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# UNIT 12 NUTRITIONAL MANAGEMENT OF METABOLIC DISEASES-I : DIABETES MELLITUS

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## Structure

- 12.1 Introduction
- 12.2 Diabetes Mellitus
  - 12.2.1 Prevalence of Diabetes Mellitus
  - 12.2.2 Classification and Etiology of Diabetes
  - 12.2.3 Factors Affecting Normal Blood Sugar Levels
  - 12.2.4 Metabolic Aberrations and Symptoms
  - 12.2.5 Diagnosis
  - 12.2.6 Complications of Diabetes
- 12.3 Management of Diabetes
  - 12.3.1 Management of Diet
  - 12.3.2 Food Exchange System
  - 12.3.3 Glycemic Index (GI)
  - 12.3.4 Sweeteners: Nutritive and Non-Nutritive Sweeteners
  - 12.3.5 Dietetic Foods
  - 12.3.6 Alcohol
  - 12.3.7 Beneficial Effect of Some Foods: Supportive Therapy
- 12.4 Exercise and Drugs
  - 12.4.1 Exercise
  - 12.4.2 Drugs and Insulin
- 12.5 Education
- 12.6 Prevention
- 12.6 Let Us Sum Up
- 12.7 Glossary
- 12.8 Answers to Check Your Progress Exercises

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## 12.1 INTRODUCTION

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You have already learnt about nutrition care for weight management (Unit 8) and nutritional management of cardiovascular diseases (Unit 9). In the Unit 12, we will learn about the nutritional management of diabetes mellitus which is an important metabolic disorder of public health significance.

Metabolism is a term that we must understand. It means the sum of physical and chemical changes taking place in living cells. It includes all reactions by which the body obtains energy from food and spends it. So when we say metabolic diseases, these diseases refer to *those disorders in which the various reactions in the cells are affected (production of energy or utilization of energy) due to abnormal production of one or more hormones, or a deficiency of an enzyme.*

The metabolic diseases that we will deal with are diabetes mellitus, gout and disorders due to inborn errors of metabolism such as phenylketonuria, tyrosinemia, maple syrup urine disease, homocystinuria and galactosemia. This unit will focus on diabetes mellitus while gout and disorders due to inborn errors of metabolism are covered in the next unit i.e. Unit 13.

in an inadequate utilization of the blood sugar. Hence, there is a rise in blood sugar levels. If the blood sugar rises above the level of 180 mg/100 ml in the blood, then the sugar is excreted in the urine also. Diabetes cannot be cured but changes in lifestyle, and diet and drugs can make an individual lead a normal life.

REMEMBER IN DIABETES THE BLOOD AND URINE SUGAR LEVELS ARE HIGH DUE TO INADEQUATE PRODUCTION OR LACK OF EFFECTIVE INSULIN. DIABETICS CAN LEAD A NORMAL LIFE IF LIFESTYLE, DIETARY CHANGES ARE MADE.

### 12.2.2 Classification and Etiology of Diabetes

Several forms of diabetes have been identified as a result of research and survey conducted world-wide. These forms of diabetes include:

- Type 1 - Insulin Dependent Diabetes Mellitus (IDDM)
- Type 2 - Non Insulin Dependent Diabetes Mellitus (NIDDM)
- Type 3 - Malnutrition Related Diabetes Mellitus (MRDM)
- Impaired Glucose Tolerance (IGT)
- Gestational Diabetes

Let us learn briefly about each one of these types.

- *Type 1 - Insulin Dependent Diabetes Mellitus (IDDM)*

Mostly children and adolescents suffer from this type of diabetes however, it may appear in adults and elderly too. In this, there is little or no production of insulin by  $\beta$ -cells of the pancreas. Hence the young individuals require daily insulin injections. If daily injection is not taken, there could be life threatening metabolic complications and the symptoms could be very severe. Since various types of insulins are available (short term and long term), the carbohydrate content of the diet has to be adjusted accordingly. More people are underweight in this type of diabetes.

#### *Type 2 - Non Insulin Dependent Diabetes Mellitus (NIDDM)*

Overweight and obese adults are generally afflicted by this type of diabetes. The insulin produced by the pancreas is normal or even high. The symptoms of the disease are gradual. The problem is caused by insulin resistance. Obesity is the main cause of insulin resistance weight reduction, diet and exercise can be helpful to decrease the insulin resistance. Anti-diabetic drugs can also be useful.

- *Type 3 - Malnutrition Related Diabetes Mellitus (MRDM)*

This type of diabetes has been categorized as a separate entity. It is often seen commonly in developing countries, India being one of them. It occurs in the young mostly between the ages of 15-30 years. People look thin, lean and malnourished. The reason for this type of diabetes is that the pancreas does not produce enough insulin (necrotic tissues on the pancreas) and hence these individuals require insulin. Very often hormonal disorders may occur. It has also been seen that when insulin is discontinued, the complications are lesser than type 1 diabetes.

- *Impaired Glucose Tolerance (IGT)*

Glucose tolerance is assessed by taking the fasting blood sugar value. An oral glucose load of 75 grams glucose is administered and blood sugar value checked again after  $1\frac{1}{2}$  - 2 hrs. The value of sugar obtained is checked against the normal or fasting value. If values are above normal, then we describe the condition as *impaired glucose tolerance*. In this type, the individuals are free from the symptoms of diabetes but they could develop diabetes at a later stage if they are unable to control the diet and avoid obesity. Regular exercise also helps in maintaining the blood sugar levels.

• *Gestational Diabetes*

When a pregnant woman develops diabetes, it is known as *gestational diabetes*. It occurs in only 1% of the pregnant women. Pregnant women who have a risk of diabetes because of family history or bad obstetrics history should be screened for diabetes. Pregnant mothers develop diabetes related complications and after delivery can also continue with the diabetic conditions.

Besides the types of diabetes discussed above, another form of diabetes namely maturity onset diabetes of the young (MODY) is being identified. *Maturity onset diabetes of the young (MODY)* refers to any of several rare *hereditary* forms of *diabetes mellitus* due to *dominantly inherited* defects of *insulin* secretion. As of now, six types have been enumerated, but more are likely to be added. MODY 2 and MODY 3 are the most common forms. The severity of the different types varies considerably, but most commonly MODY acts like a very mild version of *type I diabetes*, with continued partial insulin production and normal *insulin sensitivity*. Age of onset for MODY is usually 25 years or it may develop earlier.

Having reviewed the diabetes types, next we shall move on to the etiology of the disorder.

Etiology

The precise etiology of diabetes is not known but multiple factors contribute to the disorder. These are reviewed herewith.

*Type I Diabetes*: Factors contributing to the disease are both genetic and environmental. These are enumerated in Table 12.2.

**Table 12.2: Etiological factors**

1.	Genetic	There is, a familial tendency to develop Type-I diabetes. Altered frequency of certain (HLA) human lymphocyte antigen (usually a protein, foreign substance that produces antibodies) on chromosome 6, abnormal immune response, autoimmunity and islet cell antibodies are noted.
2.	Age	The disease can occur at younger age.
3.	Sex	In younger group males are prone, but females are afflicted in greater numbers.
4.	Dietary factors	Low intake of fibre in the diet is associated with diabetes, Excess food (especially refined food), causes an energy imbalance. May lead to obesity - a risk factor for diabetes. Over and under nutrition are important etiological factors.
5.	Infections	Viral infections such as measles and mumps can trigger abnormal auto immune response that destroy the $\beta$ -cells of pancreas which produce insulin.
6.	Increased catabolism	Excess breakdown of liver sugar (glycogen). Tissue protein and fat breakdown cause metabolic changes causing diabetes.
7.	Stress	Stress is a contributing factor in precipitating this disorder.

*Type II diabetes*: Besides some of the above genetic and environmental factors, imbalance of hormones can cause this type of diabetes many of these hormones may be insulin antagonist. These hormones include:

- **Growth Hormone:** About 1/3rd of diabetics have been shown to have excess growth hormone.
- **Adrenocortical Hormone:** Cortisol and corticosteroids lead to an increased protein breakdown and inhibit sugar utilization by the tissues, thus increasing blood sugar levels.
- **Adrenaline:** This hormone increases the breakdown of glycogen (the storage form of glucose) in the liver. It also suppresses the insulin secretion thus increasing the blood sugar level.
- **Thyroid hormone:** Excess thyroid hormone aggravates diabetes.
- Besides imbalance of hormones, diseases too could be an etiological factor,

**Diseases:** In aging, a very important cause of diabetes could be an underlying disease. Diabetes occurs secondary to some other disorders, which may lead to insulin insensitivity or impaired secretion of insulin. These diseases are pancreatitis (inflammation of pancreas), carcinoma of pancreas, pancreatectomy (surgery of pancreatic duct). Mostly type II diabetes shows insulin resistance.

**Gestational Diabetes** is the temporary diabetes seen in pregnancy. This is due to increased production of hormones which are antagonistic to insulin production.

