

Diabetes Mellitus and Its Treatment: An Overview

Mahendra Dwivedi¹*, Aadya Raj Pandey²

^{1,2}*Department of Pharmacy, Rajarshi Rananjay Sinh College of Pharmacy Amethi, Uttar Pradesh, India*

***Corresponding Author**

Email Id: mahendradwivediji@gmail.com

ABSTRACT

Diabetes Mellitus (sometimes called “sugar diabetes”) is a condition that occurs when the body can't use glucose (a type of sugar) normally. Glucose is the main source of energy for the body's cells. The levels of glucose in the blood are controlled by a hormone called insulin. The pancreas is responsible for producing insulin. The cells which produce insulin are beta cells. These cells are distributed in a cluster of cells in the pancreas called the Islets of Langerhans, named after the anatomist who discovered them. In type 1 diabetes, the beta cells that produce insulin are attacked by the body's immune system. As more beta cells get killed off, the pancreas struggles to produce enough insulin to keep blood sugar levels down and the symptoms of diabetes begin to appear. In type 2 diabetes, the body builds up resistance to insulin and more insulin is needed to bring down blood glucose levels. As a result the pancreas needs to produce more insulin than it would normally need to. If the pancreas can no longer produce enough insulin to bring down sugar levels, the symptoms of diabetes will begin to appear. Frequent urination, excessive thirst, unexplained weight loss, extreme hunger, sudden vision changes, tingling or numbness in the hands or feet, feeling very tired much of the time, very dry skin, and sores that are slow to heal are common symptoms of DM.

Keywords: Pancreas, Cardiovascular, Diabetes Mellitus, Gestational-Diabetes, Neuropathy, Nephropathy

INTRODUCTION

Diabetes Mellitus is a chronic, metabolic disease characterized by elevated levels of blood glucose (or blood sugar). The most common is type 2 diabetes, usually in adults, which occurs when the body becomes resistant to insulin or doesn't make enough insulin [1]. Symptoms often include frequent urination, increased thirst, and increased appetite. If left untreated, diabetes can cause many complications [2]. Acute complications can include diabetic ketoacidosis, hyperosmolar hyperglycemic state, or death [3]. Serious long-term complications include cardiovascular disease, stroke, chronic kidney disease, foot ulcers, damage to the nerves, damage to the eyes and cognitive impairment [2],[4]. The most common

forms of diabetes are type 1 diabetes (5%), which is an autoimmune disorder, and type 2 diabetes (95%), which is associated with obesity. Gestational diabetes is a form of diabetes that occurs in pregnancy, and other forms of diabetes are very rare and are caused by a single gene mutation [5]. There's no cure for diabetes. But with treatment and lifestyle changes, you can live a long, healthy life [6].

TYPES

There are two main types of diabetes: Type 1 and Type 2:

Type 1 Diabetes

It occurs because the insulin-producing cells of the pancreas (beta cells) are damaged. In Type 1 diabetes, the pancreas

makes little or no insulin, so sugar can't get into the body's cells for use as energy.

People with Type 1 diabetes must use insulin injections to control their blood glucose. Type 1 is the most common form of diabetes in people who are under age 30, but it can occur at any age. Ten percent of people with diabetes are diagnosed with Type 1.

Type 2 Diabetes

In this type pancreas makes insulin, but it either doesn't produce enough, or the

insulin doesn't work properly. Nine out of 10 people with diabetes have Type 2.

This type occurs most often in people who are over 40 years old but can occur even in childhood if there are risk factors present. Type 2 diabetes may sometimes be controlled with a combination of diet, weight management and exercise.

However, treatment also may include oral glucose-lowering medications (taken by mouth) or insulin injections (shots) [7].

