General introduction of anatomy and physiologies

Anatomy is the scientific study of plant and animal structures, both internal and external, whereas Physiology is the study of functions of the various body parts. By studying these two subjects together, it allows a student of Physical Education to have a better and more clear understanding of the human body system.

Anatomy

Human Anatomy is the scientific study of the form and structure of the human body and it illustrates the arrangement of the various parts and organs of the body, and this study is carried out by careful scientific observation, dissection, and through an accurate study under scanning/magnifying devices like X-Ray scan, MRI scan, microscopes etc.

Anatomy is subcategorized into two, gross anatomy and microscopic anatomy. Gross anatomy is the anatomical study of structures of the body that can be seen directly by a person’s eyes. For example, the study of the different nerves that make up the human nervous system is known as gross anatomy. Studying an MRI scan sheet of the lower spine to determine the type, situation and location of a prolapsed disc is a simple example of a gross anatomical examination. Microscopic anatomy is the anatomical study of microscopic structures using the help of microscopes and other devices of high magnification. The study of cellular structure which is known as cytology and the study of tissue samples known as histology, are examples of microscopic anatomy.

The human beings are perhaps the most complex species on earth. Imagine trillions of microscopic parts with each part having its own uniqueness. And

yet despite their differences we find them all functioning together in an orderly predefined manner for the benefit of the total being. The human body is indeed an astounding and complex machine that can carry out an almost infinite number of tasks; and to fairly understand how a machine works, it is essential to understand how it has been structured and assembled together.

The human body is indeed an astounding and complex machine that can carry out an almost infinite number of tasks; and to fairly understand how a machine works; it’s essential to understand how such a machine works structurally, region by region, level by level. The human beings are perhaps the most complex species on earth. And so one can easily picture how several billion cells work, each occupying a unique position in time and space, each having it’s own unique role in function and structure.

Andreas Vesalius, a Belgian anatomist is considered as the father of anatomy. His pioneering work in the dissections of the human body and the inferences and descriptions of his observations considerably assisted in helping the rectification and myth-busting of many misconceptions prevailing since ancient times and it laid the basic foundation of anatomy.

The word anatomy finds its root in the Greek language and literally means “ to cut apart”, which is exactly what one must do to observe and understand how something has been put together. For example, the study of the anatomical arrangement of the bones which builds the human skeleton and provides the human body its framework, is considered anatomy.

The father of Indian medicine, Charaka of the year 360 BC did considerable research and study of the anatomy of the human. He analysed and declared 360 as the total number of bones, including teeth, present in the body. He came about with the conclusion that the human heart was linked to the body through 13 main channels.

Physiology

Physiology (pronounced “ fizzee-aww-lo-jee”) is the study of how living beings function. The word “ physiology” is from Ancient Greek, “ physis” which means “ nature, origin” and “-logia” which means “ study of”. In the context of humans beings, its scope is enormously extensive. Human physiology is the study of the physical, bio-mechanical, and bio-chemical functions of human beings in normal health, the body organ systems, their organs and the cells of which they are composed. This study is taken to comprehend and figure out the numerous processes that are being accomplished in the human body. At one end of the scope of this subject, it involves the study of individual molecules – for example, how a specific protein’s structure and electrical characteristics allow it to work as a medium for ions to move into or out of a cell. At the other end of the scope, this subject deals with the complex processes that depend on the inter relationship of many widely separated organs in the human body – for example, how the brain, heart, and several glands all function together to ensure the excretion of more sodium in the urine after a person has consumed highly salted food.

In physiology, the methods applied in its study is done in a scientific manner, to determine the physical and chemical functions of organisms, organ

systems, organs, cells and the biomolecules that carry out all the numerous functions of the living system.

