Overview About Nonspecific Immunity in Humans

This article is an overview about nonspecific immnue mechansims in the human body.

Immunity are mechanisms that the body uses jointly with other systems in the body such as the endocrine and the nervous system and the respiratory system in order to sustain the existence of the individual as a unique living entity. Immunity in humans is divided to specific immunity and nonspecific immunity. This article will discuss the nonspecific type of immunity in humans. Nonspecific immunity refers to defensive system of the body that are innate in their nature and do not involve cellular components.

Physical barriers that prevent the entry of pathogens to the inner part of the body constitute the major part of this type of immunity. The other type of immunity which is called specific immunity usually involves cellular components that involve immune cells and antibodies. The nonspecific type of immunity is provided by the physical barriers that cover the body such as the skin and mucous membranes that line the epithelia of the inner organs inside the body.

The skin of humans forms a formidable barrier against entry of most pathogens and harmful compounds. Its hydrophobic nature allows only certain types of compounds to penetrate the intact skin layer. The epithelium of the skin is composed of stratified epithelium that is composed of several layers of cells. These layers form a thick layer that form a barrier against entry of compounds and pathogenic compounds.

The skin of humans also contains immune cells that form the first line of defense against pathogens. Entry to the inner side of the body is possible only through the opening of the mouth and nose or through the urethral orifice and the rectal opening. Food is usually the source of pathogens that can gain entry into the body. Also pathogens can gain entry to the blood by way of the respiratory tract.

The stomach usually has a low very acidic pH that forms offensive environment for most bacterial forms. Also the stomach secretes mucus material that can trap bacteria and restrict its free movement. Also the presence of digestive enzymes in the stomach can participate in digesting foreign material such as proteins. Pathogens that do not gain entry into the blood are usually expelled from the body by way of feces. Pathogens that gain entry into the blood travel through the blood stream to the liver via the hepatic vein.

There it faces the macrophages of the liver where they are neutralized by them. If the pathogens succeed to bypass the liver macrophages then it faces the cells of the immune system that comprise the specific type of immunity. Entry of pathogens through the respiratory tract is possible by inhalation of dusty material that can include pathogens and harmful compounds. The lining of the respiratory tract has columnar epithelium that is covered by mucus material that prevents the free movement of material in the lungs. The epithelium of the respiratory tract forms a ciliary movement by which mucus material and pathogens move outside the lungs by this process of ciliary movement. The expulled material is then either coughed or swallowed into the stomach. The respiratory system has also its own immune cells that can neutralize pathogens in the lungs.

The urethral orifice and the rectal opening especially in females are the source of entry of bacterial forms into the body. Female usually have shorter urethra than males the thing that can facilitate the entry of pathogens into the body. Interferons are sort of proteins that function to fight viruses. These proteins are considered part of the nonspecific immune system. They are usually used as pharmacological drugs to treat viral diseases such as hepatitis with all its types.

Cancer refers to a collection of medical syndromes that have in common the alteration of the genetic code manifested by the change in the sequence of DNA bases and the change in the pairing manner between different DNA bases on different strands. The chemical change of the DNA structure has dramatic effects on the whole body. This is especially manifested by the defective translational process of proteins and enzymes synthesis.

Usually proteins and enzymes are synthesized biochemically based on genetic code that is manifested as three DNA bases for each amino acid that is coded. This genetic code is changed in cancer as well as in other diseases

of genetic origins. The wrong sequence of DNA bases which codes for the individual amino acids causes wrong amino acids sequence in the proteins and the enzymes. This in turn causes defective proteins and enzymes structures.

Thus, the whole body can be affected due to this, especially metabolic reactions that use these enzymes in order to catalyze its reactions. Also cancer cells proliferate by virtue of the eukaryotic nature of human cells which multiply by division. This process of division in addition to the continuous nutritional demands of the mutated cells leads to the futile expenditure of the energy resources of the body in favor of these cancer cells.

The clinical picture that is typical of cancer patients is the loss of weight and the fatigue feeling due to the lack of energy in the body. This continuous proliferation of these foreign cells can lead eventually to the death of the affected person. This mutagenesis of eukaryotic cells is not possible in prokaryotic cells that do not have mechanisms to divide and proliferate. For example neurons of the brain are cells that are unable to divide and proliferate.

