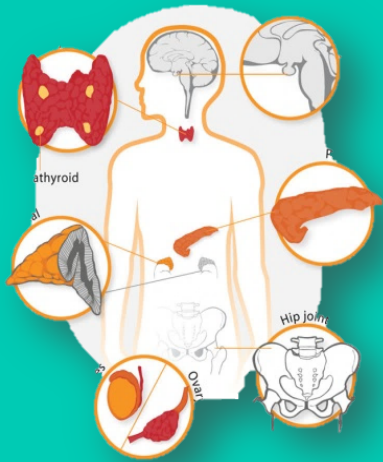


Estimation of blood glucose in diabetes



The Objectives

Not given :\

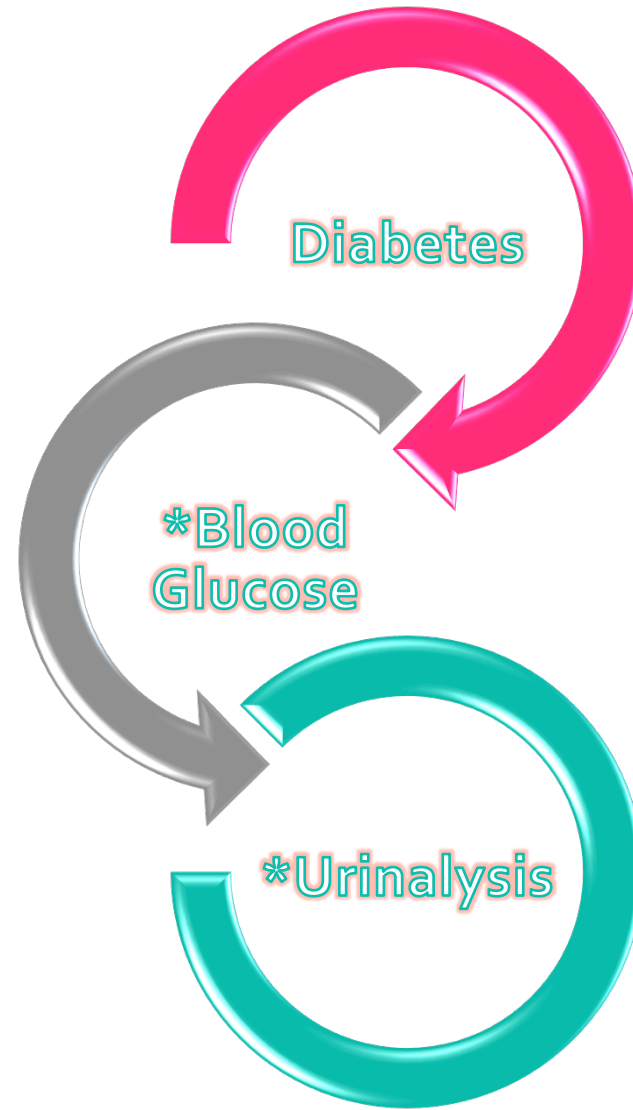
Dr.Reem said that the exam will be one of those 2 questions. Either results of blood test with reference ranges or colored picture of dipstick. We have only to interpret the results so please focus on the questions at the end..

Red = Important

Blue = explain

Green = addition notes

MIND MAP



BACKGROUND :-

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

"DM" Sign & Symptoms :

- ♣ Hyperglycemia
- ♣ Polyuria and glucosuria
- ♣ Polydipsia
- ♣ Polyphagia

Laboratory tests:

- ♣ 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 of diagnosis:-



Normal references will be given but know the values of pre-diabetes

Criteria for the diagnosis of diabetes

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

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).

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

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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Not important but read the red note!

