CHAPTER - 1
INTRODUCTION

“Be strong, my young friends, that is my advice to you, you will be nearer to heaven through football than through study of the Gita”. These are bold words, but I have to say them, for I love you. I know where the shoe pinches. I have gained a little experience. You will understand the Gita better with your biceps, your muscles, a little stronger. Make your nerves strong. What we want is Muscles of Iron and Nerves of Steel. We have wept long enough. No more weeping, but stand on your feet and be men. “Give me a few men and women who are pure and selfless, and I shall shake the world”

- Swami Vivekananda.

Above, the words tell us the importance of physical training. If you have good health then only you can concentrate on other mental effort works. Even for spirituality and also for learning morals, physical health is an essential need and importance of physical fitness for human being has been stressed by Swami Vivekananda. As a saint, he also felt the need for physical training.

The former U.S. President John F. Kennedy expressed his concern about the fitness in an article published in the sports illustrated called “The soft American”. “For the physical vigor of our citizens is one of the most precious resources. If we waste and neglect this resource we allow it to dwindle and grow soft then we will destroy much of our ability to meet the great and vital challenges, which confront our people. We will be unable to realize our full potential as a nation”.

1.1. PHYSICAL FITNESS

Physical fitness makes you feel mentally sharp, physically more comfortable and to cope up with the demands that every day makes upon you
Jackson (1985). The American Association for Health, Physical Education and Recreation (AAHPER) supported these and in 1957, developed a youth AAHPER fitness test with national norms to be used in physical education programmed throughout the country in the 21st century, many research works are conducted in exercise physiology. The research is now focused on physical, Physiological, Hematological and Biochemical level. Advance research is going on in areas like nucleus, plasma and mitochondria level.

1.2. TRAINING

Training has been explained as a programme of exercise designed to improve the skills and increase the energy capacities of an athlete for a particular event. Forx (1984).

1.3. SPORTS TRAINING

Hardayal singh (1984) stated that the sports training is a pedagogical process, based on scientific principles, aiming at preparing sportmen for higher performance in sports competition. Sports training aims at achieving high performance in sports competition. Its process which is spread over a long period of time and competition cum performance oriented endeavor as well.

1.4. EXERCISE PRESCRIPTION

The exercise programme includes dynamic large muscle activities such as Walking, Jogging, Running, Swimming, Cycling, Rowing and Dancing. The cardio respiratory training effect of exercise programme is dependent on the frequency, duration, and intensity.

Intensity

With regard to the type of training while tapering, it commonly takes the form of interval work, with sufficient recovery in order to maximize exercise intensity (Costill et al, 1991). Training at an intensity of 70% VO2max either maintained or actually worsened performance (McConnell at al, 1993).
In contrast, tapers involving training at 90% VO$_{2}$max improved performance (Costill et al., 1991). The reasons behind this were put forward by Houmard (1991) who said that intense exercise may be necessary to maintain training-associated adaptations with the reduction in training volume during the tapering period. Intense interval work, when coupled with a reduction in training volume, may also provide a unique stimulus to the musculoskeletal system which results in adaptations conducive to improving performance.

**Frequency**

Exercise frequency is concerned with the number of sessions performed each week (Houmard and Johns, 1994). The reduction in training volume cannot be achieved at the expense of a drastic reduction in frequency. Neufer (1987) examined the effects of swim-reduced training on swimming power and blood-lactate production after submaximal exercise. Two regimes were examined: (1) 80 per cent reduction in training volume, 50 per cent in frequency, and (2) 95 per cent reduction in volume and 85 per cent in training frequency. Results of the study found that swimming power significantly decreased after only seven days and submaximal blood lactate levels increased after 28 days of either reduced-training regime. These changes were indicative of a loss of training-associated adaptations and, most likely, a decrement in performance. The reduction in training schedules here were quite dramatic. Studies in which performance related Variables were maintained or improved incorporated only a 20-50 per cent reduction (Costill et al., 1985).

**Duration**

Yamamoto et al. (1988) compared the effects of either a 45 day or a 15 day taper on blood hematocrit and hemoglobin in national class swimmers. They observed that peak performance values were obtained seven days into the taper, and that this would be the optimum taper duration, with anything longer resulting in performance loss. Unfortunately, though, this study didn't measure actual swimming performance. Studies that did involve performance
assessment with tapering have reported improvements with tapers lasting from 7-21 days (Costill et al 1992). However, the effects of a more prolonged taper have not yet been thoroughly investigated, Houmard et al (1992) suggest a taper lasting 21 days would only maintain, rather than improve, actual performance.

