Revised & Approved

Bassam Alasmari
Rania Almutiri

BIOCHEMISTRY TEAM
439

MED439
KING SAUD UNIVERSITY

OSPE : Measurement Of Glucose In Blood And Urine

Editing File

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- Main Text
- Important
- Extra
- Dr.'s Notes
- Girls slides
- Boys slides

Click **here** to watch the practical video (explained by the male's doctor).

439 Doctors' Notes:

- You do <u>not</u> need to memorize the procedures.
- You should know the normal values for diagnosis of diabetes and impaired glucose tolerance.

438 Doctors' Notes:

- The units are important
- You must be able to read the glucose level from a glucose meter
- You must be able to interpret results from a dipstick test
- Memorize the criteria to diagnose DM as in slides

Blood Glucose

- Blood glucose is normally maintained within a narrow range under various conditions by insulin, glucagon and other hormones
- **Diabetes mellitus** is 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

- 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).**

→ **Fasting plasma glucose**

OGTT "Oral Glucose Tolerance Test" and **2-hour postprandial 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

Test	About test	Normal	Increased risk for DM (Pre diabetes)	Diagnosis of diabetes
Fasting plasma glucose	Fasting is defined as no caloric intake for at least 8h	Less than 100 mg/dL	**5.6 - 6.9 mmol/L (IGF)** [1] 100 - 125 mg/dL	**7 mmol/L** **≥ 126 mg/dL**
OGTT (Oral Glucose Tolerance Test) **and 2-hour postprandial test**	2-hour plasma glucose during an OGTT. Test should be preferred as described by the WHO, using a glucose load containing the equivalent of 75g anhydrous glucose dissolved in water	Less than 140 mg/dL	**7.8 - 11 mmol/L (IGT)** [2] 140 - 199 mg/dL	**11.1 mmol/L** **≥ 200 mg/dL**
HbA1c (glycated hemoglobin)	The test should be performed in a laboratory using a method that is NGSP certified and standardized to the DCCT assay	Less than 5.7%	5.7 - 6.4 %	**≥ 6.5 %**
Random blood glucose	The test should be performed in a patient with classic symptoms of hyperglycemia	-	-	**≥ 11.1 mmol** **≥ 200 mg/dL**

1- IGF : impaired fasting glucose
2- IGT : impaired glucose tolerance

Hemoglobin A_{1C}

- Hemoglobin A1C (A1C) 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
- HBA1C and fasting plasma glucose are effective in diagnosing diabetes
- Cut-off point of **≥** 6.5 % is used to diagnose diabetes

Comparison between type I and type II DM

	Type I diabetes	Type II diabetes
Age of onset	Usually during childhood	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 appropriately 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

Glucometer

Principle

The glucometer strip contains **glucose oxidase** enzyme that reacts with blood glucose converting it to gluconic acid.

The Gluconic acid then reacts with ferricyanide on the strip to produce ferrocyanide.

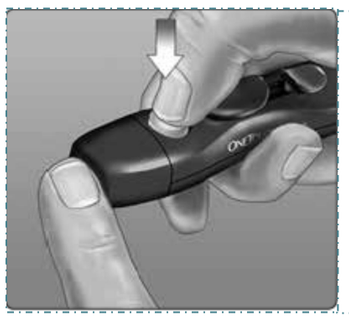
The glucometer detects **ferrocyanide** and displays the numbers on the screen.

The amount of ferrocyanide is equivalent to that of glucose in blood.

