Anatomy and Physiology workbook 2020

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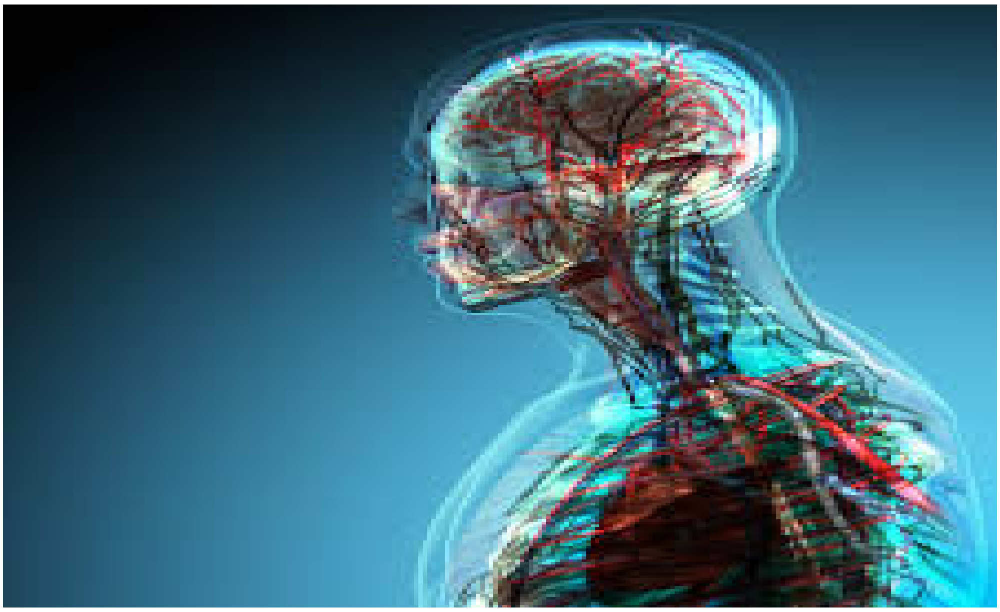
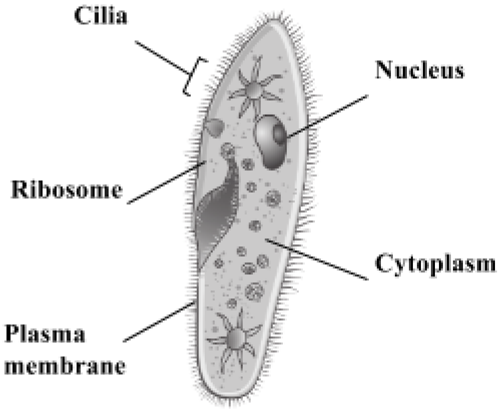
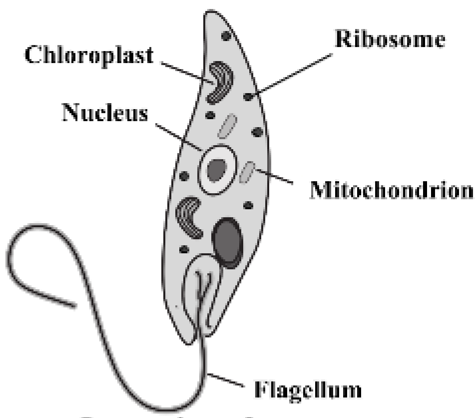


Task 1

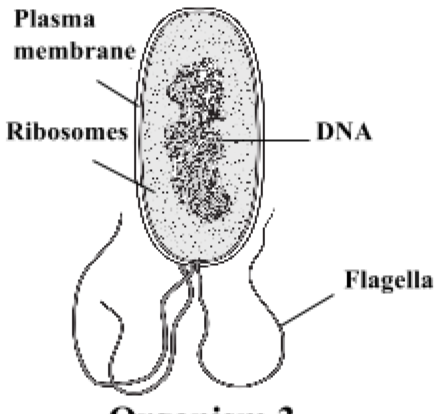
Based on the diagrams, which organism(s) are eukaryotic and why?



