Glucose measurement by:

Glucometer

Prof. Dr. Talat Tariq Khalil
Nano-Biochemistry&Clinical biochemistry

Dr. Ammar Hatem Abdullateef
MBChB - F.B.M.S Path. (Chemical pathology)

Dr. Widad Hamaza Shekair

Senior Specialist pediatrician

Introduction

- **Glucometer:** Portable device for capillary blood glucose measurement near the patient, providing immediate results for rapid clinical decisions.

It is as a **Point-of-Care Testing (POCT) Device**

Why Glucometer is a POCT Device:

- **Portable** – used at bedside, clinics, or home.
- **Rapid turnaround time** – gives results within seconds.
- **Minimal sample volume** – only a small capillary drop needed.
- **Used by healthcare staff or patients** – no laboratory setup required.
- **Immediate clinical action** – enables quick management of hypo/hyperglycemia.

main uses of a glucometer:

- - Close monitoring of diabetic patients (especially type I) at home to Improve patient management
- - Emergency hypoglycemia and Diabetic Ketoacidosis (DKA) detection
- - Screening for suspected high-risk cases of Diabetes (need lab testing for confirmation)

Principle of Operation

Electrochemical principle using enzyme-based strips as the following steps:

1-Drop of Blood:

A small capillary blood sample is placed on the test strip.

2-Enzyme Reaction:

The strip contains **glucose-specific enzymes** (*glucose oxidase* or *glucose dehydrogenase*).

Glucose reacts → produces **electrons (** or color change in old devices**)**.

3-Signal Detection:

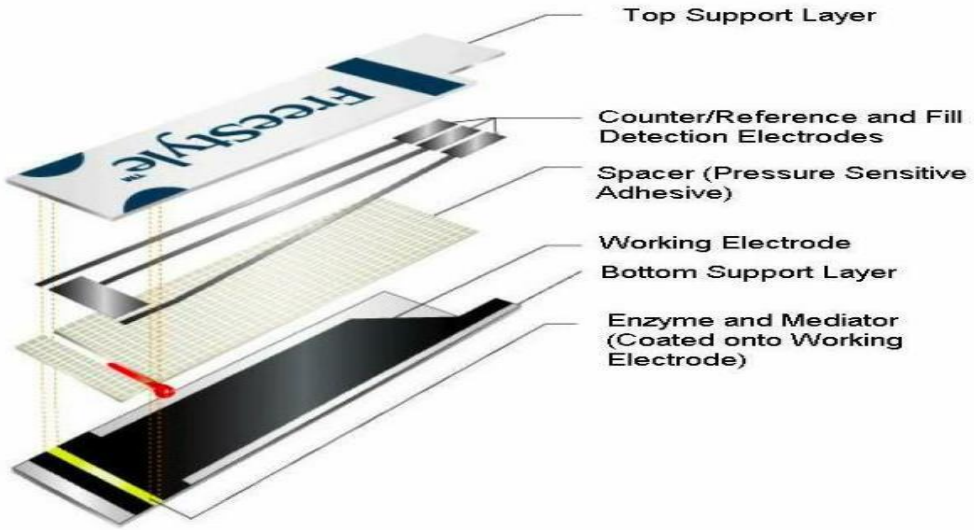
Current generated (or color intensity**)** is measured.

4-Result Display:

Meter converts signal → shows **glucose level** on the screen (mg/dL or mmol/L).

Test Strips

- When blood added, glucose is oxidized by enzyme coated on working electrode
- Voltage applied between working and reference electrode
- Measure current between working and reference electrode



- **Note: Electrochemical** (Amperometric) Glucometers is most commonly used today because it is accurate, fast, and requires small blood volume and better than old **colorimetric** one which is more affected by sample conditions.

Measurement of principle

Enzymatic Oxidation of Glucose The strip contains a specialized enzyme (usually **Glucose Oxidase - GOx** or **Glucose Dehydrogenase - GDH**). This enzyme catalyzes the oxidation of glucose (the removal of electrons from it), which converts glucose into **Gluconic Acid**. During this process, the enzyme itself becomes reduced (an electron acceptor).

$$\text{Glucose} \xrightarrow{\text{Enzyme}} \text{Gluconic Acid} + \text{Reduced Enzyme}$$

Mediator Transfer of Electrons This is where the **Electron Mediator** comes in (a chemical substance like Potassium Ferricyanide). The mediator reacts with the reduced enzyme to take the electrons, which returns the enzyme to its active (oxidized) state and reduces the mediator itself.

$$\text{Reduced Enzyme} + \text{Mediator(Oxidized)} \rightarrow \text{Enzyme(Active)} + \text{Mediator(Reduced)}$$

Current Generation and Measurement The reduced mediator travels to the **electrode** inside the strip, which is connected to the meter. At the electrode, the mediator is re-oxidized (it loses electrons) and returns to its original oxidized state, which releases an **electric current** (electrons).

The glucometer measures the intensity of this electric current. The higher the glucose concentration in the blood, the faster the reaction and the greater the electric current generated.

Components of a Glucometer System

- **1. Meter device –** with displays screen
- **2. Test strip –** contains enzyme
- **3. Lancet device –** Small pen-like device used to prick the finger to obtain a drop of blood. Contains disposable lancets.
- **4. Control solution –** for calibration (Used to check the accuracy of the glucometer and test strips). Contains a known concentration of glucose.

Steps for Glucose Measurement

- 1. Wash and dry hands
- 2. Insert test strip
- 3. Prick fingertip with lancet
- 4. Apply drop of blood
- 5. Wait for reading
- 6. Record or sync results

Sources of Error

- • Improper sample volume
- • Contaminated site
- • Expired strips
- • Hematocrit variation
- • Temperature extremes
- • Medications (Ex: vitamin C, acetaminophen)

Clinical Interpretation

1. Fasting Plasma Glucose (FPG) – after ≥8 hours fasting

- Normal: **70–100 mg/dL**
- Diabetes: **≥126 mg/dL**

2. 2-Hour Postprandial (after meal) or Oral Glucose Tolerance Test (OGTT)

- Normal: **<140 mg/dL**
- Diabetes: **≥200 mg/dL**

3. Random Plasma Glucose (any time of day)

- Diabetes: **≥200 mg/dL** with **symptoms** of hyperglycemia

- **Note:** Glucometer readings **<70 mg/dL** are considered low and need attention because **risk of hypoglycemia**

Case Example

- 55-year-old diabetic with dizziness, sweating
- Glucometer Reading: 52 mg/dL
- → Give oral glucose or IV dextrose
- → Recheck after 15 min

- So Glucometers allow rapid intervention in emergency

Good luck