Blood glucose level & Diagnosis of DM

Content

I. Glucose homeostasis

II. Definition & types of DM

III. Metabolic and biochemical disturbances in DM

IV. Diagnosis of DM

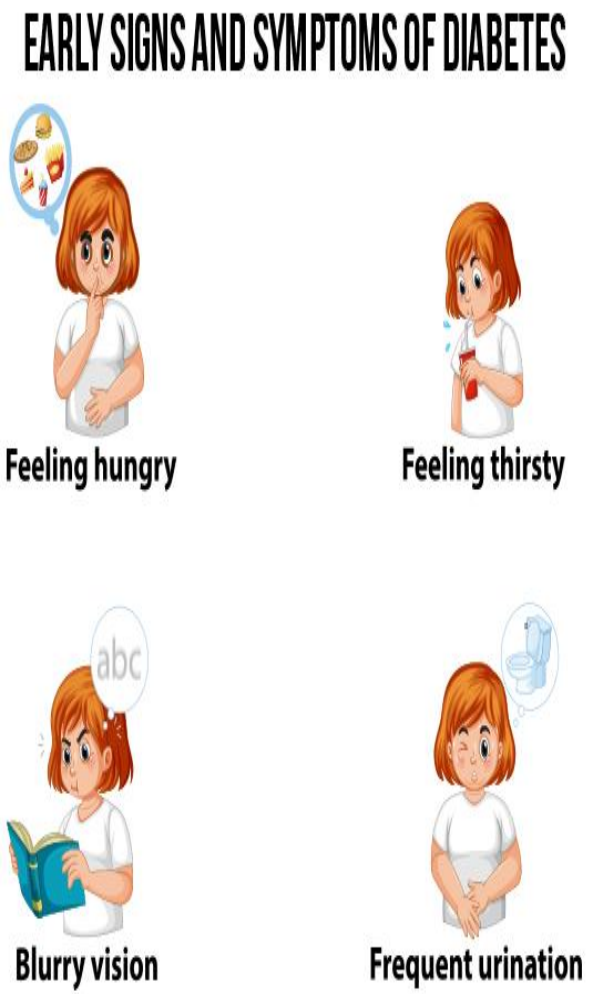
V. Complication of DM

Case scenario

- 45 years old female patient presented to outpatient clinic with frequency of urine, increase appetite, increase water intake accompanied by weight loss and blurred vision , her father had the same symptoms for years and died due to renal failure.

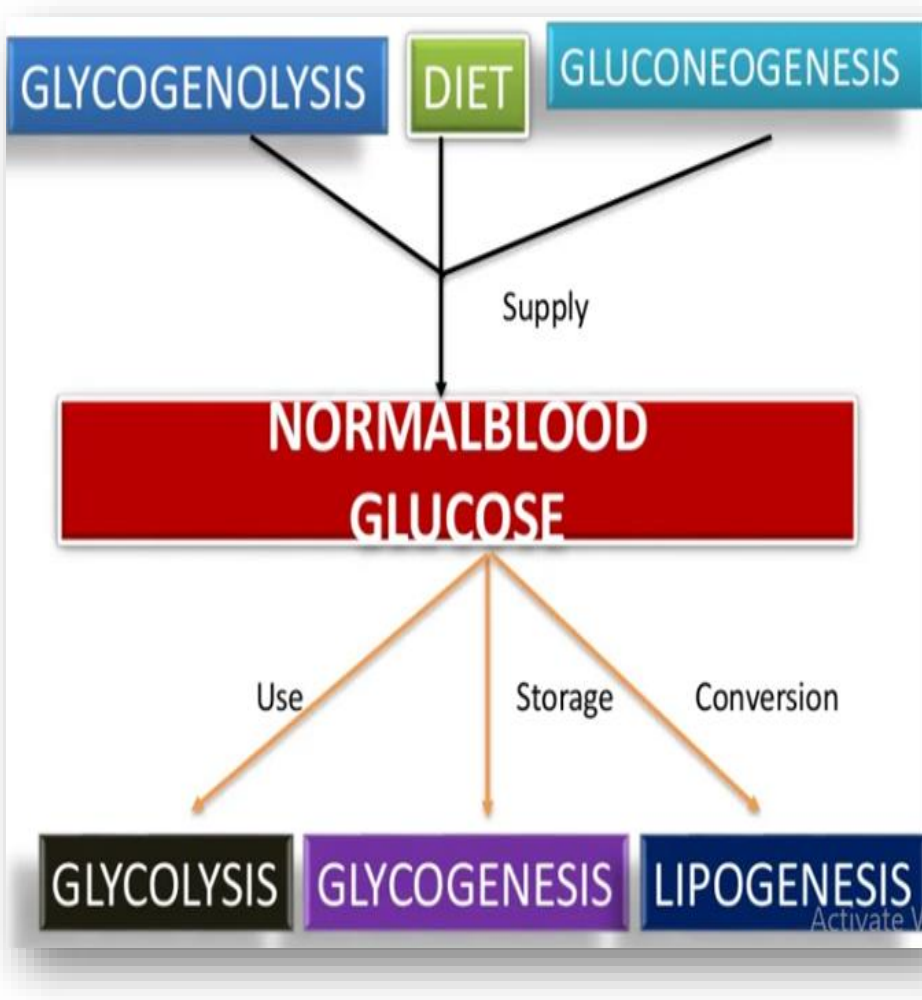
- What is your Provisional Diagnosis ?

