Chapter I

INTRODUCTION
Chapter I

INTRODUCTION

Genesis of Diabetes Mellitus

Diabetes is a constantly growing health problem in all over the world today. Diabetes mellitus has been clinically identified as a disorder / health hazard.

The first written record of diabetes was discovered on an ancient Egyptian papyrus dated back to 1500 BC, which describe excessive urination, polyuria, one of the main symptoms of diabetes. The Indian text Susruta, written in approximately 400 BC, notes the diseases and calls it madhu meh, honey in the urine. In the west, Willis first noticed the disease and was characterized by sweetness of the urine in 1675 AD. Today there is an estimation that approximately 9% of the populations have diabetes. The number of cases is said to be rising 6% each year.

The disease is not just a case of having too much sugar in the blood; it affects nearly every organ in the body. An estimated 300,000 people die from diabetes and is complications such as heart attack, stroke and kidney failure. It is also the leading cause of blindness in America, as well as causing high blood pressure, impotence, gangrene and chronic infections, which often necessitate amputation. After cancer and heart disease, diabetes
is the third most common cause of death in America. The American Diabetes Association has used a poster requesting funds for research with the slogan: “Every 60 seconds another American is diagnosed as diabetic”.

However, ancient Indian physicians “Charaka” and “Susruta” have given description of diabetes in their traditional text. They recommended doing physical exercises and ensuring proper diet for the control of diabetes.

Diabetes is one of the major health problems affecting about 5% of Indian population. Complications involved in management of diabetes and increasing prevalence of diabetes every year have been emphasized on the need for efficient control. Diet control, exercises and meditation with insulin and/or antiglycemic drug are the presently available treatment procedures. Stress management is also important in preventing the onset as well as controlling diabetes. Yoga includes moderate exercise, diet restriction, relaxation techniques etceteras, is a very good stress management system. Yoga brings harmony in body and mind, and keeps the person healthy, both physically and mentally. Literature survey indicates that effective control of diabetes; both Insulin Dependent Diabetes Mellitus and Non Insulin Dependent Diabetes Mellitus can be achieved by yoga practice, which can be explored by further experimental researches.

The science of yoga is an ancient one. It is a rich heritage of our culture. Several older books make a mention of the usefulness of yoga in the treatment of certain diseases and preservation of health in normal
individuals. The effect of yogic practices on the management of diabetes has not been investigated well. We carried out well designed studies in normal individuals and those with diabetes to assess the role of yogic practices on glycaemic control, insulin kinetics, body composition exercise tolerance and various co-morbidities like hypertension and dyslipidemia. These studies were both short term and long-term. These studies have confirmed the useful role of yoga in the control of diabetes mellitus. Fasting and postprandial blood glucose levels came down significantly. Good glycaemic status can be maintained for long periods of time. There was a lowering of drug requirement and the incidence of acute complications like infection and ketosis was significantly reduced. There were significant changes in the insulin kinetics and those of counter-regulatory hormones like cortisol. There was a decrease in free fatty acids. There was an increase in lean body mass and decrease in body fat percentage. The number of insulin receptors was also increased. There was an improvement in insulin sensitivity and decline in insulin resistance. All these suggest that yogic practices have a role even in the prevention of diabetes. There is a beneficial effect on the co-morbid conditions like hypertension and dyslipidemia.

**Classification of Diabetes**

The classification adopted by World Health Organisation is given in clinical classification of diabetes mellitus.

1. Diabetes mellitus (DM)
   1) Insulin – dependent diabetes mellitus (IDDM, Type I)
ii) Non – insulin dependent diabetes mellitus (NIDDM, Type II)
iii) Malnutrition – related diabetes mellitus (MRDM)
iv) Other types (secondary to pancreatic, hormonal drug – induced, Genetic and other abnormalities)

2. Impaired glucose tolerance (IGT)
3. Gestational diabetes mellitus (GDM)

Thus, diabetes has been mainly classified clinically as IDDM (Insulin Dependent Diabetes Mellitus) and NIDDM Non-Insulin Dependent Diabetes Mellitus). In fact IDDM is usually originated either in childhood or in adolescence and NIDDM is seen in adults.

The complications are developed due to continue elevation of blood glucose, which damages the blood vessels, heart, kidney, nervous system and even the eyes. The associated classical symptoms are frequent urination, excess hunger, weight loss, thirst, fatigue, weakness etcetera. Moreover, the IDDM patients are prone to ketoacidosis whereas NIDDM is associated with infection or stress ketosis.

The economic impact of an increasing incidence of diabetes and the cost involved in treating it and its complications is considerably high. Diabetes affects an estimated 40 million people, greatly increasing the risk of premature death and disabling complications. The management of Type II (NIDDM) diabetes imposes an enormous burden on health care professionals. Fortunately, the pathogenic factors, which cause high blood
sugar, can be controlled by exercise, diet, oral anti-diabetic drugs and, in a few instances, in combination with insulin. No oral anti-diabetic drug causes complications when used under medical supervision. With the onset of complications, insulin is desirable to prevent a worsening of the disease.\(^3\)

**Cause Unknown**

Since 1921 the discovery of insulin has saved millions of lives. However, even though the disease is one of the earliest recorded in history and despite the fact that hundreds of millions of dollars are being poured into its research all over the world, it is still poorly understood and remains the cause of untold suffering, disability and premature mortality.

Since the early pioneering work of Minkowski and the classical studies of Banting and Best, the intimate relationship between the secretion of insulin from the pancreas and clinical diabetes mellitus has been well established. However, insulin deficiency is not always the primary factor responsible for diabetes. Today there is good deal of contention as to the exact mechanism involved. For example, some people have found altered tissue responsiveness to a normal amount of blood insulin, circulating insulin antagonists (chemicals which act against insulin), abnormalities in insulin binding probably some truth in all these factors.

It appears, therefore that in diabetes one of two things can happen: either run out of insulin, now called Type I insulin dependent diabetes, or
something goes wrong with the insulin glucose metabolism so that insulin is available but comes too late and does not work properly. This is called Type II diabetes, not dependent on insulin.

The diabetes situation is complicated and difficult to research because sugar metabolism is so basic, all-pervasive, essential and complex. We do know that poor diet sedentary lifestyle, obesity and mental tension are related factors, but what really goes on and how to cure it is still unknown.4

**Glucose metabolism**

Apart from oxygen, glucose is the most important energy source in the body and is required to maintain the life and the proper function of every cell in the body. When we eat glucose, it is transported to all the various tissues of the body as fuel and also is stored for later use. The liver, pancreas and adrenal glands are the main body organs responsible for regulating sugar metabolism.

Storage of glucose and entry of glucose into the cells of the body requires insulin. When glucose enters the body, it triggers the release of insulin from the beta cells of the islets of Langerhans in the pancreas. Insulin opens the door for glucose to enter the liver, fat and muscle cells, where it will be stored and used. Storage the job of the liver and fat cells is important because glucose is our most precious fuel, without which the brain and body cannot function. However, if we run out of insulin, no matter how much
sugar we have available in the bloodstream, it is useless because there is no insulin to push glucose into the cells where it is needed.

Glucagon is a hormone that is released from the alpha cells of the islets of Langerhans and works opposite to insulin. It is released in response to starvation, severe exercise and carbohydrate restriction, so as to release stored glucose.

When we fast, about four or more hours after eating, insulin levels decrease and the liver automatically releases glucose to feed the body. Stress, increased sympathetic nervous system activity and adrenal gland activity, release more glucose into the blood. When we are tense, tired, under some kind of real or imagined threat or doing physical exercise, the sympathetic and adrenal systems release glucose to feed the overactive cells in the body.

The whole question of glucose metabolism is complex, multifactor and interrelated with the workings of the whole body. It is an extremely complicated process but this provides a broad and general outline of how things work.\(^5\)

**Role of Exercise in diabetes management**

Celsus first advocated exercise as a component of diabetes management around the time of Christ. In the 1970s, Fred Whitehouse past
president of the American Diabetes Association, stated that, “Exercise is being rediscovered as an important modality of treatment in diabetes by scientists who now need to identify how it works.’ Philip Felig, has found that exercise improves the absorption of glucose. His study shows that insulin mediated blood glucose uptake increased by 30% after training, in direct proportion to the increase in maximal aerobic capacity.

Greg Peterson, at the University of California in San Francisco School of Medicine, showed that after exercise, platelet stickiness dropped from 74-53% in diabetics and from 40-36% in normal subjects. Platelet stickiness is thought to predispose us to blood clots and arterial disease one of the major causes of complications, such as blindness (retinopathy) in diabetes.

It is important to remember, however that while asana give us the benefit of exercise, they are much more than this and act to improve physical fitness as well as inducing relaxation. They can also affect our metabolism, nervous system and endocrine glands in ways that exercise cannot. Pokordi and his associates have shown that after muscular exercise, there was an increase in lactic acid in the blood and the level of lactic acid in those doing muscular exercise was high, while in those doing asana and meditation it was lowered.