DIABETES MELLITUS

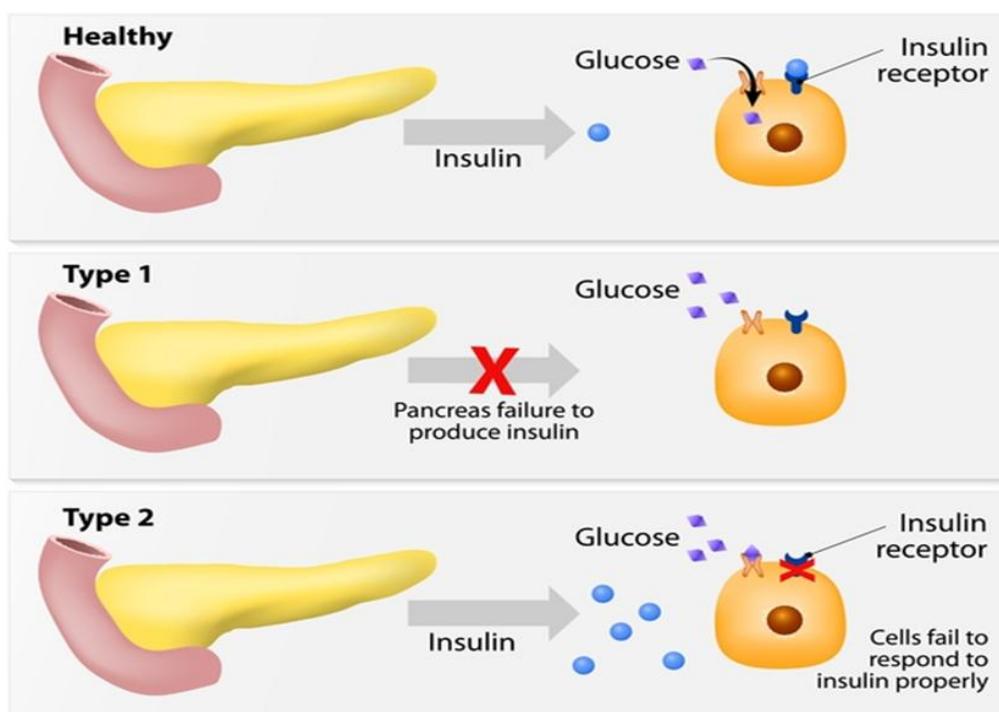


Fig. 1. Type of Diabetes Mellitus

Other types of diabetes might result from pregnancy (gestational diabetes), surgery, and use of certain medicines, various illnesses and other specific causes [7].

Gestational Diabetes (or Gestational Diabetes Mellitus, GDM) is a condition in which females who previously were not having diabetes exhibit higher than normal

levels of blood sugar while pregnant. The illness usually shows few signs/symptoms. [8] It is usually found during pregnancy medical checks. Up to 16% of pregnant women are affected by GDM. Pregnant women with family history of having diabetes and ethnic background have higher chances of getting the disease [9]

- It is still unclear what causes gestational diabetes. It may be due to the action of pregnancy hormones, blocking the action of insulin to its receptors. This prevents cells to take in glucose properly. This causes sugar to remain in blood, where it continues to rise.

- In most cases, children belonging to mothers having gestational diabetes are at higher risk of childhood obesity and Type 2 diabetes later in life. This can be stopped through healthy eating and regular exercise [10].

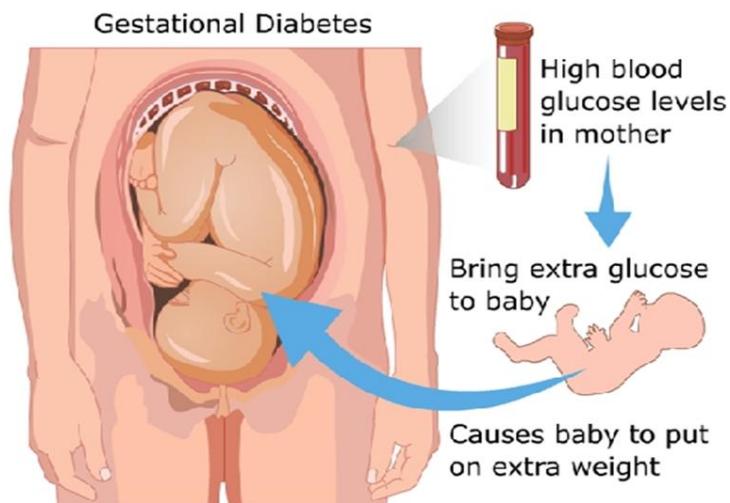


Fig.2. Gestational-Diabetes

Symptoms of Diabetes Mellitus

Diabetes symptoms are caused by rising blood sugar.