1.5. MEANING OF BENCH STEP TRAINING

Bench stepping is simply stepping up and down on a bench. Step training is a great exercise to burn fat and improves the condition of the heart and lungs. Two kinds of step training exist, step aerobics and bench stepping. Both are aerobic activities that require continuous movement supplied with lots of oxygen. The American College of Sports Medicine recommends aerobic exercise done for a minimum of 20 minutes, three times a week at 60% of the maximum heart rate. Exercising 4 or more times a week will increase your health benefits.

1.6. HISTORY OF BENCH STEP TRAINING

In the 1950's, the Harvard Step test was developed for cardio-respiratory fitness assessment and has been used for the last half of the century. Many others toyed with the concept in various training modes and with different types of elevated equipment, but it were Gin Miller, who successfully created, focused, pitched and ultimately sold people, and Reebok, on the idea of organized group "step training". Following years of "schlepping" a box in and out of corporate offices, trying to convince people that this idea would be a great concept for group fitness, Gin finally convinced Reebok and ultimately joined them in 1989 to teach the world to "Step".

Step Training in organized group fitness has been in existence since the mid to late 80's in some form or fashion. But the concept of lifting the body weight to illicit a cardio-respiratory response has actually been around for much longer. Athletic coaches long trained team members by having them run up and down stadium steps, since early in the century.
In the early 80's, group fitness was still in its relative infancy. From 1951 to 1985, Jack La Lanne hosted his television exercise show, looking ever so handsome and svelte in his black jumpsuit. Judy Sheppard Missitt founded Jazzercise in 1969 and Jackie Sorensen began leading her dance based "aerobics" in 1971. In the 80's, Richard Simmons gave a boost to the fitness craze with his "Never Say Diet" exercise book and TV show. And Jane Fonda had her best selling book, "Jane Fonda's Workout Book", and starred in her top selling high impact exercise video, in bare feet no less.

However, the fairly new fitness industry was beginning to show concern with overuse injuries and impact. High impact aerobics were the standard but low impact options and classes gradually started to take hold. This concern also led shoe companies to respond by focusing research and development on footwear that would help absorb shock and reduce the risk of injury. In 1982, Reebok released the "Freestyle" shoe, specifically for aerobic dance. As aerobics became more popular, it concurrently evolved to provide interest and challenge. Tempo increased and choreography became more complex. In retrospect, the time was right for step training to bring the world to its feet.

1.7. THE RESEARCH GUIDELINES FOR BENCH STEP TRAINING

As step continued to rise in popularity, Reebok recruited Drs. Peter Francis and Lorna Francis to conduct on going research and study the biomechanics and effects of step training. Research conducted by San Diego State University studied the Physiological and biomechanical effects, including the effects of platform height, effects of hand held weights, impact forces on the feet (force plate testing), video analysis of step training, and energy cost and fatigue. Additional research was done at the University of Colorado, Auburn University (Blessing and colleagues, use of hand weights), Dixie Stan forth and colleagues at the University of Texas (effect of changing music tempo from 120 to 128), University of Pittsburgh (Goss & colleagues - hand
weights and tempo) and Dr. Len Kravitz and colleagues at San Jose State University.

The Original Guidelines for step training were developed based on this extensive research and "Reebok University" was officially launched in 1993. The first team, which included Gin, Drs. Peter Francis and Lorna Francis, along with contributions from Karen Tichenor, and Bob Rich, wrote the Introduction to Step Reebok based on the research, which was later published as one of the first Reebok University Instructor Manuals by Reebok University Press in 1994.

1.8. SIMPLE AND BASIC STEPS FOR BENCH STEP TRAINING

Step Training was initially a very simple and athletic program. Each individual had his or her own space, reducing the concern for getting in someone else's way if one was to make a mistake. This aspect of clearly defined space was a plus for step training and encouraged those who had been intimidated by the complexity of high impact classes to attempt in learning this new activity.


The moves were uncomplicated and easy to follow and the intensity was imposed automatically with lifting the body weight on to the platform. The platforms were adjustable, which allowed everyone to work at their own fitness level. As people adapted to the lifting of their body weight, the platform could be raised to add a new variable for challenge. The platforms did rise and in the early years some people were stepping as high as 14 inches. With continuing education based on the research being conducted by the team, height
eventually began to moderate following the "90 degree angle of the knee joint recommendation". Platform height receded somewhat to an average of 8 inches, and 10" for the really tall, and instructors began to frown upon "table top" steppers using higher platforms.