- Suggest suitable biochemical tests to be done to confirm the diagnosis and the method required.

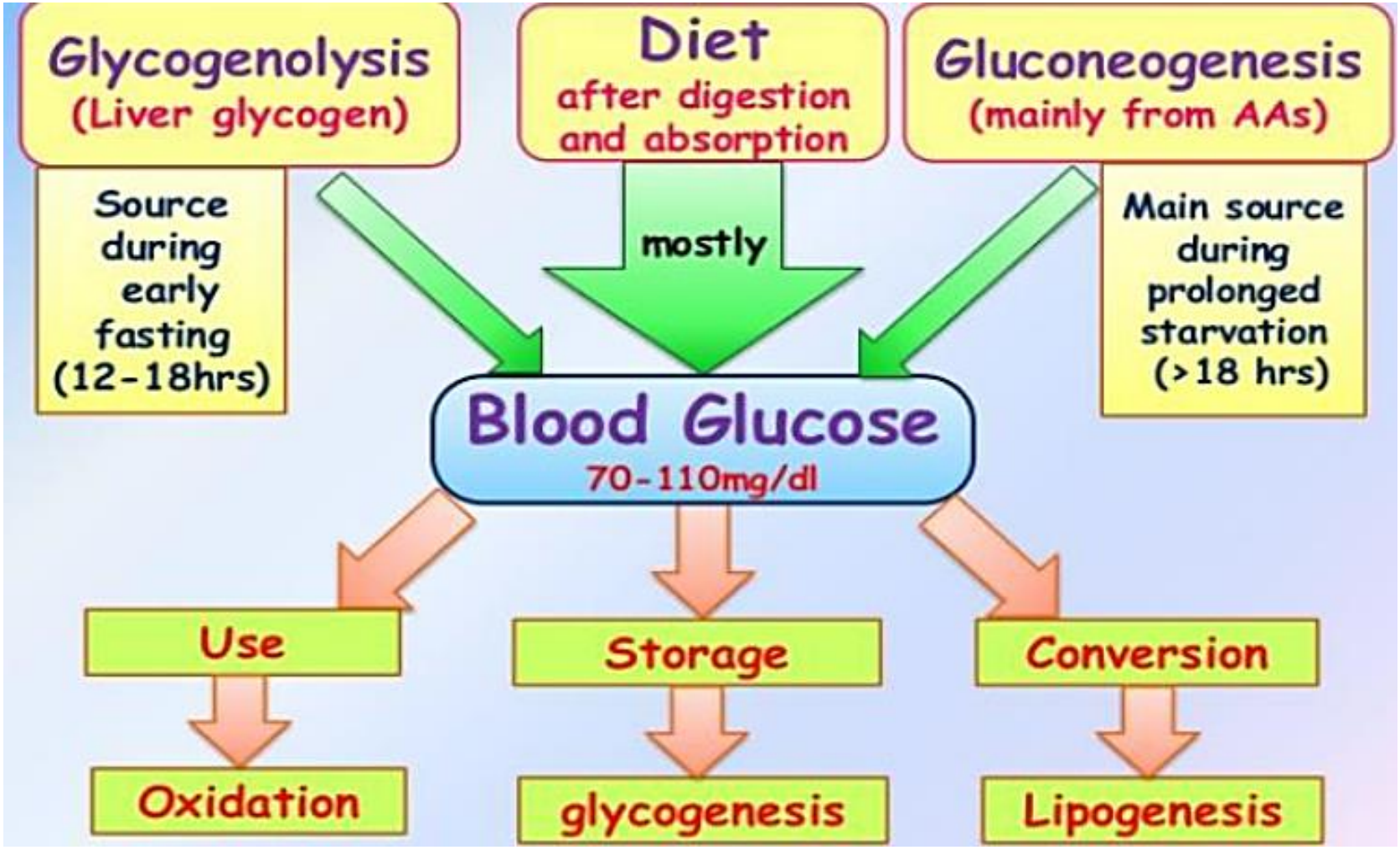


Blood glucose: Introduction

- **Glucose** the main source of energy used by the body cells.
- **Blood glucose level** must be maintained within **narrow limit**.
- The **source** and **fate** of blood sugar It is tightly regulated as a part of metabolic homeostasis.



Sources and fate of Blood glucose



Glucose Homeostasis

- It is the maintenance of blood glucose level within the normal range.

❑ **Normal blood glucose level (fasting)** is **70-110 mg/dl**

❑ **Post-prandial blood glucose level** is **120-140 mg/dl**

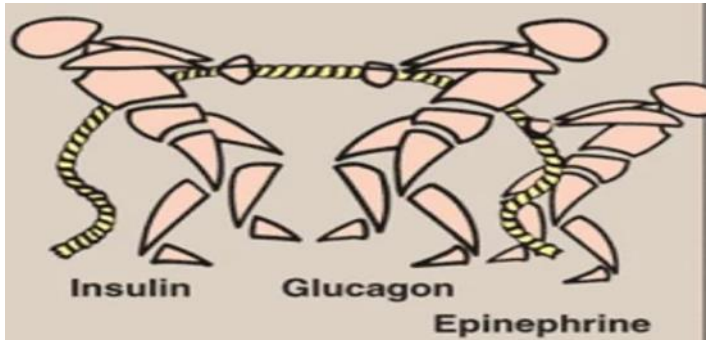
- Above and below these levels is considered as abnormal.