Pokordi and his associates also found decreased levels of vanillyl mandelic acid (VMA), MHPG and homovanillic acid (HVA) after six months of asana and meditation, whereas in muscular exercise VMA was
high but MHPG and HVA levels were not affected. There was also an accentuation of alpha and beta brain waves in those people practicing asana and meditation but no such changes in people practicing exercises. This indicates that the yoga practices can affect us at levels which normal exercise and physiotherapy cannot.⁵

**Diet for Diabetes**

The subject of what diabetics should eat is best dealt with by a dietician. However, from the practical point of view, we have found that are certain foods that are beneficial for diabetics, especially when combined with a yoga program. It is known that dietary prescription should not be too rigid and should be individualized for the patient’s culture, type of disease, etcetera. Diet is more important for non-insulin dependent diabetes than for insulin treated patients in whom any extra stress of the diet is dealt with a little extra insulin.

All nutritionists will agree that for good health a variety of minimally processed foods with lots of fresh nutrients and fiber is best. Research has found that insulin dosage can often be reduced with a high fiber diet, such as whole grains, beans and vegetables—an ashram diet. It is also known that, as diabetics have an increased incidence of heart disease and high blood pressure, moderate weight loss alone combined with exercise will bring about a general improvement. Many people have stopped using anti-diabetic drugs following the combination of a yogic lifestyle and diet.
The diet should be low fat because high fat diets impair carbohydrate metabolism and increase the chances of getting heart disease. The American Diabetic Association recommends a diet in which 60-70% of calories come from carbohydrates, while the rest of the diet should be 20-30% protein and 10-20% fats. Whatever fats are taken into the body should be unsaturated (usually plant and vegetable origin) rather than saturated Fats (animal origin).

As a general dictum for diabetes avoid excess amounts of simple sugars, such as white sugar, honey, glucose and other forms of sweets. Eat more complex carbohydrates such as wheat, oatmeal, buckwheat, corn and wholegrain (unrefined) rice. Also salt intake should be low and alcohol no more than moderate. However, research shows that diabetics may be able to occasionally eat a minimal amount of sugar. It is important to follow your doctor’s guidelines in this matter and a good doctor who is up on the latest research will advise you accordingly to your individual needs. However, as a general guideline the following is a good diabetic and general health diet:

Vegetables (Group A) the following vegetables contain insignificant carbohydrates and calories. As a salad, you can eat as much as you like. When cooked, the intake should be limited to about one quarter liter of cooked vegetables (boiled, baked or steamed, not fried), e.g. cabbage, cauliflower, cucumber, eggplant (brinjal), spinach, okra (lady’s fingers), tomato, parwal (gourd), celery, bitter gourd (darela).
Vegetables (Group B): each portion contains approximately 14 grams of carbohydrate and four grams of protein (about 80 calories) per measuring cup (1/4 litre), example carrots, onions, green peas.

Fruits: each portion contains 10 grams of carbohydrate (approximately 40 calories)

For each item mentioned: one orange, one Guava, 1/3 papaya, 1/2 apple, ½ banana, and one cup water melon.

Cereals: each portion contains 25 grams of carbohydrate and two grams of protein (approximately 70 calories) for each item mentioned: two and ½ tablespoons of wheat, jawar, millet ( bajara ) or corn flour, ½ cup of cooked rice or khichari ( rice cooked with lentils ), 20 grams of non-sweetened biscuits, 100 grams of boiled potato.

Pulses: as a rule, one cup (one portion of cooked dall (pulses). example lentils, mung beans, split peas) contains approximately 140 calories.

Fats: one portion contains five grams of fat (approximately 50 calories 0 for each item: one teaspoon butter, oil or ghee: 10 grams of cashew nuts, ground nuts or almonds.
Milk: each portion supplies 12 grams of carbohydrate, eight grams of protein, 10 grams of fat (approximately 170 calories) per item: ¼ liter whole milk (one cup), one cup yoghurt, 240 grams each. On this basis a typical diabetic diet would be as follows (the numbers indicate how many portions):

Breakfast: one bread + one milk + one fruit + one fat or handful of sprouted mung beans.

Lunch: one vegetable (Group A) + one vegetable (Group B) + three cereal + two pulse + three fat + ½ yoghurt + one fruit.

Tea: ½ milk + one bread, or one fruit + 10 grams nuts.

Dinner: one vegetable (Group A) = one vegetable (Group B) + three cereal + one pulse + two fat + one fruit.

Bed line: 1/3 milk or two fruits.

This example of a diabetic diet should supply approximately 2000 to 2500 calories per day and should be adjusted to suit your needs and wants by a skilled professional, example you may need more calories during heavy exercise.

When this diet is combined with a yogic sadhana, and once the blood sugar has been controlled by a combination of yoga, diet and medicines as
required, the diet can be readjusted. However, this kind of diet is very close
to the one used in the ashram and is recommended for most people as a light,
balanced diet which should enhance general health and increase the lifespan.

Both patient and doctor should not only be aware of the wide variety
of good and tasty foods available to the diabetic, but also that it is the
addition of yoga that can transform the life of the patient, increasing
awareness of needs and capacity, promoting digestion and metabolism and
offering the reward of new health, vitality and higher consciousness.7

**Sugar metabolism**

Any person undergoing yoga therapy for diabetes should know the
principles involved. Diabetes mellitus is a disorder of the body’s metabolism
characterized by a high blood sugar level and the subsequent excretion of
sugar in the urine. The human body requires sugar for energy to maintain the
organs and tissues of the body. The sugar which is taken into the body in the
form of carbohydrate, enters the blood in the form of glucose (mainly),
fructose and galactose. These sugars are either immediately used by the
body of else are stored for later use in the liver and muscles in the form of
glycogen.

When we eat a meal containing protein, carbohydrate and fat, the
following things happen in the normal situation.
Glucose enters the bloodstream from the intestines. Insulin is then released from the pancreas in order to help the glucose (from carbohydrates) and amino acids (from proteins) to be assimilated by the body. Insulin pushes the glucose into skeletal muscle, fat cells and liver. Fat from the meal, in the form of triglyceride, is also pushed into fat cells by insulin.

Because we do not eat continuously, periods of relative abundance alternate with food-free periods. During fasting the insulin levels reach their nadir and fat is released as a source of fuel. It is from this fat that ketones can build up to toxic levels in some people with diabetes.

The blood sugar regulates its own level. When the blood sugar level is high, the Islets of Langerhans (a group of endocrine gland cells in the pancreas with the specific function of secreting hormones) secrete insulin to lower the sugar level. The opposite effect occurs when glucagon, another Islet cell hormone, is secreted. Thus balance is achieved.

The regulation of sugar by the body is a very complex thing as glucose is the basic energy supplier of all body tissues. It plays an important role in all body functions and therefore requires sensitive and precise interaction of the pancreas, pituitary gland, muscles, liver, bloodstream, adrenal glands, thyroid gland, skin, kidneys and nervous system. So glucose monitoring and control is a very complex thing. It is easy to understand, therefore, why diabetes is such a complex disease and beyond the reach of medical therapy alone.
Diabetes mellitus is a chronic imbalance in the mechanism regulation blood sugar level. When it occurs, the glucose absorbed into the blood from the digestive system is prevented from being effectively used in the muscles and tissues, or from being stored in the liver is the form of glycogen or as fat. It is caused either by a relative or absolute lack of the hormone insulin. 

Diabetes is a serious and progressive disease but intensive treatment can substantially reduce complications. Even though the utmost care has been taken so far by the World Health Organization, the rate of increasing diabetes has become excessively high.

**Structure of Pancreas**

The pancreas is a rather unique organ in the human body. It is part of two different organ systems, the endocrine system and the digestive system. Technically, the pancreas is a large gland. A gland is a structure in the body that secretes hormones. The pancreas creates a wide range of different hormones, some of which are used to trigger internal metabolic reactions and others which are used to help break down food.

The pancreas is located just below the stomach. It develops as two separate parts which are fused together early in life. The pancreas is also located near the first part of the small intestine, known as the duodenum.
The pancreas is broken into several different subsections. The head of the pancreas is located nearest to the duodenum. The body of the pancreas is the largest section, located in the center of the gland just below the stomach. The pancreas also has a tail, which is furthest from the duodenum.

The pancreas receives its blood supply from various different arteries. These arteries all have very specific names, depending on where they originate from. Nerve supply to the pancreas is primarily through the vague nerve. There is a small duct, or drain, in the pancreas which leads to the common bile duct. This duct is used to drain the excretable hormones which aid in the digestion of food that is passing through the small intestine. In some people, this drain empties directly into the duodenum, however in most people it empties into the common bile duct. The common bile duct is the duct which drains bile from the gallbladder. The enzymes are mixed with bile and then drained into the duodenum.

Another major structure of the pancreas is known as the Islets of Langerhands. These islets are small structures dotted throughout the pancreas, and are responsible for producing insulin, as well as a wide variety of other hormones used by the body. It is estimated that each pancreas contains over one million of these islets.
Function of the Pancreas

The pancreas is involved in a wide variety of functions in the endocrine and exocrine system. Let’s first take a look at some of the endocrine functions of the pancreas. An endocrine hormone is a hormone produced by a gland (such as the pancreas) which is secreted directly into the bloodstream. These hormones include insulin, glucagon, and somatostatin. Insulin is famous for being the hormone which is deficient in people with diabetes. People with diabetes do not produce enough insulin. Insulin is responsible for regulating the amount of sugar which is absorbed into the cells of the body. Without enough insulin, the sugar remains in your bloodstream where it can cause significant health problems.

The pancreas is also an exocrine gland. Exocrine glands do not secrete hormones directly into the bloodstream. Rather, they secrete hormones into organs. In the case of the pancreas, enzymes are produced which are transported to the duodenum. These enzymes are used to aid digestion of food. Some of these hormones include pancreatic lipase, pancreatic amylase, and trypsin.