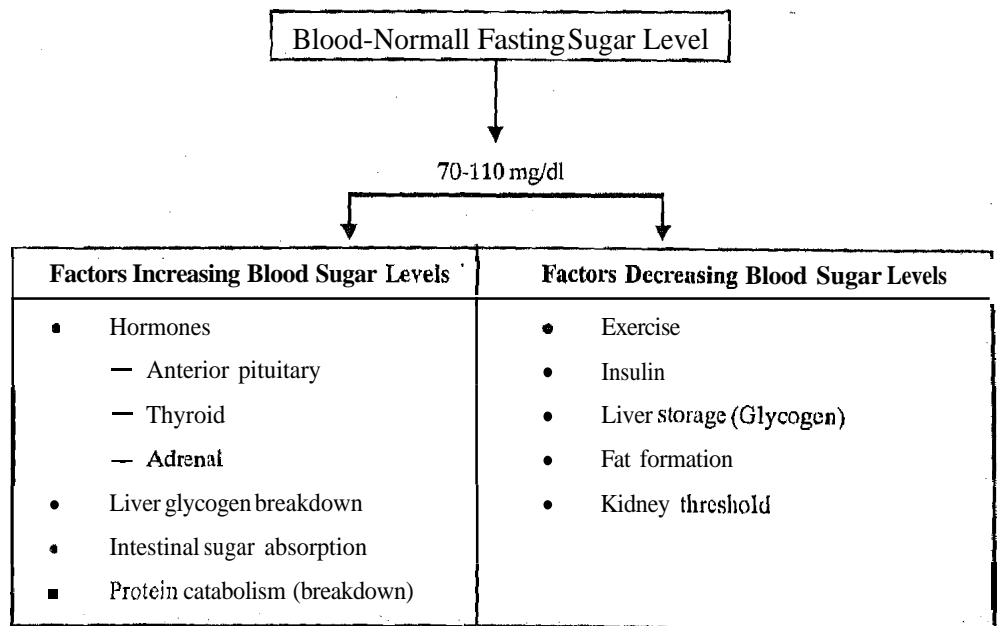
EXCESS FOOD, LACK OF EXERCISE AND AGING ARE ENVIRONMENTAL FACTORS FOR DIABETES BESIDES THE GENERIC FACTOR.

Having learnt about the causes of diabetes, next let us get to know about the factors affecting the glucose levels in blood.

### 12.2.3 Factors Affecting Normal Blood Sugar Levels

Earlier in our discussion, we learnt that insulin is the most important factor responsible for normal blood sugar levels. Now we will learn about the various factors that can increase blood sugar levels and those that can reduce it.

First of all, let us know what is the normal sugar level (glucose) in the blood? The normal sugar level ranges from 70-110 mg/100 ml. This is the fasting level also. Figure 12.1 shows some factors that increase the sugar levels and others that decrease the sugar levels.



**Figure 12.1: Factors affecting glucose levels in blood**

So we have learnt that – insufficient production or insulin resistance – can cause diabetes, commonly known as *primary* diabetes. Factors that increase sugar levels like hormones, intestinal disorders, diseases in which there is heavy breakdown of proteins (stress and trauma), dietary habits, lack of exercise, metabolic disorders, can also cause disturbances in the normal sugar levels, leading to abnormal or impaired glucose tolerance (IGT). Diabetes due to factors other than insulin is known as *secondary diabetes*. We can conclude therefore that the etiology of diabetes is multifactorial. Most common form of diabetes of course is primary diabetes.

Now, we shall see what are the symptoms of diabetes? Let us find out.

### 12.2.4 Metabolic Aberrations and Symptoms

We all know that insulin exerts an important role in the maintenance of normal blood glucose levels through its effect on the metabolism of carbohydrate, fat and proteins. Three major effects of insulin on the metabolism include:

1. Decreased utilization of glucose by the body cells with a resultant increase in the blood sugar levels to ranges between 300 to 1200 mg/dl. Thus we can say that the carbohydrate metabolism gets affected and the body cells do not get the fuel for energy purposes.

Markedly increased mobilization of fats from the fat storage areas, causes abnormal fat metabolism, as well as, deposition of lipids in vascular walls that cause atherosclerosis. Thus, the body depends more on energy derived from fat than that derived from carbohydrates. When this happens, the level of acetone, acetoacetic acid and hydroxybutyric acid in the body fluids rises thus causing a condition known as *acidosis*. A second effect which is even more important is the direct increase of ketoacids. These ketoacids have a low threshold for excretion by the kidneys. As much as 100-200 grams of ketoacids can be excreted in the urine each day. Because these are strong acids, they combine with sodium derived from the extracellular fluid replacing the extracellular fluid sodium with hydrogen ions, thereby making the urine more acidic. This causes rapid and deep breathing. These extreme effects occur in severe or poorly managed diabetes, leading to acidic coma and even death.

3. The third effect is on the depletion of protein in tissues of the body causing changes in the protein metabolism. The catabolic activity of muscle protein is accelerated in diabetes leading to increase in nitrogen that must be excreted after deamination. Also the cellular potassium in the blood is increased which needs to be excreted in the urine.

UNCONTROLLED DIABETES AFFECTS NOT ONLY CARBOHYDRATE METABOLISM BUT ALSO THE FAT AND PROTEIN METABOLISM.

Having gone through the discussion above you may now be in a position to understand the metabolic aberrations occurring in the body due to deficiency or ineffectiveness of insulin. Next, let us review the clinical signs and symptoms linked to diabetes.

#### *Clinical Symptoms*

In mild cases of diabetes mellitus, no symptoms may be seen. The diagnosis could be incidental during a blood or urine investigation. In most severe cases of diabetes, the clinical symptoms are more pronounced. These have been mentioned in Table 12.3.

**Table 12.3: Clinical symptoms of diabetes mellitus**

1.	Polyurea	Excessive urinary output especially at night. In very small children bed wetting may be commonly seen.
2.	Polydipsia	Excessive thirst due to loss of water from the body (polyurea)
3.	Polyphagia	Increased appetite, urge for sweet items of food due to heavy loss of sugar in urine.
4.	Loss of weight	Inspite of eating more (polyphagia) there is loss in weight.
5.	Lassitude and lack of energy	Untreated diabetes can cause easy tiredness, drowsiness and even coma at later stages.
6.	Pruritis vulvae	Irritation in the genitalia caused by local deposition of sugar from urine. It can also cause disturbed sleep.
7.	Paraesthesia	A tingling sensation felt in the hands and feet.
8.	Blurring of vision	Excess sugar deposits on the eye lens causing refraction changes resulting in the blurring of vision.
9.	Delay in wound healing and minor infections	Lack of nutrients to the wound delays wound healing. Minor recurrent infections occur (boils, foot, skin and urinary infections). If major infections, consult the doctor.

Polyurea, polydipsia, polyphagia, loss of weight, paraesthesia are earliest symptoms of diabetes. Polyurea is due to the osmotic diuretic effect of glucose in the kidney tubules. In turn, the polydipsia is due to dehydration resulting from polyurea. The failure of glucose (and protein) utilization by the body causes loss of weight and tendency towards polyphagia. The paraesthesia apparently is also caused by loss of body protein.

DIABETICS SHOULD TAKE SPECIAL PRECAUTIONS TO PREVENT INFECTIONS OF THE FOOT, AND THE URINARY TRACT.

Having learnt about the clinical signs and symptoms, let us learn about the diagnostic criteria.

### 12.2.5 Diagnosis

Timely and proper diagnosis plays a key role not only in identifying new cases but also in managing old cases with or without diabetic complications. Certain diagnostic tests help in understanding the previous history of a diabetic and also in preventing the onset of future complications. Let us review some of these.

When sugar is suspected in the blood or urine then tests need to be carried out to confirm that an individual has diabetes. We will briefly talk about these tests. These are:

- The Oral Glucose Tolerance Test (OGTT)
- Urinary Sugar Test (Benedicts Test)
- Glycosylated Haemoglobin Test

Let us discuss each of these.

- **Oral Glucose Tolerance Test (OGTT)**

This is most commonly used diagnostic test particularly for identifying new and 'at risk' individuals. This test is carried out after fasting overnight (12 hours). Glucose, 75 g in adults and 1.75 g/kg body weight in children, is administered orally (dissolve in

glass of water). Before the glucose load and 2 hours after the blood samples are taken and estimated for sugar levels.

The diagnostic criteria for impaired glucose tolerance test (IGT) is given in the Table 12.4. In normal individuals free from diabetes and with no impaired glucose tolerance, the fasting sugar levels are between 80-100 mg/ 100 dl. The blood sugar levels increase after glucose load and come down to basal level after 2 hours.

**Table 12.4: Diagnostic criteria for IGT and diabetes**

Parameter	Blood Sugar Levels mg/dl	
	IGT	Diabetes
Fasting	< 120	>120
Glucose load 2 hours after (also known as post prandial)	120-180	>180

Source: ICMR: Diet & Diabetes. 1993.

● *Urinary Sugar (Uristix Benedict's test)*

No sugar/glucose is excreted in the urine in normal individuals. In diabetics, glucose is excreted by the kidneys when the blood sugar levels are more than 180 mg /dl. This is known as the renal threshold. Varying amounts of glucose is found in the urine depending on the severity of diabetes and also the intake of carbohydrates. This test is not as reliable as the blood sugar test since reducing sugars such as lactose (in lactating women) can give a positive test which is not related to diabetes.