This fact makes these cells unlikely to undergo mutagenesis or cancer formation. This is a good thing but also it is a bad thing due to its inability to regenerate in case of injury to the brain. Thus injury to the nervous system is usually an irreversible process. Also due to the fact that cells of the nervous system do not divide cancer of the nervous system is very rare that is usually triggered due to another type of cells in the nervous system that are called glial cells.

These cells are the source of malignancy in cancer of the nervous system. They have mainly supporting function in the body that is supplementary to the neurons of the nervous system. Other cells that are also unable to divide include red blood cells that are usually obtained from precursor cells by a differentiation process. Most other cells of the body have the capacity to divide and proliferate. Examples include cells of the reproductive system and cells of the kidneys.

These cells are usually liable to undergo chemical changes in the structure of its DNA molecules by virtue of its susceptibility to cancerous changes. Cancer is potentially a thermodynamically irreversible process that cannot be reversed or corrected unless surgical procedures are performed to excise an existing tumor. Our current scientific knowledge does provide for information on how to reverse an existing process of malignant DNA transformation. This will probably be achieved in the future with the advent of the physical sciences.

Chemical changes in the DNA structure can be performed in several ways. One is by a change in the pairing manner of DNA bases on the different strands of the DNA molecule.

Another cause is the alkylation of the DNA bases by an alkylating agent. Alkylating agents are usually used to treat malignancies by binding to DNA bases. An example is the drug cyclophosphamide which is a nitrogen mustard. Alkylating agents have also other uses than its pharmacological effects. It has also potential uses as chemical warfare agents.

Inhibition of enzymes that catalyze the formation of cancer cells is a key strategy to fight the prolifiration of cancer cells in the body. Also energetic electromagnetic radiation is used to kill cancer cells. For example x-ray radiation is often used to kill cancer cells. Chemotherapy of cancer disease is usually of ameliorative role rather than of having a curative role in the body.

The kidney is the site where blood filtration takes place and the waste material is excreted into the urine. This function of urine formation by the kidney nephrons is regulated by two main hormones in the body. One of them is called aldosterone and the other is called vasopressin. In addition to these two hormones there is a third one that is called atrial natriuretic peptide. This hormone is less in significance than the other two but is helpful to lower blood in the case of hypervolemia or increased amount of water in the blood.

These two above mentioned hormones have similar mechanisms of their regulation in the body which are manifested by their regulation through their concentration in the blood and through the blood volume in the arteries. High concentration of both of these hormones in the blood leads to their diminished secretion. While

their presence in low concentrations in the blood leads to their increased secretion. The rate of blood filtration in the kidney nephrons is tightly regulated by the amount of these two hormones in the blood.

Vasopressin is usually secreted by the posterior pituitary gland while aldosterone is usually secreted by the adrenal cortex. Vasopressin has direct effect on the level of water in the body. This is in contrast to aldosterone which has indirect effect on the level of water in the blood. Aldosterone main effect is on the level of sodium ions in the body. Its effect on water is the result of osmotic dieresis which occurs due to the osmotic effect of sodium ions in the kidney tubules. Failure of any of these two hormones to function properly due to disorders of their secretion can lead to filtration problems in the kidney nephrons.

An example is with the medical syndrome of hypoaldosteronism. In this syndrome the level of aldosterone in the blood is unusually low. This in turn leads to low level of sodium ions in the blood with subsequent excessive water loss in the urine. Water follows sodium ions into the urine by osmotic effect. In addition to regulating the rate of urine formation in the kidney the cells of the kidney have other functions. These include for example the synthesis of the hormone erythropoietin. This hormone is crucial for the production of red blood cells.

Its deficiency as occurs in chronic renal failure can lead to diminished synthesis and secretion to the blood. This can in turn cause anemia of the blood due to the deficiency of this hormone. Another important function of the two kidneys is the synthesis of vitamin D. This hormone is important for the absorption of calcium ions in the intestine. Also this hormone is important for the deposition of calcium ions on the bones of the body. Deficiency of this hormone in the blood as occurs in chronic renal failure can lead for example to osteomalacia which is a disorder that involves deficient secretion of vitamin D in the blood.

In this case the treatment would constitute the administration of supplementary amounts of this hormone usually accompanied with calcium ions. The other known function of the kidney is to synthesize glucose from precursor molecules such as amino acids. This process is called gluconeogenesis and also involves the liver cells as well. Gluconeogenesis is the reverse process of glucose oxidation. It is an energetically uphill metabolic process that usually requires the expenditure of energy in the form of ATP molecules. The main functional unit of the kidney is called the nephron.

