CHAPTER-I

INTRODUCTION

1.1 GENERAL INTRODUCTION:

Now a day’s more and more individuals particularly boys and girls are affected by sports activities and increasing the number that are representing in the sports area. As preventive and curative health measures, it has become more successful throughout the world and, millions of teenagers should have chance of enjoying sports. During the last decade we have discovered that good health is no longer a matter of chance, but rather a matter of choice. If you choose to take responsibility for your health by exercising regularly and by consistently adopting other positive life style habits, you can not only promote better health, but also you can decrease your risk of disease, disability and premature death. (Robert Hockey, 1993)

The lack of agreement regarding the concept of physical fitness basically centers on whether or not items involving skill and ability should be include in such a battery. Some authors list only the relatively basic elements, such as strength, muscular endurance and cardiovascular endurance. Other builds from this base and includes items of agility, flexibility, power, balance, speed and neuromuscular coordination.

As fitness professionals, we spend a great deal of time inspiring and assisting others in their pursuit of improved health. Education is an important aspect of this. We must promote the benefits of regular activity and help people understand why they should be active.

1.2 EXERCISE AND EXERCISE PHYSIOLOGY:

Exercise is also known as physical activity. In simple terms exercise is any movement that works your body at a greater intensity than your usual level of daily activity. Exercise raises your heart rate and works your muscles and is most commonly undertaken to achieve the aim of physical fitness. Or in other word physical exercise is any bodily activity that enhances or maintains physical fitness and overall health and wellness. It is performed for various reasons
including strengthening muscles and the cardiovascular system, honing athletic skills, weight loss or maintenance, as well as for the purpose of enjoyment.

Exercise is planned, structured, repetitive, and purposive in the sense that a development or continuation of physical fitness is an objective. Exercise provides many effects on the human organism. Two of the different types of factors that exercise affects are the physiology of the human body and one’s physical fitness. Exercise affects the physiology of a human being in so many ways that deal with the many organ systems within the body. The physical fitness factor is also affected by exercise because exercise is a subcategory of physical activity. How efficient the exercise of a human is will determine how quality of a physical fitness that human will possess. The factors that exercise effects on the human organism vary from physiological factors within the human’s body as well as the human’s physical fitness.

Exercise physiology is the study of the acute responses and chronic adaptations to a wide range of physical exercise conditions. In addition, many exercise physiologists study the effect of exercise on pathology, and the mechanisms by which exercise can reduce or reverse disease progression. Accreditation programs exist with professional bodies in most developed countries, ensuring the quality and consistency of education. In Canada, one may obtain the professional certification title - Certified Exercise Physiologist for those working with clients (both clinical and non-clinical) in the health and fitness industry.

An exercise physiologist's area of study may include but is not limited to biochemistry, bioenergetics, cardiopulmonary function, hematology, biomechanics, skeletal muscle physiology, neuroendocrine function, and central and peripheral nervous system function. Furthermore, exercise physiologists range from basic scientists, to clinical researchers, to clinicians, to sports trainers.

Exercise physiology is the study of both the functional changes that occur in response to a single session of exercise and the adaptations that occur as a result of regular, repeated exercise sessions. Exercise initially disrupts homeostasis. The changes that occur in response to exercise are the body’s attempt to meet the challenge of maintaining homeostasis when increased demands are placed on the body. Exercise often requires prolonged coordination among most body systems, including the muscular, skeletal, nervous, circulatory, respiratory, urinary, and
endocrine systems. Heart rate is one of the easiest factors to monitor that shows both an immediate response to exercise and long-term adaptation to a regular exercise program. When a person begins to exercise, the active muscle cells use more O₂ to support their increased energy demands. Heart rate increases to deliver more oxygenated blood to the exercising muscles. The heart adapts to regular exercise of sufficient intensity and duration by increasing its strength and efficiency so that it pumps more blood per beat. Because of increased pumping ability, the heart does not have to beat as rapidly to pump a given quantity of blood as it did before physical training. Exercise physiologists study the mechanisms responsible for the changes that occur as a result of exercise. Much of the knowledge gained from studying exercise is used to develop appropriate exercise programs that increase the functional capacities of people ranging from athletes to the infirm. The importance of proper and sufficient exercise in disease prevention and rehabilitation is becoming increasingly evident.

The Effects of Physical Exercise on the Human Body the benefits of physical exercise in humans far outweighs the harmful effects associated with exercise. A prescription of physical activity has been known to delay the onset or prevention of many chronic diseases. An improvement in heart function, lower blood pressure and improve functional capacity is noticed after just a few weeks of exercising. Physical activity will also result in an increase of lean muscle mass; promote weight maintenance, increased flexibility, and a generally stronger fit individual. Conversely, exercise when preformed strenuously or obsessively it can counteract such positive effects. The Cardiovascular response to exercise occurs quite quickly, during exercise oxygen is demanded in the muscles and the body uses more nutrients, metabolic process speed up, more wastes are created, and the body's temperature increases. With intense exercise, hydrogen ion concentrations increase within the muscles and blood.