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 $\geq 6.5\%$ is used to diagnose diabetes

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

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



BACKGROUND :-



Not important

Principle:

- Blood glucose is detected by a series of enzymatic reactions that ultimately form a colored product.
- The intensity of color is **proportional** to the amount of glucose present in blood
- Color intensity is determined spectrophotometrically by measuring the absorbance of the colored solution at a wavelength of 546nm

	Test	Standard	Blank
<u>Reagent</u>	2.5 ml	2.5 ml	2.5 ml
<u>Sample</u>	25 μ l	-	-
<u>Standard</u>	-	25 μ l	-
<u>H₂O</u>	-	-	25 μ l

$$\text{Glucose conc (mmol/l)} = \frac{\text{Abs of sample}}{\text{Abs of standard}} \times \text{Conc of standard (5.6 mmol/l)}$$

Urinalysis :-



Not important

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 :-

1) Dip the dipstick in the urine sample provided

2) Remove it immediately

3) Wipe off excess urine

4) Read the color produced within 60 seconds

5) Compare color changes with the control charts provided

Q1 :- What is your Interpretation of the results ?

	Patient A	Patient B	Patient C	Normal values	Pre-diabetic	Diabetic
<u>Fasting Blood Glucose</u>	12	5	6.5	<5.6	5.6-6.9	>=7
<u>HbA1C</u>	9%	4 %	6 %	<5.7	5.7-6.4	>=6.5
<u>Serum Ketones</u>	50 mg\dl	Negative	Negative	Negative	----	----
<u>Urine ketones</u>	++	Negative	Negative	Negative	-----	-----
<u>pH</u>	5	7	7	6.5-7.5	-----	-----

Please Memorize The Red values

The Interpretation

Patient A

- *Fasting blood glucose increased "Hyperglycemia" and this indicates that the patient is **diabetic**
- ***HbA1C is raised** which indicates "Hyperglycemia" and this confirms that the patient is **diabetic**. Also, his blood glucose level was uncontrolled "high" for the last 2 months.
- *Serum ketone is high "**Ketonemia**" and this indicates the patient has **DKA**.
- *The presence of ketone bodies in urine "**ketonuria**" and this indicates that the patient **has DKA**.
- * **Low pH** of urine "Acidic urine" and this indicates presence of **ketones in urine**.

Patient B

All the results are normal

Patient C

- *Fasting blood glucose is higher than normal BUT not diabetic "**Impaired Fasting Glucose**" and this indicate that the patient is at high risk to become diabetic
- *HbA1C is raised but not for the level of being diabetic (**pre-diabetic**)Also, his blood glucose level was uncontrolled "high" for the last 2 months.

Q2\

	Patient	Normal values
<u>Fasting Blood Glucose</u>	9 mmol\L	Previous slide
<u>HbA₁C</u>	8 %	Previous slide
<u>Urine glucose</u>	50 mg\dl	Negative
<u>Urine ketones</u>	++	Negative
<u>pH</u>	5	5
<u>K⁺</u>	5.5	3.5-5
<u>Anion gap</u>	35.5	7-16

Very important !*_*

A- What is your Interpretation of the results ?

- ✓ Fasting blood glucose is increased "Hyperglycemia" and this indicates that the patient is diabetic
- ✓ HbA₁C is raised which indicates "Hyperglycemia" and this confirms that the patient is diabetic. Also, his blood glucose level was uncontrolled "high" for the last 2 months.
- ✓ The presence of glucose in urine "Glucosuria" and this indicates that the patient has high blood glucose level. And the glucose filtration level is abnormally higher than the kidney threshold.
- ✓ "Ketonuria" because of increase the ketones production thus confirms DKA
- ✓ Increase the potassium "Hyperkalemia" due to decrease its uptake that caused by insulin deficiency
- ✓ High anion gap because of increase the ketone bodies(acidosis)

B-What is the most likely diagnosis ?