This structure is the basic unit in the kidney that has approximately one million similar units in the kidney. The filtration process usually occurs through the effect of hydrostatic pressure on the walls of the nephrons. Under normal healthy conditions only small molecule are filtered in the kidney nephrons. Under pathological conditions large molecules begin to be filtered as well such as proteins and red blood cells. A typical example occurs in the medical syndrome that is called the nephritic syndrome.

The adrenal gland is a purely endocrine gland that is known to secrete mainly three types of hormones. One of them is the hormone aldosterone and the other is the hormone cortisol. The third type of hormones that is secreted also by the adrenal cortex is collectively known as androgens. These androgens are precursors of the sexual hormones in males and females that are known as testosterone and estrogen. These adrenal androgens are clinically important especially in females. Adrenal cortex tumors can sometimes lead to excessive secretion of these androgens.

The clinical manifestations of excess of these androgens in females can be manifested as male sexual characteristics such as hair growth and deepening of the voice. The other two hormones have much more important clinical symptoms. Aldosterone is secreted by the adrenal cortex by a feedback mechanism that is different than the other endocrine hormones of the other endocrine glands in the body. This hormone is mainly regulated through the level of osmolality of the blood and through the volume of the blood its self in the arteries.

An elevated level of this hormone in the blood causes increased retention of sodium ions and water into the blood. Decreased level of this hormone in the blood leads to wasting of sodium and water in the urine causing clinical symptoms of polyurea and continuous senation of thirst. Aldosterone is a steroid hormone that is hydrophobic in its chemical structure. This hydrophobic structure allows it to penetrate the cellular memebrane and exerts its

signaling effect intracellularly. All steroid hormones have similar mechanisms of cellular signaling. This is in contrast to polypeptide hormones which have polar chemical structure that does not allow it to cross the cellular membrane freely.

Aldosterone excess in the blood is associated with increased reabsorption of water into the blood with concomitant increase in blood pressure. Thus increased amount of aldosterone in the blood usually causes high blood pressure while its low value in the blood causes decreased blood pressure. The other important hormone that is secreted by the adrenal cortex is the hormone cortisol. This is also a steroid hormone that a versatile functions in the body.

Among them is its ability to suppress the immune system. Cortisol is often used in transplantation surgeries to prevent rejection of the implanted organ in the body. Also cortisol has effect on glucose level in the blood. Usually increased level of this hormone leads to increased level of glucose in the blood and vice versa. In addition cortisol has effect on the blood pressure in humans.

High level of this hormone in the blood is usually associated with high blood pressure and vice versa. Cortisol also contributed to the increase in metabolic reactions in the body. The adrenal gland has also a medulla that is important clinically as well. The medulla of the adrenal gland secretes in certain types of tumors the hormones epinephrine and norepinephrine. These two hormones are usually the mediators of the function of the sympathetic nervous system. Their increased secretion by the adrenal medulla causes symptoms that are usually associated with activation of the sympathetic nervous system. These include increased heart beat and increased respiration rate. Also increased sweating is another associated symptom with this disorder. Blood vessels constriction and high blood pressure are other manifestations.

The pancreas has both endocrine as well as exocrine functions. This organ is specialized in the secretion of hormones into the blood circulation and digestive enzymes into the intestine. The two most well known hormones are called insulin and glucagon. These two hormones are antagonists to each other. Namely they have opposite functions to each other. Insulin has usually a function that is related to decreasing the blood concentration of the sugar glucose. On the other hand glucagon usually increases the concentration of glucose in the blood by inducing the degradation of the biopolymer glycogen into glucose molecules.

Insulin is usually required for the entry of glucose into the liver cells where it is metabolized in the glycolytic pathway to generate energy rich molecules of ATP. Insulin is a polypeptide hormone or a protein hormone that is water soluble. It facilitates the entry of glucose into the liver cells which would otherwise be unable to enter these cells due to its polar structure that is repelled by the hydrophobic phospholipid bilayer of the liver cells.

Glucagon is also a polypeptide hormone that is secreted by the islet cells of langerhans into the blood circulation. It stimulates the degradation of glycogen in the liver through a stimulation that it receives from the stimulation of the sympathetic nervous system. Disorders that involve these two hormones include diabetes mellitus and glucagonoma. The first is a disorder of insulin deficient secretion into the blood which usually causes a state of hyperglycemia. The other disorder involves excessive amount of glucagon in the blood. This causes clinical signs of hypoglycemia or deficient amount of glucose in the blood. Both of these medical conditions have clinical symptoms that are typical for each of them.