“Sports bring people closer to one another and help nation to a better mutual knowledge and understanding”


“When you are fit, you look better and are likely to have more physical energy; when you feel fit, two good things of life have more meanings two sky is blue, the music is sweeter, the steak is tastier”.
1.3 HEMATOLOGY:

Hematology comes from the Greek words haima, meaning blood, and logos, meaning study or science. So, hematology is the science of blood. Hematology was practiced in various forms throughout history. Ancient Egyptian society used blood-letting techniques in order to treat illnesses, which was the first recorded instance of hematological practices. In depth it is the study of blood and an important part of clinical pathology and the diagnostic process. It includes not only the examination of the cellular and fluid potions of blood, but also includes a study of the tissues that form, store and circulate blood cells. A veterinarian uses the results of hematology tests to help determine the health of an animal. These results are used in conjunction with the history, physical exam and other laboratory findings.

1.4 BLOOD:

Blood is a bodily fluid in animals that delivers necessary substances such as nutrients and oxygen to the cells and transports metabolic waste products away from those same cells. In vertebrates, it is composed of blood cells suspended in blood plasma. Plasma, which constitutes 55% of blood fluid, is mostly water (92% by volume), and contains dissipated proteins, glucose, mineral ions, hormones, carbon dioxide (plasma being the main medium for excretory product transportation), and blood cells themselves. Albumin is the main protein in plasma, and it functions to regulate the colloidal osmotic pressure of blood. The blood cells are mainly red blood cells (also called RBCs or erythrocytes) and white blood cells, including leukocytes and platelets. The most abundant cells in vertebrate blood are red blood cells. These contain hemoglobin, an iron-containing protein, which facilitates transportation of oxygen by reversibly binding to this respiratory gas and greatly increasing its solubility in blood. In contrast, carbon dioxide is almost entirely transported extra cellular dissolved in plasma as bicarbonate ion.

In adults, the most active bone marrow is found in the pelvic and shoulder bones, back bones (vertebra), ribs, breast bone and skull. Immature blood cells found within the bone marrow are called stem cells. Stem cells can also be found in smaller amounts in the bloodstream. These are called peripheral blood stem cells. All our blood cells develop from stem cells. The process of blood cell development is called hematopoiesis. In the earliest stage of blood cell development, stem cells begin to develop either along the lymphoid cell line or the myeloid cell
line. In both cell lines, the stem cells become blasts, which are still immature cells. During the last stage of cell development, the blasts mature into 3 types of blood cells, called red bloods cells, platelets and white blood cells.

Blood is a vital part of a healthy body, functioning as a transporter for the oxygen which nourishes and powers our bodies as well as for the waste that is moved to our lungs, kidneys and digestive system to be expelled. Formed in the body’s bone marrow through a process called hematopoiesis, blood cells are key to defending against infections and other foreign contaminants in our body, forms clots to prevent blood loss and even regulate our body’s ability to heat and cool itself.

1.5 HEMATOPOIESIS:

All blood cells can be generated from a common HSC through an extremely dynamic process called hematopoiesis or blood cell formation. The process of hematopoiesis can be described as hierarchical with the rare HSCs at the top of the hierarchy giving rise first to progenitors, then to precursors with single lineage commitment and ending in terminally differentiated mature cells of various lineages which include erythrocytes, lymphocytes, mega karyocytes, granulocytes and monocytes/macrophages throughout the lifespan of the individual (Tavassoli, 1991)(Figure 1) The orderly production of blood cells is a highly regulated process involving successive stages of commitment and differentiation that involve complex interactions of the cells and cellular products of both the hematopoietic system and their stromal microenvironment.

1.6 ERHROCYTES:

Red blood cell, also called erythrocyte, cellular component of blood, millions of which in the circulation of vertebrates give the blood its characteristic color and carry oxygen from the lungs to the tissues. The mature human red blood cell is small, round, and biconcave; it appears dumbbell-shaped in profile. The cell is flexible and assumes a bell shape as it passes through extremely 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 first person to describe red blood cells was the young Dutch biologist Jan Swammerdam, who had used an early microscope in 1658 to study the blood of a frog. Unaware of this work, Anton van Leeuwenhoek provided another microscopic description in 1674, this time providing a more precise description of red blood cells, even approximating their size, "25,000 times smaller than a fine grain of sand".

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 red cell develops in bone marrow in several stages: from a hemocytoblast, a multi potential cell in the mesenchyme, it becomes an erythroblast; during two to five days of development, the erythroblast gradually fills with hemoglobin, and its nucleus and mitochondria (particles in the cytoplasm that provide energy for the cell) disappear. In a late stage the cell is called a reticulocyte, which ultimately becomes a fully mature red cell. The average red cell in humans lives 100–120 days; there are some 5.2 million red cells per cubic millimeter of blood in the adult human. A typical human erythrocyte has a disk diameter of approximately 6.2-8.2 µm and a thickness at the thickest point of 2-2.5 µm and a minimum thickness in the centre of 0.8-
1 µm, being much smaller than most other human cells. The blood's red color is due to the spectral properties of the hemic iron ions in hemoglobin. Each human red blood cell contains approximately 270 million of these hemoglobin biomolecules, each carrying four heme groups; hemoglobin comprises about a third of the total cell volume. This protein is responsible for the transport of more than 98% of the oxygen (the remaining oxygen is carried dissolved in the blood plasma). The red blood cells of an average adult human male store collectively about 2.5 grams of iron, representing about 65% of the total iron contained in the body.