Diabetes Ketoacidosis

Very important !*_*_

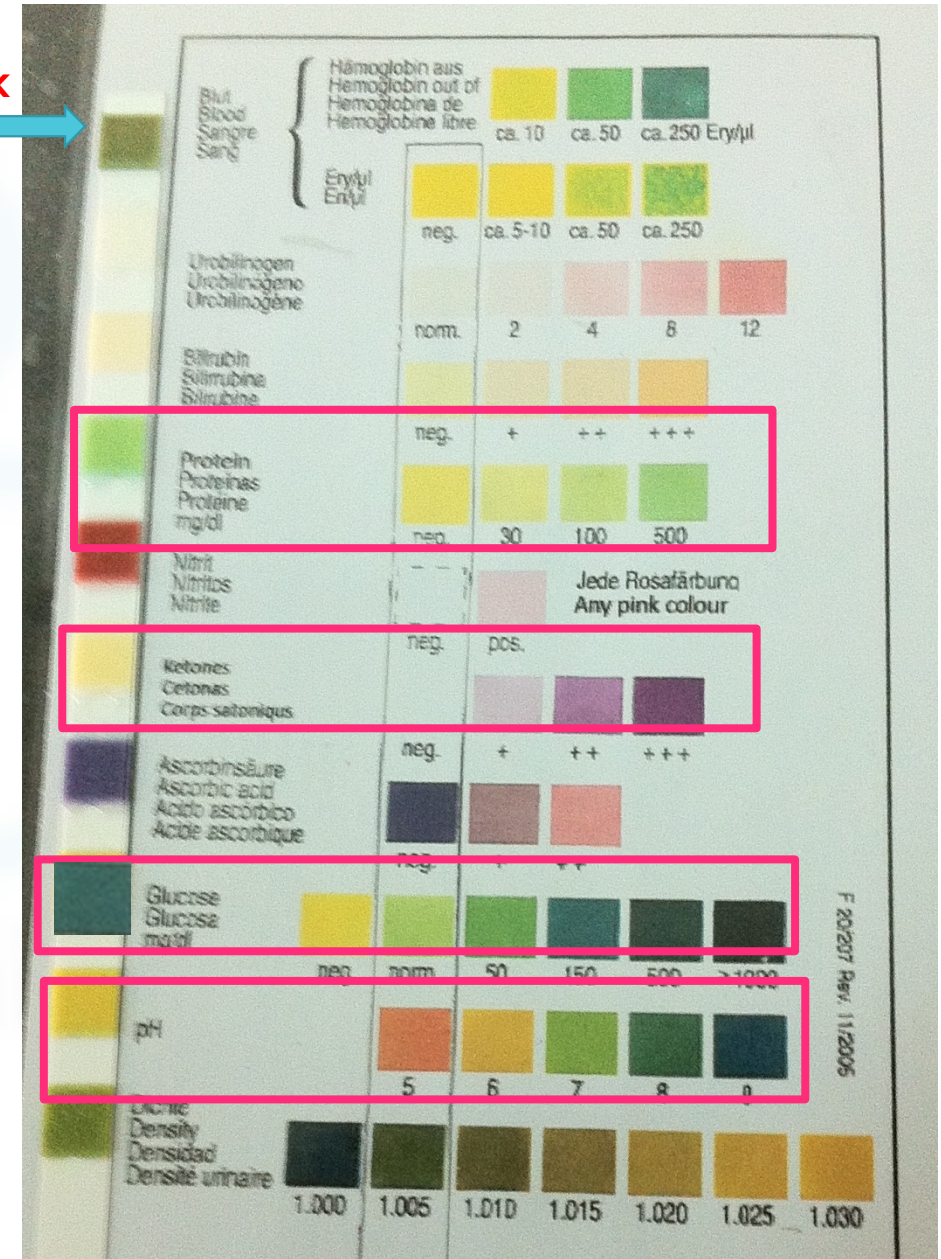
Q3\ A 44-year-old female, comes to the clinic for regular checkup. The physician arranges some tests. A- Interpret the results ?

	<u>Observation</u>	<u>Comment</u>
<u>Protein</u>	Presence of Protein in urine 500	Proteinuria
<u>Glucose</u>	Presence of Glucose in urine 150 (And the glucose filtration level is abnormally higher than the kidney threshold)	Glucosuria
<u>Ketones</u>	Negative	Normal
<u>pH</u>	6	Acidic urine

B-What is the most likely diagnosis ?

Diabetes Mellitus with nephropathy → (proteinuria).