Organism 1



Organism 2



Organism 3

Organism 1 and organism 2 are both eukaryotic because they contain a nucleus and other membrane-bound organelles. An example of eukaryotic organisms include plant cells, animal cells, fungi, protists as well as most algae. Eukaryotes may be either single-felled or multicellular and they are differentiated from other organisms called prokaryotes by the way the presence of the internal membranes separate of the eukaryotic cells from the rest of the cytoplasm and these membrane bound structures are called organelles In eukaryotes, the cell's genetic material, or DNA, is contained within an organelle called the nucleus, where it is organised in long molecules called chromosomes. Eukaryotic cells also contain other organelles, including mitochondria, which generate energy; the endoplasmic reticulum, which plays a role in the transport of proteins; and the Golgi apparatus, which sorts and packages proteins and lipids for transport throughout the cell. Plant cells additionally contain organelles called chloroplasts, which are used to collect energy from sunlight.

Create a presentation on specialised cells and upload this onto teams, this can be as a Powerpoint or word document. This will need to identify:

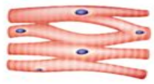
- **What a specialised cell is**
- **Summarise information on each of the specialist cells to show their structure and function.**

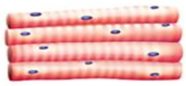
You will need to use pictures and a bibliography.

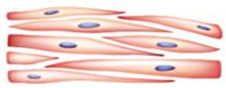
You must include, muscle cells, nerve cells, white and red blood cell, ovum and sperm cells.

Specialised cells are cells that have developed certain characteristics to perform a particular function and they have a specific role to perform. Each specialised cell also has a different job to do and they have special features that allow them to do these jobs. Most specialised cells share features such as having a nucleus, a cell membrane, cytoplasm and mitochondria. However there are differences between cells too as each type of cell, has its own job to do. These cells have special features that allow them to perform their functions effectively. Here are some examples of specialised cells and the features they have to help them with their role:

Muscle cells contain filaments of protein that slide over each other to cause muscle-contraction. The arrangement of these filaments causes the banded appearance of heart muscle and skeletal muscle. They contain many well-developed mitochondria to provide the energy for muscle contraction. Muscle cells also bring parts of the body closer together being they are held in bundles which pull together making the muscles contract (get shorter and fatter). Although there are different types of muscle cells each adapted to its function For example, Cardiac (heart) muscle cells are branched, and they join together to make a net. Cardiac muscle cells contract rhythmically, even outside the body. They never get tired, skeletal muscle is joined to bones. Its cells contract to make bones move and joints bend and smooth muscle cells make up thin sheets of muscle, such as the stomach lining. They can also be arranged in bundles, or rings, like that in the





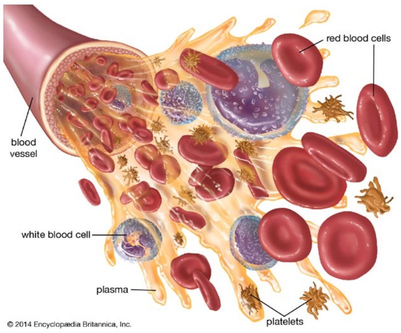


anus. Muscle cells are long, cylindrical structures that are bound by a plasma membrane (the sarcolemma) and an overlying basal lamina and when grouped into bundles (fascicles) they make up muscle.

Nerve cells are electrically excitable cells in the nervous system that function to process and transmit information. In vertebrate animals, neurons are the core components of the brain, spinal cord and peripheral nerves. Nerve cells transmit electrical signals because they are thin, and can be more than 1 metre long, which means they can carry messages up and down the body over large distances. Nerve cells also have branched connections at each end, which join to other nerve cells, allowing them to pass messages around the body and lastly they have a fatty (myelin) sheath that surrounds them, which increases the speed at which the message can travel.

nerve cell

White blood cells flow through your bloodstream to fight viruses, bacteria, and other foreign invaders that threaten your health. When your body is in distress and a particular area is under attack, white blood cells rush in to help destroy the harmful substance and prevent illness. White blood cells are also made in the bone marrow.
They have the capacity to change shape and migrate, via the vessel wall through tissues in response to chemotactic signals from infection and inflammation. The granules mediate the specific killing and signalling functions of the cells.