1.7 LEUKOCYTE:

White blood cell, also called leukocyte or white corpuscle, a cellular component of the blood that lacks hemoglobin, has a nucleus, is capable of motility, and defends the body against infection and disease by ingesting foreign materials and cellular debris, by destroying infectious agents and cancer cells, or by producing antibodies. A healthy adult human has between 4,500 and 11,000 white blood cells per cubic millimeter of blood. Fluctuations in white cell number occur during the day; lower values are obtained during rest and higher values during exercise. Intense physical exertion may cause the count to exceed 20,000 per cubic millimeter. White cell count also may increase in response to convulsions, strong emotional reactions, pain, pregnancy, labour, and certain disease states, such as infections and intoxications. Although white cells are found in the circulation, most occur outside the circulation, within tissues, where they fight infections; the few in the bloodstream are in transit from one site to another. As living cells, their survival depends on their continuous production of energy. The chemical pathways utilized are more complex than those of red blood cells and are similar to those of other tissue cells. White cells, containing a nucleus and able to produce ribonucleic acid (RNA), can synthesize protein. White cells are highly differentiated for their specialized functions, and they do not undergo cell division (mitosis) in the bloodstream; however, some retain the capability of mitosis. On the basis of their appearance under a light microscope, white cells are grouped into three major classes - lymphocytes, granulocytes, and monocytes - each of which carries out somewhat different functions.

Lymphocytes, which are further divided into B and T cells, are responsible for the specific recognition of foreign agents and their subsequent removal from the host. B
lymphocytes secrete antibodies, which are proteins that bind to foreign microorganisms in body tissues and mediate their destruction. Typically, T cells recognize virally infected or cancerous cells and destroy them, or they serve as helper cells to assist the production of antibody by B cells. Also included in this group are natural killer (NK) cells, so named for their inherent ability to kill a variety of target cells. In a healthy person, about 25 to 33 percent of white blood cells are lymphocytes.

Granulocytes, the most numerous of the white cells, rid the body of large pathogenic organisms such as protozoans or helminths and are also key mediators of allergy and other forms of inflammation. These cells contain many cytoplasmic granules, or secretory vesicles, that harbour potent chemicals important in immune responses. They also have multiplied nuclei, and because of this they are often called polymorphonuclear cells. On the basis of how their granules take up dye in the laboratory, granulocytes are subdivided into three categories: Neutrophil, eosinophils, and basophils. The most numerous of the granulocytes—making up 50 to 80 percent of all white cells—are neutrophils. They are often one of the first cell types to arrive at a site of infection, where they engulf and destroy the infectious microorganisms through a process called phagocytosis. Eosinophils and basophils, as well as the tissue cells called mast cells, typically arrive later. The granules of basophils and of the closely related mast cells contain a number of chemicals, including histamine and leukotrienes, which are important in inducing allergic inflammatory responses. Eosinophils destroy parasites and also help to modulate inflammatory responses.

Monocytes, which constitute between 4 and 8 percent of the total number of white blood cells in the blood, move from the blood to sites of infection, where they differentiate further into macrophages. These cells are scavengers that phagocytose whole or killed microorganisms and are therefore effective at direct destruction of pathogens and cleanup of cellular debris from sites of infection. Neutrophils and macrophages are the main phagocytic cells of the body, but macrophages are much larger and longer-lived than neutrophils. Some macrophages are important as antigen-presenting cells, cells that phagocytose and degrade microbes and present portions of these organisms to T lymphocytes, thereby activating the specific acquired immune response.
1.8 THROMBOCYTE:

Platelet, also called thrombocyte, colorless, non nucleated blood component that is important in the formation of blood clots (coagulation). Platelets are found only in the blood of mammals. Although red blood cells had been known since van Leeuwenhoek (1632–1723), the German anatomist Max Schultze (1825–1874) was the first to describe platelets. He described "spherules" that were much smaller than red blood cells and that occasionally clumped and were found in collections of fibrous material. Platelets are formed when cytoplasmic fragments of megakaryocytes, which are very large cells in the bone marrow, pinch off into the circulation as they age. They are stored in the spleen. Some evidence suggests platelets may also be produced or stored in the lungs, where megakaryocytes are frequently found. Platelets play an important role in the formation of a blood clot by aggregating to block a cut blood vessel and provide a surface on which strands of fibrin form an organized clot, by contracting to pull the fibrin strands together to make the clot firm and permanent, and, perhaps most important, by providing or mediating a series of clotting factors necessary to the formation of the clot. Platelets also store and transport several chemicals, including serotonin, epinephrine, histamine, and thromboxane; upon activation these molecules are released and initiate local blood vessel constriction, which facilitates clot formation.

Platelets release a multitude of growth factors including platelet-derived growth factor (PDGF), a potent chemo tactic agent, and TGF beta, which stimulates the deposition of extra cellular matrix. Both of these growth factors have been shown to play a significant role in the repair and regeneration of connective tissues. Other healing-associated growth factors produced by platelets include basic fibroblast growth factor, insulin-like growth factor 1, platelet-derived epidermal growth factor, and vascular endothelial growth factor. Local application of these factors in increased concentrations through Platelet-rich plasma (PRP) has been used as an adjunct to wound healing for several decades.