Dipstick



Very important !*_*

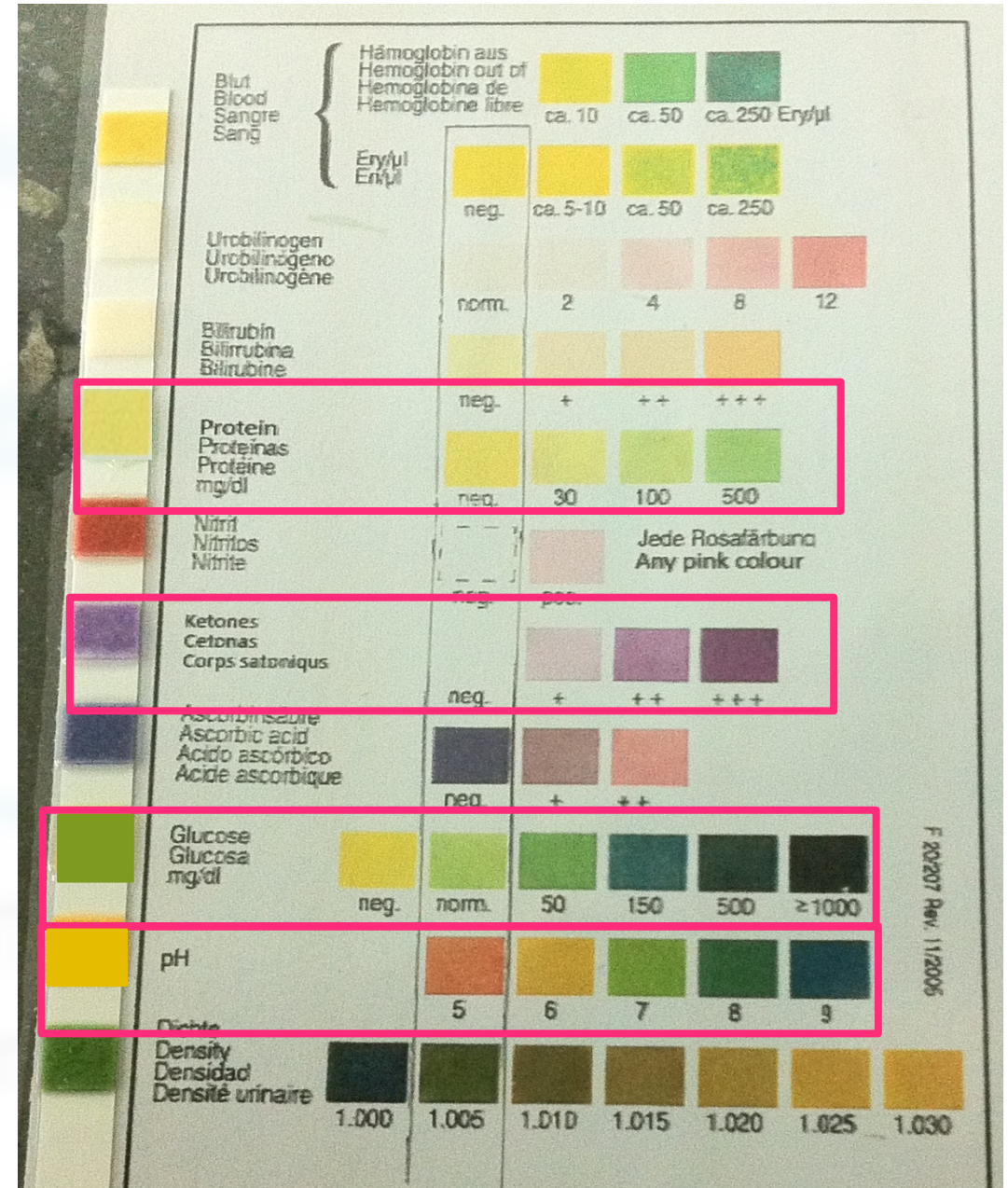
Q4\ A 60-year-old diabetic, comes to the ER. On examination, he looks confused & weak. He is Hypotensive and has a rapid pulse and breath. The physician did a dipstick. The result are shown in the figure :

A- Interpret the results ?

	<u>Observation</u>	<u>Comment</u>
<u>Protein</u>	Negative	Normal
<u>Glucose</u>	Presence of Glucose in urine 50	Glucosuria
<u>Ketones</u>	Presence of ketone bodies in urine +++	Ketonuria
<u>pH</u>	6	Acidic urine

B-What is the most likely diagnosis ?

Diabetes Ketoacidosis.



الصور والألوان راح تكون أوضح =)



If you find any mistake, please contact us:
Biochemistryteam@gmail.com

**Biochemistry team leaders:
Basil ALSuwaine And Manar AlEid**

Thank you