General Symptoms

The general symptoms of diabetes include:

- increased hunger
- increased thirst
- weight loss
- frequent urination
- blurry vision
- extreme fatigue
- sores that don't heal

Symptoms in Men

In addition to the general symptoms of diabetes, men with diabetes may have a decreased sex drive, erectile dysfunction (ED), and poor muscle strength.

Symptoms in Women

Women with diabetes can also have symptoms such as urinary tract infections, yeast infections, and dry, itchy skin.

Type 1 Diabetes

Symptoms of type 1 diabetes can include:

- extreme hunger
- increased thirst
- unintentional weight loss
- frequent urination
- blurry vision
- tiredness

Type 2 Diabetes

Symptoms of type 2 diabetes can include:

- increased hunger
- increased thirst
- increased urination
- blurry vision
- tiredness
- sores that are slow to heal

It may also cause recurring infections. This is because elevated glucose levels make it harder for the body to heal [11].



Fig.3. Symptoms of Diabetes

Gestational-Diabetes

Gestational diabetes may not present any obvious signs or symptoms, as many of the changes can be similar to those that occur during pregnancy. However, possible signs and symptoms include

- Fatigue
- Blurred vision
- Extreme thirst
- Nausea
- Frequent bladder, vaginal, or skin infections
- Frequent urination
- Sugar in the urine

Any woman experiencing new or unusual symptoms during pregnancy should speak to her doctor. The doctor may be able to determine whether she has developed

gestational diabetes or any other condition.[12]

Pathogenesis

Type 1 Diabetes

The immune system of body attacks and destroys the cells that produce insulin. As no insulin is produced, glucose levels further increase, which can seriously damage the body's organs. Type 1 diabetes is often known as insulin-dependent diabetes. It is also sometimes known as juvenile diabetes or early-onset diabetes because it usually develops before the age of 40, often during the teenage years. Type 1 diabetes is less common than type 2 diabetes.

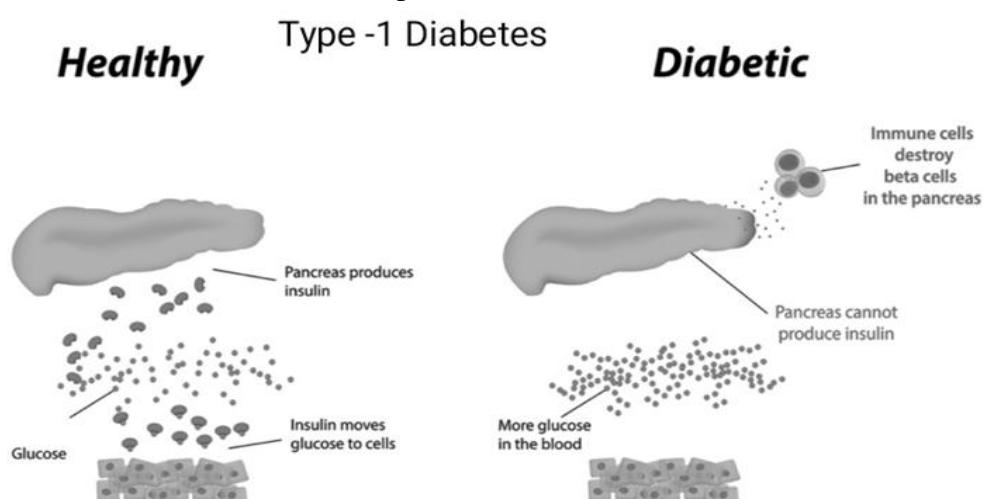


Fig. 4. Pathogenesis of Type-1 DM

Type 2 Diabetes

Type 2 diabetes is where the body does not produce enough insulin or the body's cells

do not respond to insulin. This is known as insulin resistance. Type 2 diabetes, and is far more common than type 1 diabetes.