The pancreas is an extremely important organ in your body. It has a very complex structure and has many functions related to your metabolism. Damage to the pancreas can often be quite significant - hormones and digestive enzymes can be inappropriately released into the surrounding area,
causing much damage. As is the case with many organs in the body, the pancreas is also subject to becoming cancerous.⁹

**The importance of the Pancreas**

It is both an exocrine and endocrine gland. It is responsible for controlling the blood sugar level in the body as well as providing the digestive enzymes for all three categories of food; proteins, fats, and carbohydrates.

**What happens if pancreas is removed**

If you have part of your pancreas taken out, you will probably still make enough insulin. But your doctor will need to keep a very close eye on if you have part of your pancreas taken out; you will probably still make your blood sugar to make sure you do not develop diabetes. You may not make enough digestive juices, but you can take supplements of pancreatic enzymes when you eat. The supplements come in different forms. Usually capsules that you can swallow or empty onto your food. If you have your pancreas completely removed, you will have to take pancreatic enzyme supplements and insulin. Because you won’t be making your own insulin, you will effectively have diabetes. There is a lot to learn at first. But your doctors and nurses will help you until you feel confident.
You have insulin as a small injection under the skin. Before you have an insulin injection, you have to check your blood sugar level so that you know how much to inject. You do this by pricking your finger and squeezing a drop of blood onto a testing strip.10

Causes of Diabetes

Diabetes mellitus occurs when the pancreas doesn't make enough or any of the hormone insulin, or when the insulin produced doesn't work effectively. In diabetes, this causes the level of glucose in the blood to be too high.

In Type 1 diabetes the cells in the pancreas that make insulin are destroyed, causing a severe lack of insulin. This is thought to be the result of the body attacking and destroying its own cells in the pancreas - known as an autoimmune reaction. It's not clear why this happens, but a number of explanations and possible triggers of this reaction have been proposed.

These include:
- Infection with a specific virus or bacteria;
- Exposure to food-borne chemical toxins; and
- Exposure as a very young infant to cow's milk, where an as yet unidentified component of this triggers the autoimmune reaction in the body.

However, these are only hypotheses and are by no means proven causes.
Type II diabetes is believed to develop when

- The receptors on cells in the body that normally respond to the action of insulin fail to be stimulated by it - this is known as insulin resistance. In response to this more insulin may be produced, and this over-production exhausts the insulin-manufacturing cells in the pancreas.
- there is simply insufficient insulin available; and
- the insulin that is available may be abnormal and therefore doesn't work properly.

The following risk factors increase the chances of someone developing Type II diabetes:
- Increasing age;
- Obesity; and
- Physical inactivity.

Rarer causes of diabetes include

- Certain medicines;
- Pregnancy (gestational diabetes) and
- Any illness or disease that damages the pancreas and affects its ability to produce insulin example pancreatitis.
**What doesn't cause diabetes?**

It's important to also be aware of the different myths that over the years have arisen about the causes of diabetes. Eating sweets or the wrong kind of food does not cause diabetes. However, it may cause obesity and this is associated with people developing Type II diabetes. Stress does not cause diabetes, although it may be a trigger for the body turning on itself as in the case of Type I diabetes. It does, however, make the symptoms worse for those who already have diabetes.

Diabetes is not contagious. Someone with diabetes cannot pass it on to anyone else. Drugs such as steroids, Dilantin, and others may elevate the blood sugar through a variety of mechanisms. Certain other drugs, such as alloxan, streptozocin, and thiazide diuretics, are toxic to the beta cells of the pancreas and can cause diabetes. Certain syndromes (for example, Prader-Willi, Down's, Progeria, and Turner's) may result in a hyperglycemic state; if this state is prolonged, the result can be permanent diabetes.

Diabetes resulting in an insulin-dependent state is classified as Type I diabetes. While Type I diabetes affects only between five to ten percent of the diabetic population, its effects on the body can be worse than other forms of diabetes. In the past, Type I has been known as juvenile or juvenile-onset diabetes (because it is usually diagnosed in those under thirty), brittle diabetes, unstable diabetes, and ketosis-prone diabetes. People in this classification more frequently exhibit the classic symptoms, usually with
ketones present in blood and urine. A blood-sugar level of 800 mg/dl (44 mmol) or more, especially if ketones are not present, indicates a diagnosis of hyperglycemic hyperosmolar nonketotic syndrome (a state in which the body is extremely dry (dehydrated), the chemicals in the body are concentrated, and the blood sugar is high). As stated before, diabetes is a syndrome or group of diseases (rather than one disease), leading to the prolonged hyperglycemic state. Type I is most associated with the killing of the beta cells, most likely by the body's own immune system. Either the immune system cannot kill an infecting agent, which then kills the beta cells, or the immune system itself goes "wild," attacking the body's own tissue and destroying the beta cells. The cells of the islets of Langerhans are inflamed, resulting from an infectious-disease process (for example, mumps) or, more commonly, from an autoimmune (allergic to self) response.

The autoimmune process results in the circulation of antibodies that may either cause or be caused by beta-cell death. If it is found that the antibodies cause beta-cell destruction (the body fighting what it now considers foreign to itself), the body's response to the Type I diabetes is much less severe (easier to control) with treatment. Until then, the outcome is a lack of available insulin. While the onset is said to be sudden, changes resulting in decreased insulin availability may have occurred over a longer period of time. In short, insulin-dependent diabetes mellitus is an inherited defect of the body's immune system, resulting in destruction of the insulin-producing beta cells of the pancreas.
Heredity is a major cause of diabetes. If both parents have Type II diabetes, there is a chance that nearly all of their children will have diabetes. If both parents have Type 1 diabetes, fewer than 20 percent of their children will develop Type I diabetes. In identical twins, if one twin develops Type II diabetes, the chance is nearly 100 percent that the other twin will also develop it. In Type I diabetes, however, only 40 to 50 percent of the second twins will develop the disease, indicating that while inheritance is important, environmental factors (for example, too much food, too much stress, viral infection, and so forth) are also involved in the development of Type I diabetes.\textsuperscript{11}

\textbf{Symptoms of Diabetes}

In both types of diabetes, signs and symptoms are more likely to be similar as the blood sugar is high, either due to less or no production of insulin, or insulin resistance. In any case, if there is inadequate glucose in the cells, it is identifiable through certain signs and symptoms. These symptoms are quickly relieved once the Diabetes is treated and also reduce the chances of developing serious health problems.

\textbf{Diabetes Type I}

In Type I, the pancreas stops producing insulin due to autoimmune response or possibly viral attack on pancreas. In absence of insulin, body cells don’t get the required glucose for producing Adenosin Triphosphate.
units which results into primary symptom in the form of nausea and vomiting. In later stage, which leads to ketoacidosis, the body starts breaking down the muscle tissue and fat for producing energy hence, causing fast weight loss. Dehydration is also usually observed due to electrolyte disturbance. In advanced stages, coma and death is witnessed.

**Diabetes Type II**

**Increased fatigue**: Due to inefficiency of the cell to metabolize glucose, reserve fat of body is metabolized to gain energy. When fat is broken down in the body, it uses more energy as compared to glucose; hence body goes in negative calorie effect, which results in fatigue.

**Polydipsia**: As the concentration of glucose increases in the blood, brain receives signal for diluting it and, in its counteraction we feel thirsty.

**Polyuria**: Increase in urine production is due to excess glucose present in body. Body gets rid of the extra sugar in the blood by excreting it through urine. This leads to dehydration because along with the sugar, a large amount of water is excreted out of the body.

**Polyphagia**: The hormone insulin is also responsible for stimulating hunger. In order to cope up with high sugar levels in blood, body produces **insulin** which leads to increased hunger.
Weight fluctuation: Factors like loss of water (polyuria), glucosuria, metabolism of body fat and protein may lead to weight loss. Few cases may show weight gain due to increased appetite.

Blurry vision: Hyperosmolar hyperglycemia nonketotic syndrome is the condition when body fluid is pulled out of tissues including lenses of the eye, which affects its ability to focus, resulting blurry vision.

Irritability: It is a sign of high blood sugar because of the inefficient glucose supply to the brain and other body organs, which make us, feel tired and uneasy.

Infections: The body gives few signals whenever there is fluctuation in blood sugar (due to suppression of immune system) by frequent skin infections like fungal or bacterial or urinary tract infection.

Poor wound healing: High blood sugar resists the flourishing of white blood cell which are responsible for body immune system. When these cells do not function accordingly, wound healing is not at good pace. Secondly, long standing diabetes leads to thickening of blood vessels which affect proper circulation of blood in different body parts.
Symptoms of Diabetes and How it affects Human Body

Symptoms are the complaints of disease which are felt by the patient themselves. Diabetes is of two types which exhibit delicate primary symptoms. Both type I and type II diabetes have similar symptoms owing to their high blood sugar levels and defective insulin metabolism. If diabetes is treated at the earliest then these symptoms can be annihilated without any complications.

Symptoms of Diabetes Type I: The primary symptoms exhibited in Type I diabetes are nausea and vomiting. These symptoms are ketoacidosis which leads to breaking down of energy giving muscles and tissues, thus resulting in loss of weight. This leads to severe electrolyte disturbances and dehydration which may have a poor prognosis leading to coma and death.