✓ **Hyperglycemia**: Levels above the normal range

✓ **Hypoglycemia:** Levels below the normal range

Regulation of Blood Glucose (Glucose Homeostasis)

- Hormones play important roles in maintaining glucose homeostasis
- The two hormones that directly regulate blood glucose levels are Insulin and Glucagon



Regulation of Blood Glucose (Glucose Homeostasis)

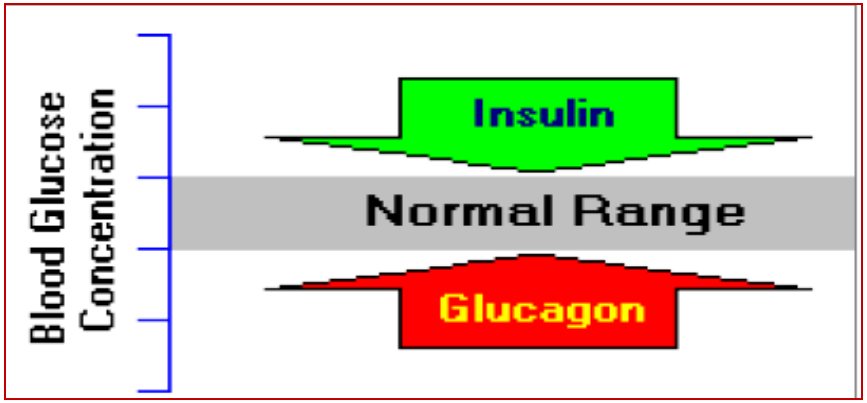
❑This balance is formed of:

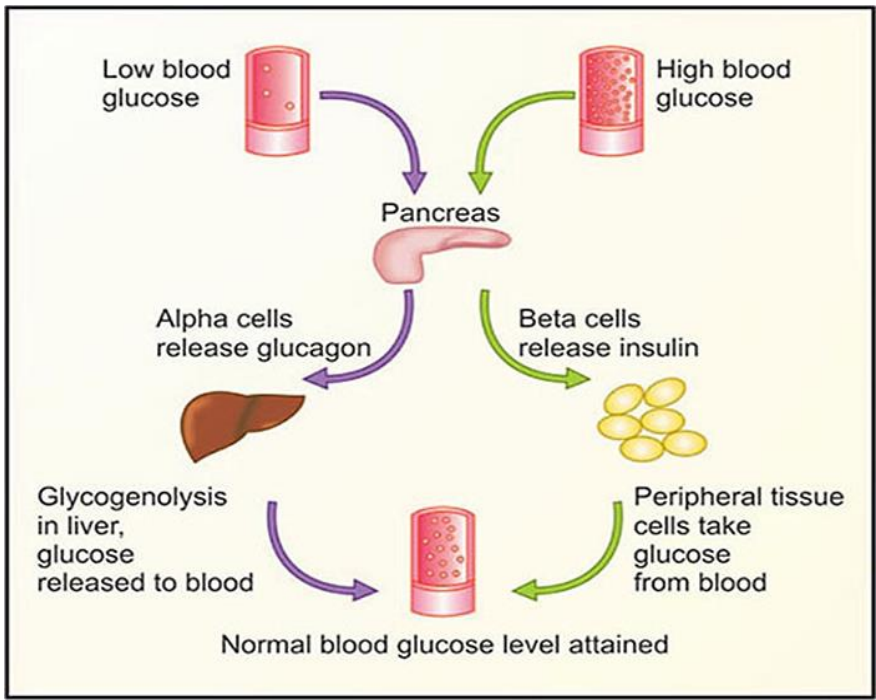
1. Insulin

tends to decrease the blood glucose,

2. Glucagon

tend to increase the blood glucose level.