Glucagonoma for example is associated with shortage of glucose supply to the brain and the nervous tissue. This in turn can lead to irreversible damage to the brain tissue. Also hyperglycemia can lead to ketoacidosis which is the production of ketonic acids in the blood as byproducts of fatty acids metabolism in the liver cells. These fatty acids are used as an alternative source of fuel than glucose molecules for the production of ATP molecules. Enzymes that are secreted by the exocrine pancreas include the enzyme amylase and lipase and chymotrypsin in addition to the enzyme trypsin. All of these enzymes have specific function of degrading specific type of macromolecules in the intestine.

For example the enzyme amylase is specific for the digestion and degradation of polymers of glucose into glucose molecules. This enzyme can be secreted by the pancreas as well as by the salivary glands of the mouth. The enzymes chymotrypsin and trypsin are both specific for the digestion and degradation of proteins. They differ in their specificity for peptide bonds in proteins. These two enzymes are secreted predominantly by the pancreatic

cells. The enzyme lipase is only secreted by the pancreatic cells. This enzyme is specific for the digestion of lipids in the intestine. Lipids are esters of glycerol and fatty acids. They are degraded into fatty acids and glycerol molecules in the intestine. In pancreatic failure the secretion of all these enzymes is diminished. The most prominent effect of pancreatic insufficiency is the maldigestion of fatty material in the intestine. This maldigestion can cause passing fatty stool that can float on water. Also constipation can occur with maldigestion.

Sodium and potassium ions in the human body constitute the major part of all electrolytes in the body. These two ions are distributed across the cellular membranes of mainly neurons and muscle cells. Mechanisms that are called active transport maintain concentration gradients of these two ions across the cellular membranes. Usually sodium ions are present outside the cell in much higher concentration than inside the cell. The reverse is true of potassium ions which are predominantly present inside the cell.

The active transport of these two ions across the cellular membrane is coupled with each other. This means that the entry of potassium ions into the cell is coupled to the exit of the sodium ions outside the cell. This process of active transport is costly energetically that requires ATP molecules to proceed. This gradient in concentration of these two ions across the cellular membrane renders an electric potential across the cellular membrane by virtue of the positive charge on the ions.

This electric potential has very important physiological role in mediating the transmission of electrical signals along the nervous system. These two ions are the main players in this process of cellular communication between neurons. The process of cellular signaling is initiated by the stimulation of the neuron by an exogenous stimulus such as a neurotransmitter. This stimulation in turn can open sodium ion channels within the cellular membrane of the neuron. This opening of the sodium ion channel allows the free entry of sodium ions into the cell through a diffusional process.

This increase of positive charge inside the cell causes a more positive electric potential across the cellular memebrane. If this electric potential reaches a certain positive value that is called a threshold value then an action potential occurs in which the electric signal that contains the nervous information such as the sensation of heat and cold is transmitted from one neuron to the other. This process of increase in the positive value of the electric potential by virtue of the entry of sodium ions into the cell is called depolarization. At the neuromuscular junction between a neuron and a muscle cell this depolarization process causes the contraction of muscles by way of opening ion channels within the membrane of the muscle cell.

This leads to the formation of action potential within the muscle cell that can lead eventually to the contraction of the muscle cell. The depolarization process ends when the sodium ions channel closes and potassium ion channels open. The opening of potassium ion channels lead to the outflow of potassium ions outside the cell. This in turn decreases the net positive charge inside the cell which makes the electric potential across the cellular memebrane more negative in its value. This process is called hyperpolarization. When the process of hyperpolarization occurs it signals the end of the electrical transmission of information between meurons.

This mechanism of information transmission across the cells of the nervous system is a target of pharmacological drugs that function either to block or support the function of a particular ion channel. For example the sensation of pain can usually be stopped by drugs that block the opening of sodium ions channels.

By blocking the function of the sodium ion channels the process of cellular depolarization is also blocked. This in turn causes stopping of electric signal transmission along the neurons of the nervous system. Also blocking potassium ion channels which usually induce hyperpolarization of the electric potential can sustain the depolarization process leading to the continuous firing of neurons in the nervous system.

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