Instructions

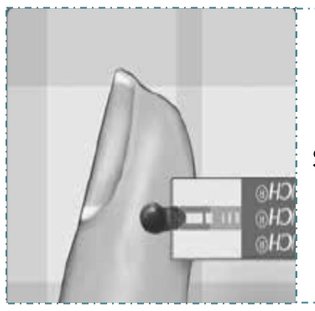
1. Insert the test strip in the glucometer as shown. This will turn on the meter

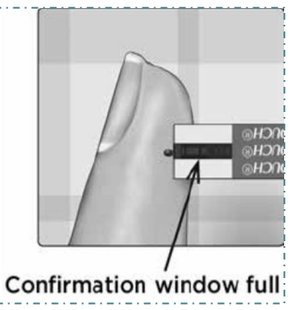
2. Disinfect your fingertip using an alcohol swab. Let it dry. Prick the finger using the lancing device. **CAUTION!** The lancet in the lancing device is for single use only. Discard it after each use.



3. Position the glucometer near your finger as shown.

4. Draw up blood using the strip until the confirmation window is full.





5. Wait for a few seconds until results are displayed. Results can be read as mmol/L or mg/dL.
Then Record and interpret your results.

Normal blood glucose range :

3.9-5.6 mmol/L
(70-100 mg/dL)

Measurement of glucose, protein and ketones by urine strips

Principle

1. Urine strips are impregnated with chemical reagents which react with specific substances in the urine to produce color-coded visual results.
The intensity of the color is proportional to concentration of the substance being detected.

2. 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.

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

-**Glucose:** Glucose oxidase enzyme on the strip reacts with glucose in urine to produce . gluconic acid and hydrogen peroxide that reacts with peroxidase to produce bluish-green, greenish-brown, dark brown color.
-**Protein:** Tetrabromophenol reacts with proteins to produce yellow-green, green, blue- green color.
-**Ketones:** Sodium nitroprusside reacts with ketones to produce pink, pink-purple color.
-**pH:** Bromothymol and methyl red indicators change color due to acidity or alkalinity of urine.

Procedure:

Dip the urine strip in the urine sample provided. → Remove it immediately → Wipe off excess urine → Read the color produced within 30-60 seconds. → Compare color changes with the control charts provided.

Benefits of self-monitoring of blood glucose level

1. It allows patients to detect their blood glucose levels without visiting a clinic.
2. It helps patients to immediately confirm hypo or hyperglycemia to avoid complications.
3. It facilitates patient education about diabetes and its management by giving them more self-care responsibilities.
4. It helps to promote well-being of patients.

Test Results and Interpretation

Test	Results	Interpretation
Blood Glucose	-	Hyperglycemia
Urine Protein	Number/Pluses	Proteinuria
Urine Ketones	Number/Pluses	Ketonuria
Urine glucose	Number/Pluses	Glycosuria
PH	Number	Normally acidic

Quiz (Extra)

1

Blood glucose tests are shown to the right:

A. What is the most likely diagnosis?
B. What are the normal ranges for these tests?

A. Diabetes
B. FPG: 3.8-5.6 mmol/l, A1C: 4-5.6%

Test	Results
FPG	7.2mmol/L
A1C	6.6%

2

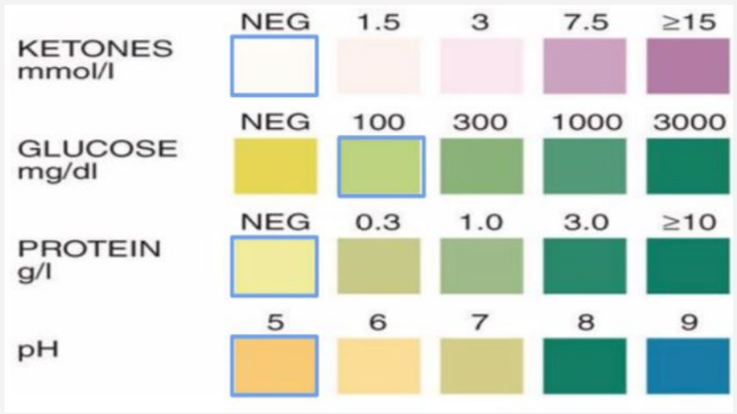
Compare between Type 1 Diabetes and Type 2 Diabetes in terms of ketoacidosis and plasma insulin.