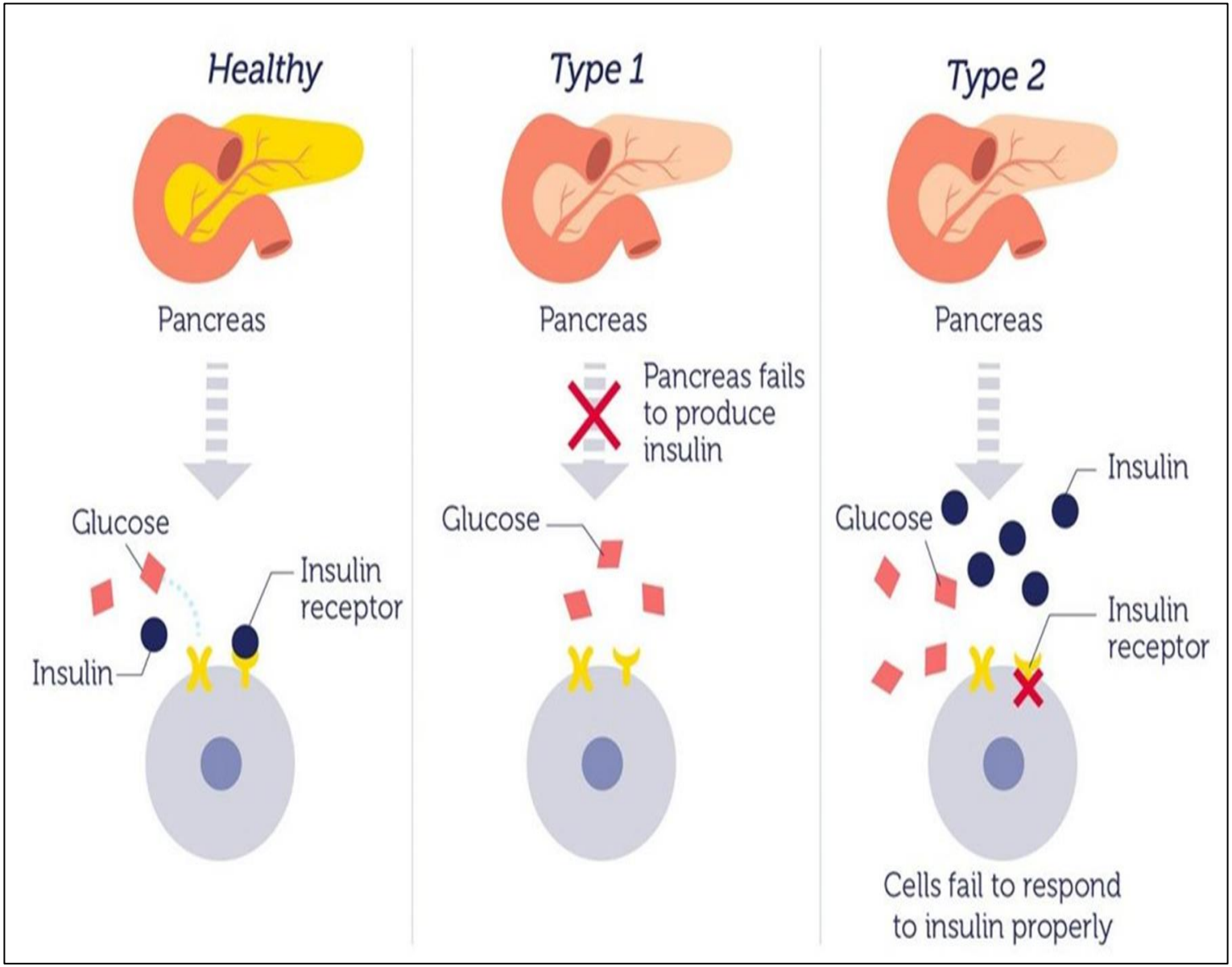
DiABEtES

Diabetes mellitus

❑ Def:-

- Metabolic disorder characterized by chronic **Hyperglycemia**
- Characterized by metabolic disturbances in carbohydrate , lipid and protein metabolism
- **Caused by:** The body either
  - Does not produce enough insulin (**Lack of insulin secretion)** , or
  - Does not properly respond to insulin (**Decreased sensitivity of the tissues to insulin) (insuline resistance)**

-This causes glucose to accumulate in the blood, often leading to various complications.


Healthy
Pancreas
Glucose
Insulin receptor
Insulin
Type 1
Pancreas
Pancreas fails to produce insulin
Glucose
Type 2
Pancreas
Insulin
Glucose
Insulin receptor
Cells fail to respond to insulin properly

Types of Diabetes mellitus

- **Type 1 diabetes:**
  - "Juvenile" diabetes
  - Insulin dependent diabetes mellitus (IDDM)
- **Type 2 diabetes:**
  - "Adult onset" diabetes
  - Non-insulin dependent diabetes mellitu

	IDDM	NIDDM
Onset	Juvenile < the age of 20	Adult > age of 40
Cause	**autoimmune disease** destruction of pancreatic (β cells)	**defective insulin secretion or improper insulin receptors**
Insulin level	↓↓ insulin level	↓↓, normal or ↑↑ insulin level
Treatment	**insulin injections**	**oral hypoglycemic drugs**

Diabetes: Common manifestations

3 P

Polyuria
(excessive urination)

Polydipsia
(excessive thirst & drinking)

Polyphagia
(excessive eating and hunger)

Metabolic and Biochemical Disturbances of DM

- Carbohydrate
- Lipid
- Protein

Metabolic changes of DM

I. On CHO Metabolism

Insulin deficiency leads to:

1. ↓ **glucose uptake** (intracellular glucose transport) by skeletal ms and adipocyte.
2. ↓ **glucose oxidation & utilization**
3. ↓ glycogenesis
4. ↑ **glycogenolysis &↑ gluconeogenesis**

1- Hyperglycemia

The glucose absorbed after a meal is **not metabolized** therefore **accumlates** in the blood

2- Glucosuria

Increased blood glucose causes **loss of glucose in urine**

I. On CHO Metabolism: Continu.

3- Polyuria

- The loss of glucose in the urine causes **osmotic diuresis** .
- The overall effect is **massive loss of the fluid** in the urine **(Dehydration)**
- Polyuria is associated with **loss of H_2O soluble vitamins** as well as **electrolytes as K^+, Na^+.**