1.8 PLASMA:

Plasma is the liquid portion of blood. Plasma serves as a transport medium for delivering nutrients to the cells of the various organs of the body and for transporting waste products
derived from cellular metabolism to the kidneys, liver, and lungs for excretion. It is also a transport system for blood cells, and it plays a critical role in maintaining normal blood pressure. Plasma helps to distribute heat throughout the body and to maintain homeostasis, or biological stability, including acid-base balance in the blood and body.

Plasma is derived when all the blood cells—red blood cells (erythrocytes), white blood cells (leukocytes), and platelets (thrombocytes)—are separated from whole blood. The remaining straw-colored fluid is 90–92 percent water, but it contains critical solutes necessary for sustaining health and life. Important constituents include electrolytes such as sodium, potassium, chloride, bicarbonate, magnesium, and calcium. In addition, there are trace amounts of other substances, including amino acids, vitamins, organic acids, pigments, and enzymes. Hormones such as insulin, corticosteroids, and thyroxine are secreted into the blood by the endocrine system. Plasma concentrations of hormones must be carefully regulated for good health. Nitrogenous wastes (e.g., urea and creatinine) transported to the kidney for excretion increase markedly with renal failure.

Plasma contains 6–8 percent proteins. One critical group is the coagulation proteins and their inhibitors, synthesized primarily in the liver. When blood clotting is activated, fibrinogen circulating in the blood is converted to fibrin, which in turn helps to form a stable blood clot at the site of vascular disruption. Coagulation inhibitor proteins help to prevent abnormal coagulation and to resolve clots after they are formed. When plasma is allowed to clot, fibrinogen converts to fibrin, trapping the cellular elements of blood. The resulting liquid, devoid of cells and fibrinogen, is called serum. Biochemical testing of plasma and serum is an important part of modern clinical diagnosis and treatment monitoring. High or low concentrations of glucose in the plasma or serum help to confirm serious disorders such as diabetes mellitus and hypoglycemia. Substances secreted into the plasma by cancers may indicate an occult malignancy; for instance, an increased concentration of prostate-specific antigen (PSA) in a middle-aged asymptomatic man may indicate undiagnosed prostate cancer.

Serum albumin, another protein synthesized by the liver, constitutes approximately 60 percent of all of the plasma proteins. It is very important in maintaining osmotic pressure in the blood vessels; it is also an important carrier protein for a number of substances, including
hormones. Other proteins called alpha and beta globulins transport lipids such as cholesterol as well as steroids, sugar, and iron.

The gamma globulins, or immunoglobulin, are an important class of proteins that are secreted by B lymphocytes of the immune system. They include most of the body’s supply of protective antibodies produced in response to specific viral or bacterial antigens. Cytokines are proteins synthesized by cells of various organs and by cells found in the immune system and bone marrow in order to maintain normal blood cell formation (hematopoiesis) and regulate inflammation. For example, one cytokine called erythropoietin, synthesized by specialized kidney cells, stimulates bone marrow blood progenitor cells to produce red blood cells. Other cytokines stimulate the production of white blood cells and platelets. Another protein system in the plasma, called complement, is important in mediating appropriate immune and inflammatory responses to a variety of infectious agents.

The electrolytes and acid-base system found in the plasma are finely regulated. A slight rise in plasma potassium can result in death. Likewise, sodium, chloride, bicarbonate, calcium, and magnesium levels in the plasma must be precisely maintained within a narrow range. Smaller molecules such as sodium, potassium, glucose, and calcium are primarily responsible for the concentration of dissolved particles in the plasma. However, it is the concentration of much larger proteins (especially albumin) on either side of semi permeable membranes such as the endothelial cells lining the capillaries that creates crucial pressure gradients necessary to maintain the correct amount of water within the intravascular compartment and, therefore, to regulate the volume of circulating blood. So, for example, patients who have kidney dysfunction or low plasma protein concentrations (especially low albumin) may develop a migration of water from the vascular space into the tissue spaces, causing edema (swelling) and congestion in the extremities and vital organs, including the lungs.

1.10 HEMATOLOGY AND GENERAL HUMAN HEALTH:

Hematology is branch of biology where it studies the pathology, internal medicine, clinical laboratory, physiology and pediatrics. The hematology tests are normally done for blood
study researches. Subsequently, the results from the researches will help medical discoveries in the topics of blood forming organs and blood diseases.

Hematology is an important medical field as it involves issues on blood diseases. Blood's components will determine the health of a person. Without good blood components in the body, blood diseases can be detected both in young and old aged patients. Worse it can also be detected in infants. Hematology tests will help researchers who are known as hematologists in studying the components of pain in back of head blood like hemoglobin, blood proteins, white cells, coagulation and etc. In order to study the blood's components in a human's body, reference ranges of blood tests are taken into considerations by blood laboratory professionals known as hemato-pathologists. Both hematologists and hemato-pathologists work together in formulating a diagnosis of a blood disease and deliver the best therapy that is needed by the patient.

A hematology test contributes largely to the study of oncology. Oncology is medical fields that study the medical treatment of cancer. Oncology focuses on the diagnosis of cancer in a patient, follow up of cancer patients who went through successful treatments, therapy and palliative care of patients. One of the most commonly used diagnostic methods in oncology is blood tests which are very much related to hematology.