The primary level focus of physiology is at the level of organs and organs systems within systems. Much knowledge was gathered about human physiology by research and inferences collected from various endeavours of animal experimentation. Physiology assists us in understanding how the human body functions, from the most minute part (cells) all the way to the whole body organism. It also assists us in understanding how various parts of the body work together. For example, the heart, lungs, and muscles must all work together in concurrence to allow a cricket player to run, bowl, bat and jump. It also helps us in understanding how our body reacts to different environmental stimuli. Whether the weather is very hot or very cold, your body has in-built mechanisms to adopt to the situation by making the insides of your body to stay at just the precise temperature. If you plan to travel into unfamiliar terrain or say to outer space or say into the depths of the ocean waters then physiology would help you a lot in understanding how your body would react to these extreme conditions. Physiology helps us understand how living things do all the activities that they do: interact, eat, sleep, run, jump, respire, reproduce etc.

Erasistratus is considered as the father of Physiology, his work is one of the earliest attempts at applying physical laws to function. Aristotle was also noted for his work in this field. And Claude Bernard is considered as the father of Modern Physiology. He pointed out the steadiness of the body regardless of the changing outside environment.

The ancient Indian scientist Charaka was the first physician to present the concept of digestion, metabolism and immunity. According to his translations of the Vedas, a body functions because it contains three principles, namely: movement, transformation and lubrication/stability.

The following quotation is attributed to Charak:

“ A physician who fails to enter the body of a patient with the lamp of knowledge and understanding can never treat diseases. He should first study all the factors, including environment, which influence a patient’s disease, and then prescribe treatment. It is more important to prevent the occurrence of disease than to seek a cure.”

Homeostasis

A human body is made up of many cells all functioning together for the survival of the entire living organism. While cells may perform very diverse functions, all the cells are almost similar in their metabolic necessities. Safeguarding an internal composition along with all that the cells need to survive on, is necessary for its healthy well-being of individual cells and the healthy status of the entire body. The varied processes undertaken by the body to control its internal composition in such a manner are collectively referred to as homeostasis.

Claude Bernard was the first person to study this process. But the term Homeostasis was given by Walter Cannon. The word finds it root in the Greek language, “ homoios” means “ resemble” and “ stasis” means “ stand”.

Homeostasis is the name given to the physiological process that checks and maintains a stable internal equilibrium in the body. For the body to survive, it must consistently monitor both its internal as well as external environment and make the required adjustments. In order for cells to thrive, they must be maintained in an environment that ensures a proper temperature range, appropriate oxygen levels and sufficient availability of nutrients. Survival of the living organism depends upon the body’s ability to maintain homeostasis.

Homeostasis is managed by receptors which transmit signals to a control center which monitors to ensure that it falls within the body’s set points. Any process or metabolic reaction that occurs in the living body always has the sole purpose of achieving directly/indirectly the consistent aim of a stable equilibrium (homeostasis). Most of the processes of homeostasis are regulated by method of negative feedback. E. g. The maintenance and monitoring of blood sugar levels. Then, there are also some positive feedback mechanisms e. g. The case of blood clotting.

Elaborating further, all organisms need to maintain a balanced environment in order to sustain metabolism in the cell that is highly essential to life. When the internal environment of a given organism is disturbed, then it’s possible that there would be a disruption in the normal processes. One best example to explain this phenomenon further is how the body adapts to the change in body temperature by performing actions that balance out. If a person is feeling cold, then involuntarily he/she will be inclined to shiver which, causes the muscles to generate heat or if you are feeling hot, then the person’s body releases sweat that helps in the evaporation of heat from the body.

Homeostasis therefore maintains the stability of the body by ensuring that the internal set points are maintained to be stable, though not static.

Feedback Control

When a change occurs, there are two main kinds of feedback:

A. Negative feedback

This is the most common method of how the body regulates most systems. Negative feedback is a reaction method in which the system counters the situation in a negative/reverse direction of change. Since this has the motive to keep things balanced, it allows for the state of equilibrium, homeostasis. For example, when the concentration of CO2 in the human body significantly increases, the respiratory organs are made ready to act to increase their activity and expel out more CO2. Body temperature-regulation as discussed earlier, is another common example of negative feedback. When body temperature increases, the receptors of the skin and the hypothalamus sense a difference, this triggers a signal from the brain. This signal form the brain causes the body to start sweating and to start dilating the blood vessels to decrease the body temperature.