4- Polydepsia

Due to fluid loss and hyperglycemia → **thirst sensation.**

5- Polyphagia

(excessive eating and hunger)

II. On Lipid Metabolism

Insulin deficiency leads to:

↑ Lipolysis in adipocytes & ↓ lipogenesis

5- ↑ rate of **catabolism of triglycerides** with mobilization of free fatty acids from adipose tissues **(loss of weight)**

6- ↑↑ **fatty acids oxidation** --> ↑ ketone bodies formation **(ketonemia and ketonuria).**

III. On protein Metabolism

Insulin deficiency leads to:

7- ↑↑ protein catabolism

⟶ (muscle wasting)

8- ↓↓ protein synthesis ⟶ ↓↓ antibodies formation ⟶ the patients liable for

(infections and poor wound healing)

Diagnosis of DM

A) Symptoms and Signs of DM

1- Excessive eating and hunger pain (Polyphagia)

2- Excessive thirst & drinking (Polydipsia)

3- Excessive urination (Polyurea)

4- Weight loss

5- More liability to infection and delayed wound healing

B) Laboratory tests for diagnosis of DM

- Fasting blood glucose
- 2 hours post prandial blood glucose
- Oral Glucose tolerance test
- Glycated hemoglobin(HbA1C)

Diagnosis of DM

Plasma glucose level

Fasting (mg/dl)

Normal	DM
70-110	≥ 126

2 h. Post Prandial (mg/dl)

Normal	DM
Up to 140	≥ 200

Random Blood glucose (mg/dl)

≥ 200

2- Oral Glucose Tolerance Test (OGTT)

Procedure of the test

- The patient is instructed to **fast for 8–12** hours before the test. Then blood and urine samples are taken for glucose determination **(zero time (baseline)** .
- A **glucose load is taken orally**: 1 gm/kg body weight , with maximum of 75 gm glucose in about 250ml water.
- **4 Blood samples** are collected at **30 minutes** intervals over a period **of 2 hours** for glucose measurement (i.e after 0.5, 1, 1.5, and 2 hours).
- All blood samples are subjected to glucose estimation.
- **Graph the results** of blood glucose levels **against time in hours** .