The references ranges for blood tests are actually a set of standardized values that is done by medical professional to interpret the results of blood tests of patients. The laboratory work will involves viewing the bone marrow and blood films slides under the microscopes. Normally the blood samples will be obtained from patients who are with blood diseases like leukemia, blood transfusions, anti coagulation therapy radiotherapy and more. The reference ranges for blood tests are done within the field of clinical chemistry. Clinical chemistry is an area of pathology study that focuses on the bodily fluids analysis. In medical terms, clinical chemistry may also be known as chemical pathology, pure blood chemistry and clinical biochemistry.

1.11 HEMATOLOGY AND SPORTS PERFORMANCE:

While the crucial role of hemoglobin in aerobic exercise has been well accepted, there is still a great deal of controversy about the optimal hematological parameters in the athletic population. The initial part of this review will examine the question of anemia in athletes. The
most common finding in athletes is a dilatational anemia that is caused by a plasma volume expansion, rather than an actual blood loss. It is not a pathological state and normalizes with training cessation in 3 to 5 days. This entity should be distinguished from conditions associated with lowered blood counts, such as intravascular haemolysis or iron deficiency anemia. The evaluation of true anemia states in the athlete must take into account not only blood losses secondary to exercise, such as foot strike haemolysis or iron losses through sweat, but non-athletic causes as well. Depending on the age and sex of the athlete, consideration must be given to evaluation of the gastrointestinal or genitourinary systems for blood loss. Finally, a comprehensive nutritional history must be taken, as athletes, especially women, are frequently not consuming adequate dietary iron. The second section of the paper will deal with the very contentious issue of sickle cell trait. While there have been studies demonstrating an increased risk of sudden death in people with sickle cell trait, it is still quite rare and should not be used as a restriction to activity. Further, studies have demonstrated that patients with sickle cell trait have an exercise capacity that is probably normal or near normal. However, in the cases of sudden death, it has been secondary to rhabdomyolysis occurring among sickle cell trait athletes performing at intense exertion under hot conditions, soon after arriving at altitude. The recommendations are that athletes with sickle cell trait adhere to compliance with the general guidelines for fluid replacement and acclimatization to hot conditions and altitude. The final section of the paper examines the issue of hematological manipulation for the purposes of ergogenic improvement. Although experiments with blood doping revealed improvements in running time to exhaustion and maximal oxygen uptake, the introduction of recombinant erythropoietin has rendered blood doping little more than a historical footnote. However, the improvements in performance are not without risk, and the use of exogenous erythropoietin has the potential for increased viscosity of the blood and thrombosis with potentially fatal results. Until a definitive test is developed for detection of exogenous erythropoietin, it will continue to be a part of elite athletics.

1.12 STATEMENT OF THE PROBLEM:

Exercise and physical activity is an important function of living systems. It may affect hematologic and biochemical parameters of most systems. Human adaptation to exercise is characterized by adaptation of cardiovascular activity and changes in hematological and
biochemical parameters (Arslan et al., 1997; Baltaci et al., 1998). Doing exercise regularly has effect initially on preventing cardiovascular illnesses; besides enabling normal performance of most of the biochemical and hematologic parameters, it also regulates breathing system (Thomas et al., 2003; Cakmakci, 2009). When life is sustained without doing exercise, it is an indication that there is a decrease in functional skills and as a result, functional inadequacy illnesses may grow (Colakoglu and Karacan, 2006). But on the other side, exercise causes stress on human organism (Akil et al., 2011) and the result of this stress can cause different physiological and metabolic effects. Some of these effects are the changes arising in blood (Hazar and Yilmaz, 2008). The most important result of exercises done regularly is on blood cell. When blood cell is investigated, exercises done regularly have different effects on blood level (Buyukyazi and Turgay, 2000) and these differences are the result of factors such as experiment method, experiment time, type of exercise done, age, sex and training condition of subjects. It has been expressed that exercise raises blood volume too (Ibis et al., 2010).

Some of the physiological changes associated with strenuous exercise and their relationship with athletic performance are well known. In several studies, various physiological responses were associated to cardio-respiratory, metabolic, hormonal, neuromuscular, and immunological parameters. There have been frequent reports of a suboptimal hematological status being observed in athletes involved in intensive physical activity (Biancotti et al. 1992). There have even been reports of “sports anemia” resulting from intensive physical exercise in humans (Hasibeder et al. 1987). Ozyener et al. (1994) showed that acute submaximal exercise significantly increases erythrocyte, hematocrit, hemoglobin, leukocyte, and trombocyte counts in comparison to the levels before exercise. Abbasciano et al. (1998) stated that the RBC decreased during endurance sports. Actually, during physical exercise, red blood cells must deliver oxygen to tissues at a higher flow rate in a more viscous fluid, due to a reduced plasma volume (Gabriel et al. 1992). During the exercise, certain amount of liquid enters into the tissues leaving the veins and the density of erythrocyte, hemoglobin and plasma proteins increases (K. Karacabey et al., 2004, Ozdengul, 1998). However, there is no complete consensus in the literature how exercise affects on blood concept. While some researchers express that exercise increase blood volume (M.Gunay et al., 2006), others state that it does not change (N. Akgun, 1994).