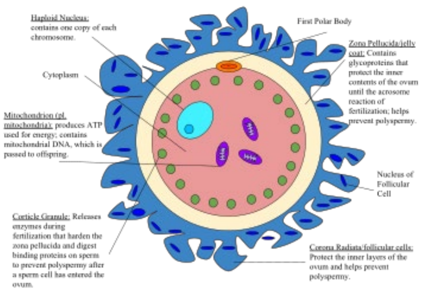


The function of the red cell and its hemoglobin is to carry oxygen from the lungs or gills to all the body tissues and to carry carbon dioxide, a waste product of metabolism, to the lungs, where it is excreted. In invertebrates, oxygen-carrying pigment is carried free in the plasma; its concentration in red cells in vertebrates, so that oxygen and carbon dioxide are exchanged as gases, is more efficient and represents an important evolutionary development. The mammalian red cell is further adapted by lacking a nucleus—the amount of oxygen required by the cell for its own metabolism is thus very low, and most oxygen carried can be freed into the tissues. The biconcave shape of the cell allows oxygen exchange at a constant rate over the largest possible area. The cell is flexible and assumes a bell shape as it passes through extremely

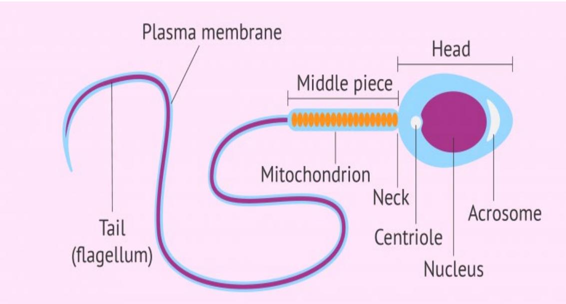
red blood cell

small blood vessels. It is covered with a membrane composed of lipids and proteins, lacks a nucleus, and contains hemoglobin—a red iron-rich protein that binds oxygen.

The function of the ovum is to carry the set of chromosomes contributed by the female and create the right environment to enable fertilisation by the sperm. Ova also provide nutrients for the growing embryo until it sinks into the uterus and the placenta takes over. The ovum itself has a central nucleus that contains the female's genetic material; this, with the genetic material in the sperm cell, determines the inherited characteristics of the child. Surrounding the nucleus is a cell plasma, or yolk, that contains nutritional elements essential to the developing egg cell.



A sperm cell consists of two parts, the head and the tail. The overall structure of the sperm makes it perfectly designed to carry out its function. The primary function of the sperm is to pass on the necessary biological information required to produce a new organism. The sperm cells head contains the genetic material for fertilisation in a haploid nucleus and the acrosome in the head contains enzymes so that a sperm can penetrate an egg. The middle piece is packed with mitochondria to release energy needed to swim and fertilise the egg. Lastly, the tail enables the sperm to swim.



Task 2

Research human tissue and answer the following questions in full:

1. **Which of the four major types of tissues is the most widely distributed in the human body?**

The human body is composed of four basic kinds of tissue: nervous, muscular, epithelial, and connective tissue. Connective tissue is the most abundant, widely distributed, and varied type. It includes fibrous tissues, fat, cartilage, bone, bone marrow, and blood. As the name implies, connective tissues often binds other organs together, hold organs in place, cushions them, and fills space. Connective tissue is distinguished from the other types in that the extracellular material (matrix) usually occupies more space than the cells do, and the cells are relatively far apart. Fat is an exception, having cells in close contact with each other; but with large, nonliving, intracellular lipid droplets, fat contains much more nonliving material than living material. The matrix of connective tissue typically consists of fibers and a featureless ground substance. The most abundant fiber in connective tissues is a tough protein called collagen. Tendons, ligaments, and the white stringy tissue (fascia) seen in some cuts of meat are composed almost entirely of collagen, as is leather, which consists of the connective tissue layer (dermis) of animal skins. Collagen also strengthens bone and cartilage. Elastic and reticular fibers are less abundant connective tissue proteins with a more limited distribution.The ground substance may be liquid, as in blood; gelatinous, as in areolar tissue; rubbery, as in cartilage; or calcified and stony, as in bone. It consists mainly of water and small dissolved ions and organic molecules, but the gelatinous to rubbery consistency of some tissues results from enormous protein-carbohydrate complexes in the ground substance. The hard consistency of bone results mainly from calcium phosphate salts in the ground substance. Some of the cells of connective tissue are fibroblasts (which produce collagen fibers and are the only cell type in tendons and ligaments); adipocytes (fat cells); leukocytes (white blood cells, also found outside the bloodstream in fibrous connective tissues); macrophages (large phagocytic cells descended from certain leukocytes); erythrocytes (red blood cells, found only in the blood and bone marrow); chondrocytes (cartilage cells); and osteocytes (bone cells).