Type 2 Diabetes

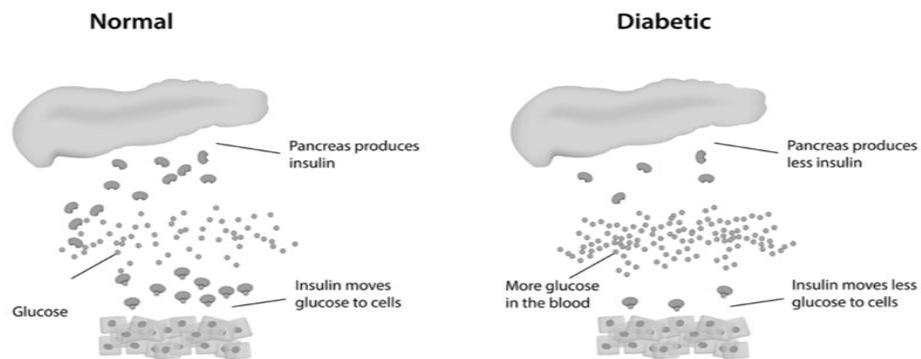


Fig.5. Pathogenesis of Type-2 DM

Gestational Diabetes

Some women tend to experience high levels of blood glucose as during pregnancy due to reduced sensitivity of insulin receptors [13].

Prevention of Diabetes Mellitus

Type-1 Diabetes

Type 1 diabetes can't be prevented. Doctors can't even tell who will get it and who won't. No one knows for sure what causes type 1 diabetes, but scientists think it has something to do with genes. But just getting the genes for diabetes isn't usually enough. In most cases, a child has to be exposed to something else — like a virus — to get type 1 diabetes [14].

Type – 2 Diabetes

Here are some tips to help you reduce your risk of type 2 diabetes.

- 1) **Check your Risk of Diabetes.** Take the life! Risk assessment test and learn more about your risk of developing type 2 diabetes. A 12+ score indicate that you are at high risk and may be eligible for the Life! Program – a free Victorian lifestyle modification program that helps you reduce your

risk of type 2 diabetes and cardiovascular disease, or call 13 RISK (13 7475).

- 2) **Manage your Weight:** Excess body fat, particularly if stored around the abdomen, can increase the body's resistance to the hormone insulin. This can lead to type 2 diabetes.
- 3) **Exercise Regularly:** Moderate physical activity on most days of the week helps manage weight, reduce blood glucose levels and may also improve blood pressure and cholesterol.
- 4) **Eat a Balanced, Healthy Diet:** Reduce the amount of fat in your diet, especially saturated and trans fats. Eat more fruit, vegetables and high-fibre foods. Cut back on salt.
- 5) **Limit your Alcohol Intake:** Too much alcohol can lead to weight gain and may increase your blood pressure and triglyceride levels. Men should have no more than two standard drinks a day and women should have no more than one.
- 6) **Quit Smoking:** Smokers are twice as likely to develop diabetes as non-smokers.

- 7) **Control your Blood Pressure:** Most people can do this with regular exercise, a balanced diet and by keeping a healthy weight. In some cases, you might need medication prescribed by your doctor.
- 8) **Reduce your Risk of Cardiovascular Disease:** Diabetes and cardiovascular disease have many risk factors in common, including obesity and physical inactivity [15].

Complications

Over time, type 1 diabetes complications can affect major organs in your body, including heart, blood vessels, nerves, eyes and kidneys. Maintaining a normal blood sugar level can dramatically reduce the risk of many complications.

- 1) **Heart and Blood Vessel Disease:** Diabetes dramatically increases your risk of various cardiovascular problems, including coronary artery disease with chest pain (angina), heart attack, stroke, narrowing of the arteries (atherosclerosis) and high blood pressure.
- 2) **Nerve Damage (Neuropathy):** Excess sugar can injure the walls of the tiny blood vessels (capillaries) that nourish your nerves, especially in the legs. This can cause tingling, numbness, burning or pain that usually begins at the tips of the toes or fingers and gradually spreads upward. Poorly controlled blood sugar could cause you to eventually lose all sense of feeling in the affected limbs. Damage to the nerves that affect the gastrointestinal tract can cause problems with nausea, vomiting, diarrhoea or constipation. For men, erectile dysfunction may be an issue.
- 3) **Kidney Damage (Nephropathy):** The kidneys contain millions of tiny blood vessel clusters that filter waste from your blood. Diabetes can damage this delicate filtering system. Severe damage can lead to kidney failure or

irreversible end-stage kidney disease, which requires dialysis or a kidney transplant.