The inter relationships between exercise and immune function have been widely studied on exercise-induced leukocytosis (Shephard, 1997). An acute bout of exercise places a wide
spectrum of demands on the body, depending on the form, intensity and duration of the required effort, together with physiological and psychological constraints peculiar to the host. High-intensity exercise causes tissue damage, production of stress hormones, and alterations in the circulating quantity and function of various immune cells. Leukocyte numbers have been found to increase in the circulation immediately after exercise, regardless of the intensity and duration of exercise, and remain increased at varied durations (Gleeson et al. 1995).

Many clinical-physical stressors such as surgery, trauma, burns and sepsis induce a pattern of hormonal and immunological response similar to that of exercise. Specific changes that have been observed, both following strenuous exercise and in infectious disease states, include: the acute phase response, leukocyte mobilization and activation, release of inflammatory mediators (cytokines), tissue damage and cell infiltration, the production of free radicals and activation of the complement, coagulation and fibrinolytic pathways (Shephard RJ et al., 1997, NorthoffH et al., 1995). It has thus been suggested that heavy exercise might be used to cause graded and well defined amounts of muscle trauma, thereby serving as an experimental model for inflammation and sepsis. Obviously, the responses to ethically acceptable doses of exercise are much smaller than those seen in sepsis. Therefore, in order to obtain readily measured changes, it is important to choose a pattern of activity that maximizes disturbances in immune function. A parallel investigation has reported changes in cytokines and natural killer cell activity (Brenner et al., 1999). From the early phases of the immune response to exercise have only had limited examination until now.

Pathological and clinical studies have suggested that platelets play an important role in the pathogenesis and progression of cardiovascular diseases (Hirsh p. et al 1981, Fitzgerald et al 1986, Davies et al. 1986). It has also been postulated that regular exercise may reduce the risk of major vascular thrombotic events and protect us against cardiovascular diseases (Paffenbarger et al. 1975, Morris JN et al. 1980, Arraiz et al. 1992) However; Siscovick et al. (1984) reported that the risk of primary cardiac arrest was transiently increased during exercise. Therefore, physical exercise seems to be able to protect us against cardiovascular disease on the one hand and to provoke sudden cardiac death on the other hand. Accordingly, it is hypothesized that different intensities of exercise may affect platelet function differently. Moreover, subjects who are physically active and those who are sedentary may respond differently to the same exercise protocol. Various studies, found an increase in platelet counts ranging from 18% to 80%
immediately after treadmill or bicycle exercise (Warlow et al. 1974, Meheta J et al. 1982, Davis RB et al. 1990). Despite the increase in platelet number, most studies regarding the effects of exercise on platelet functional behavior, mainly aggregation and secretion, have been either controversial or incomplete (Bourey RE et al. 1988). In addition, studies of the effect of exercise on platelet adhesiveness are very few because of technical difficulties. This aspect was studied about 20 years ago, and the assays used in previous studies could not distinguish adhesion from aggregation (Pegrum et al. 1967, Bennett et al. 1972). Therefore, how the various intensities of exercise affect platelet function, is still unclear.

All studies express that exercises make positive contributions into human organism. Researchers have reported positive contribution of exercise in physical, physiological, psychological and motor features. It is stated that these differences depend on the severity, duration and frequency of exercise as well as physical and physiological conditions of subjects (Buyukyazi and Turgay, 2000).

There is not a full consensus as to how exercise makes an effect on hematology. Studies in this field contain different findings concerning blood biochemistry depending on the relevant exercise. Despite the studies showing a decreasing (Ricci et al., 1988) and increasing (Baltaci et al., 1998; Ercan et al., 1996; Gunay et al., 2006) change in blood biochemistry due to acute and chronic exercises, there are also studies which report that hematological values do not change with exercise (Spiropoulos and Trakada, 2003; Akgun, 1994).

From the above discussions and references the present researcher find some gap about the concrete picture of hematological changes and individual performance with various type and level of exercise practice for a certain period of time. So, in this study researcher is very much interested to find out some fruitful findings about hematological changes and its impact on performance with practicing of three different level of physical activity for 16 weeks duration. And also to know which levels of physical activity are more beneficial in the hematological parameters by comparing among three different physically active groups. In this study the researcher is trying to compare some Hemato-physiological dynamic changes among three different physically trained and non-trained groups within four month of observation. Thus the problem stated as “A Comparative Study of Selected Hematological Parameters and its Impact on Performance among Three Different Groups”.
1.13 OBJECTIVES OF THE STUDY:

The objectives of the study are:

1. To measure the selected Hematological variables of three different physically active groups after 8 weeks and 16 weeks of observation.

2. To assess the selected physiological variables of three different physically active groups after 8 weeks and 16 weeks of observation.

3. To find out aerobic, anaerobic and Vo$_2$ max as performance capacities of three different physically active groups after 8 weeks and 16 weeks of observation.

4. To compare the selected Hematological changes among three different physically active groups after 8 weeks and 16 weeks of observation.

5. To compare the selected physiological changes among three different physically active groups after 8 weeks and 16 weeks of observation.

6. To compare changes in aerobic, anaerobic and Vo$_2$ max capacities among three different physically active groups after 8 weeks and 16 weeks of observation.

7. To find out the comparative effects of high physical activity, moderate physical activity and low physical activity on Hemato-physiological changes and performances of the students.

1.14 DELIMINATIONS OF THE STUDY:

The study has been delimited in the following:

1. **Area:** The study has been conducted in West Bengal, India.