Symptoms of Diabetes Type II: The major symptoms exhibited by a Type II diabetes patient are polydipsia, polyuria, polyphagia, blurry vision, fatigue, irritability. Polydipsia is a condition of increased thirst resulting from dilution of blood caused by hormonal imbalance. In order to remove the excess blood sugar which is excreted through urine, large amount of water is also excreted along with the excess sugar which is known as polyuria. Excess of insulin is secreted by the body for metabolism of excess blood sugar which results in extreme hunger known as polyphagia. The combination of the effects of polyphagia, polyuria and polydipsia result in severe weight fluctuation. Similar to Type I diabetes, muscle and fat tissues
are broken down for production of energy. This results in improper overall body metabolism and causes fatigue.

**Effect of Diabetes on blood and circulatory system:** Diabetes patients also exhibit a defective blood metabolism which is a result of excessive blood sugar. This results in severe hormonal imbalance and also leads to defective formation of various blood components. Diabetes also results in poor blood circulation to various parts which may result in blurred vision, and aching pain.

**Diabetes symptoms as autoimmune disorders:** Various skin, genito-urinary tract and respiratory complaints occur as a result of autoimmune infections. Defective formation of various blood components like White blood cells and platelets result in poor blood composition. This may result in complications like poor wound healing and easy susceptibility to injuries. Few Complications may arise if not annihilated at the earliest. They may result in blindness, cataract, gangrene, diabetic nephropathy, diabetic neuropathy, and diabetic foot.  

**Status of Health Related Physical Fitness in Diabetics**

The concept of Health related physical fitness has been evolved by AAHPERD (American Alliance for Health, Physical Education, Recreation and Dance) during 1975 because AAHPERD Youth Fitness Test did not place enough emphasis on the health related aspects of physical fitness. A
Joint committee AAHPERD and ARAPCS (Association for Research and Professional Councils and Societies) in 1975 recommended that a physical fitness test should meet the following criteria:

That it measures an area which extends from severely limited dysfunction to high levels of functional capacity. That it can be improved with appropriate physical activity. That its changes in functional capacity are accurately reflected by changes in test scores.

The joint committee’s recommendations, consisting of the fundamental components of health related fitness, were forwarded to the AAHPERD Board of Governors and in late summer, 1977, AAHPERD president, LeRoy Walker, appointed an AAHPERD Task Force on Youth Fitness. The Task Force was charged with following on the joint committee’s recommendations and achieving a revision of the Youth Fitness Test. Test Force members were Steven Blair, Harold B. Falls (Chair), B. Don Franks, Andrew S. Jackson, Michael L. Pollock, and Margaret J. Safrit, where Raymond A. Ciszek served as AAHPERD Staff Liaison.

However, the Task force was active for three years. Its work culminated in the publication of the Health Related Physical Fitness Test Manual in 1980. The AAHPERD Youth Fitness Test was not revised. Although the Task Force recommended that the Health Related Physical Fitness Test replace the Youth Fitness Test, the AAHPERD Board of
Governors made a decision that the two tests would co-exist—at least for a limited evaluation period.

In fact, the responses to the Health Related Physical Fitness Test have varied since publication of the test manual in 1980. Even some national organizations have been reluctant to accept the concept that health related physical fitness is of primary importance for citizens. On the other hand, other groups, many state level organizations. Individuals have enthusiastically endorsed the new test and moved forward with its promotion and use. Illinois, for example, has developed an outstanding programme to provide workshops so that school personnel can learn about the concepts of health related fitness and the techniques of using the test. The test was included as one of the instructional modules in the 1982 by Post Cereals Forums on youth fitness. The University of Wisconsin, in a project by Margaret J. Safrit, has developed an instrument for evaluation the use of the test. The test has been adopted for use in the Boys Clubs of America Super-Fit All Stars programme.

The 1980 version of the AAHPERD Health Related Physical Fitness Test was not the final answer, nor was it purported to be. Early in its deliberations, the Task Force recognized the need for much additional research in this area. The concept of a technical manual to accompany the test manual was conceived in response to that perception. The Task Force realized that the mere act of publication 9th the new test would stimulate research. Indeed, various individuals and groups have undertaken a
significant number of studies in the three ensuing years. However, more impetus was then felt necessary. The Task Force anticipates that publication of this Technical Manual would more clearly identify needed areas for research for the many investigators who might potentially conduct research on health related physical fitness.

In fact, publication of the Technical Manual represents a milestone of sorts. Physical fitness tests published in the past have not had an accompanying technical manual, even though provision of such information part of the total test development process. However the test manual of Health Related Physical Fitness Test contains the following information:

The rationale underlying the health related physical fitness approach: The rationale for selection of the items included in the test battery;

Modern medicine system suggests proper exercise, diet and lifestyle for management of diabetes, because excess blood glucose harms the functioning of almost all the major organs in our body. Thus, overall health status of diabetics is gradually decreased. Since health and fitness are the relative terms, it is assumed that overall status of health related fitness is questionable in diabetes. This status can be evaluated by the AAHPERD’s (American Alliance of Health, Physical Education, Recreation and Dance) Health Related Physical Fitness Test, which was developed in 1980.
The manual (AAHPERD 1980) includes the test items and norms and a chapter on the general principles of exercise prescription. This allows the teacher to diagnose a person’s weaknesses and to provide a sound, individualized physical fitness program. This is, in fact, needed for patients of diabetes. Therefore, attributes of *health related physical fitness* has been considered in this study.¹³

**Rationale of Yoga for Health Related Physical Fitness in Diabetics**

Indian society, today, healthy life-style has become a very significant aspect of human life. In fact, health and fitness are the outcome of systematic practice of physical exercises.

Various research reports (Berlin and Colditz¹⁴, 1990, Lauer *et al.*,¹⁵ 1975, Paffenbarger *et al.*,¹⁶ 1986, Pate and Shephard¹⁷, 1989, Powell, *et al.*,¹⁸ 1987) have revealed that sedentary behaviour and physical inactivity are prominent seen among the people, which are the major risk factors of cardio-vascular diseases, obesity, serum cholesterol, blood pressure etcetera which promote premature mortality. These results indicate that our modern civilization has provided the discomfort physically, mentally and socially. Such discomfort of our life situations produces tremendous stress, anxiety, depression etcetera which in turn lead towards the sufferings from various newer health problems including diabetes. It appears from the data of current literature that the health status has been remarkably declined in diabetics.
The components of yoga for diabetics may be as follows

Asana

A series of asanas is to be practiced in the treatment of diabetes. These asanas adjust the function of the organs involved by regulating nervous impulses and blood flow to the glandular nervous impulses and blood flow to the glandular areas and by gently massaging all the glands and organs.

Kriya

Kriya is to be practiced in the treatment of diabetes. This purificatory process adjust the function of the organs involved by regulating nervous impulses and blood flow to the glandular nervous impulses and blood flow to the glandular areas and by gently massaging all the glands and organs.

Pranayama

Pranayama controls the body’s energy, allowing vital forces to flow to those areas that require extra energy. The brain, pancreas and other organs can then be revitalized consciously and systematically.
Meditation

The mind, through the nervous system, controls every action and reaction that occurs in the human body. It keeps a record of everything that a person and his body have undergone in the past and relates it to the decisions which rule every action that a person makes, whether voluntary or involuntary. This control extends from the unconscious and automatic control of the organs and muscles right up to the decisions that are made with the conscious intellectual mind. Every person’s whole existence is based upon the correct function of the nervous system.

The science of yoga holds that the nervous system (and the body that it rules) can be brought under a high degree of control and can be made to operate with the greatest possible degree of efficiency through the practice of meditation. This ancient theory has been bolstered by scientific research done in India, Europe and the United States. The bulk of this research has shown conclusively that the daily practice of meditation brings about harmonious changes in the physical organism.

In regard to diabetes, meditation practices have been shown definitely to help the endocrine glands through relaxation of the sympathetic nervous system arising from practices such as ajapa japa. Regulation of the anterior pituitary hormones, which are under the direct control of the hypothalamus, is greatly affected by yoga nidra. Also, a general increase in mental efficiency is brought about.
An estimated 30 million persons in the South-East Asia region are affected at present. It is estimated that by the year 2025 there will be nearly 80 million diabetes in this region. The highest among World Health Organization regions. In addition, in non-insulin dependent diabetes, which is rather silent, chronic, often unidentified killer most of among the adult population. Of the estimated 27,000 death of diabetic children aged 2-14 years worldwide in 1990, almost 45 percent (12,000) occurred in India alone.

**Objectives of the problem**

This study was conducted with the following objectives:

- To evaluate health related physical fitness status of the diabetic patients.
- To impart existed medical treatment to the diabetes patients and also to execute training programme of Indian traditional exercises to them.
- To compare how the selected exercises and existed medical treatment can contribute to improve health related physical fitness of the diabetic patients.

