) Short bone.**



**Question No. 9 of 10**

**Instructions:** (1) Read the problem and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.



**Question #09**

**9.** Ossification is the process of laying down new bone. There are two major methods in which ossification occurs. Which of the following statements about endochondral ossification is correct?

- (A) In this type of ossification, hyaline cartilage is converted into bone.
- (B) Both hyaline cartilage and articular cartilage can function as a bone precursor in endochondral ossification.
- (C) During endochondral ossification, osteoblasts are converted to perichondrium cells in the early steps.
- (D) The blood vessels that form the primary ossification center in the the developing bone enter through the epiphysis then pass into the main medullary cavity.
- (E) The medullary cavity is formed in the ends of the bones (epiphysis) before the main shaft (diaphysis) of the bone.



**Feedback**

A. Correct!

During endochondral ossification, hyaline cartilage is converted into bone.

B. Incorrect!

Only hyaline cartilage is converted to bone during endochondral ossification.

C. Incorrect!

The perichondrium cells on the edges of the cartilage are converted into osteoblast cells.

D. Incorrect!

The blood vessels in the primary ossification center enter the shaft of the bone through the nutrient foramen.

E. Incorrect!

The medullary cavity in the shaft of the bone develops before the secondary ossification center in the ends of the bone.



**Solution**

Ossification occurs by two methods: intramembranous ossification and endochondral ossification.

Step 1: During this first step of endochondral ossification, the cartilage is enlarging and the chondrocytes near the center are greatly increasing in size. The matrix becomes calcified and then the chondrocytes die off and leave cavities within the cartilage.

Step 2: During the second step, the perichondrium cells on the edges of the cartilage begin to convert to osteoblasts. This leads to a thin layer of bone on the outside of the shaft. Simultaneously, blood vessels begin to grow around the edges of the cartilage.

Step 3: Next, the blood vessels penetrate the cartilage and enter the central region where the spongy bone begins to form. This is the site of the primary ossification center. The medullary cavity is formed, and bone formation continues along the shaft of the bones towards the ends.

Step 4: During the fourth step, the medullary cavity is expanded as bone formation continues. The cartilage near the epiphysis is converted to bone, and the shaft of the developing bone increases in length and thickness.

Step 5: The secondary ossification center is formed during step 5. This takes place in the epiphysis; capillaries, blood vessels and osteoblasts become active.

Surrounding the secondary ossification center is a layer of Hyaline cartilage.

Step 6: During step 6, the ends of the long bone become covered in articular cartilage. By this step, the epiphysis at each end of the bone is filled with spongy bone. The epiphyseal cartilage, at the metaphysis, separates the epiphysis from the shaft of the bone (diaphysis).

**(A) In this type of ossification, hyaline cartilage is converted into bone.**

## Question No. 10 of 10

**Instructions:** (1) Read the problem and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.



### Question #10

**10.** Which of the following statements about bone maintenance in the human skeletal system is correct?

- (A) Osteoblasts and osteoclasts remain active after the age of skeletal maturity.
- (B) Once an individual reaches the age of 25, all cell activity in the bones stops.
- (C) Approximately 80- 90% of the total skeletal system is turned over each year.
- (D) Bone maintenance only takes place in the bones of the skull.
- (E) Bone maintenance begins after the age of 20 for approximately 15 years.



### Feedback

A. Correct!

Both osteoblasts and osteoclasts remain active after the age of 25.

B. Incorrect!

Even after the age of skeletal maturity, bones are maintained by cellular activity from osteoblasts and osteoclasts.

C. Incorrect!

Approximately 15-20% of the total skeletal system is turned over each year.

D. Incorrect!

Bone maintenance takes place in various regions of the skeletal system, including the long bones of the upper and lower limbs.

E. Incorrect!

Bone maintenance continues throughout life.



### Solution

Normally, there is a balance between the bone produced by osteoblasts and the bone degraded by osteoclasts. These cells remain very active throughout life. Under normal conditions, the mineral content of bone is decreased and then rebuilt by bone maintenance. Approximately 15 - 20% of the total skeletal system is turned over (degraded and replaced) each year. This turnover of bone requires tremendous control, including hormones and cellular activity. One key exception to bone turnover is the shaft of long bones and the compact bone it contains; this is rarely turned over.

**(A)Osteoblasts and osteoclasts remain active after the age of skeletal maturity.**