2. **District:** Only two districts i.e. Kolkata and Bardhaman have been selected as the study area.
3. **No. of subjects:** Total thirty five (35) subjects for all three groups have been selected as subjects in this study.

4. **Sex:** Only male students have been selected.

5. **Age:** 17-22 years in age ranged students have been considered.

6. **Grouping:** SAI trainees, B.P.Ed students and General college students have been selected and grouped as high active, moderate active and low active groups respectively.

7. **Duration of observation:** Only 16 weeks participation in physical activities of the subjects has been considered as observation period.

8. **Variables:** Following variables with numbers have been selected for the study:
   
   a) Fifteen (15) measures for Hematological variables,
   
   b) Three (3) measures for Physiological variables, and
   
   c) Three (3) measures for Physical performance variables.

1.15 **HYPOTHESES OF THE STUDY:**

On the basis of the available literatures and keeping the above logical concepts, the following Hypotheses have been formulated:

**H**₁ : There would be significant changes in Hemato-physiological parameters among three physically active groups after 8 weeks and 16 weeks of observation.

**H**₂ : There would be significant changes in aerobic and anaerobic capacities among three physically active groups after 8 weeks and 16 weeks of observation.

**H**₃ : There would be some significant affect of hematological changes on performance.
1.16 SIGNIFICANCE OF THE STUDY:

It is believed that the result of the study may help the field of Physical Education and Sports in many ways. Some of the major influences of the study are as follows-

1. This study may pin-point the actual physical activity which is more beneficial for better hematological health.

2. This study may identify the development status in aerobic and anaerobic capacity among three different physically active groups.

3. This study may help to understand the effect of different level of physical training on Hemato-Physiological components.

4. This study may point out the effect of 16 weeks exercises of different loads on some immune functions of the students.

5. This study may also help to the physical educators and coaches to develop physiological basis of training method.

6. The study may be also helpful for students to maintain their good health.

7. This study may be helpful to prevent the athlete from ‘Sports anemia’ during training.

8. Results of the study may helpful to the coaches as well as athletes to understand better the exercise load and prevent from overload.

1.17 LIMITATIONS OF THE STUDY:

1. The subjects taken for the study were healthy men students, who had no primary or secondary complications and did not have the same characteristics as far as the selected variables were concerned, i.e., heart rate, blood pressure, blood cell count may vary from person to person.

2. Psychological and sociological aspects of their day - to - day life interactions to their environment could not be controlled.
3. The food habits, hereditary aspects life styles of the subjects were not ascertained and this may influence the study.

4. The race, and emotional states were not ascertained and this may influence the study.

5. Administrations of tests of the three groups are not conducted in the same day.

6. Activity programmes of the SAI trainees and B.P.Ed students during the observation period have been followed as per their day to day schedule which the researcher considers it as one of the limitation of the study.

7. Less number of male subjects and 16 weeks observation employed in this study, the researcher think, may influence the study.

1.18 DEFINITION OF THE TERMS:

Hematology:

Hematology, also spelled haematology, is the branch of internal medicine, physiology, pathology, clinical laboratory work, and pediatrics that is concerned with the study of blood, the blood-forming organs, and blood diseases. Hematology includes the study of etiology, diagnosis, treatment, prognosis, and prevention of blood diseases.

RBC:

RBC Shorts for red blood cells that carry oxygen and carbon dioxide through the blood. This rather remarkable feat is thanks to hemoglobin, the pigment that makes red cells (and blood) look red. The red blood cells are also known as red corpuscles or erythrocytes (literally, red hollow vessels). RBC also stands for the red cell count, the number of red blood cells in a given volume of blood.

WBC:

WBC is the any of various nearly colorless cells of the immune system that circulate mainly in the blood and lymph and participate in reactions to invading microorganisms or foreign particles, comprising the B cells, T cells, macrophages, monocytes, and granulocytes.
Platelet:

A minute, irregularly shaped, disk like cytoplasmic body found in blood plasma that promotes blood clotting and has no definite nucleus, no DNA, and no hemoglobin. Also called blood platelet, thrombocyte.

Hemoglobin:

An iron-containing protein present in the blood of many animals that, in vertebrates, carries oxygen from the lungs to the tissues of the body and carries carbon dioxide from the tissues to the lungs. Hemoglobin is contained in the red blood cells of vertebrates and gives these cells their characteristic color. Hemoglobin is also found in many invertebrates, where it circulates freely in the blood. It consists of four peptide units, each attached to a nonprotein compound called heme that binds to oxygen.

Hematocrit:

Hematocrit is a blood test that measures the percentage of the volume of whole blood that is made up of red blood cells. This measurement depends on the number of red blood cells and the size of red blood cells.

Mean corpuscular volume:

The mean corpuscular volume, or "mean cell volume" (MCV), is a measure of the average red blood cell volume that is reported as part of a standard complete blood count. The MCV is calculated by dividing the total volume of packed red blood cells (also known as hematocrit) by the total number of red blood cells. The resulting number is then multiplied by 10. The red blood cells get packed together when they are spun around at high speeds in a centrifuge.

