# Locomotion and Movement

## Case Study Based Questions

**Read the following passages and answer the questions that follow:**

**1.** Each muscle fibre has a sarcolemma, which surrounds the sarcoplasm. Because the sarcoplasm includes several nuclei, muscle fibre is a syncytium. The sarcoplasm also contains sarcoplasmic reticulum, which, is a calcium ion storage compartment. The sarcoplasmic reticulum (SR) can be functionally defined as a specialised form of the endoplasmic reticulum (ER) dedicated to Ca2+ storage and release with respect to regulation of muscle contraction. The first studies showing the convoluted structure of the SR and the associated T-tubule system go back to the beginning of the 20th century when Veratti described a complex network of membrane structures, characterised by longitudinal tubules interconnected with large cisternae. The real structure of the SR was, however, fully appreciated only half a century later, following electron microscopy studies by Porter and Palade.
(A) Describe the role of calcium with regard to the changes in myofibril bands?
(B) What happens to the cross-bridge in a muscle fibre after ATP binding?
(C) Sarcolemma, sarcoplasm and sarcoplasmic reticulum are all different names for the parts of muscle. Which parts of the muscle do these names refer to?

**Ans. (A)** As a result of the calcium changes, the connected actin filaments shift towards the middle of the A-band. The Z-line also moves inward, and the muscles contract due to sarcomere contraction. During muscular contraction, the I-band shortens while the A-band remains the same length. The cross-bridge is broken when the ADP and Pi-releasing myosin head return to its state of relaxation and then another fresh ATP binds, breaking the cross-bridge.
**(B)** The cross-bridge is broken when a fresh ATP binds. The myosin head hydrolyses ATP again, and the cycle of cross-bridge formation and breakage is repeated, generating further sliding. The procedure is repeated until the Ca2+ ions are pushed back into the sarcoplasmic cisternae, obscuring actin filaments. This causes the 'Z' lines to revert to their previous position, i.e., relaxation.
**(C)** These names refer to the following parts of muscle:

**2.** The Sarcolemma: Plasma membrane Sarcoplasm: Cytoplasm Sarcoplasmic reticulum: Endoplasmic reticulum muscle fibre is a syncytium. A characteristics features of the muscle fibre is the presence of a large number of parallelly arranged filaments in the sarcoplasm called myofilaments or myofibril each myofibril has alternate dark and light bands on it. Skeletal muscle fibres are classified into two types: type 1 and type 2. Type 2 is further broken down into subtypes.

Type 1: These fibres utilise oxygen to generate energy for movement. Type 1 fibres have a higher density of energy-generating organelles called mitochondria. This makes them dark.

Type 2A: Like type 1 fibres, type 2A fibres can also use oxygen to generate energy for movement. However, they contain less mitochondria, making them light. Type 2B: Type 2B fibres don't use oxygen to generate energy. Instead, they store energy that can be used for short bursts of movement. They contain even less mitochondria than type 2A fibres and appear white.

**(A) Why is muscle fibre called a syncytium?**

(a) As it is aseptate.

(b) As it has more than one nuclei.

(c) As it has more than one sarcoplasm.

(d) As it has dark and light bands.

**(B) Give a characteristic feature of muscle fibre.**

(a) Presence of myofilaments

(b) Absence of myofilaments

(c) Presence of branching pattern

(d) Spindle-shaped appearance

**(C) Name some visceral organs of the human body.**

(a) Femur, legs, arms

(b) Oesophagus

(c) Stomach

(d) Both (b) and (c)

**(D) Skeletal muscles are.....**

(a) Involuntary

(b) Voluntary

(c) Any of the above depending on the situation

(d) Non-striated

**(E) Assertion (A):** Fatigue is the inability of muscles to relax.

**Reason (R):** It is due to lactic acid accumulation repeated contractions. by

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

**Ans. (A)** (b) As it has more than one nuclei.

**Explanation:** Muscle fibres, also known as skeletal muscle cells, are multinucleated syncytia that form during development when myoblasts, mononucleated progenitor cells, combine.

**(B)** (a) Presence of myofilaments

**Explanation:** The muscles are made up of muscle bundles in which the muscle fibres are arranged parallelly.

There are thick (myosin) and thin filaments (actin) that slide onto each other. The protein (actin) contributing to the myofilaments belongs to the group of cytoskeletal proteins - microfilaments. The myofilaments are arranged in a functional unit known as a sarcomere.

**(C)** (d) Both (b) and (c)

**Explanation:** Visceral organs are the soft internal organs of the body, including the lungs, the heart, and the organs of the digestive, excretory, reproductive, and circulatory systems

**(D)** (a) Involuntary are

**Explanation:** Skeletal muscles voluntary muscles, meaning you control how and when they move and work.

**(E)** (a) Both A and R are true and R is the correct explanation of A.

**Explanation:** The amount of ATP that is readily available decreases when voluntary muscles (skeletal muscles) are continuously activated or stimulated.