	Type 1 Diabetes	Type 2 Diabetes
Ketoacidosis	Common	Rare
Plasma Insulin	Low to absent	High early in disease; low in disease of long duration

3

A 50 year old male came to this clinic with symptoms of dehydration, polyuria, and polydipsia. A urine sample was taken from him, and the results are shown **on the right**. What are your findings and interpretation?

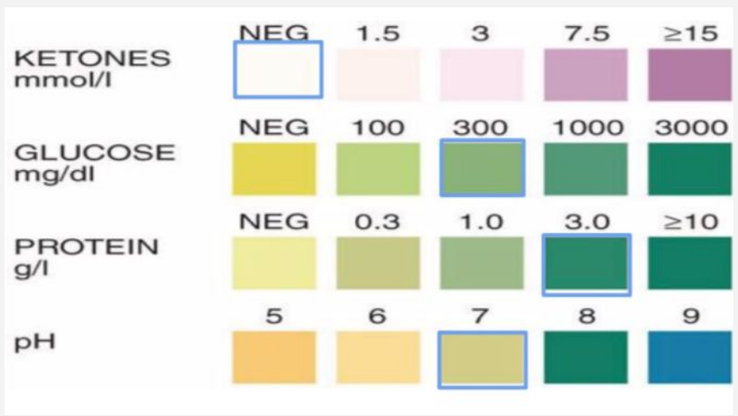
Test	Results	Interpretation
Urine Protein	-	Normal
Urine Ketones	-	Normal
Urine Glucose	100/+	Glycosuria
pH	5	Acidic (normal)



4

A 50 year old male came to this clinic with symptoms of dehydration, polyuria, and polydipsia. A urine sample was taken from him, and the results are shown **on the right**. What are your findings and interpretation?

Test	Results	Interpretation
Urine Protein	3/+	Proteinuria
Urine Ketones	-	Normal
Urine Glucose	300/+	Glycosuria
pH	7	High pH



5

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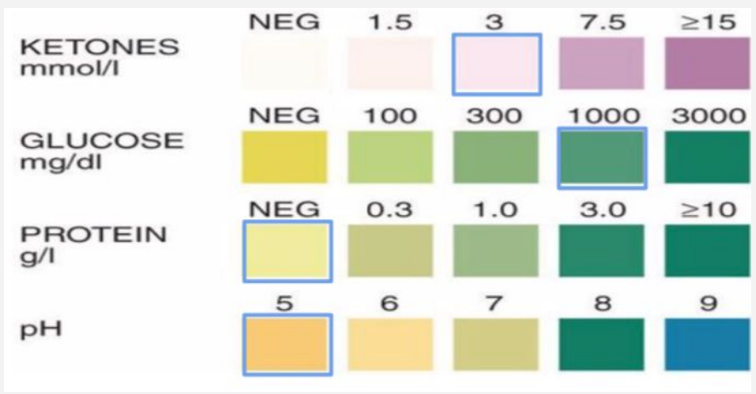
Test	Results	Interpretation
Urine Protein	-	Normal
Urine Ketones	3/+	Ketonuria
Urine Glucose	1000/+	Glycosuria
pH	5	Acidic (normal)



Leaders

Sadeem Alzayed

Ghada Alabdi

Osama Alharbi

Members

Banan Alqady
Budoor Almubarak
Dana Naibulharam
Farah Alsayed
Ghaida Alassiry
Mais Alajmi
Mayasem Alhazmi
Noura Alkathiri
Rania Almutiri
Renad Alhomaidi
Shatha Aldossari
Shayma Alghanoum
Yara Alasmari
Yasmine Alqarni

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Abdulrhman Alsuhaibany
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Ghada Alothman

Mona alomiriny
Norah aldakhil
Reem Alamri

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Lama Alahmadi
Raghad Albarrak
Reem Alqahtani
Nouf Alsubaie

Mohammed Benhjji
Mohammed Beyari
Nawaf Alshahrani

Revisers

Noura Alshathri

Rania Almutiri

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