This study was conducted with a view to evaluate the efficacy of yogic practice or aerobic exercise on diabetic patients.
Statement of the Problem

Diabetes is an “Iceberg”. According to recent estimates the prevalence of diabetes mellitus in adults was around 4% world wide, and the means that over 143 million persons are now affected. It is projected that the disease prevalence will be 5.4% by the year 2025 with global burden of disease is projected to occur in the developing countries. The rising prevalence of diabetes in developing countries is closely associated with industrialization and socio-economic development. The major determinants for projected increase in the number of diabetics in these countries are: population growth, age structure, and urbanization. Diabetes will increasingly concentrate in the urban areas. Important differences are observed in age structure of diabetic population between developed and developing countries. Whereas in the developed world, the majority of diabetes are aged 65 years and above, it was 45-65 years in the developing world. This means, that in developing countries the majority of diabetic patients acquire the condition during the most productive period of their lives. This will have major implications with respect to health care needs. Diabetes mellitus a chronic disease once thought to be uncommon in the developing world has now emerged as an important public health problem in Asia. An estimated 30 million persons in the South-East Asia region are affected at present. It is estimated that by the year 2025 there will be nearly 80 million diabetes in this region. The highest among World Health Organization regions. In addition, in non-insulin dependent diabetes, which is rather silent, chronic, often unidentified killer most of among the adult
population. Of the estimated 27,000 death of diabetic children aged 2-14 years world wide in 1990, almost 45 percent (12,000) occurred in India alone.

As a result the patients suffer with a great loss in health-related physical fitness. It is, therefore, thought that the ancient traditional exercises are useful in treating diabetes being exhibited through improvement in health related physical fitness. The purpose of this study was to determine the *Effect of Indian traditional exercises on health related physical fitness on diabetic patients*.

As a sub-problem the scholar has made an attempt to determine the effect of selected yogic practices (The Indian traditional exercises) and selected aerobic exercises on selected health related physical fitness tests, selected physiological variables, and on selected lipid profiles. Based on the available literature on diabetes, it is evident that the selected subjects were suffering from diabetes mellitus, hence the influence of selected yogic practices and selected aerobic exercises will have an impact on the selected health related physical fitness, physiological and lipids profiles.
Hypotheses

On the basis of literature available so far, the researcher formulated the following hypotheses:

H₁: The separate training programmes of Yoga (Indian traditional exercises), anti-diabetic drugs and Aerobics, anti-diabetic drugs would be effective in improving the health related physical fitness and associated selected variables of the subjects suffering from diabetes mellitus.

H₂: The existed conventional medical treatment procedure (anti-diabetic drugs) plus diet would also improve the health related physical fitness and associated selected variables of the subjects suffering from diabetes mellitus.

Delimitation

The study was delimited to the following aspects:

1. The subjects were confined to men suffering from diabetes mellitus as i.e., assessed by medical diagnosis.
2. The subject’s age ranged from 40 to 65 years.
3. The experimental training included aerobic exercises and yoga practices, which were imparted with an intervention of six weeks and six weeks follow up.
4. On purposive sampling 60 male diabetes mellitus were selected from a random survey employed. With the assistance of a diabetologist men (patients) who volunteered were selected and at the same time men (patients) undergoing intensive treatment with life saving medicines were excluded.

5. The subjects suffering from diabetes mellitus and undergoing intensive treatment with life saving medicines were excluded from this study.

Limitations

The followings were the limitations of the study which need to be recognized while interpreting and generalizing the results:

1. Meteorological variations such as air, temperature, atmospheric pressure, relative humidity etceteras during the testing periods were not considered and their possible influence was common for all the different experimental and control groups.

2. The subjects living conditions, lifestyle, diet, personal habits, family, and history was not taken into consideration for this study.

3. The researcher could not control the subjects’ routine work, was considered as a drawback of the study.

4. The researcher could not measure certain variables such as functions of brain or the eye- due to paucity of fund.
5. The psychological aspects are important to bring changes in the subjects from the investigation; however the researcher did not include these Psychological variables due to the problems arising of handling multiple variables at a time.

OPERATIONAL DEFINITIONS AND EXPLANATION OF IMPORTANT TERMS

Diabetes mellitus

Diabetes mellitus is now seen as a heterogeneous group of disease, characterized by a state of chronic hyperglycemia, resulting from a diversity of antilogies, environmental and genetic, acting jointly. The underlying cause of diabetes is the defective production or action of insulin, a hormone that controls glucose, fat and amino acid metabolism. Characteristically, diabetes is a long-term disease with variable clinical manifestations and progression. Chronic hyperglycemia, from whatever cause, leads to a number of complications cardiovascular, renal, neurological, ocular and others such as undercurrent infections.

Insulin Dependent Diabetes Mellitus is the most severe form of the disease its origin abrupt and is usually seen in individual less than 30 years is lethal unless promptly diagnosed and treated.
Non-Insulin Dependent Diabetes Mellitus is much more common than Insulin Dependent Diabetes Mellitus. It is often by chance. It is typically gradual in onset and occurs middle-aged and elderly, frequently mild, slow to the compatible with long survival with adequate treatment picture is usually complicated by the presence of processes.

A metabolic disease resulting from insulin deficiency; characterized by a failure in glucose transport from the blood into cells at normal glucose concentration, with the result excess sugar appears in the blood and urine associated with thirst and loss of body weight; more common than diabetes insipidus.19

A metabolic disease resulting from insulin deficiency; Characterized by a failure in glucose transport from the blood into cells at normal glucose concentrations.20

Health – Related Physical Fitness (HRPF)

Physical fitness is an ability to carry out daily tasks with vigor and alertness, without undue fatigue, with ample energy to enjoy leisure time pursuits, and to meet unforeseen emergencies. However, a person having good level of physical fitness may not have a good health. Therefore, AAHPERD (American Alliance of Health, Physical Education, Recreation and Dance) developed the concept of Health Related Physical Fitness that means a state of physical fitness which have favourable relationship one’s
good health. AAHPERD identified four important attributes of health related physical fitness viz., cardiovascular efficiency, abdominal muscles strength and endurance, flexibility and body fat percentage.

Thus, health related physical fitness is a scientific body of knowledge that links the positive effects of regular, vigorous exercises with the prevention of degenerative disease.\textsuperscript{21}

That portion of physical fitness directed toward the prevention of or rehabilitation from disease as well as the development of a high level of functional capacity for the necessary and discretionary life tasks.\textsuperscript{22}

**Indian Traditional Exercises**

These exercises include Asana, Breathing awareness (Pranayama), Passive stretching exercises; Progressive relaxation exercises etceteras as referred in Indian Traditional Texts.

**Cardio-vascular Endurance**

The ability to perform muscular work at sub maximal level by moderate contractions for a long time is known as cardio-vascular endurance.
Cardiovascular Endurance - the ability of the heart to provide oxygen to muscles during physical activity for a prolonged period of time.

Cardiovascular Endurance is the ability of the heart, blood vessels, and lungs to supply oxygen to working muscles. To improve your cardio fitness you need to move, and move a lot. The more you move, and the faster you move, the greater the improvement will be on your cardiovascular system. Moving can include jogging, walking, swimming, cycling, rowing, climbing stairs, cardio machines such as elliptical, hiking, etc. The only limit is your imagination.23

Cardiovascular Endurance: The ability of the heart, blood vessels, and lungs to supply oxygen to working muscles during physical activity for a prolonged period of time.24

Cardiovascular endurance is the ability of the heart, lungs and blood vessels to deliver oxygen to working muscles and tissues, as well as the ability of those muscles and tissues to utilize that oxygen.

Cardiovascular endurance is also frequently called cardio-respiratory endurance, cardiovascular fitness, aerobic capacity, and aerobic fitness or is sometimes more broadly termed “endurance” — although endurance may also refer to the ability of the muscle to do repeated work without fatigue. It is also one of the five components of physical fitness.25
Flexibility

Flexibility can be defined as the ability to perform movement with greater range of motion or large amplitude. It is controlled partly by energy liberation process of the body and partly by energy liberation process of the body and partly by coordinate processes of central nervous system.

Flexibility is the ability of a point to move through an entire range of motion, without hindrance.

The range of movement in a joint or sequence of joint is known as flexibility.

Flexibility (anatomy), the range of motion of a joint, which may be increased by stretching (example That dancer has much more flexibility than many others.)

Flexibility is defined by Gummerson as "the absolute range of movement in a joint or series of joints that is attainable in a momentary effort with the help of a partner or a piece of equipment." This definition tells us that flexibility is not something general but is specific to a particular joint or set of joints. In other words, it is a myth that some people are innately flexible throughout their entire body. Being flexible in one particular area or joint does not necessarily imply being flexible in another. Being "loose" in the upper body does not mean you will have a "loose"
lower body. Furthermore, according to SynerStretch, flexibility in a joint is also "specific to the action performed at the joint (the ability to do front splits doesn't imply the ability to do side splits even though both actions occur at the hip)."\textsuperscript{27}

Flexibility refers to the absolute range of movement in a joint or series of joints that is attainable in a momentary effort with the help of a partner or a piece of equipment. Flexibility in some joints can be increased to a certain degree by stretching.

Flexibility has long been underestimated and perhaps overlooked by health-care professionals. Quality of life is enhanced by improving and maintaining a good range of motion in the joints. Overall flexibility should be developed with specific joint range of motion needs in mind as the individual joints vary from one to another.

Many factors are taken into account when establishing personal flexibility: joint structure, ligaments, tendons, muscles, skin, tissue injury, fat (or adipose) tissue, body temperature, age and gender all influence an individual's range of motion about a joint. Achieving flexibility is an individual accomplishment.\textsuperscript{28}
Muscular strength and muscular endurance are defined generally as the ability of the muscles to generate force. Even though muscular strength and muscular endurance are related, there is a basic difference between the two. Strength is defined as the ability to exert maximum force against resistance. Endurance is the ability of a muscle to exert sub maximal force repeatedly over a period of time. Muscular endurance depends to a large degree on muscular strength and to a lesser degree on cardio-vascular endurance. An example of muscular strength is lifting a heavy weight 10 times, while an example of muscular endurance is lifting a lighter weight 100 times.29

Testing the abdominal strength and abdominal endurance is important because it is an indicator of core strength and, thus the core stability and support of lower back.