Interpretation of the result of the curve

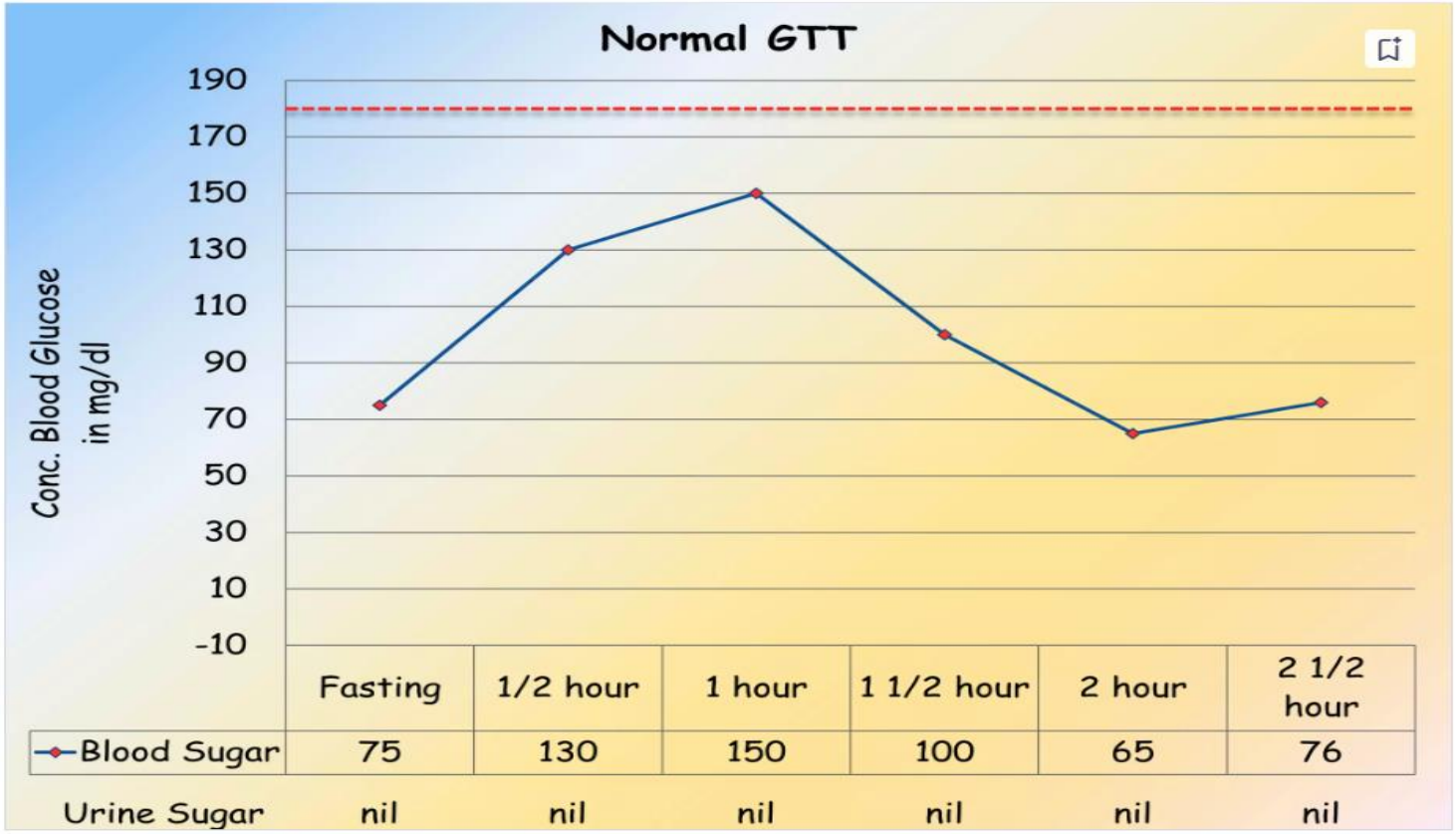
A) Normal OGTT

- **Fasting plasma glucose** level:70-110 mg/dL.

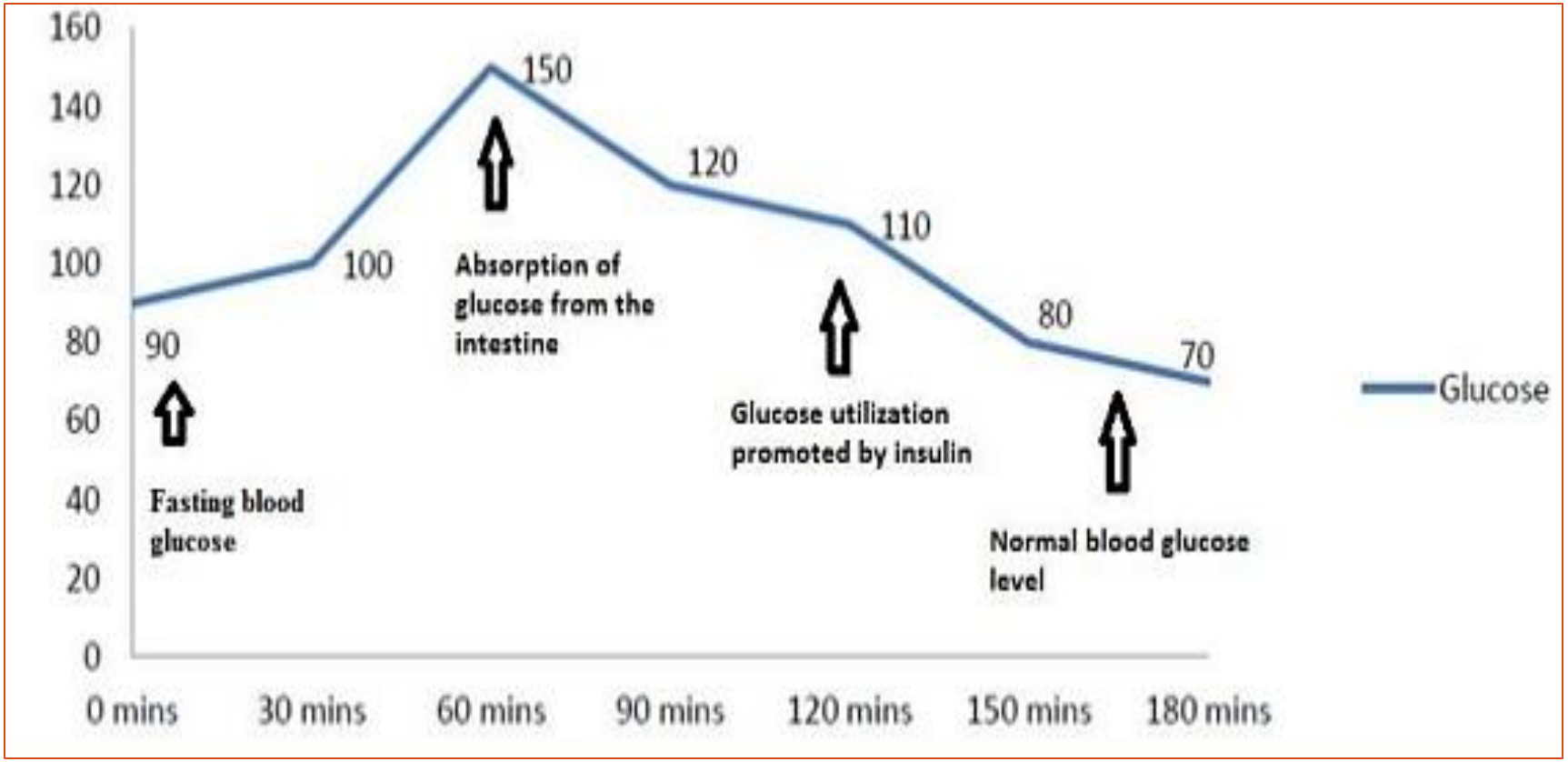
- **The blood glucose level increase gradually** till reaching the **maximum in 1 hour** (120-150 mg/dL). (The ***ascending limb*** of the curve represents **glucose absorption**.)

- **Then the plasma glucose start to decrease gradually** reaching the starting fasting level **after 2-2.5 hours**. (The ***descending limb*** represents **glucose utilization** by the tissues in response to *insulin* secretion.)

- **No glucose in all urine samples** (i.e no glucosuria).