Today, commercially diagnostic strips (uristix) are available with the chemists. The strip is dipped in the urine and the colour change on the strip indicates the sugar level in the urine. Another method of checking sugar in the urine is called the Benedict's test. In this test, eight drops of urine and 5 ml of Benedict's solution are taken in a test tube, mixed and heated for 5 minutes. Change of colour indicates sugar in the urine. The interpretation of Benedict's test is given in the Table 12.5. Self monitoring by this method can be done several times if diabetes is severe (blood sugar levels at 180 mg ,or more per 100 dl). It is better to carry the test in the morning in the second urine sample. Urinary sample will more or less reflect the blood sugar level.

**Table 12.5: Interpretation of Benedict's test**

Colour	Report	Urine g%	Blood mg%
Green discolouration	0 to trace	-	< 200
Green precipitate	+	0.25	200-500
Greenish yellow ppt	N/A	0.5	250-300
Yellowish orange ppt	+++	1.0	300-350
Brick red ppt	++++	>2.0	>350

Source: ICMR 1993. Diet and Diabetes

● *Glycosylated Haemoglobin*

Glycosylated haemoglobin values give important diagnostic inferences regarding the recent past of a diabetic i.e. how well did he/she manage the hyperglycemia over the past few months. It is currently one of the best ways to check whether diabetes is under control or not. The higher the value the poorer has been the management. It is based upon the concept that excess blood sugar level circulating in the blood gets attached to the pigment (haemoglobin) present in the red blood cell (RBC) to make a glycosylated haemoglobin called Hb A1C. This deposit increases with the degree of diabetes. The combined glucose and haemoglobin in RBC can be estimated. This

level is high in diabetics (8-18% range) as compared to normal individuals (4-7% range). The glycosylated haemoglobin reflects the trend of sugar levels in the blood during the past 2-3 months. Patients having high values should be identified as the target groups for rigorous counseling regarding management of hyperglycemia.

It must be clear by the discussion above that these tests need not only be used for identification of new cases but also for the management of old/chronic patients. Regular assessment of vital parameters such as renal, blood and liver function tests along with blood glucose and glycosylated haemoglobin can prevent or delay the onset of several complications which arise due to sustained elevated blood glucose levels. These complications may be acute or chronic in nature and need to be handled as of utmost urgency by the entire medical team. Let us brief ourselves on some of the common complications.

## 12.2.6 Complications of Diabetes

Diabetes, as you know, is a lifelong disease. We have said earlier also that it can be controlled but not cured. Control of diabetes by ensuring normal blood level is important for preventing the complications to develop, but sometimes they do develop as acute or chronic complications. Let us read further and see what we mean by these complications.

### A. Acute Complications of Diabetes

Acute complications of diabetes include:

- *Hypoglycemia or low blood sugar*: The most frequent cause of low blood sugar is poor timing of meals and snacks. As you know, the treatment programme is based on proper balance of insulin, food consumption and exercise. Hence by reducing the food intake, by skipping or delaying a meal or snack, the amount of sugar in the blood will be less than if one had followed the normal meal. This creates a situation in which there is more insulin than needed for the sugar in the blood. The insulin will work on whatever sugar it gets and lower the existing blood glucose levels further. The second cause could be exercising more than usual without adding an extra meal or snack in the diet. So the usual amount of insulin and increased exercise can lower the blood sugar level further.

Low blood sugar can also be caused by accidentally taking too much of insulin. When this occurs, more insulin is present in the body than needed. The extra insulin works on glucose (sugar) already in the blood resulting in abnormally low blood sugar. The symptoms of low blood sugar are called 'insulin reactions' or 'hypoglycemia'. These reactions appear suddenly and must be treated immediately.

Symptoms appearing first are shakiness, nervousness, sweating, dizziness, weakness, irritability and hunger. Symptoms that develop further but slowly are crying, anger, drowsiness, confusion, staggered gait, inability to complete work, blurred vision and headache.

If the above are not treated immediately, more serious symptoms may eventually develop. These are increased confusion, delirium, convulsions and unconsciousness. If the individual is conscious, encourage him/her to eat a fast acting carbohydrate, such as sugar, honey, sweet or a chocolate and coca cola. Stop all activity and allow to rest for 10-15 minutes.

The glucose in the food should raise the blood sugar levels quickly. If not, try the second time. If unconscious, a friend, a family member should come to the rescue. The individual may need an injection of glucagon (glucagon is a hormone like insulin but produced by the alpha cells of islets of Langerhans and the pancreas). It has an action opposite to that of insulin as it increases blood sugar.

**DIABETICS SHOULD AVOID SUDDEN CHANGES IN FOOD CONSUMPTION, EXERCISE AND INSULIN DOSAGE.**

- *Hyperglycemia* (abnormally high blood sugar): Maintenance of blood glucose levels within or close to the normal range has been stressed by all medical authorities worldwide. Even with conscientious effort there may be times when the blood sugar is high or abnormally low. Either of these two conditions left untreated can lead to serious problems. We have already learnt about low blood sugar (hypoglycemia) and now let us see what can happen during hyperglycemia, ketoacidosis.

This condition occurs when there is not enough insulin to meet the body needs and the deficiency is allowed to continue uncorrected. With high sugar levels in the blood, the sugar in the urine is excreted at high levels. In addition, the body breaks down fat for energy and ketones are made: Increased production of ketones is known as ketosis and their elevated levels in blood is referred to as ketonemia. Their increased excretion in urine is referred to as ketonuria and the term ketoacidosis includes all the above mentioned disorders associated with enhanced fat break down. Ketoacidosis is an extremely serious condition which can cause "Diabetic coma" or even death. The onset of ketoacidosis is gradual but when ketones are present, it is important to test for both glucose or ketones in the urine.

Do you know how ketoacidosis develops?

The chain of reaction begins with insufficient insulin to meet the needs of the body. Several factors then work together. These include:

1. Illness, infection, injury or emotional stress could increase the body's need for insulin because of the extra energy required. Effectiveness of available insulin would also require release of additional glucose from liver (already stored as glycogen) or from fat sources.
2. Omitting insulin doses, which reduce the amount of insulin available to the body.
3. Reducing exercise thereby upsetting the food, insulin and exercise balance. This factor and other factors given above may aggravate the tendency towards ketoacidosis.
4. Excessive amounts of carbohydrate food may also aggravate the ketoacidosis.

What will happen? Without enough insulin two things can happen. Firstly, the cells of the body will be unable to use the glucose in the blood for energy. Secondly, glucose cannot be converted to glycogen in the liver for future use. Thus blood sugar levels will rise and the sugar levels reach above 180 mg/100 ml. The extra sugar will spill into the urine causing high levels of sugar in the urine. So to make energy available the fat sources will be used for getting energy as a result of which ketoacids in the blood and urine will increase.

The onset of ketoacidosis is gradual but in the young diabetics this development is faster. Diabetic coma can develop in 12-24 hours. Many symptoms are similar to hypoglycemia but additional symptoms can appear. These are excessive urination, excessive thirst, increased hunger, drowsiness, unexplained weight loss, slow healing of cuts and wounds, dry itching skin, vaginal itching, abdominal pain and rapid shallow breathing with acetone smell.

Can we prevent ketoacidosis?

Normally, while maintaining a good sugar control, there is a very little danger of ketoacidosis. One should test for ketones under the following conditions:

- e Blood glucose levels are about 240 mg/100 ml  
fever is present
- nausea and vomiting
- stress, and
- if insulin dosages is being adjusted.

SEVERE KETOACIDOSIS IS LIFE THREATENING CONDITION. THE PATIENT NEED HOSPITALIZATION AND CARE BY A PHYSICIAN IMMEDIATELY.

We will now proceed towards the long-term complications which are generally observed among old cases of diabetics i.e. after the initial diagnosis.

### ***B. Chronic complications***

These occur gradually when the diabetics do not monitor the blood sugar and they are careless about eating, exercise and the medications as a result of which the blood sugar levels are high. Uncontrolled diabetes with circulating high sugar and lipids precipitate vascular disease. The chronic complications arising due to uncontrolled diabetes are highlighted herewith.

- *Atherosclerosis*: Degeneration of walls of the arteries due to fatty plaques - deposition on arterial walls as you may recall studying in the Figure 11.2 in Unit 11. Diabetics are more prone to myocardial infarction, stroke and deep artery blockages in extremities. Atherosclerosis is a common complication in the diabetics. Lipoprotein abnormalities are common in diabetics and responsible for this condition.
- *Nephropathy*: Changes occur in the nephrons of the kidney due to thickening of capillary basement membrane, leading to glomerulonephrosis (disease of kidneys). These changes lead to defects in filtration increasing the proteins in urine (protein urea) and causing uraemia and finally renal failure about which we will learn later in Unit 16.