B. Positive feedback

This is a response to amplify the change that has occurred. And this gives a destabilizing effect, and so does not result in homeostasis. The Positive feedback mechanism is fairly less in number compared to negative feedback, but it has its applications and does serve a purpose, particularly when a particular response needs to be increased. For instance, take the case of

child birth, the child is born and emerges out of the uterus, by the continued pressure of the uterus walls, the walls contract themselves, and push further and further till the child is born. This contraction of the uterus is triggered by a hormone called oxytocin which is secreted by the hypothalamus gland. This hormone is released to stimulate the uterus to contract itself. Now we must know that, this hormone is only released when it senses that there is a pressure on the cervix (the exit neck of the womb). So the more the body senses pressure on the cervix, the more is the oxytocin released, and the more the oxytocin correspondingly the more will be the uterus contraction, and the more is the contraction correspondingly the more will be the pressure on the cervix and thus more oxytocin is released and this cycle continues until the child is born. This is a wonderful example of a positive feedback control system.

Some Important terms in Negative feedback control

1. Set point: The set point is a preset level that is required for the body to be in its normal condition. For instance, there is set point for the body heat and sugar levels.

2. Integrating center: When a change occurs with respect to a particular set point, then the receptive sensors will detect the deviation and send a signal to the Integrating center.

3. Effectors: The effectors ensure that the set point is maintained. Muscles and glands then function as effectors to ensure that the set point is restored to the normal level.

4. Analogy: An Ironing box thermostat has a predefined set temperature like a set point. When the Iron sensor detects temperature variation, it will signal to the integration center to activate the effectors to start the heating system to ensure the maintenance of the temperature in accordance to the required heat set point.

1aii. Need and importance of the study of Anatomy & Physiology in PE

A human body is a unique exquisite machine. Scientists have always been curious about its composition. Since the last few centuries, researchers are providing massive information regarding the constituents of human body. And the discipline of Chemical science entered into this field as early as in 18th century. It is apparent that human body depends on chemical normality to maintain its homeostasis (stability).

An understanding of the particular structure and function of the human body serves as the foundation for choosing wisely the course of action a person must follow to attain his/her rightful place in the home, school and society. To survive, the human beings must carry out certain processes to cleanse and nourish the body and for active functions of all the body systems. Without such understanding the person accepts blindly the rules of didactic teaching and often pursues the alternative of irrational blind superstition and frequently becomes the victim of obnoxious propaganda or vile advertisements.

Now the question is that do athletes differ from non-athletes in body composition? Some prerequisites should be taken into consideration before

answering these questions. We know that body composition differs between the genders, it is differs in the alteration by age and the lean body mass is a function of stature at all ages. A specific type of physique is required for the best performance of athletes in a specific sport event. Body composition components control the physique of an individual. So, the inner content of the body composition of the athletes is of utmost importance for their peak performances and to keep their physical fitness intact.

If the students can identify the muscles and understand the interrelationship that individual muscles have with each other, then the chances for a greater understanding of human movement and sports skills are increased. Every student should know more about the anatomy of sports skills and thence the students would seldom ever challenge the professors.

In the study of Anatomy and Physiology, the student will learn how cells form tissues and organs, how organs form systems, how glands regulate the emotions, how the oxygen we breathe affects the cells of the body, how to develop and ensure the growth of strong bones, how to build up strong muscles, how the nerves regulate the body processes, how disease may be prevented, how perseverance serves humankind, how food is digested for use by the tissues, how the sense organs recognize familiar objects and senses, how health services endeavor to protect the wellbeing of families and communities.