The abdominal strength tests are intended to test the abdominal muscles ability to function optimally and hold a correct position under increasing difficulty. The abdominal endurance tests are intended to test the ability of the abdominal muscles to perform repeated abdominal curls in a set time (60 seconds) or a set rate.30
Maximal work ability of abdominal muscles at a stretch for one minute, as measured by modified Sit Ups, signifies abdominal muscle strength and endurance.

**Body Fat**

Adipose tissue is derived from lipoblasts. Its main role is to store energy in the form of fat, although it also cushions and insulates the body. Obesity or being overweight in humans and most animals does not depend on body weight but on the amount of body fat specifically, adipose tissue. Two types of adipose tissue exist: white adipose tissue (WAT) and brown adipose tissue (BAT). Adipose tissue also serves as an important endocrine organ by producing hormones such as leptin, resistin and the cytokine TNFα. The formation of adipose tissue appears to be controlled by the adipose gene. Adipose tissue was first identified by the Swiss naturalist Conrad Gessner in 1551.  

It is the body mass that is not composed of lean muscle, water, bones or vital organs.

Tissue made up of billions of cells filled with varying amounts of triglyceride. If triglyceride is added to or removed from a fat cell, the cell will increase in size or shrink accordingly.
Body fat is a compound comprised of glycerol - a substance formed in fatty acids - and fatty acids which is required as a concentrated energy source for our muscles. Fat is a storage substance for the body's extra calories and it fills fat cells (adipose tissue) that help insulate the body. When the body has used up the calories from carbohydrates it begins to depend on the calories from fat.\textsuperscript{34}

Body fat is essential for good health. However, excess accumulation of fat in the body is harmful and causes mainly cardiac problems. The state of excessive body fat in body is known as obesity. Freedom from Obesity is measured by finding body fat content with respect to ones body weight.

**Pulse Rate**

The rate of the pulse as observed in an artery; recorded as beats per minute.\textsuperscript{35}

The rate of the pulse as observed in an artery, expressed as beats per minute.\textsuperscript{36}

The rate at which the heart beats; usually measured to obtain a quick evaluation of a person's health.\textsuperscript{37}
Diastolic Pressure

Lowest pressure to which blood pressure falls between contractions of the ventricles. 38

Systolic pressure

(Science: cardiology, physiology) The pressure exerted on the walls of the arteries during the contraction phase of the heart. Considered abnormally elevated if consistently over 150 mm/Hg. Systolic blood pressure varies with age, sex, size and relative condition. 39

"Systolic" comes from the Greek systole meaning "a drawing together or a contraction." The term has been in use since the 16th century to denote the contraction of the heart muscle The blood pressure when the heart is contracting. It is specifically the maximum arterial pressure during contraction of the left ventricle of the heart. The time at which ventricular contraction occurs is called systole. In a blood pressure reading, the systolic pressure is typically the first number recorded. For example, with a blood pressure of 120/80 ("120 over 80"), the systolic pressure is 120. By "120" is meant 120 mm / Hg (millimeters of mercury). A systolic murmur is a heart murmur heard during systole, the time the heart contracts, between the normal first and second heart sounds. 40
**Cholesterol**

Cholesterol is the third major lipid in membranes. With four fused rings and a c8 branched hydrocarbon chain attached to the D ring at position 17, cholesterol is a compact, rigid, hydrophobic molecule. It also has a polar hydroxyl group at c-3. Cholesterol alters the fluidity of membranes and participates in controlling the microstructure of plasma members. 41

A lipid molecule with a characteristic four – ringed steroid structure (called a sterane nucleus): occurs in the plasma membranes of animal cells, but not in plants, precursor of the animal steroid hormones and bile acids. 42

**Uric Acid**

Uric acid is a waste product normally present in the blood as a result of the breakdown of purines. Excessive amounts of uric acid can cause crystals to form in the joints and cause gout.  

Uric acid is produced by xanthine oxidase from xanthine and hypoxanthine, which in turn are produced from purine. Uric acid is more toxic to tissues than either xanthine or hypoxanthine.  

In humans and higher primates, uric acid is the final oxidation (breakdown) product of purine metabolism and is excreted in urine. In most other mammals, the enzyme uricase further oxidizes uric acid to allantoin.
The loss of uricase in higher primates parallels the similar loss of the ability to synthesize ascorbic acid. Both uric acid and ascorbic acid are strong reducing agents (electron donors) and potent antioxidants. In humans, over half the antioxidant capacity of blood plasma comes from uric acid.

The Dalmatian dog has a genetic defect in uric acid uptake by the liver, resulting in decreased conversion to allantoin, so this breed excretes uric acid, and not allantoin, in the urine.

In birds and reptiles, and in some desert dwelling mammals (e.g., kangaroo rat), uric acid also is the end product of purine metabolism, but it is excreted in feces as a dry mass. This involves a complex metabolic pathway that is energetically costly in comparison to processing of other nitrogenous wastes such as urea (from urea cycle) or ammonia, but has the advantage of reducing water loss.

In humans, about 70% of daily uric acid disposal occurs via the kidneys, and in 5-25% of humans impaired renal (kidney) excretion leads to hyperuricemia.

Uric acid is a waste product normally present in the blood as a result of the breakdown of purines. Excessive amounts of uric acid can cause crystals to form in the joints and cause gout.43
In humans and higher primates, Uric acid is excreted as such in the urine, and it is very poorly soluble in aqueous solutions, causing it to crystallize when concentrations of the compound in the urine are abnormally high. This leads to crystalluria (excretion of crystals in urine), hematuria (blood in the urine), infection, or urinary tract stones. Other mammals do not experience these problems, as they express an enzyme, uricase, which catalyzes the conversion of uric acid to allantoin, which is highly soluble. A nonprimate exception is the Dalmatian dog, in which high rates of excretion of uric acid are a consequence of defective renal tubular reabsorption; thus, the uric acid is excreted before it can be oxidized. In birds and reptiles, uric acid is an excretory end product of the metabolism of proteins.\textsuperscript{44}

Uric Acid loses a prolong at physiological PH to form urate. In human beings, urate is the final product of urine degradation and is excreted in the urine. High serum levels of urate induce gout, a disease in which salts of urate crystallize and damage joints and kidneys. Allopurinol, an inhibitor of xanthine oxidase, used to treat gout in some cases.\textsuperscript{45}

An organic compound belonging to the purine group; a colorless crystalline solid that is slightly soluble in water; occurs in very small amounts in the urine of some animals (reptiles and aves) as breakdown product of amino acids and nucleic acid; being quite insoluble in water, it is thus nontoxic when released during embryonic development within the egg; also permits the removal of nitrogen with a minimum of water loss and is
eliminated as a thick paste or even dry pellets, sodium and potassium salts of
the acid are deposited in the joints in cases of gout.46

Creatinine

Creatinine (from the Greek kreas, flesh) is a break-down product of
creatine phosphate in muscle, and is usually produced at a fairly constant
rate by the body (depending on muscle mass). Chemically, creatinine is a
spontaneously formed cyclic derivative of creatine. Creatinine is chiefly
filtered out of the blood by the kidneys, though a small amount is actively
secreted by the kidneys into the urine. There is little-to-no tubular
reabsorption of creatinine. If the filtering of the kidney is deficient, blood
levels rise. Therefore, creatinine levels in blood and urine may be used to
calculate the creatinine clearance (CrCl), which reflects the glomerular
filtration rate (GFR). The GFR is clinically important because it is a
measurement of renal function. However, in cases of severe renal
dysfunction, the creatinine clearance rate will be "overestimated" because
the active secretion of creatinine will account for a larger fraction of the total
creatinine cleared. Ketoacids, cimetidine and trimethoprim reduce creatinine
tubular secretion and therefore increase the accuracy of the GFR estimate,
particularly in severe renal dysfunction. (In the absence of secretion,
creatinine behaves like insulin.)17

Creatinine is a chemical waste molecule that is generated from muscle
metabolism. Creatinine is produced from creatine, a molecule of major
importance for energy production in muscles. Approximately 2% of the body's creatine is converted to creatinine every day. Creatinine is transported through the bloodstream to the kidneys. The kidneys filter out most of the creatinine and dispose of it in the urine.

Because the muscle mass in the body is relatively constant from day to day, the creatinine level in the blood normally remains essentially unchanged on a daily basis.48

Creatinine: A chemical waste molecule that is generated from muscle metabolism. Creatinine is produced from creatine, a molecule of major importance for energy production in muscles. Approximately 2% of the body's creatine is converted to creatinine every day. Creatinine is transported through the bloodstream to the kidneys. The kidneys filter out most of the creatinine and dispose of it in the urine.