*Retinopathy*: Long duration diabetes with uncontrolled sugar may affect the small blood vessels of the eyes (microangiopathy). This can result in rapid deterioration of the eyesight (retinopathy).

- *Neuropathy*: Lesions of peripheral nervous system (neuropathy) could cause tingling, burning or numbness in the sensation of the upper and lower limbs.
- *Infections*: Diabetics are also prone to various bacterial, viral and fungal infections. In diabetics, cuts and wounds heal slowly. Individuals are prone to tuberculosis, infections of the skin, urinary tract and foot. The doctor must be consulted and appropriate antibiotics taken. Foot care is most important as the common problems related to the foot are lack of circulation and neuropathy. In 5% diabetics, amputation is necessary due to negligence.

MONITOR AND MAINTAIN SUGAR LEVELS TO AVOID ACUTE OR CHRONIC DIABETIC COMPLICATIONS

So far we have learnt about the increasing prevalence of diabetes, types of diabetes, etiology, diagnosis and a briefly on the salient complications. In our next section we shall learn about the management of diabetes wherein a dietician plays a key role. However, let us first review our knowledge through the questions mentioned in check your progress exercise 1.

### Check Your Progress Exercise 1

1. Fill in the blanks.
  - a) Diabetes is a disease of insulin deficiency or resistance characterized by disturbances in the metabolism of ....., ....., ..... and water and electrolyte balance.
  - b) Type 1 diabetes is usually due to absolute..... deficiency.
  - c) Type 2 diabetes is predominantly due to insulin .....
  - d) Diabetes in pregnant women is known as ..... diabetes.
  - e) High birth weight babies have a .....risk of developing diabetes.
2. Tick mark the correct answer.
  - a) Normal blood sugar range is:
    - i) 70- 110 mg/100 ml
    - ii) 110-120 mg/100 ml
    - iii) 120-150 mg/100 ml
  - b) Sugar appears in urine when blood sugar levels are
    - i) >180 mg/100 ml
    - ii) <180 mg/100 ml
  - c) The chronic complication of diabetes mellitus is:
    - i) Hypoglycemia
    - ii) Nephropathy
    - iii) Ketoacidosis
    - iv) Hyperglycemia
3. Explain the following terms in one line:
  - a) Polyurea:
  - b) Paraesthesia:
  - c) Polyphagia:
  - d) Retinopathy:
  - e) Neuropathy:
4. Mention true or false. Correct the false sentence.
  - a) Obesity is a risk factor for diabetes mellitus.  
.....
  - b) Checking for sugar in the urine is better than measuring glycosylated haemoglobin.  
.....
  - c) Irritability, trembling and nervousness are the first mild symptoms of hypoglycemia.  
.....

- d) Glucagon injection is given in early hypoglycemic condition when you are conscious.  
.....
- e) Hyperglycemia leads to ketoacidosis which can cause diabetic coma or even death.  
.....

Now that you know what is diabetes and its symptoms, complications, let us next review the management of diabetes with a particular focus on dietary management.

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## 12.3 MANAGEMENT OF DIABETES

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By now you know that diabetes can not be cured but can be treated so that an individual leads a normal life. Patients who maintain their blood glucose levels within the normal range suffer from lesser complications as compared to those who frequently experience fluctuations in the blood glucose levels. A good synchronization between diet, life style and drugs can help in preventing/delaying the onset of complications.

As a dietitian, our key objective involves bringing about life-long adoptable quantitative and qualitative changes in the nutrient intake, dietary habits and food choices of the patient(s) as per their insulin/ drug dosage and life-style. The dietician should work in close co-ordination with the doctor, and other members of the patient care team. We will now discuss the details for dietary management for diabetic which will be followed by a briefing on life style modifications and drug/insulin. While reading the subsequent concepts one must keep in mind that successful management of diabetes involves a holistic approach with coordination between diet, lifestyle and hypoglycemic drugs/insulin. Let us begin our discussions with dietary management.

### 12.3.1 Management of Diet

Diet plays a very important role in management of diabetes as it exerts a direct influence on the blood glucose levels. It is one of the vital components in diabetes control besides the medical, exercise and behavioural aspects of the treatment. Let us talk of the diet first. The goals of diet therapy are to maintain and prolong a healthy, productive and a happy life. This means nutritional assessment is important for setting the practical and acceptable goals for the patient. Goal that the patient can comprehend, relate to, and can be followed easily. Only after this can we plan the diet and execute it. Clinical parameters should be monitored from time to time in order to improve adherence to the programme and make the necessary changes if required. Dietary changes can be made in the plans which are more acceptable and can easily be followed. This also means that:

DIABETIC DIETS SHOULD BE INDIVIDUALIZED, BASED ON THE NUTRITIONAL STATUS OF THE PATIENT. IT SHOULD BE PRACTICAL, SUITED TO THE NEEDS AND CAN BE FOLLOWED TO MEET THE DIETARY GOALS.

What are the dietary goals? Well here they are. These are to:

1. supply optimum nutrition to maintain good health,
2. provide calories for maintaining ideal weight and allowing for normal growth and development (in case of children),

3. maintain blood sugar control (glycemic control),
4. achieve optimum blood lipid levels, and
5. minimize acute and chronic complications of diabetes mellitus.

The above objectives can be met by adhering to some of the basic principles of planning diets which include the consideration of factors like:

1. body weight, age, sex, activity,
2. economic, social and cultural factors,
3. type of diabetes, mode of treatment and control of diabetes, and
4. other factors like pregnancy, obesity, cardiovascular and renal disorders or even gastrointestinal problems and other infections.

Keeping the above principles in mind, the diet planned should be such as to help in maintaining an optimum nutritional status and achieving desirable body weight. As a thumb rule if the patient is undernourished, feed more calories, and if over-nourished reduce the calories. Calories are mainly obtained from carbohydrates, protein and fat. You already know that one gram of carbohydrate and proteins provide 4 Kcal and one gram of fat supplies 9 kilocalories. Let us now understand the contribution of these macronutrients in a diabetic diet.

#### A. Calories, Proteins, Fats and Carbohydrates

We have learnt earlier that sufficient calories should be given to maintain an ideal weight for adults and to provide for normal growth and development for children and adolescents and also provide for the increased needs during pregnancy, lactation and illness.

**Calories:** The energy requirements of adult patients is governed by their present body weight and the need to maintain a desirable or ideal body weight. Remember, we learnt about computations of energy requirements on the basis of ideal body weight earlier in Unit 9. Table 12.6 gives details of the energy requirements for excess, normal and underweight patients. We can calculate the energy requirements using the values.

**Table 12.6: Calorie requirements according to weight and activity**

	Weight	Activity Levels	Calories Required/kg Ideal Body Weight
1.	Ideal body weight	Sedentary activity	25
2.	Ideal body weight	Moderate activity	30
3.	Overweight	Sedentary activity	15-20
4.	Underweight	Sedentary activity	30
5.	Underweight	Moderate activity	35

Source: Diet Management 2<sup>nd</sup> ed.1999 Churchill Living Stone.

**Proteins:** Proteins should be provided in adequate amounts to maintain a normal body composition and prevent depletion of lean tissue mass. Adult diabetics without any complications are able to maintain good health when given 1.0 gm protein/kg ideal body weight per day. During childhood, adolescence, pregnancy and lactation the requirements are higher than the RDI and patients usually benefit by increasing the protein by 10 to 15%. However, in case of renal complications protein intake needs be restricted in accordance with the clinical parameters of renal function test. In such situations the patient should not be given more than 0.8 gm per kg IBW per day.

**Fats:** The total fat recommended by WHO is less than 30% of the total calories. However in view of the widely prevalent Asian paradox in India, it is generally recommended not to provide more than 15-20% of the total energy from dietary fat. This is particularly important in case of obese diabetics having hypertension or cardiac disorders. Vegetable oils rich in mono/poly unsaturated fatty acids should be preferred over animal fats which are generally rich in saturated fatty acids. (Refer Table 12.7 for details) regarding quantity and quality of fat.

**Table 12.7 : Recommendations regarding quantity and quality of fat**

Type of Fat	Recommended %
Polyunsaturated fats (vegetable oil)	10
Saturated fats (ghee, butter, vanaspati, margarine)	7
Monosaturated (Olive, palm, ground nut)	10-13

The dietary cholesterol intake should be kept below 300 mg/day for diabetics without any complications. However, if the patient is at risk or is suffering from hyperlipidemia or CAD, the cholesterol intake should not exceed 200 mg/day. We hope that you do remember the food sources of cholesterol we discussed in the previous unit. Well, a quick recapitulation would have taken your thoughts to sources of cholesterol such as whole milk and its products, egg yolk, red meat, organ meats (liver, kidney, brain).

**Carbohydrates:** These to a large extent depend on the food habits. Complex carbohydrates with more fibre are recommended to simple carbohydrates like sugars.

The amount should provide 55-65% of the day's caloric intake. The percentage and distribution of carbohydrate will vary with the insulin regimens and the treatment goals and also individual habits. Remember diabetics need not restrict their carbohydrate intake, but they can alter the type of carbohydrates in their diets, eat complex carbohydrates (whole cereals, pulses and vegetables) and avoid foods rich in simple carbohydrates (honey, jaggery, sugar and jams).