Connective tissue type and characteristics	Functions	Locations
Areolar (loose) connective tissue. Loose array of random fibers with a wide variety of cell types	Nourishes and cushions epithelia, provides arena for immune defence against infection, binds organs together, allows passage for nerves and blood vessels through other tissues	Under all epithelia; outer coverings of blood vessels, nerves, oesophagus, and other organs; fascia between muscles; pleural and pericardial sacs
Adipose tissue (fat). Large fat-filled adipocytes and scanty extracellular matrix.	Stores energy, conserves body heat, cushions and protects many organs, fills space, shapes body	Beneath skin; around kidneys, heart, and eyes; breast; abdominal membranes (mesenteries)
Dense irregular connective tissue. Densely spaced, randomly arranged fibers and fibroblasts.	Toughness; protects organs from injury; provides protective capsules around many organs	Dermis of skin; capsules around liver, spleen, and other organs; fibrous sheath around bones
Dense regular connective tissue. Densely spaced,	Binds bones together and attaches muscle to bone; transfers	Tendons and ligaments

Connective tissue type and characteristics	Functions	Locations
parallel collagen fibers and fibroblasts.	force from muscle to bone	
Cartilage (gristle). Widely spaced cells in small cavities (lacunae); rubbery matrix.	Eases joint movements; resists compression at joints; holds airway open; shapes outer ear; moves vocal cords; forerunner of fatal skeleton; growth zone of children's bones	External ear, larynx, rings around trachea, joint surfaces and growth zones of bones, between ribs and sternum, intervertebral discs
Bone (osseous tissue). Widely spaced cells in lacunae; much of matrix in concentric onionlike layers; hard mineralized matrix.	Physically supports body, provides movement, encloses and protects soft organs, stores and releases calcium and phosphorus	Skeleton
Blood. Erythrocytes, leukocytes, and platelets in	Transports nutrients, gases, wastes, hormones,	Circulates in cardiovascular system

The table above lists representative locations and functions of the major types of connective tissue.

1. **List the most important functions of stratified squamous epithelial tissue. Name two places you would find it in the human body.**

Epithelium consists of multiple cell layers and they are generally found in regions where there is mechanical or chemical abrasion and stress and these tissues protect underlying structures from harm. Stratified squamous epithelium are found in nearly every organ system where the body comes into close contact with the outside environment – from the skin to the respiratory, digestive, excretory and reproductive systems. They also protect the body from desiccation and water loss. They perform a variety of functions that include protection, secretion, absorption, excretion, filtration, diffusion, and sensory reception.

2. **What are the general structural characteristics of connective tissues?**

Some general structural characteristics of connective tissue is that It ranges from avascular to highly vascular, it is composed mainly of nonliving extracellular matrix that separates the cells of the tissue and it is present in between different tissue and organs. It can be found in and around the body organs. skeletal tissue present in the form of bone and cartilage, and fluid connective tissue as blood and lymph are connective tissue.

Connective tissue is incredibly diverse and contributes to energy storage, the protection of organs, and the body's structural integrity.