1.9. EFFECTS OF BENCH STEP TRAINING

In 1989, Step was billed as the "workout with muscle". Lifting the body weight not only improved cardio-respiratory "strength" but it also increased strength in the primary movers of the lower body, the quadriceps, glutei's and hamstrings. To put even more muscle into the workout and provide upper body strength training, hand weights were used in the initial stage of step training. Keep in mind that, at the time, step was slow by today's standards, a relative snail's pace, with beats per minute (BPMs) ranging between 80 and 120. This slow pace not only allowed thousands of people to gradually learn and adapt to the new vertical lifting activity, but it also allowed a greater degree of control when hand weights were used.

The research that was eventually conducted by Drs. Peter and Lorna Francis, and others, included a study on "The Effects of Hand Held Weights". The study done at Auburn University found that there was no significant difference in the energy cost when stepping on an 8-inch platform with or without 1-pound dumbbells, according to oxygen uptake. But the subjects in the study perceived that the energy cost was greater and reported higher heart rate using the 1-pound weights. The conclusion was that the perceived exertion was most likely due to discomfort and fatigue of the shoulder muscles and the higher heart rate was reportedly due to the "Presser Response". The same group at Auburn also looked at the use of heavier weights - 2 pounds on an 8-inch platform. While the energy cost did increase by about 6.7%, the subjects using the weights complained of acute pain and soreness in the shoulder muscles - and the same group was unwilling to exercise with 3-pound weights.
At San Diego State, the group looked at the aspect of the Presser Response by conducting a comparative study of oxygen uptake and heart rate over a range of intensities for both treadmill running and step training. They concluded that heart rate was an accurate indicator of energy cost for both activities, and when hand weights are not used, the Presser Response does not seem to have a significant influence on heart rate. In an earlier study at the University of Pittsburgh, the effects of stepping with 1 and 2 pound weights at the range ends of tempo - 80 bpm and 120 bpm. The platform height was 14 inches. The results were: At 80 bpm, energy cost increased by 18.6% with 1 lb and 21.7% with 2 lbs, pumping arms from mid thigh to shoulder height. At 120 bpm, there was an increase by 17% with 1 lb, and 21.2% with 2 lbs. However they did not look at the energy cost of pumping arms without weights, and according to the Step Reebok manual, Introduction to Step Training (1994), it was "not possible to determine the effects of the hand weights alone from these data."

What is of interest at this point in time is that the really slow speed of 80 bpm, produced 18.6% with 1lbs, but only 17% at 120 bpm. This seems to suggest that slower tempos actually require more energy, but again, it should be noted that the platform height was 14 inches. Ultimately, it became the standard recommendation not to use hand weights while stepping - that the potential risk of injury to the joints of the shoulders and elbows far outweighed the relative benefit of using hand weights. Because of this injury concern with repetitious upper body strength movements combined with the dynamic lower body movements of step training, Reebok created Step Reebok Circuit Workouts. The original circuit handout, published in 1991, included suggested formats and set-ups for alternating strength with the cardio step segments.

1.10. BENCH STEP TEST

The use of stepping for the evaluation of fitness has been utilized since the turn of the century. Other tests, such as the 3-Minute Step Test, were
introduced as a means of evaluating fitness levels during sub maximal effort. This test is conducted on a 12-inch high bench, with a stepping rate of 24 steps/min for the 3 minutes (ACSM, 1991). Following the test, the subjects are instructed to immediately sit down while heart rate is counted for 1 minute. Step tests have traditionally been used for submaximal testing because of their decreased oxygen consumption values compared to treadmill testing.

Holland et al. (1990) has shown that the additional limitations of step tests include muscle fatigue in the legs and balance problems at higher stepping rates. While newer step-test protocols are available, their use has been limited with the advent of computerized step ergometers. These devices require arm or leg movements and usually provide the necessary technology for measurement and display of power variance. These step ergometers have been designed to simulate stair climbing offering a more feasible way of evaluating work capacity, especially for peak exercise.

Holland et al. (1990) tested college students using a step treadmill by Stairmaster (SM) that simulates stair climbing. The SM 6000 incorporates a rotating set of stairs similar to an escalator. An incremental protocol equating MET values was used in the comparison of stair climbing vs. treadmill exercise. Results of this study indicate that no significant differences were found for peak Physiological responses between the stair climber and treadmill. Overall, mean VO2peak data was higher for the Stair Master than the treadmill. Similarly, during submaximal work rates (stage I and II) oxygen consumption and heart rates were higher for the stair climber. These results led researchers to conclude that stair climbing ergometers is a viable alternative exercise modality for this population. Recent research, however, has demonstrated more discernible differences between stair stepping and treadmill exercise.

Zeni et al. (1996) conducted research evaluating the energy expenditure of the treadmill compared to the stair stepper. The exercise test comprised 3
stages of 5 minutes at self-selected work rates corresponding to ratings of perceived exertion (RPE) values of 11 (fairly light), 13 (somewhat hard), and 15 (hard). The treadmill induced significantly higher rates of energy expenditure for fixed RPE values than the stair stepper.