SIMPLE CARBOHYDRATES ARE NOT RECOMMENDED FOR DIABETICS, COMPLEX CARBOHYDRATES ARE BENEFICIAL.

We just read about laying emphasis on complex carbohydrates. What is the benefit of complex carbohydrates over simple ones? We will now learn about the significance of incorporating complex carbohydrates, particularly the non-starch polysaccharides (dietary fibre) with respect to maintaining blood glucose within normal range.

**B. Dietary Fibre**

Dietary fibre is that part of food which is not digested by the intestines. High fibre meals have shown to give the best glycemic control in diabetics. It not only reduces blood sugar but lowers blood cholesterol and hence is good for cardiovascular diseases, constipation and some forms of cancer. Fibre is found in a wide range of foods such as whole cereals, pulses, fruits, green leafy vegetables (insoluble fibres). Many soluble fibres such as those present in beans, fenugreek seeds are found to be more effective in controlling blood sugar and serum lipid levels. We will talk about these later. Intake of 25 g of dietary fibre per 1000 calories/day is considered optimum for a diabetic. Remember high fiber diets are of low calorie value and also have a low glycemic index. So diabetics must consume more of these foods. We will tell you more about glycemic index later in this unit. Dietary fibre content of some commonly consumed Indian foods is mentioned in Table 12.8.

Table 12.8: Fibre content of some common Indian foods

Foods	Dietary Fibre (g/100 g)
<i>Cereals</i>	
Rice	7.6
Wheat	17.6
Ragi	18.6
Oatmeal	3.5
Bajra	20.3
<i>Pulses</i>	
Soyabean	3.7
Whole green gram	13.5
Black gram	14.3
Bengal gram	14.1
<i>Nuts and Oils</i>	
Ground nut	6.1
Coconut (dry)	8.9
<i>Roots and Tubers</i>	
Sweet Potato	7.3
Potato	4.0
Yam	5.3
<i>Fruits</i>	
Pomegranate	5.1
Banana	2.5
Guava	5.2
Mango	2.3
<i>Vegetables</i>	
Fenugreek Leaves	1.1
Palak	5.0
Peas (green)	4.0
French Beans	1.8
Ridge gourd	5.7
Yellow pumpkin	5.0

Source: Nutritive value of Indian Foods, Indian Council of Medical Research (1991).

### C. Vitamins and Minerals

The recommendation of vitamins and minerals is the same as for general population. However, lower levels of magnesium are associated with risk of diabetes. Magnesium depletion has been associated with insulin insensitivity, which may improve with oral supplements. Chromium supplementation has been shown to exhibit beneficial effects in diabetic patients.

Mineral and other vitamins supplementation must be considered during infections and complications or situations such as extreme weight reducing diets, strict vegetarians, pregnant, lactating and elderly or those individuals who are on drugs and have malabsorption disorders and other ailments. Sodium restriction is suggested for hypertensive diabetics or those who are suffering from renal complications/oedema.

In our discussion above we learnt about the nutrient requirement, In short, we have learnt that the diabetics should avoid simple carbohydrates, use fat in limited amounts, consume less saturated fats and more polyunsaturated fats, take whole cereals and pulses in right amount, use fiber rich food in large amount, take vegetables as desired and fruits in limited amounts.

Some handy guidelines for selection of foods for diabetic patients is presented next. You may be aware that some foods need to be avoided, other used in moderate amount and yet use some foods freely. Let us get to know which these foods are:

Foods to be used freely	Foods to be used in moderate amounts	Foods to be avoided
<ul style="list-style-type: none"> <li>- Vegetables (low starch)</li> <li>- Green leafy vegetables</li> <li>- Spices and condiments</li> <li>- High fibre foods</li> <li>- Coffee/tea (without sugar)</li> </ul>	<ul style="list-style-type: none"> <li>- Flesh food especially red meats</li> <li>- Fats</li> <li>- Nuts</li> <li>- Cereals/Roots/Tubers</li> <li>- Pulses</li> <li>- Milk Products</li> <li>- Eggs</li> </ul>	<ul style="list-style-type: none"> <li>- Sugar</li> <li>- Sweets</li> <li>- Honey</li> <li>- Jams</li> <li>- Jellies</li> <li>- Cakes and Pastries</li> <li>- Pizzas</li> <li>- Aerated drinks and sweetened juices</li> <li>- Sweetened yoghurt</li> </ul>

By now you must be well versed with the dietary guidelines of diabetics. In brief avoid sweets, use less fat, take whole cereals and pulses in right amount. Consume vegetables as desired. Take permitted fruits in moderate amounts and include as much fibre rich foods as you can. An important aspect about dietary management of diabetics involves the concept of substituting food-stuffs having similar (not same) nutritive value or at least similar contribution to the post-prandial blood glucose. The use of food exchanges is a very convenient method, which is essentially adopted by dieticians and patients for maintaining blood glucose levels within a safe range. In our subsequent discussion we shall learn about food exchanges — their characteristic features and how to use them.

### 12.3.2 Food Exchange System

In a diabetic's day to day diet, the calorie intake and the quantity of food consumed should not have wide fluctuations. Also the diet should not get monotonous and rigid pressurizing the patient to take the same foods day in and day out. Variety in foods makes life more interesting. Don't you think so? For this reason we have the food exchange system which provides almost the same amount of calories, carbohydrates, proteins and fats grouped together. By this we keep the total intake of nutrients constant but at the same time provide variety in foods. Thus there may be difference in the weight of the food which provides the constant nutrients. For example, let us take the milk exchange as highlighted in Table 12.9.

**Table 12.9: Milk exchange (Provides 100 calories and 5 g protein)**

Food	Quantity
Butter milk	750 ml
Cheese	30 g
Curd	210 g
Khoa	30 g
Buffalo Milk	90 ml
Cow's Milk	180 ml
Skimmed Milk	260 ml*
Skimmed Milk Powder	30 g*

Source: ICMR Diet and Diabetes 1993

\*Provide 10 gm protein

Is this not interesting? If we know the total exchanges of milk we have to take in a day, we can have a number of choices of milk alternatives which we can substitute for milk giving us the same nutritive content. Occasionally, we could have curds, buttermilk, cow's milk, even cheese, khoa or skimmed milk, if we want to. So if we can educate the diabetics regarding all exchanges of food groups they can play with their diet themselves. Exchanges for vegetables, fruits, cereals, pulses, meat or fats have similarly been worked out. Each exchange list will provide a number of items that can be exchanged within the group or with each food group. You will use these exchange lists while planning your diets in the practicals and therefore will be more familiar with them.

Next, we shall learn about glycemic index—an important tool for planning diabetic diets.

### 12.3.3 Glycemic Index (GI)

Although the use of exchange lists is still popular for planning diabetic diets, it has been realized in recent years that in exchange lists though different foods contain the same amount of nutrients, the rise in blood sugar after the meal (post-prandial) varies and is not the same. This has given rise to a new concept that different carbohydrates raise the blood sugar to a variable extent. In diabetic diets, it is important to know that how much would the blood sugar rise using different foods or combination of foods. Therefore, the glycemic index concept was born.

What is this glycemic index? *Glycemic index is the numerical index given to a carbohydrate-rich food that is based on the average increase in blood glucose level occurring in blood after the food is eaten.* The higher the number, the greater the blood sugar response.

If you take a certain food and measure the rise in blood sugar in response to the food consumed in comparison with the response to an equal amount of glucose and know the glycemic index in percentage, then it would be a better method of planning diabetic diets. We do have glycemic index of individual food items such as wheat, rice, pulses and vegetables. For example, cereals like wheat, rice, vegetables (potato and carrots) have a high glycemic index (65-75%), fruits have 45-55%, lentils (peas, beans, green gram, Bengal gram) have a low glycemic index (30-40%). Glucose has a glycemic index 100%. So diets with lower glycemic index are more beneficial for diabetics. These foods generally have a more fibre content. Since we do not take individual foods but two or more foods cooked and prepared, we would be interested in glycemic index of common mixed foods consumed by us in our main meals and also some common snacks. Work is being conducted in various institutions on this area. Some day we will have this data and would be able to switch from food exchange system to glycemic index of cooked food for planning diabetic diets. We can calculate the glycemic index of food by using this formula:

$$GI = \frac{\text{Area under 2 hours blood response curve to test food}}{\text{Area under 2 hours response for equivalent glucose}} \times 100$$

You can get some idea of individual raw foods and cooked foods for their glycemic index values from the Table 12.10.

**Table 12.10: Glycemic Index of some common food items**

Food Items	Glycemic Index
Rice	72
Parantha, Wheat	70
Bread	70
Upma	75
Idli	80
Chole	65
Sprouted gram	60
Milk	33
Ice Cream	36
Curds	36
Tomato soup	38
Groundnuts	13
Apple	39
Orange	40
Banana	69
Potato	70
Sweet potato	48
Beetroot	64
Soyabeans	43
Rajmah	29
Bengal gram	47
Glucose	100
Honey	87
Fructose	20

Source: Ragburam et al. *Diab Bull*, 7:64. 1987

These low G.I. foods are beneficial for diabetics.