<u>Key Points</u>

- Connective tissue is the most abundant and widely distributed of the primary tissues.
- Connective tissue has three main components: cells, fibers, and ground substance. Together the ground substance and fibers make up the extracellular matrix.
- Connective tissue is classified into two subtypes: soft and specialised connective tissue.
- Major functions of connective tissue include: 1) binding and supporting, 2) protecting, 3) insulating, 4) storing reserve fuel, and 5) transporting substances within the body.
- Connective tissues can have various levels of vascularity. Cartilage is avascular, while dense connective tissue is poorly vascularised. Others, such as bone, are richly supplied with blood vessels.

<u>Key Terms</u>

- extracellular matrix: Cells of the connective tissue are suspended in a non-cellular matrix that provides structural and biochemical support to the surrounding cells.
- fibroblast: A type of cell found in connective tissue that synthesises the extracellular matrix and collagen.

- connective tissue: A type of tissue found in animals whose main function is to bind, support, and anchor the body.

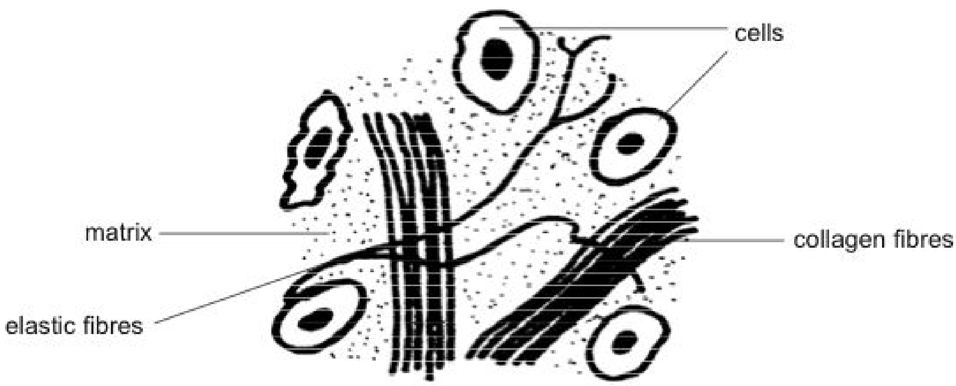
Connective tissue (CT) is a one of the four main classes of tissues. Although it is the most abundant and widely distributed of the primary tissues, the amount of connective tissue in a particular organ varies. Like to the timber framing of a house, the connective tissue provides structure and support throughout the body.

Structure of Connective Tissue

Connective tissue has three main components:

1. Ground substance
2. Fibers
3. Cells

Together the ground substance and fibers make up the extracellular matrix. The composition of these three elements vary tremendously from one organ to the other. This offers great diversity in the types of connective tissue.



Structural elements of connective tissue: Connective tissues consist of three parts: cells suspended in a ground substance or matrix; and most have fibers running through it.

Ground substance is a clear, colourless, viscous fluid that fills the space between the cells and fibers. It is composed of proteoglycans and cell adhesion proteins that allow the connective tissue to act as glue for the cells to attach to the matrix. The ground substance functions as a molecular sieve for substances to travel between blood capillaries and cells.

Connective tissue fibers provide support. Three types of fibers are found in connective tissue:

1. Collagen
2. Elastic fibers
3. Reticular fibers

Collagen Fibers

Collagen: Collagen fibers are the strongest and most abundant of all the connective tissue fibers.

Collagen fibers are fibrous proteins and are secreted into the extracellular space and they provide high tensile strength to the matrix.

Elastic Fibers

Elastic fibers are long, thin fibers that form branching network in the extracellular matrix. They help the connective tissue to stretch and recoil.

Reticular Fibers

Reticular fibers are short, fine collagenous fibers that can branch extensively to form a delicate network.

Function of Connective Tissue

The major functions of connective tissue include:

1. Binding and supporting.
2. Protecting.
3. Insulating.
4. Storing reserve fuel.
5. Transporting substances within the body

3. Where would you find areolar (loose) connective tissue in the human body? What is it's primary function?

Loose connective tissue is found around every blood vessel, helping to keep the vessel in place. The tissue is also found around and between most body organs. In summary, areolar tissue is tough, yet flexible, and comprises membranes. Areolar connective tissue holds organs in place and attaches epithelial tissue to other underlying tissues. It also serves as a reservoir of water and salts for surrounding tissues. Almost all cells obtain their nutrients from and release their wastes into areolar connective tissue.