Finally, this study aims to guide youth in the formulation of desirable habits and appreciations which are highly pertinent for the flourishing of happiness and service in the field of Physical education. The health of our beautiful

nation depends upon an enlightened people. The period of adolescence, when the youth turn its attention to the delicate amalgamation of self with the value of an individual to society, provides an exceptional opening to inculcate desirable aspirations and attitudes towards healthful living based upon spot on information and knowledge.

1b. Characteristics of Living bodies

Introduction

When we observe the world, it is the reverberating miraculous process of life that distinguishes a living organism from the thing that is inorganic in nature. If something shows life then it will be equipped with a mechanism of ensuring its survival whereas something that is dead does not posses life, that is, it is either dead or it is an ordinary non-living object. A living organism is composed of cells, it utilise energy, maintains stability, responds to environmental stimulus, reproduces, and passes on its characteristics to its off-springs.

In the science of biology, the first subject matter that a student would be learning and understanding would be the characteristics of life. All living bodies show these basic characteristics. And it is based on these shared properties of life that we decide to which category we can classify a body in, living or non-living. There are some characteristics that are specific to a particular species and there are some that are characteristics of life which are common to all living beings.

By gathering just a few observations of the structure and functioning of the human body, one can easily make out some quick observations that reveal

the following characteristics: Our bodies are always respiring repetitively, that is, we breathe in O2 from the atmosphere and breather out CO2; then we consume certain substances known as food which are akin to those that constitute our body. And through the process of Metabolism which includes Anabolism and Catabolism, the body generates its energy for self-sustenance.

If we view our body through an Infrared camera, we would be able to see that our living bodies are always consistently generating heat energy and emitting it out to the neighbouring areas. And this heat-up/heat-loss mechanism is simply to ensure that the body's temperature is maintained at a given set point from time to time. The mechanism makes sure that the body is always at its required level of temperature which is normally a temperature that is higher than the surrounding area.

Another basic characteristic that our bodies display, is the power of locomotion, we can observe that the body parts move themselves, they can move internally as in part over part, and externally as in the whole body moves from place to place. And the driving power for these movements is not provided by an external source but rather the energy is supplied by the bodies themselves. Then lastly, our bodies excrete waste products from time to time. The waste expelling system/mechanism makes sure that the body is always at its required level of body composition. These waste products are the by products of the metabolic processes that occur in the body for the oxidation of material consumed as food. The following are the characteristics of the living bodies in detail:

Characteristics of Living bodies

1. Cells

The cell is the smallest basic unit that can be found in every living organism. All organisms are made up of an assemblage of one or more cells. There organisms can be categorised into two types: single cell and multi-cellular organisms. Single cellular organisms are also known as unicellular organisms as they are made up of a single cell. And multi-cellular organisms are made up of several cells. And in such type of organisms, each cell have a specific function to perform.

Generally speaking, the cell consists of small constituents or parts called organelles. Some examples of organelles are Mitochondria, Golgi apparatus, nucleus, Ribosomes, etc. which are the equivalents of organs in our body. These organelles are produced out of proteins, lipids, nucleic acids, and carbohydrates, etc. And these carry out the function of producing energy in the form of ATP energy molecules. And eventually, the cells of the similar kind join together to form tissues, and those tissues of the similar kind in turn join together to form organs.

2. Homeostasis

This is the mechanism by which a body achieves an almost stable internal environment so that the functions carried out by the cell are done at maximum efficiency.

3. Heredity

Every single living organism receives some hereditary characteristics from their parental genetic material. All living parent beings on reproduction pass

their genes to their off-springs. The genes contain all the information related to the hereditary process. These genes are composed of DNA. These genes are what constitute the predefining material code for how an organism should display certain characteristics or behave in a certain manner. The science of heredity is called genetics. The species evolve by the inheritance of different characteristics from the parents and the process goes on over a long period of time. This is caused by the process of heredity. This is one of the most important characteristics of life.