A GI of 70 or more is high, a GI of 56 to 69 is medium and a GI of 55 or less is low.

Thus From our discussion above it is clear that the glycemic index tells us how rapidly a particular carbohydrate turns into sugar. It certainly does not tell us how much of carbohydrate is actually present in a serving of a particular food. This information too is important if we want to assess the true impact of carbohydrate consumption. To know this we need to understand another concept called the *glycemic load*. The glycemic load of a food is the glycemic index divided by hundred and multiplied by its available carbohydrate content (i.e. carbohydrate minus fibre) in grams. The glycemic load is a relatively new way to assess the impact of carbohydrate consumption that takes the glycemic index into account, but gives a full picture than does glycemic index alone. For example, if we consider watermelon. Watermelon has a high glycemic index (about 72). However, a serving of 120 g of watermelon has only about 6 grams of available carbohydrate per serving. So its glycemic load is pretty low i.e.  $72/100 \times 6 = 4.32$ . Perhaps suitable for diabetics.

We all know that sugar, honey, jaggery i.e. all sweeteners, which are rich in mono and disaccharides, are completely omitted from the diet of diabetics. However, craving to eat sweet meats is always high among several patients. It is for this reason that diabetics are suggested to use artificial (nutritive/non-nutritive) sweeteners, which usually do not provide any significant amount of calories or other nutrients. Let us now brief ourselves on the commonly used sweeteners.

### 12.3.4 Sweeteners: Nutritive and Non-Nutritive Sweeteners

**Nutritive Sweeteners:** We know some sweeteners like glucose, honey, molasses, fruit juice, dextrose, maltose, mannitol, sorbitol, xylitol and hydrogenated starch hydrolysates have shown no advantage or disadvantage over sucrose.

Fructose which occurs in fruits, vegetables and honey provides 4 Kcals/g. Fructose through natural foods in the form of fruits and vegetables can be given in moderate amount to diabetics. Restriction of these nutritive sweeteners is because of its caloric content.

**Non-Nutritive Sweeteners:** These are characterized by an intense sweet taste. They are needed in small quantities and do not make any nutritive contribution which is significant. Three non nutritive sweeteners available are saccharin, aspartame and acesulfame K. In some countries, cyclamate and stevioside is available. From the data available on clinical studies it is seen that these sweeteners have no adverse affect on diabetes control. The recommended use of aspartame has been approved by the American Diabetic Association. The recommended safe limit for aspartame is 50 mg/kg of body weight per day. Aspartame is commercially known as 'Equal', 'Nutrasweet' and 'sugarfree'. In America, Acesulfame is the newest non nutritive sweetener available. It is available commercially as 'Sunette' or 'Sweet one'. The safety limit given by FDA is 15 mg/kgbody weight per day.

Let us read a little more about commercially available processed foods which have been developed particularly for diabetics.

### 12.3.5 Dietetic Foods

With advances in food technology, foods for special use by diabetics are now available in the global market, they are emerging in India also. These foods have reduced calories or sugar content. Diet pepsi/cola, high fibre flour, breakfast cereals or even ice-cream is available in the Indian market currently.

A dietetic food product must contain less than 20 calories per serving and may be used as a 'free food' at meals or as snacks. In a day, not more than 60 calories should be obtained by dietetic foods. All diabetics should be counseled to read the food label carefully and then only select the food for consumption.

What about alcohol? Can diabetic patients be allowed to take a peg or two? Let us find out.

### 12.3.6 Alcohol

Intake of alcohol should be limited. It is high in calories, lacks essential nutrients and may therefore promote ketoacidosis, hypertriglycerdemia (high triglycerides) and alcohol induced hypoglycemia (low sugar levels in the blood). Hypoglycemic drugs should never be consumed with alcohol. Patients on insulin should take not more than 2 drinks per day (one drink equals to 12 oz beer, 5 oz wine, 1½ oz whisky). The composition of common alcoholic beverages is given in Table 12.11. The calorie content of drinks consumed can be accordingly calculated. Total food intake should not be reduced when the patient is consuming alcohol. When calorie intake is restricted alcohol consumption should preferably be avoided. Women diabetics should abstain from alcohol during pregnancy and lactation. Here are some guidelines regarding alcohol consumption for insulin users:

1. Avoid drinking alcoholic beverages
2. Take not more than 2 small drinks a day.
3. Drink only with food.
4. Do not reduce food intake.
5. Restrain yourself if pregnant or lactating.

For non-insulin users:

1. Substitute for fat calories. A drink providing 100 calories should be substituted by 2 fat exchanges.
2. Avoid if your triglycerides are high,
3. Limit if calorie intake is restricted.
4. Restrain if pregnant or lactating.

Table 12.11: Composition of common alcoholic beverages

Alcoholic Beverages	Quantity (ml)	Kilocalories
Whisky	30	91
Rum	30	98
Gin	30	84
Brandy	30	98
Wine	100	78
Beer (regular)	250	122

We read about sweeteners and dietetics foods in sub section 12.3.4 and 12.3.5. These foods help in **improving** taste and increasing variety in the diet of diabetics. In our subsequent discussion let us learn about certain foods or food components **which** can help in creating a plateau affect in the **post-prandial** blood glucose thereby reducing the risk for developing acute complications (**hyper/hypoglycemia**) and at times perhaps also reduce the **insulin**/drug dosage. Let us now read about some **commonly** available foods, which can be used as a supportive therapy to manage hyperglycemia.

### 12.3.7 Beneficial Effect of Some Foods: Supportive Therapy

Certain foods, part of food or food components have been found to be beneficial in managing hyperglycemia. Most of these have been identified due to the presence of soluble and /or insoluble fibre in them. Research has well documented evidence that soluble fibre is particularly are useful for managing hyperglycemia and **hyperlipidemia** (particularly elevated cholesterol seen among diabetics). Some of the common and effective sources include:

**Fenugreek seeds:** Commonly known as methi seeds in Hindi. They are commonly used in Indian cuisine in chutney and even in pickles and several dishes. These seeds are rich in fiber which is mucilaginous (20-50% fiber content). It also contains an alkaloid substance called *Trigonelline* known to reduce blood sugar levels. Fenugreek powder reduces blood and urine sugar levels and **improves** glucose tolerance. It has an action on blood lipids, lowering **triglycerides** or blood cholesterol.

Fenugreek seeds are beneficial for use in diabetics. The same beneficial effects are not seen with fenugreek leaves. About 25-50 g of fenugreek seeds can be soaked in water or powdered form can be mixed in a drink of buttermilk or water, It should be taken in **15** minutes before meals 2-3 times a day. The seeds are bitter but **benefits** are great. You could use the powdered form in rice, dal and vegetable preparation.

**Other foods/ isolated fibre:** It is generally recommended that diabetics should substitute whole wheat flour with soya flour, whole Bengal flour or stalks of green leafy vegetables in the ratio **3:1** while preparing dough for chapattis etc. as it helps in increasing the fibre content of meals and preventing peak rise **post-prandially**.

**Wheat bran, bengal gram husk** can be given in doses around **15 g/day**. These show a hypoglycemic effect in diabetics. Wheat bran is best incorporated into biscuits 'bran biscuits' and are available in the market as **high/rich** in the insoluble fibers. Guar **gum** (a soluble fiber) can also be incorporated in the **form** of biscuits or laddoos (20% level). Both these fibers have shown beneficial effect on blood sugar of diabetics and in type 2 diabetics have demonstrated a reduction in hypoglycemic drugs.

With this discussion we end our study of dietary management of diabetes. Let us recall what we have learnt so far.

### Check Your Progress Exercise 2

1. Mention any four important goals related to the dietary management of diabetes.

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2. Mention if true or false. Correct false statements.

a) Activity is more important for planning diabetic diets than the body weight.

.....

b) A moderate worker who is underweight needs 30 calories per kg body weight in a day.

.....

c) The protein requirements of a diabetic are 1g/kg per day.

.....

d) Lipidemia is a cardiac disorder in which there are high level of lipids in the blood.

.....

e) Eggs and liver are rich in cholesterol content.

.....

3. Identify five foods rich in dietary fiber.

.....

4. What foods can be given daily in moderate amounts for a diabetic?

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.....  
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5. Describe the following briefly:

a) Food exchanges

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b) Glycemic Index of foods

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c) Diabetic foods

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d) Fenugreek seeds as supportive therapy

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In the beginning of section 12.3 it was highlighted that the overall management of diabetes must involve a successful co-ordination between the diet, exercise (physical activity) and drugs. We have discussed about the varied aspects of diet. Let us now proceed over to the role of exercise and drugs with respect to diabetes.

## 12.4 EXERCISE AND DRUGS

In this section, we shall review the role of exercise and drug in the management of diabetes. We shall begin with exercise.

### 12.4.1 Exercise

Regular controlled exercise helps to increase glucose utilization. It helps attain ideal weight by burning calories. It also builds stamina and provides a sense of well being.

