Estimation of blood glucose in diabetes mellitus

Blood glucose

➢ Blood glucose is normally maintained within a narrow range under various conditions by insulin, glucagon and other hormones

➢ The most common disorder of carbohydrate metabolism is diabetes mellitus characterized by high blood glucose level

➢ Measurement of blood glucose is one of the most commonly performed tests in clinical biochemistry labs of hospitals

Diabetes Mellitus: Common signs, symptoms and Lab results

➢ **Hyperglycemia**

➢ **Polyuria and glucosuria**

➢ **Polydipsia**

➢ **Polyphagia**

Laboratory tests for glucose

➢ **Fasting plasma glucose** is measurement of plasma glucose after 12 hours of fasting (no caloric intake)

➢ Normal level: 3.9-5.6 mmol/l (70-100 mg/dL).

➢ **OGTT (Oral Glucose tolerance Test) and 2-hour post-prandial test:**
Serial measurement of plasma glucose before and after a specific amount of glucose given orally (75g glucose)

Impaired glucose tolerance

When fasting plasma glucose or 2-hour postprandial glucose level is above normal but below diabetic level

Criteria for Diagnosis of DM*

Categories of increased risk for diabetes*

FPG 100-125 mg/dL (5.6-6.9 mmol/L) [IFG]
2-h PG on the 75-g OGTT 140-199 mg/dL (7.8-11.0 mmol/L) [IGT]
A1C 5.7-6.4 percent

FPG: fasting plasma glucose; IFG: impaired fasting glucose; PG: post glucose; OGTT: oral glucose tolerance test; IGT: impaired glucose tolerance; A1C: glycated hemoglobin.

Criteria for the diagnosis of diabetes

1. A1C ≥6.5 percent. The test should be performed in a laboratory using a method that is NGSP certified and standardized to the DCCT assay.*
OR
2. FPG ≥126 mg/dL (7.0 mmol/L). Fasting is defined as no caloric intake for at least 8 h.*
OR
3. Two-hour plasma glucose ≥200 mg/dL (11.1 mmol/L) during an OGTT. The test should be performed as described by the World Health Organization, using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.*
OR
4. In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose ≥200 mg/dL (11.1 mmol/L).

A1C: glycated hemoglobin; NGSP: National glycohemoglobin standardization program; DCCT: Diabetes control and complications trial; FPG: fasting plasma glucose; OGTT: oral glucose tolerance test.
* In the absence of unequivocal hyperglycemia, criteria 1-3 should be confirmed by repeat testing.
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*American Diabetes Association (ADA), 2017

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HEMOGLOBIN A$_{1C}$

- Hemoglobin A$_{1C}$ (A$_{1C}$) is produced due to non-enzymatic glycosylation of hemoglobin

- It is used to estimate glycemic control in the last 1-2 months

- Recommended for the detection of type 2 DM

- HBA$_{1C}$ and fasting plasma glucose are effective in diagnosing diabetes

- Cut-off point of ≥ 6.5 % is used to diagnose diabetes

Comparison of type 1 and type 2 DM

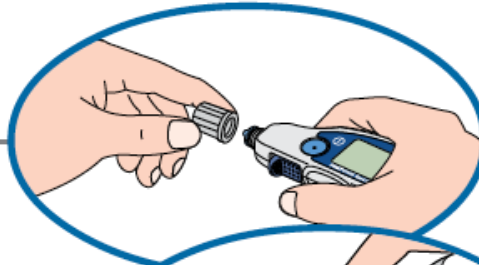|	Type 1 Diabetes	Type 2 Diabetes
Age of onset	Usually during childhood or puberty	Frequently after age 35
Prevalence %	10% of diagnosed diabetics	90% of diagnosed diabetics
Defect or deficiency	β cells are destroyed, eliminating insulin production	Insulin resistance combined with inability of β cells to produce appropriate quantities of insulin
Ketoacidosis	Common	rare
Plasma Insulin	Low to absent	High early in disease; low in disease of long duration
Treatment	Insulin is always necessary	Diet, exercise, oral hypoglycemic drugs, +/- insulin

Ketone Bodies

- Acetone (exhaled by lungs, gives characteristic smell in diabetic ketoacidotic patients)

- Acetoacetate

- β-Hydroxybutyrate

- Produced by the liver and utilized for energy production by peripheral tissues

Measurement of blood glucose level using glucometer
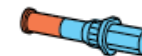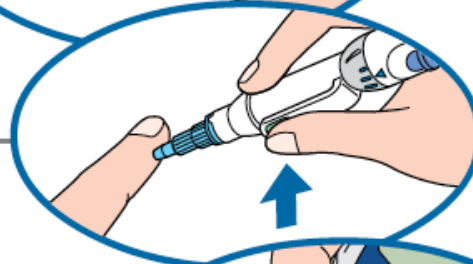

Outline of how to use

Attach the Test TIP

Prick

Draw up blood

Test TIP

Meter

Lancet

Lancing Device

Meter

Beep

Completes the measurement in **10** seconds

After blood is applied to the Test TIP, glucose in the blood reacts with the reagent on the Test TIP, and colours the reagent pad. The Meter measures this colour concentration, and shows the blood glucose level on the display.