4. Use of Energy

All living bodies need energy to carry out the various processes like development, reproduction, growth, repair, etc. Most living bodies require this energy in the form of ATP molecules. They need this energy for the functions of movement and metabolism, these two activities require most of the energy. Metabolism involves a sequence of processes that allow living organisms to be self-sustaining. The cell takes in the essential nutrients like amino acids through the cell wall and utilizes them. The food materials consumed by a human are absorbed in and assimilated. Anabolism is the process that consumes energy to change chemicals into cellular constituents like molecules and catabolism gives out energy by breaking down molecules from the organic matter.

So the entire sequence of chemical processes and developments that take place in the living organism, starting with consumption of food, absorption and ending with excretion, is included in the word, metabolism. And Anabolism is the process by which a living body builds up living material building complex substances from the simpler basic materials. Whereas

Catabolism is the reduction of complex substances into simpler forms, the various complex materials are broken into smaller forms and in the process it results in the production of energy. Thus a piece of meat, is a complex substance that is built of an enormous number of molecules. Now when this meat is broken down by the digestion process to simpler bodies, the energy stored up in the meat as potential energy becomes generated and is utilised for active life, this force is known as kinetic energy.

5. Differentiation

Differentiation is a process of development by which cells that are not specialized convert into cells of specialization with some distinguishing structural and functional characteristics.

6. Respiration

Respiration is the collective name given to all the processes concerned with breathing. The body breathes in air, and the lungs ensure the exchange of O2 and CO2 in the process. The blood circulatory system makes sure that the cells get nourished with the fresh oxygen and the CO2 is expelled out to the external environment. The cellular respiration is a major process for the survival of the cell, as the cell utilizes Oxygen and releases Carbon dioxide during its process of metabolism.

7. Digestion

Digestion is the process of breaking down of complex absorbed food substances into basic simple forms of molecules. And these end molecules can be easily absorbed into the blood and can be used or transported to any region of the body for its nourishment.

8. Excretion

Excretion is the process that removes the unwanted products out of the body. These waste products are actually the by-products of the metabolic processes. These by-products are can be poisonous and therefore they are expelled out of the body from time to time.

9. Reproduction

Every living organism has the characteristic of reproduction. By the process of reproduction, a living organism can produce new organisms of the similar kind. Reproduction can be of two types: asexual, this is where a single parent is capable of producing an organism and the second type is the sexual type, which involves the male and female sex cells. The two parents, male and female contribute hereditary information to the off-spring. When a unicellular organism reproduces to give a daughter cell, then it is known as asexual reproduction and sexual reproduction is the process by which animals reproduce.

10. Response to Environment

All organisms react to a given stimulus. When there is a stimulus from the nearby surrounding, the organism is bound to respond in such a manner so that it may save its self or maintain its equilibrium. E. g. If a torch light is suddenly flashed into a person’s eyes, the eye lids will close on their own. Or when a unicellular organism is exposed to a strange chemical, they immediately respond to it by contracting. Most responses generally manifest in the form of some kind of movement of body parts or constituents.

11. Evolution and Adaptation

All living bodies have the characteristic of adaptation to adjust themselves to their environment. For instance, plants can be found in the desert that have thick succulent leaves, and that enables them with the capability to hoard up and maintain its water content. And these plants evolve over a certain time period according to their environment. This characteristic is a fundamental of evolution.

Environmental needs of the human body

The human body depends on its environment for its nourishment. The following are the various needs that it must satisfy from its nearby environment:

a. Food for the generation of energy

b. Fresh Oxygen for respiration and cell nourishment

c. Water for most processes of the human body

d. Energy to maintain body temperature

e. Adequate pressure for proper respiration and blood circulation

Chemical composition of the body

The human body is chiefly made up of thirteen chemical elements. They are Oxygen, Hydrogen, Nitrogen, Chlorine, Fluorine, Carbon, Phosphorus, Sulphur, Calcium, Potassium, Sodium, Magnesium, and Iron. Besides these 13 elements, a few other elements like Silicon are also found in negligible

quantities. The following list gives the proportion in which these various elements are present:

Oxygen, Hydrogen and Nitrogen, these three elements, which are gases in their uncombined form, make up most of the weight of the whole human body. Carbon forms more than one fifth of the weight of the body. Thus carbon and the three main elements mentioned earlier are the most major elements that constitute the body.