Davis and Sipe (1995) investigated an inclined stepper and its VO2 response to maximal exercise as well as its test-retest-reliability. Using 28 college-aged subjects, VO2peak values were found to be significantly (~15%) less for the inclined stepper compared to the treadmill. Also, results indicated that the stepper can be administered by researchers with the confidence knowing that oxygen uptake values will not differ significantly from day to day (r=0.91). From these studies, it is not clear whether the Physiological demands obtained during constant-load and incremental exercises are similar for treadmill and stair climbing exercise.

1.11. EFFECTS OF BENCH STEP TRAINING ON PLASMA GLUCOSE

Glucose was first isolated in 1747 from raisins by Andreas Marggraf. Plasma is a straw colored clear liquid. It contains 91 to 92% of water and 8 to 9% of solids. The solids are the organic and inorganic substances of the plasma. Plasma glucose is the primary fuel of nervous system. The majority on hormonal changes associated with fascinating or exercise are aimed at maintain this impartment homeostatic variable. It is interesting to study the biochemical changes in muscle that occur as a result of endurance training help maintain the blood glucose concentration during prolonged sub maximal exercise.

The increased number of mitochondria increases muscle fiber capacity to oxidize both carbohydrate and fat. However, the most dramatic change in muscle metabolism following training is the increased utilization of fat, and the spring of carbohydrate. This is due to an improved capacity to mobilize FFA from adipose tissue to muscle, an increased ability to transport FFA from the cytoplasm to the mitochondria of the muscle, and an increase in the fatty acid
cycle enzymes needed to degrade the FFA to acetyl-Co-A units for the Krebs cycle.

Plasma FFA provide half the fat oxidized by muscle during exercise, and the uptake of FFA by muscle is proportional to the FFA concentration in the plasma. The enhanced mobilization of FFA due to the lower blood lactate would favor the maintenance of the plasma FFA concentration at a time when the muscle is using FFA at a faster rate, the increase in capillary density at the muscle allows for both a slower muscle capillary blood flow during exercise and an increased surfaces area for the diffusion of FFA in the muscle. Lastly, there is some evidence that a high cytoplasm concentration of FFA acts to inhibit PFK activity to further reduce carbohydrate metabolism. All of these adaptations favor a reduced rate of carbohydrate oxidation, sparing the muscle glycogen and plasma glucose. Based on this discussion, one might expect the plasma FFA concentration to be higher after training since the adipose cell is not inhibited by a high blood lactate concentration.

**Major Functions of Plasma**

The plasma or blood serves numerous functions;

1. Plasma carries wastes and potentially toxic material from various areas of the body for excretion through the kidneys

2. Plasma maintains another phase of homeostasis through a totally different system known as the plasmatic coagulations system.

3. Plasma is the main vehicle for carrying nutrients including fats, proteins and carbohydrates to and form various organs [especially in the liver] for processing and further use in the body’s metabolic process, the nutrients are then stirred in tissue for caloric expenditure, that is energy.

4. Plasma maintains adequate circulations of electrolytes, minerals, nutrients, and vitamins. Alterations in their qualities can lead to many different problems, especially in active athletes.
5. Small quantities of oxygen to aid the red cells in oxygen delivery are carried by plasma.

1.12. EFFECTS OF BENCH STEP TRAINING ON PLASMA CREATINE

Creatine is an essential, natural substance required for energy metabolism, muscular movement and human existence. Creatine is a necessary to life as protein, carbohydrates, fats, vitamins and minerals.

The human body synthesizes creatine from three amino acids: glycine, arginine, and methionine, these amino acids are components of protein. In humans, the enzymes involved in the synthesis of creatine are located in the liver, pancreas and kidneys. Creatine can be produced in any of these organs and then transported into the muscle via the blood stream. Approximately 95% of the total creatine pool is stored in skeletal muscle tissue. The remaining 5% can be found in the heart, brain and testes. It is estimated that a 70 kg (154 lbs.) male will have a total creatine pool of approximately 140 grams in his body.

The total creatine pool in humans refers to the combined amount of creatine in its free form and phosphocreatine form. In skeletal muscle tissue, phosphocreatine accounts for two-thirds of the total creatine pool, with free form creatine making up the balance. In the absence of exogenous (from the diet) creatine, the rate of creatine excreted in the form of creatinine has been estimated to be around 1.6% per day in humans. Thus, with a bodyweight of 70kg (154 lbs.) and a total creatine pool of 140 grams, a human will lose approximately 2 grams of creatine per day from normal everyday activity. This turnover of creatine will increase with greater physical activity and must be replaced by the diet or the bodies own natural production.