Although it is a waste, creatinine serves a vital diagnostic function. Creatinine has been found to be a fairly reliable indicator of kidney function. As the kidneys become impaired the creatinine will rise. Abnormally high levels of creatinine thus warn of possible malfunction or failure of the kidneys, sometimes even before a patient reports any symptoms. It is for this reason that standard blood and urine tests routinely check the amount of creatinine in the blood.
Normal levels of creatinine in the blood are approximately 0.6 to 1.2 milligrams (mg) per deciliter (dl) in adult males and 0.5 to 1.1 milligrams per deciliter in adult females. (In the metric system, a milligram is a unit of weight equal to one-thousandth of a gram, and a deciliter is a unit of volume equal to one-tenth of a liter.) Muscular young or middle-aged adults may have more creatinine in their blood than the norm for the general population. Elderly persons, on the other hand, may have less creatinine in their blood than the norm. Infants have normal levels of about 0.2 or more, depending on their muscle development. A person with only one kidney may have a normal level of about 1.8 or 1.9. Creatinine levels that reach 2.0 or more in babies and 10.0 or more in adults may indicate the need for a dialysis machine to remove wastes from the blood. Certain drugs can sometimes cause abnormally elevated creatinine levels.  

Urinary amino acid concentration is usually expressed as Umol/g creatine. Creatinine is an amino acid derived from muscle, and is excreted in relatively constant amounts per unit body mass per day. Thus, the creatine concentration in urine, normally about 1mg/ml. can be used to correct for urine dilution. The most abundant amino acid in urine is glycine, which is present as 400-2000 Ug/g creatinine.  

Storage of high-energy phosphate, particularly in cardiac and skeletal muscle, occurs by transfer of the phosphate group from ATP to creatine. Creatine is synthesized by transfer of the guanidinum group of arginine to glycine, followed by addition of a methyl group from adowlet. The amount
of creatine in the body is related to muscle mass, and a certain percentage of this undergoes turnover each day. About 1-2% of preexisting creatine phosphate is cycled nonenzymatically to creatine and excreted in urine, and new creatine is synthesized to replace it. The amount of creatinine excreted by an individual is therefore constant from day to day. When a 24-hour urine sample is requested, the amount of creatinine output in the sample can be used to determine whether the sample truly represents a whole day's urinary.

The nitrogenous waste material of muscle creatine.

Triglyceride

Triglycerides are a form of fat carried through the bloodstream. Most of your body's fat is in the form of triglycerides stored in fat tissue. Only a small portion of your triglycerides is found in the bloodstream. High blood triglyceride levels alone do not necessarily cause atherosclerosis (the buildup of cholesterol and fat in the walls of arteries). But some lipoproteins that are rich in triglycerides also contain cholesterol, which causes atherosclerosis in some people with high triglycerides, and high triglycerides are often accompanied by other factors (such as low HDL or a tendency toward diabetes) that raise heart disease risk. So high triglycerides may be a sign of a lipoprotein problem that contributes to heart disease.
<table>
<thead>
<tr>
<th>Triglyceride Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
</tr>
<tr>
<td>Borderline-high</td>
</tr>
<tr>
<td>High</td>
</tr>
<tr>
<td>Very High</td>
</tr>
</tbody>
</table>

An ester of glycerol with three molecules of fatty acids which may be saturated (in animal fats) or unsaturated (in vegetable oils) also called neutral fat or triacylglycerol.\textsuperscript{54}

An ester of glycerol with three molecules of fatty acid also called neutral fat.\textsuperscript{55}

An ester formed between glycerol and three fatty acids.\textsuperscript{56}

Cholesterol is a lipid, waxy steroid found in the cell membranes and transported in the blood plasma of all animals. It is an essential component of mammalian cell membranes where it is required to establish proper membrane permeability and fluidity. Cholesterol is the principal sterol synthesized by animals, but small quantities are synthesized in other eukaryotes, such as plants and fungi. It is almost completely absent among prokaryotes, which include bacteria. Cholesterol is classified as a sterol. Since cholesterol is essential for life, it is primarily synthesized de novo within the body. However high levels in blood circulation, depending on how transported within lipoproteins, are strongly associated with progression of atherosclerosis. For a person of about 150 pounds (68 kg), typical total
body cholesterol synthesis is about 1 g (1,000 mg) per day (automatically adjusting for amount of dietary intake) and total body content is about 35 gm. Typical daily additional dietary intake, in the United States and societies with similar dietary patterns, is 200–300 mg. Cholesterol is recycled. It is excreted by the liver via the bile into the digestive tract. Typically about 50% of the excreted cholesterol is reabsorbed by the small bowel back into the bloodstream. Intestinal tract absorption is highly selective for cholesterol, excreting plant stanols and sterols (which promote atherosclerosis progression more than cholesterol), back into the intestinal lumen for elimination.

The name cholesterol originates from the Greek chole- (bile) and stereos (solid), and the chemical suffix -ol for an alcohol, as François Poulletier de la Salle first identified cholesterol in solid form in gallstones, in 1769. However, it was only in 1815 that chemist Eugène Chevreul named the compound "cholesterine".  

**Cholesterol**

Also called: HDL, Hypercholesterolemia, Hyperlipidemia, Hyperlipoproteinemia, LDL

Cholesterol is a waxy, fat-like substance that occurs naturally in all parts of the body. Your body needs some cholesterol to work properly. But if
You have too much in your blood, it can stick to the walls of your arteries. This is called plaque. Plaque can narrow your arteries or even block them.

High levels of cholesterol in the blood can increase your risk of heart disease. Your cholesterol levels tend to rise as you get older. There are usually no signs or symptoms that you have high blood cholesterol, but it can be detected with a blood test. You are likely to have high cholesterol if members of your family have it, if you are overweight or if you eat a lot of fatty foods.

You can lower your cholesterol by exercising more and eating more fruits and vegetables. You also may need to take medicine to lower your cholesterol.\textsuperscript{58}

**What is cholesterol?**

Cholesterol is an integral part of each cell in the body. It is a waxy substance made naturally in the body. Your body needs some cholesterol to work properly and it can make all it needs from some fats in the diet.

**What happens when there is too much of it?**

Cholesterol may cause problems if your body makes too much or if you consume too much in your food. The extra cholesterol can deposit in the arteries and lead to blocked arteries. If an artery that supplies blood to your
heart gets blocked, a heart attack occurs. If an artery that supplies blood to your brain gets blocked, a paralytic stroke occurs. Higher the cholesterol, greater is the risk of heart disease and stroke.

"GOOD" CHOLESTEROL AND "BAD" CHOLESTEROL

Not all cholesterol is harmful. There is a "bad" kind and a "good" kind. The "bad" kind is called LDL (Low-Density Lipoprotein) cholesterol, and the "good" kind is called HDL (High-Density Lipoprotein) cholesterol. The bad cholesterol tends to block the arteries, but the good kind helps to clean up this bad cholesterol inside the arteries.

Understanding the Cholesterol Levels

When you have your blood cholesterol checked, the laboratory will report on LDL cholesterol, HDL cholesterol and also triglycerides. Triglycerides are the most common fats in the diet and in the blood. If you have a high reading of LDL or triglycerides, or a low reading of HDL, you may have a higher risk of having heart disease. But whenever, doctors normally refer to "Cholesterol as being high", they mean that the "total" cholesterol is high, which is most often due to a high level of "bad" cholesterol.59

Cholesterol is a waxy fat that is present in all human beings. About 80 percent of the cholesterol in the body is manufactured by the liver. The rest
is consumed through cholesterol-rich foods such as meat, eggs and dairy products.

Cholesterol itself is vital for survival. However, it can also contribute to coronary artery disease. To understand how cholesterol is related to heart disease, it is necessary to understand how it is transported through the body. Cholesterol is carried in the bloodstream in specialized protein packages called lipoproteins. These are comprised of another building block called apolipoproteins.

A good analogy is to think of lipoproteins like vehicles on the road, while cholesterol represents the passengers. Some of the cars are sleek and fast, while others are cumbersome, large and slow. The nature of the lipoprotein package, or vehicles, ultimately determines what will happen to the cholesterol it carries. In some cases, excess cholesterol will be transported to the liver, where it is metabolized harmlessly. In other cases, excess cholesterol will penetrate the walls of arteries throughout the body, contributing to a disease called atherosclerosis.

Although there are many subclasses of lipoproteins, researchers generally focus on the following five types:

High-density lipoproteins (HDL), which transport cholesterol away from arteries and are protective.
Low-density lipoproteins (LDL), which can penetrate the arterial wall and deposit cholesterol within the artery, thus contributing to heart disease.

Very-low-density lipoproteins (VLDL), which are similar to LDLs, but can more easily penetrate the artery wall.

Intermediate-density lipoproteins. Like VLDLs, these also carry triglycerides and cholesterol.

Chylomicrons, which carry only a small percentage of cholesterol. Chylomicrons are mostly rich in another type of fat called triglycerides.

Many studies have shown that high levels of LDLs, IDLs and VLDLs are associated with increased risk of heart attack because these lipoproteins actually harm arteries. Conversely, higher levels of HDLs protect against heart attack because these lipoproteins remove potentially dangerous cholesterol from the blood stream. Thus, modern cholesterol management tends to focus on reducing LDLs while increasing HDLs. The National Cholesterol Education Program classifies cholesterol levels as follows (all measurements are in milligrams per deciliter):

- Total cholesterol levels less than 200 are desirable.
- Total cholesterol levels between 200 and 239 are borderline-high.
- Total cholesterol levels that are 240 or higher are high.
HDL levels of less than 40 for men and 50 for women are considered low, and levels of 60 or more are considered protective against heart disease.

HDL levels should be 40 or above (the American College of Cardiology recommends levels of 45 or above for women).