Task 3

1. **How many types of joints are there? Please name them?**

There are six types of joints called the synovial joints, they are the most moveable type of joint found in the human body and they are formed where the bones come together. For example, there is the pivot, the hinge, the saddle, the plane, the condyloid and the ball and socket joint.

2. **What are the characteristics of the synovial joint?**

Synovial joints are characterised by the presence of an articular cavity filled with synovial fluid surrounded by a joint capsule. In this type of joint, bones can perform larger movements, in part, because joint surfaces are coated with hyaline cartilage. The five main characteristics are Joint capsule which forms a covering around the articulating ends of the bones, holding them together, synovial membrane, which lines the joint capsule and secretes synovial fluid, lubrication opposing surfaces of the bones, joint cavity which is the Space between the opposing surfaces of bones and the joint, articular cartilage which is a thin covering of cartilage that cushions the articulating bone surfaces, ligaments which connects the bone to other bone and articular disks which are pads of cartilage between articulating surfaces in some synovial joints

3 **Explain the functions of the joints?**

The Ball and socket joint permits movement in all directions, the ball and socket joint features the rounded head of one bone sitting in the cup of another bone. For example, your shoulder joint and your hip joint.

The Hinge joint is like a door, opening and closing in one direction, along one plane. For example your elbow joint and your knee joint.

The Condyloid joint allows movement, but no rotation. For example your finger joints and your jaw.

The Pivot joint also called the rotary joint or trochoid joint, is characterised by one bone that can swivel in a ring formed from a second bone. For example the joints between
your ulna and radius bones that rotate your forearm, and the joint between the first and second vertebrae in your neck.

The Gliding joint is also called the plane join. Although it only permits limited movement, it's characterised by smooth surfaces that can slip over one another. For example the joint in your wrist.

The Saddle joint. Although the saddle joint does not allow rotation, it does enable movement back and forth and side to side. For example the joint at the base of your thumb.

4. **What is the difference between the axial and the appendicular skeleton?**

We are composed of one skeleton that can be divided into two major regions, the axial and appendicular skeleton. The axial skeleton makes up our central axis and consists of the following bones: skull, vertebrae, ribs and sternum. Whereas, the appendicular skeleton consists of the limbs and girdles. The girdles are the attachment points for the limbs. The pelvic girdle is the attachment point for our thigh bone (femur) and consists of an individual os coxae (ilium, icshium, pubis). The pectoral girdle is formed by the clavicle and scapula and serves as the attachment point for our are (humerus).

4. **Describe the structure of the vertebral column?**

It consists of a sequence of vertebrae (singular = vertebra), each of which is separated and united by an intervertebral disc. Together, the vertebrae and intervertebral discs form the vertebral column. It is a flexible column that supports the head, neck, and body and allows for their movements.

5. **What are the characteristics of the long bone?**

Long bones are hard, dense bones that provide strength, structure, and mobility. The thigh bone (femur) is a long bone. A long bone has a shaft and two ends. Some bones in the fingers are classified as long bones, even though they are short in length.

6. **Describe the term, hematopiesis?**

Hematopoiesis is the production of all types of blood cells including formation, development, and differentiation of blood cells. Prenatally, hematopoiesis occurs in the yolk sack, then in the liver, and lastly in the bone marrow. In the normal situation, hematopoiesis in adults occurs in the bone marrow and lymphatic tissues. All types of blood cells are derived from primitive cells (stem cells) that are pluripotent (they have the potential to develop into all types of blood cells).

Task 4

1 Describe the relationship between the muscular and the skeletal system. How do they work together?

Muscles connect to your skeleton and they contract and move the skeleton along. Your skeletal system is made up of cartilage and calcified bone that work together. They help the process of movement happen in a smoother manner and the calcified bones of your skeleton also work with the circulatory system.

3. **What is the largest muscle in the body?**

The gluteus maximus is the largest muscle in the human body. It is large and powerful because it has the job of keeping the trunk of the body in an erect posture. It is the chief antigravity muscle that aids in walking up stairs.