Functions of Creatine

Creatine plays a very powerful role in energy metabolism as a muscle fuel. The immediate energy source for a skeletal muscle contraction is from a
molecule called ATP (adenosine triphosphate). All fuel sources, carbohydrates, fats and protein are first converted through various chemical reactions to ATP, which is then available as the only molecule the body uses for energy. Everything must be first converted to ATP before it can be used as fuel.

Adenosine Triphosphate is a simple chemical consisting of one molecule of adenosine and three molecules of phosphate. When ATP releases its energy to fuel muscle contractions, a phosphate group is split off and a new molecule are formed called ADP (adenosine diphosphate). This reaction is reversible by the energy-rich compound phosphocreatine. Phosphocreatine delivers a phosphate group to ADP re-synthesizing it back into an ATP molecule, thus making it ready again to release energy to fuel continued muscle contractions. The remaining free form creatine is accumulated in the active muscles and then rephosphorylated back into phosphocreatine.

The primary purpose of phosphocreatine is to re-supply ADP with high-energy phosphates to buffer levels of ATP when ATP levels are falling rapidly as in intense exercise. ATP is the only direct source of energy that can be used by the cells.

Phosphocreatine levels are initially about three times greater than the ATP levels (about 75 mmol/kg dm of PCr as compared to 25 mmol/kg dm of ATP). This 3:1 ratio of phosphocreatine to ATP allows ATP to be regenerated from ADP at a faster rate than the ATP is depleted. Phosphocreatine would eventually be depleted in the cell within seconds (about 10 seconds) but is recharged from creatine while the cell is at rest (using ATP produced by the electron transport chain). About 50% of the phosphocreatine is regenerated within 30 seconds during the recovery period. It can have a positive impact on the following aspects, Arapoff and Riley (1998).

1. Expediting recovery between workouts,
2. Increase the amount of exercise that can be performed during workouts,
3. Increase muscle size and strength,
4. Improve anaerobic power and endurance, and
5. Increase body weight

During a brief period of high intensity exercise, the ATP demand in the working muscles increases significantly to several hundred times higher versus when at rest. High intensity exercise can totally deplete phosphocreatine stores within 10 seconds. The depleted stores of ATP and phosphocreatine must be steadily replenished in order for muscular contractions to continue at peak levels of frequency and intensity.

1.13. EFFECTS OF BENCH STEP TRAINING ON PLASMA INORGANIC PHOSPHATE

Enhance Metabolic Regulation

Phosphate is the major anion of the intra cellular fluid and the proportion of intercellular phosphate available for energy metabolism depend upon the extra cellular concentration. Which are the major components of cell membranes, Phospholipids, may also serve as donors of phosphate radicals when they are needed for different chemical reaction in the tissues. Phosphors bind reversibly with a number of coenzymes systems and other compounds involved in metabolism

Enhancing ATP and PCr Synthesis

Phosphate is integrally involved in the formation of pureness and primitives and thereby DNA and RNA synthesis. In this regard, phosphate contributes to the development of adenine, components of adenosine as well as provide high energy bond in an adenosine troposphere and PCr. The 3 phosphorallyation potential, given as ratio as (ATP) to (ADP + pi) is an index for energy status of the cell and is dependent upon the concentration of Pi. The phosphorlyation potential is directly related to the free energy available from ATP.
Enhanced 2, 3-Diphosphoglycerate Syntheses

2, 3-diphosphoglycerate is a high anionic phosphate, which binds to hemoglobin in the erythrocyte. 2,3-DPG serves to lower the oxygen affinity of oxygen by a factor of 26 thereby facilitating the release of oxygen to the tissue. Several studies have shown that there is an increase in 2,3-DPG levels in the adaptation to hypoxia at altitude.

Enhanced Cardiovascular to Exercise

Phosphate affects myocardial function at rest and during exercise. In this regard, hypophosphate is associated with depressed myocardial contractility and cardiac output. Reversal hypophoatema has been reported on markedly improved myocardial responses in the canonic. In addition, there is several reports indication that sodium or calcium phosphate enhance peripheral extraction of oxygen, reduces sub-maximal cardiac output and or stroke volume, and increase myocardial contractility and ejection fraction during intense endurance exercises.

Enhanced Buffering Capacity

Phosphate loading has also been suggested to enhance acid base balance during intense exercise. In this regard, phosphate is an active participant in much Physiological buffer system and is involved in acid base balance within the plasma and in the cells.