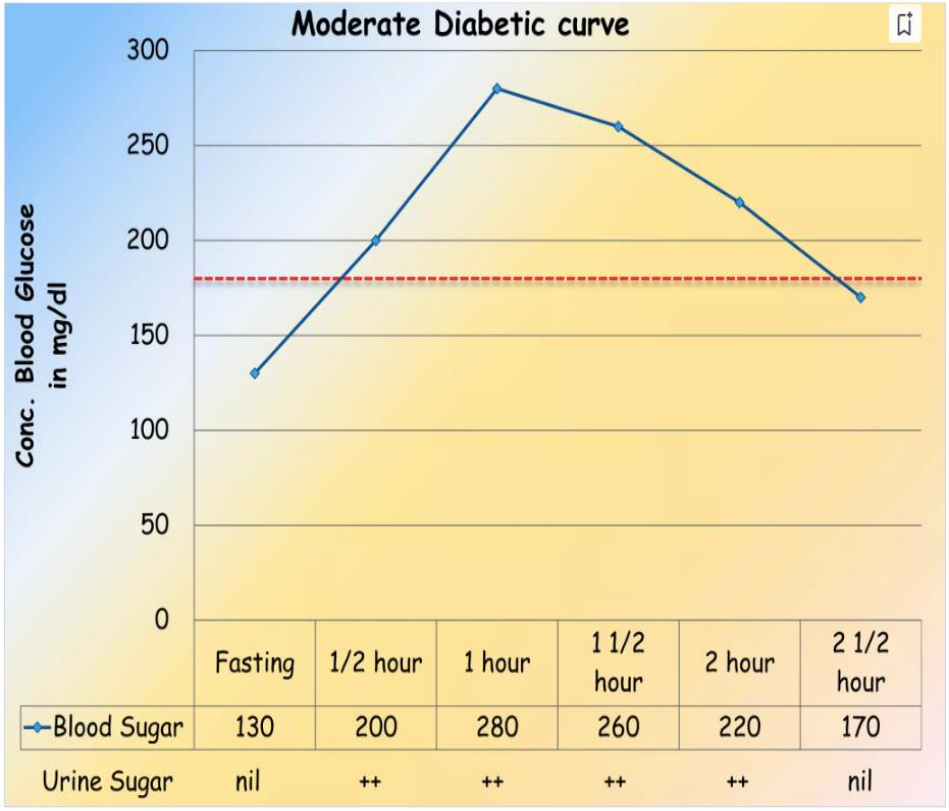
	Fasting	1/2 hour	1 hour	1 1/2 hour	2 hour	2 1/2 hour
Blood Sugar	75	130	150	100	65	76
Urine Sugar	nil	nil	nil	nil	nil	nil

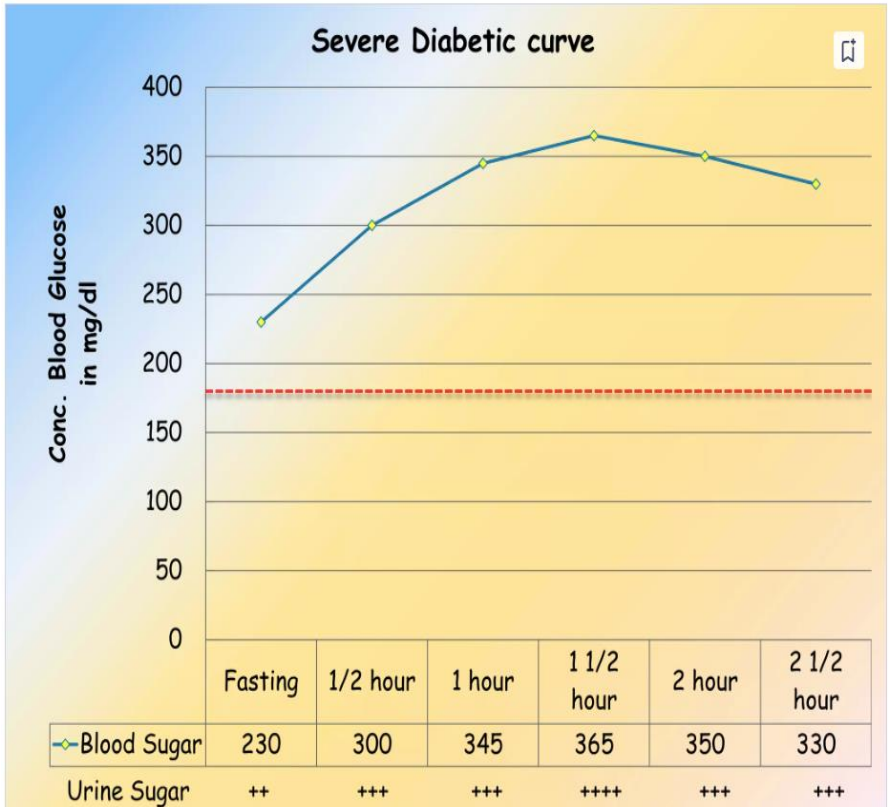


Normal Oral Glucose Tolerance Test

B) Diabetic OGTT

- **Fasting blood glucose** is higher than normal **limit > 126 mg/dl**
- **After glucose ingestion**, blood glucose level will **rise higher** and may exceed renal threshold (>180 mg/dl) leading to glucosuria.
- **The blood glucose remains high for a longer time** (take more than 2 hours to return to the fasting basal level (**the curve is flat**).
- **Urine samples contain glucose**, (i.e glucosuria) if the blood glucose exceed the **renal threshold (180mg/dl)** (rate of glomerular filtration exceed the rate of tubular excretion).