4. **Which muscle never tires? Explain why this is?**

Cardiac muscle is unique to the heart and it never tires. The body's involuntary muscles work our internal organs and they are outside our control. Voluntary muscles make the body move and they are attached to the skeleton and can be controlled. Voluntary muscles also have fast twitch and slow twitch fibres. Fast twitch fibres contract quickly, but do not use oxygen well and tire quickly. Slow twitch fibres contract slowly, but use oxygen well and keep going for a long time. For example top sprinters have more 'fast twitch' fibres. Endurance athletes tend to have more 'slow twitch' fibres.

5 **Describe the difference between voluntary and involuntary muscles?**

Involuntary muscle is under unconscious control while voluntary muscle is under conscious control. Voluntary muscle is also under the control of the autonomic nervous system while the involuntary muscle is under the control of the somatosensory nervous system. Voluntary muscles include skeletal muscle that attaches to bone and skin whereas Involuntary muscle includes smooth muscle that lines organs, and cardiac muscle of the heart. While some involuntary muscles (e.g. cardiac muscles) contract in a constant rhythmic cycle, voluntary muscles do not. Voluntary muscle contains multi nucleated cells, while involuntary muscle is uninucleated. Voluntary muscle nuclei are located on the edges of the cell while those of involuntary muscle are located in the centre of the cell. Voluntary muscle cells are very long while involuntary muscle cells are short. Voluntary muscle cells also have sarcomeres while involuntary muscle cells do not have sarcomeres. Some involuntary muscle cells are joined by an intercalated disc, while voluntary muscle cells join at a Z disc. Troponin is present in all voluntary muscle but is present only in some involuntary muscle (cardiac). Lastly, Voluntary muscle tires easily while involuntary muscle does not tire out (cardiac) or tires out very slowly (smooth).

5. **What are myofibrils made up of?**

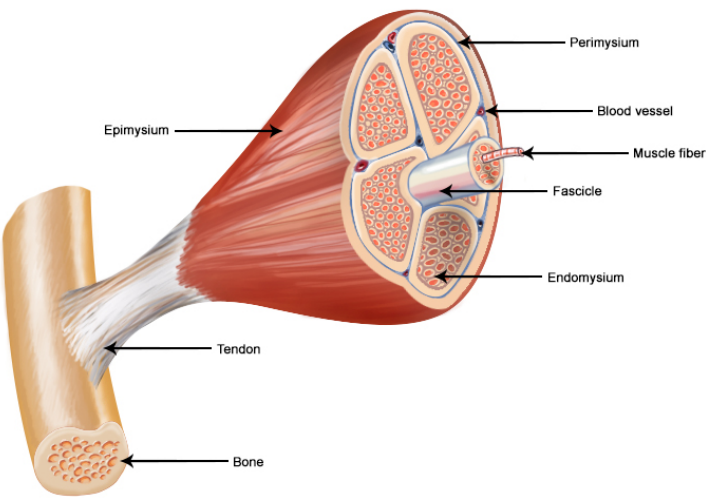
Myofibrils are made up of thick and thin myofilaments, which help give the muscle its striped appearance. The thick filaments are composed of myosin, and the thin filaments are predominantly actin, along with two other muscle proteins, tropomyosin and troponin.

6. **Describe the structure of skeletal muscles?**

A whole skeletal muscle is considered an organ of the muscular system. Each organ or muscle consists of skeletal muscle tissue, connective tissue, nerve tissue, and blood or vascular tissue. Skeletal muscles vary considerably in size, shape, and arrangement of fibers. They range from extremely tiny strands such as the stapedium muscle of the middle ear to large masses such as the muscles of the thigh. Some skeletal muscles are broad in shape and some narrow. In some muscles the fibers are parallel to the long axis of the muscle; in some they converge to a narrow attachment; and in some they are oblique.