A MODERATE EXERCISE SCHEDULE SHOULD BE PART OF  
MANAGEMENT PROGRAMME OF DIABETES.

Aerobic exercise for atleast 20-30 minutes four or more times a week is recommended. Exercise after meals is preferred. There are many benefits of exercise particularly for type 2 diabetes. It:

- lowers or eliminates the need for insulin drugs,
- decreases insulin resistance,
- helps in weight loss and maintenance of decreased weight,
- lowers the triglyceride and increases the HDL levels,
- improves circulation throughout the body,
- reduces stress, and
- reduces high blood pressure.

What are the moderate intensity exercises?

- Walking for ½ hr or jogging
- Biking leisurely for ½ hr.
- Playing tennis, swimming, gardening, golfing
- Vacuuming for ½ hr.

Walking is the best form of exercise especially for the elderly.

What precautions should be taken while exercising?

Being a diabetic the patient have to take a few precautions. These are:

- Initiate the exercise programme gently and then build it up gradually.
- Be particular about the intensity, timing and type of exercise.

- In case you get hypoglycemia, keep sugar/sweet ready for use.
- If your blood sugar values are high and diabetes is not under control, stop exercising.

It has been discussed earlier in section 12.3 that the meal pattern and the quantity of food served for each meal should be according to the dosage, timing and peak action of drugs/ insulin. We will now learn about drug and insulin commonly used for the management of diabetes.

It has been discussed earlier in this unit that hypoglycemic drugs and or insulin are used for the management of hyperglycemia among NIDDM and IDDM patients respectively. You must be remembering that earlier in this section 12.3, it was mentioned that the meal pattern and the quantity of food served for each meal should be in accordance with the dosage, timing and peak action of drugs/ insulin. We will now learn about the commonly employed drugs and insulin used during diabetes mellitus.

### 12.4.2 Drugs and Insulin

When diet, exercise or even weight reduction do not improve the diabetic symptoms and blood sugar levels, the use of hypoglycemia drugs become necessary. Oral hypoglycemia drugs are generally recommended to NIDDM, patients. Several types of oral drugs are available. They work by stimulating the pancreas to release additional insulin or to help the cells of the body to utilize the insulin properly. Some commonly used hypoglycemia drugs include:

- **Sulphonylureas:** *Tolbutamide* is the mildest and its effect remains for 8 hours hence 2-3 doses need to be taken. Another drug, chlorpropamide, needs only a single dosage as it is a stronger and a long acting medicine. They stimulate the pancreas to release more insulin. Tolbutamide and tolazamide are first generation sulphonylureas while glyburide, glibenclamide, glimeperide belong to the category of second generation sulphonylureas.
- **Biguanides:** They are anti-diabetic drugs which do not affect the output of insulin. These are preferred to sulphonylureas because they do not cause weight increase. Metformin is from this group and generally prescribed to obese subjects while sulphonylureas are given to non-obese individuals.

Are there any side effects of oral hypoglycemic drugs? These are rare but may occur such as skin rashes, itching, loss of appetite and stomach upset on weight increase. These, if present, must be reported to your doctor.

Depending on the diabetic condition, the doctor can prescribe a combination of oral drugs or insulin. Let us get to know more about insulin and its types.

### INSULIN

The discovery of insulin has dramatically changed the lives of people having type 1 diabetes. With this wonder drug diabetics can lead a normal, enjoyable and a productive life.

A dietician should be well versed with the salient characteristics of different types of insulin in order to plan an appropriate diet and meal pattern for diabetics. Let us see what these facts are:

1. Insulin is measured in units. A unit of insulin lowers the blood glucose by a certain amount. The doctor will decide the number of units of insulin a diabetic will need per day.
2. Insulin is generally produced in two different strengths —U100 and U40. This means that if the diabetic takes U100, there are 100 units of insulin in each cubic centimeter. Similarly U40 has 40 units of insulin per cubic centimeter.

3. Three types of Insulin is available. The type varies in how quickly it starts working (lowering blood glucose), time of peak activity (when they work the hardest) and how long it works. The three types are short acting, intermediate acting and long acting.
- *Short acting:* This type of insulin begins working quickly, works hardest 2-3 hours after injection but is completely gone after 4-6 hrs. So if a diabetic takes this type of insulin, they need a shot every 4-6 hrs. This is also known as Regular insulin. Sometimes, a small amount of zinc is added to the regular insulin because it prolongs its action. This is known as the 'Semilente'.
  - *Intermediate acting:* This type works more slowly than short acting. It works hardest 8-12 hours after injection and still keeps on working to some extent 24 hours later. One form of this type of insulin is known as *Neutral Protamine Hagedorn* (NPH). Hagedorn is the name of the developer and protamine is a simple protein added to it. Intermediate acting insulin is called Lente.
  - *Long acting:* Long acting insulin does not work until 4 to 8 hours after injecting. Its peak activity occurs 18 to 24 hours after injection and it continues to work to some extent after 36 hours. This is used less commonly because it is easier to work with 4 hours or 24 hours rather than 36 hours. Sometimes the doctor uses a combination of short and intermediate insulin.

The carbohydrate distribution varies with the type of insulin prescribed. For example, in case of regular insulin  $\frac{1}{3}$ rd each carbohydrate in three meals can be distributed but not in the intermediate or long-acting insulin. In intermediate it could be  $\frac{1}{7}$ th for breakfast,  $\frac{2}{7}$ th for noon,  $\frac{1}{7}$ th mid-afternoon,  $\frac{2}{7}$ th for evening and  $\frac{1}{7}$ th at bed time. For long acting insulin; it could be  $\frac{1}{5}$ th for breakfast,  $\frac{2}{5}$ th noon and  $\frac{2}{5}$ th evening and remaining for bed time. You will understand this in your practical classes.

A diabetic patient need not always be hospitalized and can refer to a dietician on a day-to-day basis. The food intake and activity level are ever changing variables that affect blood glucose levels. Festivals, religious occasions, professional and social responsibilities along with common illness such as constipation, fever, cold etc. can affect the insulin and food requirements markedly. It has, therefore, been strongly advocated that diabetics must be rigorously counseled so that they can manage their blood glucose levels themselves. Patient education through counseling sessions and mass media can help reduce the morbidities associated with diabetes. The subsequent discussion will highlight some of the points which should be kept in mind by the dietician while planning or implementing a counseling session.

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## 12.5 EDUCATION

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Education is very important for diabetics because it is a lifelong disorder. In order to enable the patient to lead a healthy and a good quality life free from complications, the diabetics must be educated sufficiently in the areas given below:

- The nature of disease.
- Its acute and chronic complications, (consequences of negligence).
- Self monitoring at regular interval for sugar (urine and blood) and serum lipids or any weight alterations and importance of weight maintenance.
- Adequate information on the diet (foods restricted, foods given in the moderation and free foods, concept of food exchanges glycemic index and planning meals).

- Knowledge about insulin and drugs in relation to carbohydrates.
- Importance of management by Diet, drugs and exercise.
- Sick day guidelines (Refer to Box 12.3.)
- Clarification of common food fads and misbeliefs, (Refer to Box 12.2)

Suitable information needs to be distributed to diabetics. This could be self care materials, food guides or even simple innovative recipes. Audiotapes and videotapes in local languages may be developed so as to facilitate wide spread dissemination of knowledge throughout the country.

Box 12.1	Sick Day Guidelines
<p>A sickness, even minor, can <b>increase</b> the body's <b>need</b> for insulin. Extra insulin may be required <b>because</b> of the extra <b>energy</b> required by the body to overcome the illness. This can result in energy needs <b>being</b> fulfilled from other sources of energy in the body like fats causing acidosis. On any sick day, one <b>must</b> consider the need and follow the sick day guidelines given below:</p> <ol style="list-style-type: none"> <li>1. Never omit the insulin dose, even if the <b>person</b> is unable to eat.</li> <li>2. Test the blood glucose level before each mealtime and at bedtime.</li> <li>3. If blood glucose levels are 240 mg/100 ml or higher, one should also test for urine ketones. <b>DO THIS WHEN ILL FROM ANY CAUSE.</b></li> <li>4. Take liquids every hour.</li> <li>5. If the patient is too ill to follow the meal plan, advice to eat and drink whatever they <b>can</b> tolerate. Use fluids, water, fruit juice, tea etc. If they are unable to take fluids because of vomiting, call the <b>DOCTOR</b>. Soft foods like baked custard, cooked soft cereal, creamed soups, milk shake, jelly, toast and even an ice-cream can be consumed.</li> <li>6. Rest or keep warm, do not exercise. Ask someone to care for the patient. If too unwell call the Doctor.</li> </ol>	

Box 12.2	Food Fads and Misbeliefs
<p>Some common food fads and fallacies linked with <b>feeding</b> diabetic patients are highlighted herewith.</p> <ol style="list-style-type: none"> <li>1. <i>You cannot eat rice if you are a diabetic.</i></li> </ol> <p>Both wheat and rice have a similar glycemic index which <b>means</b> that they raise the blood sugar level to the same extent, As long as you <b>restrict</b> the quantity (see food exchange), it does not matter what you eat.</p> <ol style="list-style-type: none"> <li>2. <i>You can fast if you are a diabetic.</i></li> </ol> <p>Total fasting is not good especially for those who are on insulin or hypoglycemic drugs. It causes acute complications of hypoglycemia which can be life threatening.</p> <ol style="list-style-type: none"> <li>3. <i>Carbohydrates should be restricted in diabetics.</i></li> </ol> <p>It is now known that carbohydrates need not be restricted and it could provide 60-65% of the day's calories. Complex carbohydrates (high fiber content) found in cereals, pulses or green vegetables are known to improve the <b>insulin</b> action but simple carbohydrates present in sugar, sweets, honey and jams can increase blood sugar levels. Type of carbohydrate consumed is more important,</p>	

Initial and time to time counseling regarding prevention and control or management of diabetes must be obtained by individuals suffering from diabetes. In case of doubt seek the help of a dietitian. What are the preventive measures which a diabetic patient needs to practice to ensure a healthy life? These measures are discussed finally.