Moderate Diabetic curve
Conc. Blood Glucose in mg/dl
300
250
200
150
100
50
0
Fasting
1/2 hour
1 hour
1 1/2 hour
2 hour
2 1/2 hour
Blood Sugar
130
200
280
260
220
170
Urine Sugar
nil
++
++
++
++
nil


Severe Diabetic curve
Conc. Blood Glucose in mg/dl
400
350
300
250
200
150
100
50
0
Fasting
1/2 hour
1 hour
1 1/2 hour
2 hour
2 1/2 hour
Blood Sugar
230
300
345
365
350
330
Urine Sugar
++
+++
+++
++++
+++
+++

3- Glycated hemoglobin A1c (Hb A1c)

- **Definition:** A hemoglobin A1c is a form of hemoglobin that is non-enzymatically bound to glucose **(glycated hemoglobin).**

- **Uses:** HbA1c test measures the amount of blood glucose attached to hemoglobin, so it give a long-time idea about the control of DM within the previous **2-3 months** (RBCs life span is about 90-120 days), So, it is a good prognostic factor) .

- **Diagnosis of DM using HbA1c**
  - **Normal range**: 4.6 - 5.6%.
  - **Prediabetes**: 5.7- 6.4 %
  - **Diabetes** : ≥ 6.5 %

Complications of DM

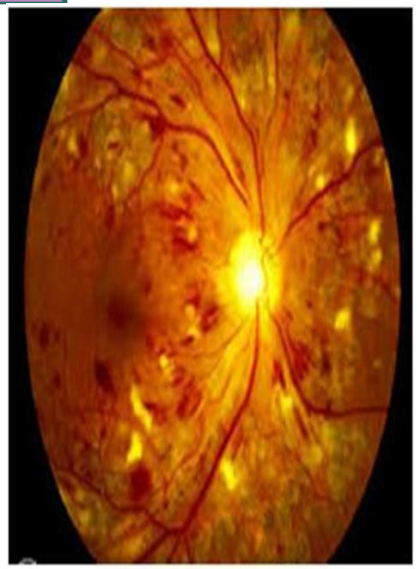
Complications of DM

A) Chronic complications

1) Microvascular complications

Hyperglycemic→ production of oxygen free radicals **(oxidative stress)** → cellular inflammation & injury with **damage of small blood vessel**s leading to:

1- Diabetic nephropathy
2- Diabetic neuropathy
3- Diabetic retinopathy & cataract



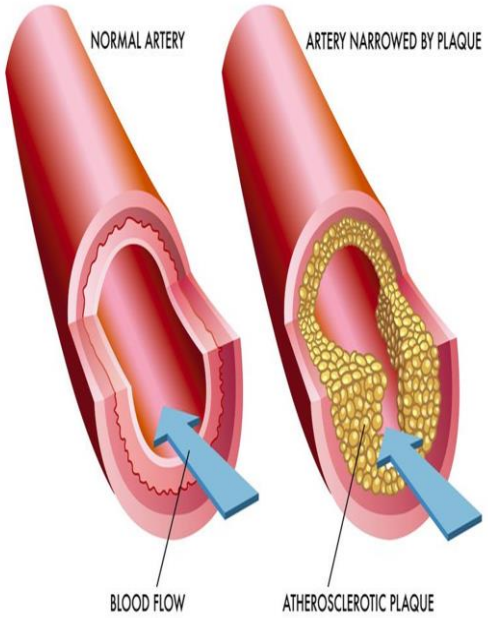
2) Macrovascular complications

Due to **chronic inflammation** and injury of the arterial wall of **large** blood vessels leading to:

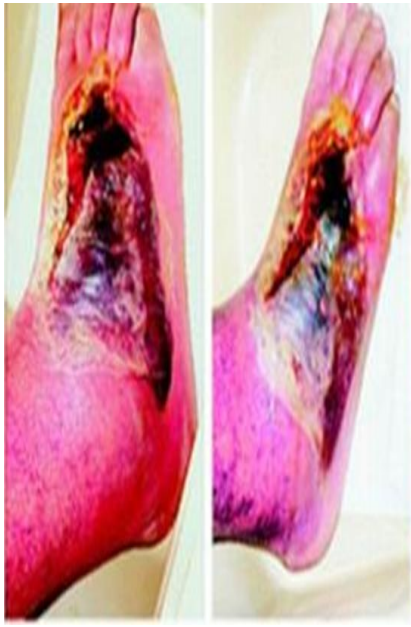
1- Coronary artery diseases like

- **Angina**
- **Atherosclerosis**
- **Myocardial infarction**

2- Diabetic foot ulcer



Atherosclerosis



Diabetic foot

B) Acute complications

Diabetic ketoacidosis:

It is an acute major, life-threatening complication characterized by sever uncontrolled hyperglycemia with ketonemia and ketonuria


Thank You.