All living organisms are subject to constant growth as well as its antonym, decay. Life is a procedural condition of ceaseless changes, comprising of two opposite processes, repair(growth) and decay. Therefore, the exact composition of our bodies are different from time to time, we are not composed of exactly the same particles in one moment compared to the next, although in appearance we seem to remain the same human individuals.

The Structure of the body

The framework of the body is primarily and profoundly an intelligent compromise between rigidity and mobility. As we can easily observe, the construction of the body with its bones are either enveloping or supporting the structural systems of various closely packed organs. The bones, muscles, and flesh all provide for the supporting framework. If we observe this keenly, we can come to the conclusion that a human body is indeed an exquisite machine of the highest intelligence of its own.

The skeleton gives the upright strength to the body and in some places, such as the skull and thorax, acts as a protective layer. The joints give the bones mobility and the muscles applies support and protection.

The contents of the chest and abdomen are incessantly moving along with various processes like the beating of the heart, inspiration and expiration in the lungs and peristalsis of the bowel. These structures can move without difficulty as they are surrounded by special, smooth layers of tissue known as pericardium, pleura and peritoneum. These small cavities of tissue, or sacs to give them their medical name, are rather like a very soft balloon containing a little fluid. Similar “ sacs” occur in bone joints, around bone tendons passing over joints and at the point of friction. These sacs are known as synovial sacs.

The body’s largest organ is the skin. In an adult it covers approximately 2 square meters and not only envelops the whole body in a protective waterproof layer but is also part of the heat-regulating system. The liver, meanwhile is the most complicated organ with the greatest number of functions- transforming digested food into usable materials and disposing of waste substances.

The circulation is constantly restoring and revitalizing as well as removing waste products from the basic unit of the body – the cell. The cell is as we discussed earlier, a microscopic structure, billions of which on assembling together, build up the whole body. Each cell specializes and carries out its own particular function. All the structures and organs are held together by

the connective tissue, made up of cells that act as a kind of packing to protect and support the internal mechanisms.

Body systems

Claude Bernard, the father of modern physiology made an astounding observation. He noted that body cells survived in a healthy condition only when the parameters of pressure, temperature, and chemical composition of their environment remained relatively constant. Later, Walter B. Cannon elaborated on the concept of homeostasis for the relatively consistent states maintained by the body. These two scientists laid down the foundation for the scientific study of body systems.

Body functions include the physiological and psychological activities of body systems. The body's functions can be ultimately deduced to its cells' activities. Survival is the cell's chief goal. Survival depends on the body's restoring and consistent maintenance of homeostasis.

Structural levels of organization in brief

A. The atomic level is the least complex level. E. g. C, N

B. Molecular level e. g. CO_2.

C. Macromolecular level e. g. carbohydrates, lipids, proteins, nucleic acids.

D. Organelle level e. g. mitochondria, nucleus, Golgi apparatus.

E. Cellular level e. g. sperm cell, skin cell, neuron, egg cell.

F. Tissue level e. g. epithelial tissues, connective tissues.

G. Organ level e. g. Lungs, Heart, Brain

H. Organ system level e. g. Digestive, Circulatory

I. Organism level e. g. The human organism.

Organizational levels of the human body

At every level of the organizational framework, there is a division of function. Each constituent has its own function to perform in tandem with others. Even a single cell, if it loses its focus, it is bound to die.

Cell

The cell is the basic structural and functional unit of an organis