Homeostasis of skeletal and muscular systems

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Living cells of plants and animals are only able to survive under a narrow range of certain conditions that include nutrient availability, pH concentration, temperature, ion concentration among other factors. The human body, usually called inner environment has to time and again adapt to the outside environment which is ever experiencing weather changes and great climate diversification that occurs from one hour to another, one day to another day and from one season to another. It is in this respect that human beings have to device physiological mechanisms in order to survive because any inability by the human body to adjust to these changes leads to either diseases or to death. Human beings for example can only survive under a narrow range of pH values of 7. 35 and 7. 45. Any value below these results to a situation called acidosis whereas any excess of this causes a situation called alkalosis. It is of paramount importance to note that either condition is as life threatening as the other. Likewise, the normal body temperature of 37. 2 to 37. 7 degrees Celsius has to be equally maintained to ensure survival of a living organism. Any deviation from these results to a condition called hypothermia (if the core body temperature goes below 33 degrees Celsius or 91 degrees Fahrenheit) or hyperthermia (if the core body temperature goes above 42 degrees Celsius or 108 degrees Fahrenheit)

This is done through the process called Homeostasis. Homeostasis is the tendency of a system of a living organism, either closed or open, to regulate an internal environment while maintaining a constant and stable condition. Homeostasis is made possible through multiple dynamic equilibrium adjustment and regulation mechanism and not a stable equilibrium as such. This is because internal body conditions are never absolutely stable but

varies within a narrow range of average commonly referred to as set point. Several body systems are involved in the process of homeostatic regulation. The Nervous system is in charge of controlling other body parts by sending an electrochemical signal to the brain whenever there is any change from optimum levels. The brain then corresponds by sending the required stimulus to the respective body organ. The Circulatory system, made up of arteries and veins, maintains this balance through the circulation of blood to all other body parts. Through capillaries, an exchange of nutrients in each cell is initiated. This system also enhances the transportation of toxic excretory wastes and other liquid material to the excretory organs. Through lymphatic vessels, the Lymphatic system is involved in homeostasis by collecting excess tissue fluids and taking them back to the veins. The Endocrine system, the main regulator of this process of homeostasis, on the other hand contains hormones (chemical messengers) that keeps circulating throughout the blood stream and acts on the respective target organs. As much as the Endocrine system cannot work without coordinating with the Nervous system, its effects as long lasting even thou they are slow.

The process of Homeostatic regulation takes place under a mechanism called feedback. This feedback can either be negative-to ensure stability or positive-to enhance a rapid change. A negative mechanism loop is where a body senses a change in the internal environment and activates methods to negate, reverse or counter that change. A very relevant example of negative mechanism is the process of temperature regulation. A rise in blood temperatures is sensed by specialized neurons located in the hypothalamus found in the brain. This is then signaled to other nerve centers which in turn

relay them to the blood vessels of the skin. The dilation of the blood vessels pushes the blood to flow closer to the body surface and excess heat is radiated from the body. If this does not cool the body back to the set point, sweating is activated by the brain. A strong cooling effect is thus felt on the skin due to evaporation of sweat. In the event that the body temperatures fall too low, the same hypothalamus senses this and signals this to the cutaneous arteries (that supply the skin with blood) to perform an action called constriction. Deeper retention of warm blood in the body is initiated thus less heat is lost from the body surface. If this effect is inadequate, the brain likewise activities the act of shivering and in the course of shivering, each muscle tremor releases heat energy to return the body back to the set point of 37 degrees Celsius.

The second mechanism of homeostasis, a counterpart to the negative feedback loop is that of positive feedback and rapid change. In this positive feedback loop mechanism, once the body is able to sense a change, it activates a mechanism to either accelerate or increase that change. As much as this mechanism aids in homeostasis, it mostly produces opposite results and can be life threatening or fatal. A good example of a beneficial positive feedback is exhibited in the process of blood clotting where an enzyme that is used to form the matrix of blood clot thrombin in the complex biochemical pathway is catalyzed thus the process is speeded up. Another beneficial positive feedback is seen in the process of childbirth where the secretion of hormone oxytocin is triggered by the stretching of uterus and this enhances uterine contraction that speeds up labor. Similarly, a beneficial positive feedback is experienced in the process of protein digestion where secretion

of hydrochloric acid and enzyme pepsin is initiated by the presence of partially digested protein particles that once digestion begins, it becomes a process that is self-accelerating. However, this mechanism has more harmful and more potential fatal consequences that often results to rapid loss of internal stability. The death of a small area of a heart tissue for example triggers myocardial infarction, a kind of heart attack, because the heart is not able to pump an adequate amount of blood hence the heart itself is deprived of blood and more tissues begins to die. In many cases, this leads to rapid cardiac mal-functioning leading to death. It is therefore important to bear in mind that many deaths that occur are as a result of positive feedback loop.

However both the skeletal and the muscular systems work hand in hand in the process of homeostatic regulation in a combined system otherwise known as the muscular skeletal system or rather musculoskeletal system. This system consists of the bones and joints- skeletal system and voluntary or striated muscles-skeletal muscle system. Skeletal muscle fibers contain numerous nucleuses on each cell and the cell nuclei are found beneath the plasma membrane of the skin. Both the skeletal and the muscular systems work together in the process of performing basic and essential functions necessary for life that includes protection (of the brain and other internal organs), supportive services of maintaining an upright posture, blood cell formation in a process called hematopoesis, storage of minerals and fats among other minor duties like leverage that involves magnifying movement or force speed. Musculoskeletal system comprises of five major tissues that include bones, tendons, ligaments cartilage and skeletal muscles. The

ligaments are the tissues on which one bone is attached to another bone. Cartilages are protective and gel-like substances that line interveterbral discs and joints while tendons usually attach muscles to bones. Each of these tissues has four connective blocks that build tissues. They include fibroblasts, collagen, elastic fibers and proteoglycans. Fibroblasts are the mother of all these other connective tissues as it is the one that produces them. Collagens are the principal proteins that are long and thin and are organized into various intertwining fibers to form strong ones that do not stretch. Elastic fibers are found in the walls of arteries whereas proteoglycans are ground substances normally called matrix in which the other connective tissues reside.

This combination of functions by both the muscular and skeletal happens mostly when there is a change in both the body pH and the central venous pressure. Active body muscles usually respire and in the process carbon dioxide is produced. The carbon dioxide that is produced dissociates in the blood to produce both hydrogen and carbon ions which have an impact of lowering this pH. Once there is such a decrease in the pH, the chemoreceptors that are centrally located in the brain detect this and induce respiration that accelerates expulsion of the carbon dioxide gas thus maintaining the internal body temperature. The second way in which muscular skeletal homeostasis in the body is evident happens during exercise. Here, more blood is diverted into body muscles as a result of relaxation of arterioles hence a considerable decrease in the volume of blood flowing to the heart. This brings about an impact in the central venous pressure. In order to correct this defect and bring about homeostasis, the

aortic and carotid barroreceptors via the cranial nerves detects this and relays this information in the cardiovascular (medulla) part of the brain. This then lowers the action potential rate in the brain thereby increasing and decreasing the sympathetic and the parasympathetic outputs respectively. The overall result is an increase in not only the inotropy (heart rate) and chronotropy (contractility) but also in vasoconstriction and total peripheral resistance (blood pressure).