1.14. EFFECTS OF BENCH STEP TRAINING ON HEMOGLOBIN

Hemoglobin is the iron-containing oxygen-transport metalloproteinase in the red cells of the blood in mammals and other animals. Hemoglobin is a molecule comprised of four subunits. Each subunit contains an iron containing pigment (heme) and a protein (globulin). There are two types of subunits, alpha and beta. Each gram of hemoglobin can carry 1.34 ml of oxygen. The oxygen carrying ability of blood is directly proportional to its hemoglobin concentration. The numbers of red blood cells does not indicate blood's oxygen
content because some cells may contain more hemoglobin than others. Hemoglobin determination is used to screen for anemia, to identify the severity of anemia, and to assist in evaluating the athlete’s response to anemia therapy. Hemoglobin also serves as an important pH buffer in the extracellular fluid.

Normal hemoglobin values are:

1. Male: 13.5 - 17 g/dl
2. Female: 12 - 15 g/dl

Increased levels of hemoglobin are found in any condition in which the number of circulating red blood cells rises above normal. Examples of conditions associated with increases in hemoglobin are polycythemia Vera, severe burns, chronic obstructive pulmonary disease, and congestive heart failure.

As blood passes through the tissue capillaries, the uptake of carbon dioxide by red cells raises the oxygen tension of oxyhemoglobin at a given oxygen saturation by means of the Bohr effect, thereby facilitating the unloading of oxygen. The unloading of oxygen lowers the carbon dioxide tension inside the red cells at a given carbon dioxide content by means of the Haldane effect, thereby facilitating the uptake of carbon dioxide. These rapid interactions between the Bohr and Haldane effects promote the optimal transport of both oxygen and carbon dioxide by red cells, particularly during exercise. The net effects are to maximize the difference in oxygen content between arterial and venous blood and to minimize both the difference in carbon dioxide tension between arterial and venous blood and tissue acidosis. Up to 40 percent of the exchange of carbon dioxide in the tissues and 20 percent of the exchange of oxygen in the tissues can be attributed to these coupled oxygen–carbon dioxide transport mechanisms.
Functions of Hemoglobin

When hemoglobin is exposed to oxygen, the oxygen molecules combine reversibility with the hemo protein of the alpha and beta chain to form Oxyhemoglobin.

1. Oxyhemoglobin is bright red in color, when oxygen is released to the tissue, the hemoglobin is called deoxy-hemoglobin which appears darker.

2. Each gram of hemoglobin carries 1.3 ml of oxygen, 97% of oxygen in the blood carried from the lungs is combined with hemoglobin, and the other 3% is dissolved in the plasma.

3. Hemoglobin binded with carbon dioxide at the amino acid of the globin portion. The carb-amino hemoglobin informed accounts only 20% of carbon dioxide transported in the blood. Remaining 80 % are carried in the form of bicarbonate irons.

1.15. EFFECTS OF BENCH STEP TRAINING ON RED BLOOD CELLS

The primary function of the red blood cells or erythrocytes is to carry oxygen from the lungs to body tissues and to transfer carbon dioxide from the tissues to the lungs. Oxygen transfer is accomplished via the hemoglobin contained in red blood cells. Hemoglobin combines readily with oxygen and carbon dioxide. Oxyhemoglobin in arterial blood reflects a bright red color while carboxyhemoglobin of venous blood appears dark red. To enable the maximum O₂ saturation of hemoglobin, red cells are shaped like biconcave disks. The shape provides more surface area for exposure of hemoglobin to dissolved oxygen. Red blood cells are also able to change shape to permit passage through small capillaries that connect arteries with veins.

The RBC is a count of the number of red blood cells per cubic millimeter of blood. In response to hypoxia, the hormone erythropoietin, secreted by the kidneys, stimulates the bone marrow to produce red blood cells. The formation of red blood cells is known as erythropoiesis.
Normal red blood cells values at various ages are:

1. Male: 4.6 - 6.0 million
2. Female: 4.2-5.0 million

**Functions of Red Blood Cells**

1. Erythrocytes transport oxygen from the lungs to the tissues. The hemoglobin in red blood cells combines with oxygen and 97% of oxygen is transported as oxyhemoglobin.

2. Red blood cells transport carbon dioxide from the tissues to the lungs. The hemoglobin in red blood cells combines with carbon dioxide and from carbhemoglobin. About 30% of carbon dioxide is transported in this form.

3. Hemoglobin in red blood cells also functions as a good buffer. By this action, it regulates the hydrogen ion concentration and thereby takes part in the maintenance of acid base balance.

4. Red blood cells carry the blood group antigens like an agglutinogen, B agglutinogen and Rh factor. This helps in the determination of blood group and blood transfusion.