Below is a structure of a skeletal muscle:

Structure of a Skeletal Muscle



Each skeletal muscle fiber is a single cylindrical muscle cell. An individual skeletal muscle may be made up of hundreds, or even thousands, of muscle fibers bundled together and wrapped in a connective tissue covering. Each muscle is surrounded by a connective tissue sheath called the epimysium. Fascia, connective tissue outside the epimysium, surrounds and separates the muscles. Portions of the epimysium project inward to divide the muscle into compartments. Each compartment contains a bundle of muscle fibers and each bundle of muscle fiber is called a fasciculus and is surrounded by a layer of connective tissue called the perimysium. Within the fasciculus, each individual muscle cell, called a muscle fiber, is surrounded by connective tissue called the endomysium. Skeletal muscle cells (fibers), like other body cells, are soft and fragile. The connective tissue covering furnish support and protection for the delicate cells and allow them to withstand the forces of contraction. The coverings also provide pathways for the passage of blood vessels and nerves. Commonly, the epimysium, perimysium, and endomysium extend beyond the fleshy part of the muscle, the belly or gaster, to form a thick rope like tendon or a broad, flat sheet-like aponeurosis. The tendon and aponeurosis form indirect attachments from muscles to the periosteum of bones or to the connective tissue of other muscles. Typically a muscle spans a joint and is attached to bones by tendons at both ends. One of the bones remains relatively fixed or stable while the other end moves as a result of muscle contraction. Skeletal muscles have an abundant supply of blood vessels and nerves. This is directly related to the primary function of skeletal muscle, contraction. Before a skeletal muscle fiber can contract, it has to receive an impulse from a nerve cell. Generally, an artery and at least one vein accompany each nerve that penetrates the epimysium of a skeletal muscle. Branches of the nerve and blood vessels follow the connective tissue components of the muscle of a nerve cell and with one or more minute blood vessels called capillaries.

7 What is the difference between type 1 and type 11 muscle fibres?

The two types of skeletal muscle fibers are slow-twitch (type I) and fast-twitch (type II). Slow-twitch muscle fibers support long distance endurance activities like marathon running, while fast-twitch muscle fibers support quick, powerful movements such as sprinting or weightlifting.

Characteristic	Slow-Twitch Type I	Fast-Twitch Type IIA	Fast-Twitch Type IIX or IIB
Activities	Marathons, distance running, swimming, cycling, power	Powerlifting, sprinting, jumping, strength and agility training	Powerlifting, sprinting, jumping, strength and agility training

	walking, endurance training		
Muscle Fiber Size	Small	Large	Large
Force Production	Low	High	Very High
Resistance to Fatigue	Slow	Quick	Very Quick
Contraction Speed	Slow	Quick	Very Quick
Mitochondria	High	Medium	Low
Capillaries	High	Medium	Low
Myoglobin	High	Medium	Low
ATPase Level	Low	Medium	High
Oxidative Capacity	High	Medium	Low

Slow-Twitch, Type I

Slow-twitch muscle fibers have high concentrations of mitochondria and myoglobin. Although they are smaller than the fast-twitch fibers, they are surrounded by more capillaries (1,2). This combination supports aerobic metabolism and fatigue resistance, particularly important for prolonged sub-maximal (aerobic) exercise activities

Type 1 fibers produce less force and are slower to produce maximal tension (lower myosin ATPase activity) compared to type II fibers but they are able to maintain longer-term contractions, which is key for stabilisation and postural control (1,2).

Fast-Twitch, Type II

Fast-twitch type II muscle fibers are further divided into Type Iix and Type IIa. Typically, these have lower concentrations of mitochondria, myoglobin, and capillaries compared to our slow-twitch fibers, which means they are quicker to fatigue (1,2). These larger-sized fibers also produce a greater and quicker force, an important consideration for power activities (1,2). Type IIX (also known as Type IIB) fibres produce the most force, but

are incredibly inefficient based on their high myosin ATPase activity, low oxidative capacity and heavy reliance on anaerobic metabolism (1,2). Type IIA fibers, also known as intermediate muscle fibers, are a mix of type I and type IIx, with comparable tension. They are able to use both aerobic and anaerobic energy systems because these fibers have a higher oxidative capacity and fatigue more slowly than type IIx (1,2).

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