Mean corpuscular hemoglobin:

The mean corpuscular hemoglobin, or "mean cell hemoglobin" (MCH), is the average mass of hemoglobin per red blood cell in a sample of blood. It is reported as part of a standard
complete blood count. It is calculated by dividing the total mass of hemoglobin by the number of red blood cells in a volume of blood. \( \text{MCH} = \frac{\text{Hgb} \times 10}{\text{RBC}} \)

**Mean corpuscular hemoglobin concentration:**

The mean corpuscular hemoglobin concentration is the measure of the concentration of hemoglobin in a given volume of packed red blood cells. It is reported as part of a standard complete blood count. It is calculated by dividing the hemoglobin by the hematocrit.

**Red blood cell distribution width:**

The red blood cell distribution width (RDW or RCDW) is a measure of the variation of red blood cell (RBC) volume that is reported as part of a standard complete blood count. Usually red blood cells are a standard size of about 6-8 \( \mu \text{m} \). Certain disorders, however, cause a significant variation in cell size. Higher RDW values indicate greater variation in size. Normal reference range in human red blood cells is 11–15%.

**Neutrophils:**

Neutrophil granulocytes [also known as neutrophils or polymorphonuclear leukocytes (PMNs)] are the most abundant type of white blood cells in mammals and form an essential part of the innate immune system. Neutrophils may be subdivided into segmented neutrophils (or segs) and banded neutrophils (or bands). They form part of the polymorphonuclear cell family (PMNs) together with basophils and eosinophils.

**Eosinophils:**

Eosinophil granulocytes, usually called eosinophils or eosinophiles (or, less commonly, acidophils), are white blood cells and one of the immune system components responsible for combating multicellular parasites and certain infections in vertebrates. Along with mast cells, they also control mechanisms associated with allergy and asthma.

**Basophils:**

Basophil granulocytes, mostly referred to as basophils, are the least common of the granulocytes, representing about 0.01% to 0.3% of circulating white blood
Lymphocyte:

A lymphocyte is a kind of white blood cell in the vertebrate immune system, specifically, a landmark of the adaptive immune system. Under the microscope, lymphocytes can be divided into large lymphocytes and small lymphocytes. Large granular lymphocytes include natural killer cells (NK cells). Small lymphocytes consist of T cells and B cells.

Monocytes:

It is a large, circulating, phagocytic white blood cell, having a single well-defined nucleus and very fine granulation in the cytoplasm. Monocytes constitute from 3 to 8 percent of the white blood cells in humans.

Aerobic capacity:

Aerobic capacity is the maximal amount of physiologic work that an individual can do as measured by oxygen consumption. It is determined by a combination of aging and cardiovascular conditioning and is associated with the efficiency of oxygen extraction from the tissue.

Aerobic is the body's capacity to use its systems while using oxygen as fuel. Aerobic exercise is physical exercise of relatively low intensity that depends primarily on the aerobic energy-generating process. Aerobic literally means "living in air", and refers to the use of oxygen to adequately meet energy demands during exercise via aerobic metabolism.

Aerobic exercise has the aim of improving the body's consumption of oxygen. The word aerobic means with oxygen. Aerobic refers to our body's use of oxygen in its metabolic process (energy-generating process). Most aerobic exercises are done at moderate levels of intensity for longer periods, compared to other categories of exercise. An aerobic exercise session involves warming up, exercising for at least 20 minutes, and then cooling down. Aerobic exercise involves mainly the large muscle groups. A physical therapist, Col Pauline Potts, and an exercise physiologist, Kenneth Cooper M.D., both in the US Air Force, were the first to use the term aerobic exercise during the 1960s. Dr. Cooper wanted to find out why some very strong people were poor at long-distance running, swimming and cycling. He researched people's performance in terms of their ability to use oxygen with the use of a bicycle ergometer. In 1968 Dr. Cooper
published his book *Aerobics*. The book included scientific programs using aerobic exercises, such as swimming, running, cycling and walking. The book became a bestseller. All present aerobic programs use Cooper's data as a baseline.

**Anaerobic capacity:**

Anaerobic capacity is the body's capacity to use its systems without using oxygen. It contrasts with aerobic capacity, which is your body's capacity to use its systems while using oxygen as fuel. It is therefore important for high-intensity, low-duration activities.

Anaerobic capacity is your body's capacity to use its systems without using oxygen. Anaerobic exercise is exercise intense enough to trigger anaerobic metabolism. It is used by athletes in non-endurance sports, leading to greater performance in short duration, high intensity activities which last from mere seconds up to about 2 minutes.

Oxygen is not used for energy during anaerobic exercise. During this type of exercise a by-product - lactic acid - is produced. Lactic acid contributes to muscle fatigue and must be used up during recovery before that muscle can be subjected to another anaerobic session. During the recovery period oxygen is used to give the muscle a "refill" - to replenish the muscle's energy that was used up during the intensive exercise. Overall, anaerobic exercise uses up fewer calories than aerobic exercise. The cardiovascular benefits of aerobic exercises are greater than the cardiovascular benefits of anaerobic exercises. However, anaerobic exercise is better at building strength and muscle mass, while still benefitting the heart and lungs. As you build more muscle you will burn more fat, even at rest. Muscles burn more calories per unit volume than any other tissue in the body.

**Vo2 Max:**

VO2 max is the maximal oxygen uptake or the maximum volume of oxygen that can be utilized in one minute during maximal or exhaustive exercise. It is measured as milliliters of oxygen used in one minute per kilogram of body weight.