- 4) **Eye Damage:** Diabetes can damage the blood vessels of the retina (diabetic retinopathy), potentially causing blindness. Diabetes also increases the risk of other serious vision conditions, such as cataracts and glaucoma.
- 5) **Foot Damage:** Nerve damage in the feet or poor blood flow to the feet increases the risk of various foot complications. Left untreated, cuts and blisters can become serious infections that may ultimately require toe, foot or leg amputation.
- 6) **Skin and Mouth Conditions:** Diabetes may leave you more susceptible to infections of the skin and mouth, including bacterial and fungal infections. Gum disease and dry mouth also are more likely.
- 7) **Pregnancy Complications:** High blood sugar levels can be dangerous for both the mother and the baby. The risk of miscarriage, stillbirth and birth defects increases when diabetes isn't well-controlled. For the mother, diabetes increases the risk of diabetic ketoacidosis, diabetic eye problems (retinopathy), pregnancy-induced high blood pressure and preeclampsia [16].

Type 2 diabetes can be easy to ignore, especially in the early stages when you're feeling fine. But diabetes affects many major organs, including your heart, blood vessels, nerves, eyes and kidneys. Controlling your blood sugar levels can help prevent these complications. Although long-term complications of diabetes develop gradually, they can eventually be disabling or even life-threatening. Some of the potential complications of diabetes include:

- 1) **Heart and Blood Vessel Disease:** Diabetes dramatically increases the risk of heart disease, stroke, high blood

pressure and narrowing of blood vessels (atherosclerosis).

2) **Nerve Damage (Neuropathy):** Excess sugar can cause tingling, numbness, burning or pain that usually begins at the tips of the toes or fingers and gradually spreads upward. Eventually, you may lose all sense of feeling in the affected limbs. Damage to the nerves that control digestion can cause problems with nausea, vomiting, diarrhoea or constipation. For men, erectile dysfunction may be an issue.

3) **Kidney Damage:** Diabetes can sometimes lead to kidney failure or irreversible end-stage kidney disease, which may require dialysis or a kidney transplant.

4) **Eye Damage:** Diabetes increases the risk of serious eye diseases, such as cataracts and glaucoma, and may damage the blood vessels of the retina, potentially leading to blindness.

5) **Slow Healing:** Left untreated, cuts and blisters can become serious infections, which may heal poorly. Severe damage might require toe, foot or leg amputation.

6) **Hearing Impairment:** Hearing problems are more common in people with diabetes.

7) **Skin Conditions:** Diabetes may leave you more susceptible to skin problems, including bacterial and fungal infections.

8) **Sleep Apnea.** Obstructive sleep apnea is common in people with type 2 diabetes. Obesity may be the main contributing factor to both conditions. Treating sleep apnea may lower your blood pressure and make you feel more rested, but it's not clear whether it helps improve blood sugar control.

9) **Alzheimer's Disease.** Type 2 diabetes seems to increase the risk of Alzheimer's disease, though it's not clear why. The worse your blood sugar

control, the greater the risk appears to be [17].

Studies show that men with diabetes often have reduced testosterone levels, which can affect their sex drive.

However, the main sexual health problem affecting men with diabetes is an inability to achieve or maintain an erection; known as erectile dysfunction (ED). For a man to achieve an erection there must be significant blood flow to the penis.

However, diabetes damages the blood vessels, which can affect blood flow to the penis [18].

Diagnosis

Diabetes is diagnosed through blood tests that detect the level of glucose in the blood.

1) **Fasting Plasma Glucose (FPG) test:** A blood sample is taken in the morning after you fast overnight. A normal fasting blood sugar level is between 70 and 100 milligrams per deciliter (mg/dL). Diabetes is diagnosed if the fasting blood sugar level is 126 mg/dL or higher.

2) **Oral Glucose Tolerance Test (OGTT):** Your blood sugar is measured two hours after you drink a liquid containing 75 grams of glucose. Diabetes is diagnosed if the blood sugar level is 200 mg/dL or higher.

3) **Random Blood Glucose Test:** A blood sugar of 200 mg/dL or greater at any time of day, combined with symptoms of diabetes, is sufficient to make the diagnosis.

4) **Hemoglobin A1c(Glycohemoglobin):** This test measures your average blood glucose level over the prior two to three months. Diabetes is diagnosed if the haemoglobin A1c level is 6.5% or higher [19].