**Increase in Red Blood Cells**

An increase in red blood cell mass is known as polycythemia. Normal physiological increases in the RBC count occur at high altitudes or after strenuous physical training. At high altitudes, less atmospheric weight pushes air into the lungs, causing a decrease in the partial pressure of oxygen and hypoxia. With strenuous physical training, increased muscle mass demands more oxygen.

**1.16. EFFECTS OF BENCH STEP TRAINING ON URINE CREATINE**

Creatinine is cleared from the body through the kidney primarily by glomerular filtration. However, 15-20% of the creatinine in urine can occur by active secretion from the blood through the renal tubules (Boeniger et al.
The rate of secretion can vary substantially among persons because of various genetic and biological factors. Researchers have found a high correlation between urinary creatinine concentrations and muscle mass (Edwards and Whyte 1959; Fuller and Rich 1982); higher urinary creatinine concentrations in men than in women (Bjornsson 1979; Turner and Cohn 1975); decreased urinary creatinine concentrations in adults with increasing age, probably because of a general decline in muscularity and glomerular filtration rate (GFR) (Alessio et al. 1985; Drive and McAlevy 1980); and seasonal variation in creatinine concentrations in children (Freeman et al. 1995; O'Rourke et al. 2000). In addition, persons with a high red meat intake have a higher urinary creatinine concentration than to those on a low-red-meat diet (Lykken et al. 1980). The effects of these factors and others on urinary creatinine concentrations have been reviewed (Boeniger et al. 1993).

Most of the creatinine excreted in urine is derived from the intracellular creatinine precursors creatine and phosphocreatine by nonenzymatic processes (i.e., dehydration and hydrolysis) occurring in muscle. Therefore, measurement of urinary creatinine excretion serves as a simple biochemical tool for evaluating total-body skeletal muscle mass or body composition. In addition, urinary creatinine output is frequently used to check roughly the completeness of urine collection or to estimate the excretion rates of certain analyses from the respective ratios from creatinine.

1.17. EFFECTS OF BENCH STEP TRAINING ON URINE INORGANIC PHOSPHATE

The normal serum concentration of phosphorus range between 0.75 to 1, 35 mmol/l with a mean of 1.1 mmol/l. When serum level is low, additional phosphorus is absorbed from the intestine and the proximal tubule of the nephron. When serum level of phosphorus are high, extra phosphorus is typically excreted by the kidney. The normal urinary excretion of phosphorus is approximately 175 to 300 mmol/dl. approximately 50% of serum
phosphorus exist as free phosphate while remaining phosphorus is bound with sodium, calcium, magnesium, and protein. Serum phosphorus levels normally fluctuate between 0.3 and 0.6 mmol/l. The fluctuation generally reflects shifts between inter cellular and extra cellular concentration.

Heaton and Hodgkinson (1963) concluded that the effect of exercise, urine flow and food intake on the renal excretion of calcium, magnesium, water, sodium, potassium, phosphate and creatinine was observed in normal adults. During fasting, the rate of calcium and magnesium excretion in the subjects was greater during the night than the day, irrespective of whether the subjects were at rest or active during the day. When the subjects were receiving normal meals, the excretion rate of calcium and magnesium was usually greater during the day than night. A rapid rise in the excretion of calcium and magnesium occurred after a meal, the average rate of excretion increases two to four times in the first 3 h and then decreases during the next 12–15 h. No significant effect on the excretion of sodium, potassium, creatinine or phosphate was observed. The excretion of calcium and magnesium was reduced during moderate exercise but the excretion of sodium, potassium, creatinine, and inorganic phosphate was unaffected. No correlation was found between urine flow and the excretion of calcium or magnesium during water diuresis but there was a significant correlation between urine flow and the excretion of sodium and potassium.

1.18. REASONS FOR THE SELECTION OF THE STUDY

In our country, adequate infrastructure and facilities for sportsmen are provided to improve their skills. But, due to the lack of proper training methods, our athletes have not performed to their potential, which resulted in poor performance in international competition.

In recent years, bench step training has earned a place for itself among sports personalities throughout the world because of its simplicity, cost effectiveness and usefulness. This method has been adopted by our athletes for
the past few years and the result has improved drastically in both national and international competitions. However, the performance of our athletes can be improved further by incorporating advance methods in the bench step training.

In order to improve the performance of athletes, the researcher has decided to implementing two different intensities of bench step training to improve their performance and find out the appropriate intensity of bench step training programme to improve selected Physiological, Hematological and Biochemical variables of college men athletes.

1.19. STATEMENT OF THE PROBLEM

The purpose of the study was to investigate the effects of two different intensities such as 30 Cadence per minute and 23 Cadence per minute of bench step training on selected Physiological, Hematological and Biochemical variables of college men athletes.