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## 12.6 PREVENTION

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We now know that diabetes is the outcome of many genetic and environmental factors. The former is not in our control but the latter can be modified. The most important rule in the prevention strategy is to maintain ideal weight. We have already learnt in Unit 9 about this concept. We can use the information given in the unit to calculate ideal weight for a diabetic patient depending on the height, gender and activity pattern. Can you not? Yes you can.

TO SUCCESSFULLY CONTROL THE WEIGHT, ENCOURAGE A DIABETIC PATIENT TO DEVELOP LIFELONG, HEALTHY EATING AND LIFESTYLE HABITS

So you can prevent diabetes by encouraging the diabetic patient to:

1. Maintaining ideal body weight.
2. Avoid high sugar, salt and fat foods.
3. Take small bites and chew foods thoroughly. Eat and drink slowly.
4. Eat protein rich food at each meal.
5. Eat wisely at social gatherings and restaurants.
6. Do physical activity. Walk daily.
7. Avoid aerated and excessive alcoholic drinks.
8. Minimize use of tobacco and other harmful drugs.
9. Use artificial sweeteners if you have a 'sweet tooth'.
10. Read and educate yourself on various aspects of diabetes.
11. Avoid stress; enjoy good music, meditate and have positive attitude towards life. In other words make life-style and behavioural changes for better health.

The section above must have helped you in understanding about the overall management of diabetes. Next, the check your progress exercise 3 given herewith will help you in recapitulating your concepts.

### Check Your Progress Exercise 3

1. Fill in the blanks:
  - a) Regular controlled exercise in diabetics helps to increase glucose.....  
.....
  - b) Stop exercising if your blood sugar values are..... or too  
..... and not under control.
  - c) .....exercise by diabetics should be followed for 20-  
30 minutes 4 or more times a week.
  - d) Exercise benefits type ..... diabetics more.
  - e) ..... is the best form of exercise for the elderly,

2. Give five beneficial effects of aerobic exercises for diabetics.

.....  
.....  
.....  
.....

3. State whether true or false. Also, correct the false statements.

a) Oral hypoglycemic drugs are ineffective in type 2 diabetics.

.....

b) The biguanide drugs are preferred to sulphonylureas because they do not cause weight increase in diabetics.

.....

c) Insulin is produced in two different strengths and measured in milligrams.

.....

d) Short acting insulin works immediately and can be combined with long acting insulins.

.....

e) Protamine is a simple protein added to regular insulin.

.....

4. Why is education for diabetics important?

.....  
.....

5. The key to 'Diabetic Management' is diet, drugs and exercise. Comment on this statement.

.....  
.....  
.....  
.....

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## 12.6 LET US SUM UP

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Diabetes as we all know is a disease with ever increasing prevalence in our country. It can be described as a disease characterized by disordered metabolism and inappropriate hyperglycemia due to a deficiency either of insulin secretion or to a combination of insulin resistance and inadequate insulin secretion.

In this unit we have learnt about the various types of diabetes and impaired glucose tolerance in different age groups. A brief note on the symptoms and complications of diabetes, as well as, the common diagnostic tests to identify and monitor diabetes are also given.

The unit further elaborated on the overall management of diabetes with emphasis on diet related aspects. We learnt that the management of diabetes involves a co-ordination between the diet, drugs and activity pattern of the patient, The nutrient

requirements are elaborated and the use of alternative food components/ supportive therapy is also discussed. This unit also dealt with the significance and advantages of regular exercise for maintaining blood glucose within normal range. The use of different types of drugs/ insulin, their characteristic features and duration of action were also discussed thereafter.

A dietitian is very often involved with counseling sessions which are aimed to help the patient in becoming self-reliant regarding the day-to-day management of variations in blood glucose. Some useful tips regarding an effective education programme were also elucidated.

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## 12.7 GLOSSARY

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- Acidosis** : depletion of the body's alkali reserve with resulting disturbance of acid-base balance. Excess acid in the blood and body fluids.
- Ascites** : a type of oedema characterized by the accumulation of fluid in the abdominal cavity.
- Insulin resistance** : the condition in which the cells fail to respond to insulin as they do in healthy people.
- Polyuria** : excessive urination due to glucose in urine.
- Polyphagia** : increased appetite due to inadequate utilization of glucose.
- Somogyi effect** : hyperglycemia in the morning as a feed back response of counter-regulatory hormones to nocturnal hypoglycemia.
- Dawn phenomenon** : reduced tissue sensitivity early morning resulting in mild hyperglycemia.

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## 12.8 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

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### Check Your Progress Exercise 1

- carbohydrate, fat, protein
  - insulin
  - resistance
  - gestational
  - increased
- (i)
  - (i)
  - (ii)
- Polyuria** refers to excessive urination at night in response to glycosuria
  - Paraesthesia** is a tingling sensation felt in the hands and feet followed by numbness.
  - Polyphagia** is a feeling of increased hunger or appetite.
  - Retinopathy** is a highly specific vascular complication of diabetes involving the **innermost** lining of the retina.

- e) Neuropathy is a complication of chronic diabetes which involves damage to the sensory, motor and autonomic nerves.
4. a) True
- b) False: Measuring glycosylated haemoglobin is better.
- c) True
- d) False. Glucagon injection is given in early hypoglycemic condition when you are unconscious.
- e) True

### Check Your Progress Exercise 2

1. The important goals of dietary management during diabetes include:
- maintain an optimum nutritional status
  - maintaining of desirable or ideal weight and allowing for normal growth and development (in case of children)
  - maintain near normal blood sugar levels and avoid fluctuations
  - delay the onset and prevent progression of acute and chronic complications of diabetes mellitus.
2. a) False. Both are important factors for determining the energy requirements.
- b) False. 35 calories per kg body weight . . .
- c) True
- d) True
- e) True
3. Wheat, bajra, ragi, whole pulses, beans, peas, fenugreek
4. Skimmed milk, egg white, high fibre foods such as dalia, fruits and vegetables with their edible peels.
5. a) Food Exchange: It is a comprehensive, easy to use tool for planning balanced diet for diabetics. They are used in the form of food exchange lists which help in making quick and fairly accurate estimations of the nutritive value of diet.
- b) Glycemic index of food is the blood glucose response to a food. It is measured by comparing the glycemic effect of a particular (test) food with that from an equal amount of carbohydrate from a standard source of carbohydrate usually white bread or glucose.
- c) Diabetic Foods are a range of semi processed, ready-to-eat foods which have been developed by the food industry to suit the nutrient requirements of diabetics.
- d) Fenugreek or methi seeds are good sources of soluble fibre. It contains an alkaloid substance called trigonelline which helps in reduce blood glucose. Hence it is a supporting therapy.

### Check Your Progress Exercise 3

1. a) maintain
- b) high, low

- c) Aerobic
  - d) 2
  - e) walking
2. Any five of the following:
- e lowers or eliminates the need for insulin/ drugs,
  - decreases insulin resistance, helps in weight loss and maintenance of decreased weight,
  - lowers the triglyceride and increases the HDL levels,
  - improves circulation throughout the body,
  - reduces stress, and
  - reduces high blood pressure.
3. a) False, oral hypoglycemic drugs are effective for type 2 diabetes since they help by stimulating the pancreas to release insulin or increasing insulin sensitivity effectiveness
- b) True
- c) False, Insulin is measured in units (units per centimeter)
- d) True
- e) False. It is added to intermediate acting insulin.
4. Education is very important for diabetics because it is a lifelong disorder. In order to enable him to lead a healthy good quality life free from complications, the diabetics must be educated adequately. Suitable self care materials, food guides or even simple innovative recipes for diabetics which should be translated into all the languages should be provided. Initial and time to time counseling regarding prevention and control or management of diabetes must be undertaken by a registered dietitian.
5. Successful management of diabetes involves a good co-ordination between the diet, activity and drugs consumed by the patient. This is also because all the three parameters mentioned above can result in the release or utilization of blood glucose. An imbalance between the three can result in frequent episodes of hyper/hypoglycemic shocks and thus, an increased risk for developing chronic complications or even death.