TESTS FOR BLOOD GLUCOSE LEVELS			
TEST	NORMAL	PREDIABETES	DIABETES
A1C	less than 5.7%	5.7% to 6.4%	6.5% or higher
FPG	less than 100 mg/dl	100 mg/dl to 125 mg/dl	126 mg/dl or higher
Oral Glucose Tolerance Test (OGTT)	less than 140 mg/dl	140 mg/dl to 199 mg/dl	200 mg/dl or higher

Fig. 6. Test for Blood Glucose Level

Treatments

Treatment for Type 1 Diabetes includes

- 1) Taking insulin
- 2) Carbohydrate, fat and protein counting
- 3) Frequent blood sugar monitoring
- 4) Eating healthy foods
- 5) Exercising regularly and maintaining a healthy weight

The goal is to keep your blood sugar level as close to normal as possible to delay or prevent complications. Generally, the goal is to keep your daytime blood sugar levels

before meals between 80 and 130 mg/dL (4.44 to 7.2 mmol/L) and your after-meal numbers no higher than 180 mg/dL (10 mmol/L) two hours after eating.

Insulin and Other Medications

Anyone who has type 1 diabetes needs lifelong insulin therapy. Types of insulin are many and include:

- 1) Short-acting (regular) insulin
- 2) Rapid-acting insulin
- 3) Intermediate-acting (NPH) insulin
- 4) Long-acting insulin



Fig. 7. Modern Insulin Product

Artificial Pancreas

In September 2016, the Food and Drug Administration approved the first artificial pancreas for people with type 1 diabetes who are age 14 and older. It's also called closed-loop insulin delivery. The implanted device links a continuous

glucose monitor, which checks blood sugar levels every five minutes, to an insulin pump. The device automatically delivers the correct amount of insulin when the monitor indicates it's needed.

- There are more artificial pancreas (closed loop) systems currently in clinical trials.



Fig. 8. Artificial Pancreas

Other Medications

Additional medications also may be prescribed for people with type 1 diabetes, such as:

- 1) High blood pressure medications. Your doctor may prescribe angiotensin-converting enzyme (ACE) inhibitors or angiotensin II receptor blockers (ARBs) to help keep your kidneys healthy. These medications are recommended for people with diabetes who have blood pressures above 140/90 millimeters of mercury (mm Hg).
- 2) Aspirin. Your doctor may recommend you take baby or regular aspirin daily to protect your heart.
- 3) Cholesterol-lowering drugs. Cholesterol guidelines tend to be more aggressive for people with diabetes because of the elevated risk of heart disease. [20]

Treatments of Type – 2

Management of type 2 diabetes includes:

- 1) Weight loss

- 2) Healthy eating
- 3) Regular exercise
- 4) Possibly, diabetes medication or insulin therapy
- 5) Blood sugar monitoring

These steps will help keep your blood sugar level closer to normal, which can delay or prevent complications.

Diabetes Medications and Insulin Therapy

Some people who have type 2 diabetes can achieve their target blood sugar levels with diet and exercise alone, but many also need diabetes medications or insulin therapy. The decision about which medications are best depends on many factors, including your blood sugar level and any other health problems you have. Your doctor might combine drugs from different classes to help you control your blood sugar in several different ways. Examples of possible treatments for type 2 diabetes include:

- Metformin (Glucophage, Glumetza, others).
- Sulfonylureas.
- Meglitinides.
- Thiazolidinediones.
- DPP-4 inhibitors.
- GLP-1 receptor agonists.
- SGLT2 inhibitors.

Insulin: Some people who have type 2 diabetes need insulin therapy. In the past, insulin therapy was used as a last resort, but today it's often prescribed sooner because of its benefits. Low blood sugar (hypoglycemia) is a possible side effect of insulin [21].

CONCLUSION

Diabetes Mellitus is a metabolic disease in which the level of blood sugar level increases. In DM type-2 diabetes is most common in patients. Gestational-diabetes occurs while pregnancy. It can affect

major organs in your body, including heart, blood vessels, nerves, eyes and kidneys. Type 2 diabetes seems to increase the risk of Alzheimer's disease. Fasting plasma glucose (FPG) test, Oral glucose tolerance test (OGTT), Random blood glucose test and Hemoglobin A1c (glycohemoglobin) are the most common test for diagnosis of DM. Finally DM can't be cured but taking insulin, frequent blood sugar monitoring, eating healthy foods, exercising regularly and maintaining a healthy weight, carbohydrate, fat and protein counting can help to DM patients. *Aloe vera*, bilberry extract, bitter melon, cinnamon, fenugreek, ginger is the some plant based product that can help to DM patients.