Anaerobic and aerobic respiration then restores it. The rate of ATP synthesis by breathing eventually cannot meet the demands in the muscles if the continual stimulation persists. Fatigue occurs from this.

**3.** The remains of an individual were brought to attention in the 1980s when a citizen saw some of the bones on an outcropping in the mountains of Albion, Idaho. What

remained was scattered bones and parts of decomposed clothes. The remains were the majority of a skeleton, with only the kneecaps, hands, wrists, hyoid, a few vertebrae and the skull missing. A newspaper was found in one the pockets of the decaying clothes, with a date in the 1920s. This allowed initial investigators to pinpoint the individual as one of three individuals who went missing in that time frame. From there investigators were able to get an identification by interviewing the families of those missing. The man was identified as a Ferrier (a craftsman who trims and shoes horses' hooves) in his late twenties. Once the remains had been identified, the case was turned over to the local pathologist to clearly determine manner and cause of death. Our age estimation, as seen in our result, is at an older range than the age identified. This is most likely due to the evident biomechanical stress, as seen in our 'pathologies' section - wear on the bone that can cause a skeleton to look older than it is. The bones also had prominent muscle attachments which is indicative of a heavily muscled individual, consistent with the occupation as a Ferrier.

(A) Give one difference between bone and cartilage.

(B) Write the functions of the skeleton in vertebrates.

(C) How many parts, the human skeleton is divided into? Name them.

**Ans.** (A) Bones are solid, rigid made up of a matrix which contains calcium phosphates, calcium carbonates and magnesium whereas cartilage is firm and flexible due to the presence of chondroitin salts in the matrix.

(B) Skeleton serves a number of functions:

(1) It supports the body and forms a rigid framework which gives and maintains the shape of the body.

(2) It encloses vital organs and gives protection to them.

(3) Help in movement of body.

(4) Help in hearing, breathing and fat storage.

(C) The human skeleton is divided into two parts: Axial skeleton and Appendicular skeleton.

**4.** As Sophia discovered in the beginning of the chapter, wearing high heels can result in a condition called metatarsalgia. Metatarsalgia is named for the metatarsal bones, which are the five bones that run through the ball of the foot just behind the toes. Don't think you are immune to stress fractures just because you don't wear high heels! This injury also commonly occurs in people who participate in sports involving repetitive striking of

the foot on the ground, such as running, tennis, basketball, or gymnastics. They may be avoided by taking preventative measures. You should ramp up any increase in activity slowly, cross-train by engaging in a variety of different sports or activities, rest if you experience pain, and wear well-cushioned and supportive running shoes. It is important to know that your cardiovascular and muscular systems adapt to an increase in physical activity much more quickly than the skeletal system.

**(A) Which one of the following is not a function of bone?**

(a) Place for muscle attachment.

(b) Protection of vital organs.

(c) Secretion of hormones for calcium regulation in blood and bones.

(d) Production of blood corpuscles.

**(B) The hollow space in the middle of bones is filled with:**

(a) air

(b) blood

(c) bone cells

(d) bone marrow

**(C) Choose the incorrect option:**

(a) Bones are where most blood cells are made.

(b) Bone serves as a storehouse for various minerals.

(c) Bone is a dry and non-living supporting structure.

(d) Bone protects and supports the body and its organs.

**(D) What makes bones so strong?**

(a) Silica

(b) Cartilage

(c) Blood and marrow

(d) Calcium and phosphorus.

**(E) In mammals, lower jaw is made up of:**

(a) Mandible

(c) Tibia

(b) Maxilla

(d) Fibula

**Ans. (A)** (c) Secretion of hormones for calcium regulation in blood and bones.

**Explanation:** Bone plays an important role like it is site for muscle attachment and also protects the vital organs from injury and formation of blood corpuscles whereas it does not secrete hormones for calcium regulation in blood but it regulates calcium and phosphorus level in blood.

**(B)** (d) bone marrow

**Explanation:** Bone marrow is found in the hollow middle of bones. The cells of bone marrow are soft to produce red blood cells in the protected hollow space and release them to the bloodstream whereas blood runs through canals, not in the hollow space of bones and bone cells are not present in hollow space.

**(C)** (c) Bone is a dry and non-living supporting structure.

**Explanation:** Bone is a living structure with many functions whereas the other options are correct.

**(D)** (d) Calcium and phosphorus.

**Explanation:** Calcium and phosphorus are minerals that give bones their strength and make them strong while silica is not found in human bones, blood and marrow are found in bones, but they do not make bone cells strong and cartilage is softer than bone.

**(E)** (a) Mandible

**Explanation:** Lower jaw of mammalian mouth is made up of mandible bone.