Measurement of blood glucose level using glucometer

Instructions:

1. Attach the test tip to the glucometer as shown.

2. The meter will read "OK" indicating that it works properly.

3. Disinfect your fingertip using an alcohol swab.

4. Let it dry.

Outline of how to use

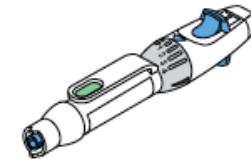Attach the Test TIP — Test TIP — Meter

Prick — Lancet — Lancing Device

Draw up blood — Beep — Meter

After blood is applied to the Test TIP, glucose in the blood reacts with the reagent on the Test TIP, and colours the reagent pad. The Meter measures this colour concentration, and shows the blood glucose level on the display.
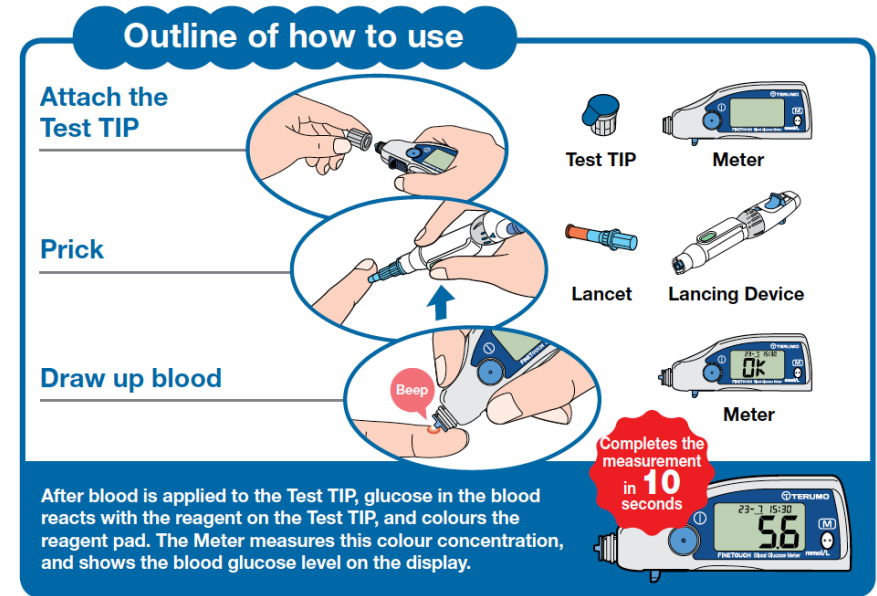
Completes the measurement in **10** seconds

5. Prick the finger using the lancing device.

BIOHAZARD!

The lancet in the lancing device is for single use only. Discard it after use.

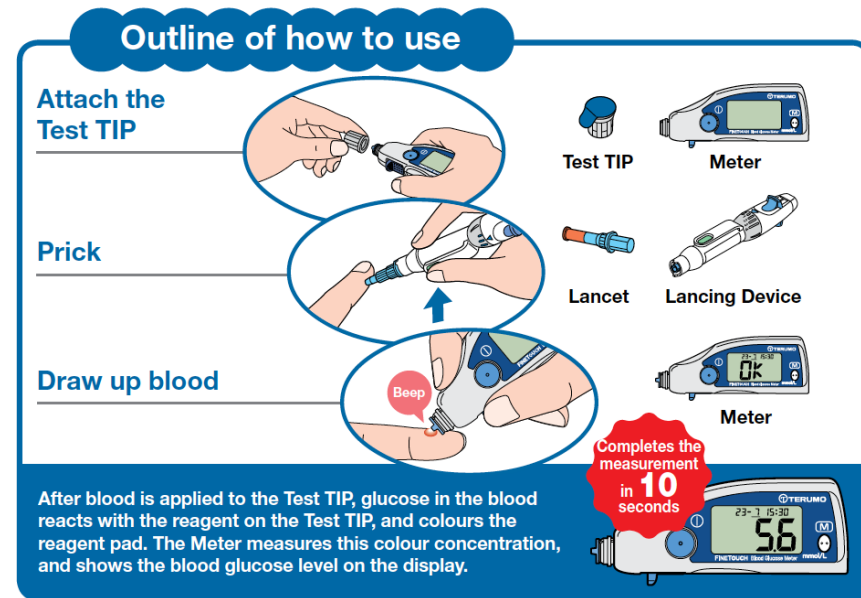# Measurement of blood glucose level using glucometer

Instructions: (Continued...)

6. Draw up blood until the glucometer beeps.

7. Wait for 10 seconds until results are displayed.

8. Results can be read as mmol/L or mg/dL.

9. Interpret your results.

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Prick

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Test TIP   Meter

Lancet   Lancing Device

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5.6

Normal blood glucose range

3.9–5.6 mmol/L (70–100 mg/dL)

Urinalysis using dipstick:

Principle:

➢ **Dipsticks** are plastic strips impregnated with chemical reagents which react with specific substances in the urine to produce color-coded visual results

➢ They provide quick determination of pH, protein, glucose and ketones. The depth of color produced is proportional to the conc. of the substance in urine

➢ Color controls are provided against which the actual color produced by the urine sample can be compared

Procedure:

➢ Dip the dipstick in the urine sample provided

➢ Remove it immediately

➢ Wipe off excess urine

➢ Read the color produced within 60 seconds

➢ Compare color changes with the control charts provided

Test Results and Interpretation

Test	Results	Interpretation
Blood Glucose		
Urine Protein		
Urine Ketones		
Urine Glucose		
Urine pH		

Benefits of self-monitoring of blood glucose level

➢ It allows patients to detect their blood glucose levels without visiting a clinic

➢ It helps patients to immediately confirm hypo or hyperglycemia to avoid complications

➢ It facilitates patient education about diabetes and its management by giving them more self-care responsibilities

➢ It helps to promote well-being of patients