Blood sugar level chart for diabetic, prediabetic and non-diabetic patients is given below.

	FASTING	JUST ATE	3 HOURS AFTER EATING
NORMAL	80-100	170-200	120-140
PRE-DIABETIC	101-125	190-230	140-160
DIABETIC	126+	220-300	200+

Fig. 9. Blood Sugar Level Chart

REFERENCES

- 1) https://www.who.int/health-topics/diabetes#tab=tab_1
- 2) "Diabetes Fact sheet N°312". WHO. October 2013. Archived from the original on 26 August 2013. Retrieved 25 March 2014.
- 3) Kitabchi AE, Umpierrez GE, Miles JM, Fisher JN (July 2009). "Hyperglycemic crises in adult patients with diabetes". *Diabetes Care*. 32 (7): 1335–43. doi:10.2337/dc09-9032. PMC 2699725. PMID 19564476.

4) Saedi, E; Gheini, MR; Faiz, F; Arami, MA (15 September 2016). "Diabetes mellitus and cognitive impairments". *World Journal of Diabetes*. 7 (17): 412–22. Doi:10.4239/wjd.v7.i17.412. PMC 5027005. PMID 27660698.

5) Dean L, McEntyre J. The Genetic Landscape of Diabetes [Internet]. Bethesda (MD): National Center for Biotechnology Information (US); 2004. Chapter 1, Introduction to Diabetes. 2004 Jul 7.

6) <https://www.webmd.com/diabetes/guide/types-of-diabetes-mellitus>

7) Diabetes Mellitus: An Overview <https://my.clevelandclinic.org/health/diseases/7104-diabetes-mellitus-an-overview>

8) <https://www.diabetes.org.uk/Guide-to-diabetes/What-is-diabetes/Gestational-diabetes/Symptoms-and-complications/>

9) "Number of women with gestational diabetes underestimated". Diabetes UK.

10) "Gestational diabetes". nhs.uk. 20 October 2017.

11) Everything You Need to Know About Diabetes Medically reviewed by Marina Basina, M.D.—Written by Stephanie Watson—Updated on February 26, 2020 <https://www.healthline.com/health/diabetes#symptoms>

12) What are the symptoms of gestational diabetes? Medically reviewed by Valinda Riggins Nwadike, MD, MPH

— Written by Jenna Fletcher on May 15, 2019

13) Diabetes Mellitus : Causes , Diagnosis and Management January 30, 2017 Category: DISEASES & MANAGEMENT <https://www.aimu.us/2017/01/30/diabetes-mellitus-causes-diagnosis-and-management/>

14) <https://kidshealth.org/en/parents/prevention.html#:~:text=Type%201%20diabetes%20can't,diabetes%20isn't%20usually%20enough.10%20tips%20to%20help%20prevent%20type%202%20diabetes>

15) <https://www.betterhealth.vic.gov.au/health/ten-tips/10-tips-to-help-prevent-type-2-diabetes>

16) <https://www.mayoclinic.org/diseases-conditions/type-1-diabetes/symptoms-causes/syc-20353011>

17) <https://www.mayoclinic.org/diseases-conditions/type-2-diabetes/symptoms-causes/syc-20351193>

18) How does diabetes affect your sex life? Medically reviewed by Janet Brito, Ph.D., LCSW, CST — Written by Rachel Nall, MSN, CRNA on April 5, 2019

19) Diabetes Mellitus, Medically reviewed by Drugs.com. Last updated on Aug 24, 2020.

20) <https://www.drugs.com/health-guide/diabetes-mellitus.html>

21) <https://www.mayoclinic.org/diseases-conditions/type-1-diabetes/diagnosis-treatment/drc-20353017>

22) <https://www.mayoclinic.org/diseases-conditions/type-2-diabetes/diagnosis-treatment/drc-20351199>