LDL levels should optimally be less than 100 (levels greater than 129 are considered borderline-high, and levels greater than 159 are considered high). Among some patients, physicians might aim for an even lower LDL target of 70.

Regular cholesterol screenings are important. The NCEP recommends that males and females 20 years of age and older have a cholesterol test every five years. Regular cholesterol screenings are particularly important for people who have risk factors such as diabetes, obesity or a family history of cardiovascular disease. Such higher-risk individuals, and people over age 65, may be screened more frequently.

In the event of high cholesterol or triglyceride levels, physicians may recommend lifestyle modifications along with cholesterol-lowering medications.
LIPOPROTEIN

A lipid - protein aggregate that serves to carry water – insoluble lipids in the blood. The protein component alone is an apolipoprotein. 61

A conjugated protein in which lipid molecules are the prosthetic groups; a protein – lipid complex that transports water – insoluble lipids in blood. 62

A lipid – protein conjugate that serves to carry water – insoluble lipids in the blood. The protein component alone is an apolipoprotein. 63

High-density lipoprotein

High-density lipoprotein (HDL) is one of the five major groups of lipoproteins (chylomicrons, VLDL, IDL, LDL, HDL) which enable lipids like cholesterol and triglycerides to be transported within the water based blood stream. In healthy individuals, about thirty percent of blood cholesterol is carried by HDL.

It is hypothesized that HDL can remove cholesterol from atheroma within arteries and transport it back to the liver for excretion or re-utilization which is the main reason why HDL-bound cholesterol is sometimes called "good cholesterol", or HDL-C. A high level of HDL-C seems to protect against cardiovascular diseases, and low HDL cholesterol levels (less than
40 mg/dL) increase the risk for heart disease. Cholesterol contained in HDL particles is considered beneficial for the cardiovascular health, in contrast to "bad" LDL cholesterol.64

High-density lipoproteins form a class of lipoproteins, varying somewhat in their size (8-11 mm in diameter) and contents that carry cholesterol from the body's tissues to the liver.

Because HDL can remove cholesterol from atheroma within arteries, and transport it back to the liver for excretion or re-utilization, they are seen as "good" lipoproteins.65

High density lipoproteins are the smallest and densest lipoproteins, and contain a high proportion of protein. They are synthesized in the liver as empty proteins and they pick up cholesterol and increase in size as they circulate through the bloodstream. Because HDL can remove cholesterol from the arteries, and transport it back to the liver for excretion, they are seen as "good" lipoproteins.66

**How the test is performed?**

A needle will be used to take a sample of blood from a vein, usually from the inside of the elbow or the back of the hand.
First, the area will be cleaned with a germ-killing product (antiseptic). An elastic band is placed around your upper arm to help the vein swell with blood, and the needle is inserted.

The needle is attached to an air-tight tube or syringe, which is used to collect the blood. During the procedure, the band is removed to restore circulation. Once the blood has been collected, the needle is removed, and the needle stick area is covered with a small bandage to stop any bleeding.

**How to prepare for the test?**

Do not eat anything from 9.00 a.m to 12’O clock before the commencement of the test.

**How the test will feel?**

When the needle is inserted to draw blood, some people feel moderate pain, while others feel only a prick or stinging sensation. Afterward, there may be some throbbing.

**Why the test is performed?**

This test is done to check the level of cholesterol in your blood and to see if you are at high risk of a heart attack, stroke, or other cardiovascular problem. Studies of both men and women have shown that the higher your
HDL, the lower your risk of coronary artery disease, thus HDL is sometimes referred to as "good" cholesterol.

The main function of HDL is to help soak up excess cholesterol from the walls of blood vessels and carry it to the liver, where it breaks down and is removed from the body in the bile.

The laboratory test for HDL actually measures the cholesterol part of HDL, not the actual amount of HDL in the blood.67

**Low-density lipoprotein**

Low-density lipoprotein (LDL) is a type of lipoprotein that transports cholesterol and triglycerides from the liver to peripheral tissues. LDL is one of the five major groups of lipoproteins; these groups include chylomicrons, very low-density lipoprotein (VLDL), intermediate-density lipoprotein (IDL), low-density lipoprotein, and high-density lipoprotein (HDL), although some alternative organizational schemes have been proposed. Like all lipoproteins, LDL enables fats and cholesterol to move within the water-based solution of the blood stream. LDL also regulates cholesterol synthesis at these sites. It is used medically as part of a cholesterol blood test, and since high levels of LDL cholesterol can signal medical problems like cardiovascular disease, it is sometimes called "bad cholesterol," (as opposed to HDL, which is frequently referred to as "good cholesterol" or "healthy cholesterol").68
LDL (low-density lipoprotein): A molecule that is a combination of lipid (fat) and protein. Lipoproteins are the form in which lipids are transported in the blood. Low-density lipoprotein (LDL) transports cholesterol from the liver to the tissues of the body. LDL cholesterol is therefore considered the "bad" cholesterol.

Low density lipoprotein (LDL) is the major cholesterol-carrying lipoprotein of plasma. The LDL receptor binds LDL and transports it into cells by endocytosis. In order to be internalised, the receptor-ligand complex must first cluster into clathrin-coated pits. Seven successive cysteine-rich repeats of about 40 amino acids are present in the N-terminal of this multi-domain membrane protein. The LDL receptor is closely related in structure to several other receptors, including LRP1, LRP1b, megalin/LRP2, VLDL receptor, lipoprotein receptor, MEGF7/LRP4, and LRP8/apolipoprotein E receptor2); these proteins participate in a wide range of physiological processes, including the regulation of lipid metabolism, protection against atherosclerosis, neurodevelopment, and transport of nutrients and vitamins.

The LDL receptor class A domain contains 6 disulphide-bound cysteines and a highly conserved cluster of negatively charged amino acids, of which many are clustered on one face of the module. In LDL receptors, the class A domains form the binding site for LDL and calcium. The acidic residues between the fourth and sixth cysteines are important for high--affinity binding of positively charged sequences in LDLR's ligands. The
repeat consists of a beta-hairpin structure followed by a series of beta turns. In the absence of calcium, LDL-A domains are unstructured; the bound calcium ion imparts structural integrity. Following these repeats is a 350 residue domain that resembles part of the epidermal growth factor (EGF) precursor. Numerous familial hypercholesterolemia mutations of the LDL receptor alter the calcium coordinating residue of LDL-A domains or other crucial scaffolding residues.\textsuperscript{70}

Low-density lipoprotein (LDL) refers to a class and range of lipoprotein particles, varying in their size (18-25 nm in diameter) and contents, which carry cholesterol in the blood and around the body, for use by cells. It is commonly referred to as "bad cholesterol" due to the link between high LDL levels and cardiovascular disease.\textsuperscript{71}

**Significance of the Study**

This study may help in the prevention and rehabilitation of the patients suffering from diabetes mellitus in enriching health related physical fitness.

The outcome of this research may contribute to upgrade the knowledge of medical science in favour of managing diabetes mellitus, keeping Indian traditional exercises as supportive means.
Modern rehabilitation procedure of diabetes mellitus requires a huge amount of financial involvement. On the contrary, Indian exercise system economical this in turn is easily accessible to the common people suffering from the diabetes mellitus.

Further, this study has significance and importance not only in medical education but also to the field of physical education and yoga.
REFERENCES


11. chinese-school.netfirms.com/diabetes-causes.html

12. diabetesinformationhub.com/SymptomsOfDiabetes.php


22http://www.gdn.edu/Faculty/jwhite/Exercise%20Physiology%20Terms.htm

23http://www.healthlessonsonline.com/cardiovascular-endurance/

24http://wiki.answers.com/Q/What_is_cardiovascular_endurance

http://en.wikipedia.org/wiki/Flexibility


http://en.wikipedia.org/wiki/Flexibility_(anatomy)

http://www.healthyschools.net/WellnessCenter/Library/fit_ex/fitness/def_b.htm

http://ezinearticles.com/?Abdominal-Muscles-Strength-Test-Using-7-Simple-Ab-Exercises&id=1043019

http://www.sueshealthcenter.com/diet_pills_glossary.html


http://highered.mcgraw-

http://weightloss.about.com/od/glossary/g/blfatdef.htm

http://www.biology-online.org/dictionary/Pulse_Rate
36 medical-dictionary.thefreedictionary.com/pulse+rate

37 http://www.thefreedictionary.com/pulse+rate

38 www.methodisthealth.com/tmhs/basic.do

39 http://www.biology-online.org/dictionary/Systolic_pressure

40 www.medterms.com/script/main/art.asp?articlekey=16163


43 arthritis.about.com/od/goutdiag/g/uricacid.htm


47 en.wikipedia.org/wiki/Creatinine

48 www.medicinenet.com/creatinine_blood_test/article.htm


53 www.nhlbisupport.com/chd1/tri.htm


57. en.wikipedia.org/wiki/Cholesterol


59. healthy-india.org/preventheart4.asp

60. yourtotalhealth.ivillage.com/cholesterol.html


64 en.wikipedia.org/wiki/High-density_lipoprotein

65 www.sciencedaily.com/articles/.../high_density_lipoprotein.htm

66 (from Wikipedia)


68 en.wikipedia.org/wiki/Low-density_lipoprotein

69 www.medterms.com/script/main/art.asp?articlekey=6232

70 www.ebi.ac.uk/interpro/IEntry?ac=IPR002172

71 www.ebi.ac.uk/interpro/IEntry?ac=IPR002172