1.20. SIGNIFICANCE OF THE STUDY

1. This study would be very much useful and suitable for College level athletes.

2. The study would be of great significance because it would provide an opportunity to the physical educators, coaches and the athletes as they would be able to scientifically understand and assess the changes in the variables such as Physiological, Hematological and Biochemical changes due to the two different intensities of bench step training dealt in this training.

3. The findings of the study would enrich the physical education profession with better insight into methods to enhance Physiological, Hematological and Biochemical changes of college men athletes.

4. The outcome of the study would educate not only athletes but also ordinary people to get benefit of bench step training.

5. If the study is successfully completed, it would be scientifically accepted that the Bench Step training not only develops, the
performance of the athlete but also develops internal organs like respiratory system, nervous system, circulatory system, excretory system, muscular system etc.

1.21. HYPOTHESIS

1. It was hypothesised that there would be a significant improvement in selected Physiological variables such as Plasma Glucose, Plasma Creatine, Plasma Inorganic Phosphate, Hematological variables such as Hemoglobin, Red Blood Cells and Biochemical variables such as Urine Creatine, Urine Inorganic Phosphate, due to the influence of 30 Cadence and 23 Cadence per minute of bench step training of college men athletes.

2. It was hypothesised that 30 Cadence per minute would have greater significant effect on selected Physiological, Hematological and Biochemical variables than that of 23 Cadence per minute of college men athletes.

1.22. DELIMITATION

This study was delimited to the following aspects:

1. Forty five male college athletes were selected as a subject at random and their age was between 20 and 24 years.

2. Forty five subjects were equally divided into three groups of fifteen each forming 30 Cadence per minute and 23 Cadence per minute and Control Group.

3. The training bench height is 40 centimeter for both 30 Cadence per minute and 23 Cadence per minute. There was no change in this till the end of the training period.

4. In this study the following variables were selected, on the basis of the past research report and the opinion and suggestions of the authorities of this field.
1.23. DEPENDENT VARIABLES

A. Physiological Variables
   1. Plasma Glucose
   2. Plasma Creatine
   3. Plasma Inorganic Phosphate

B. Hematological Variables
   1. Hemoglobin
   2. Red Blood Cells

C. Biochemical Variables
   1. Urine Creatine
   2. Urine Inorganic Phosphate

1.24. INDEPENDENT VARIABLES

   1. 30 Cadence per minute
   2. 23 Cadence per minute
   3. Control Group

1.25. LIMITATIONS

   The study was restricted to the following areas:
   1. Certain factors like food habit, life style, daily routine work; climatic
      conditions and environmental factors, which may have an effect on the
      result of this study, were not taken into consideration while interpreting
      the result.
   2. The randomly assigned subject for Cadence per minute and control
      groups, hailed from different family backgrounds and economic/
      atmospheric conditions were beyond control and hence the factors may
      influence the study and was accepted as limitations.
3. No special motivational techniques were used during training.

4. No attempt will be made to control the factors like air resistance, indoor climate, intensity of light, atmospheric and temperature during testing and training period.

1.26. DEFINITION AND EXPLANATIONS OF THE TERMS

Glucose:
A simple sugar that is transported via the blood and metabolized by tissue, Powers (1994).

Blood Glucose:
Plasma glucose is a primary fuel of nervous system, Powers (1994).

Creatine Phosphate:
A compound found in skeletal muscle and to used resynthesis ATP from ADP, Powers (1994).

Inorganic Phosphate:
A stimulator of cellular metabolism; split off, along with ADP, from ATP when energy is released ; used with ADP to from ATP in the electron transport chain, Powers (1994).

Hemoglobin:
A complex molecule found in red blood cells, which contain iron (heme) and protein (globin) and is capable of combining with oxygen, Fox. et.al (1993).

Red Blood Cells:
Pearce (1985) explained that the red blood corpuscles or erythrocytes are small circular biconcave discs so called because they are concave at both sides that looked like two crescents placed back to back. They are 50, 000, 00 red cells in cubic millimeter of blood.
**Intensity:**
According to Hardayal Singh (1984) intensity is the rate of doing work. In other words, it is the pace at which physical activity is done.

**Cadence:**
The beats, time or measure of rhythmic motion or activity such as pedaling a bicycle is called Cadence, Gin Miller (1994)

**Exercise prescription**
A course of exercise to meet desirable individual objectives for fitness. Includes activity types, duration, intensity, and frequency of exercise, Scott K. Powers (1994).

**Bench stepping:**
Bench stepping is simply stepping up and down on a bench, Ricci B (1966).