

# Blood glucose measurement and urinalysis/endocrine worksheet

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## Oral glucose tolerance test

The OGTT evaluates the efficiency of the body to metabolize glucose and has been regarded as the "gold standard" for diagnosis of diabetes. Diabetes symptoms do not appear until the pathology has become well established, sometimes for years. Glycaemia monitoring remains the best method to detect pre-diabetic states and also make people sensitive to the influence of their lifestyle (BMI, exercise, foods etc.) on the physiology of their body and on their health.

The test takes places after an overnight fast (minimum 8 hours). A blood test is taken before the patient is asked to consume a drink containing 75g glucose. Samples of blood are collected at regular intervals (such as 30min, 60min, 90min) or at 120min after glucose ingestion. World Health Organization-defined glucose levels are shown in Table 1.

Table 1. 2006 WHO recommendations for diagnostic criteria for diabetes and intermediate hyperglycaemia

	Normal	Impaired glucose tolerance	Diabetes mellitus
Fasting	< 6.1 mmol/L	< 7.0 mmol/L	≥ 7.0 mmol/L
OGTT (2h)	< 7.8 mmol/L	≥ 7.8 and < 11.1 mmol/L	≥ 11.1mmol/L

Absorption of a meal rich in carbohydrate (such as in the OGTT) acutely elevate the blood glucose level, and we rely on control systems to monitor such changes and make appropriate adjustments, maintain blood glucose within a relatively narrow range (4 – 8mmol/L).

1. Describe how blood glucose is controlled - which hormones are involved, what processes do they regulate? (300 words)

Foods will have different effects on blood glucose both due to the body's state of health and the composition of the food. Glycaemic index (GI) is a measure of how rapidly the carbohydrates in a food lead to an elevation in blood glucose; a food with a high GI (such as chocolate, biscuits) raises blood glucose more than a food with a medium or low GI (wholemeal bread, beans). Glycaemic load (GL) relates to the overall effect a food has on blood sugar, the total amount of digestible carbohydrates in a food.

In a study to examine the effects of glycaemic load on postprandial blood glucose, the following data were obtained: Table 2 shows the summary data for each of the "treatments" in normal healthy subjects (aged 20-25 years). Included also is the OGTT of a normal healthy subject and that of a patient with diabetes mellitus in which an OGTT was performed in the diagnosis of her condition.

Table 2. Mean blood glucose (mmol/L) for treatment GL groups (n=8), sampling following an overnight fast and at intervals after ingestion of a "meal"

	Fasted	30 min	60 min	120 min
OGTT, normal	4.4	7.6	8.4	6.2
OGTT, diabetes	7.2	10.8	13.4	12.8
HGL	4.6	8.1	7.3	6.3
MGL	4.4	6.3	6.2	5.5
LGL	4.5	5.2	4.8	4.5

Treatments groups:

- OGTT 75g glucose in 250mL water (75g CHO, 300 Kcal)
- HGL (high GL) Energy drink and pop tart (102g CHO, 521 Kcal)
- MGL (medium GL) Bagel, peanut butter, banana (89g CHO, 565 Kcal)
- LGL (low GL) Ham, cheese (12g CHO, 520 Kcal)

2. Using graph plot on Excel, draw a suitable graph to represent the data for the two OGTT test results. Describe the responses to the oral glucose test. (100 words)
3. Using the same graph, represent the data for the three GL meals. Attach the generated graph to this document. What conclusions can be drawn? (100 words)
4. Consider the following: how does the physical state of the meal (solid vs. liquid, cooked vs. uncooked, high fibre vs. low fibre) affect digestion and absorption rates (and hence postprandial blood glucose)? (100 words)

5. What are the disadvantages to regularly consuming meals high in fat and low in carbohydrates? (200 words)
6. What is the function of fasting a minimum of 8 hours before an OGTT? (50 words)

## Case Studies

### CASE STUDY 1

A 55-year old woman reports of intense thirst and recurrent vaginal thrush infections. On further questioning, she describes frequent trips to the toilet and blurring of her vision.

A physical examination reveal a height of 5'3" (1.60m), weight of 12 stone 9lbs (80kg), and blood pressure of 160/100mmHg (normal <140/90). A simple "pin-prick" blood test reveals a random blood glucose of 17mmol/ L (normal < 11.1 mmol/ L).

A provisional diagnosis of type 2 diabetes is made.

1. Comment on the presenting symptoms, explain the physiological processes that lead to their presentation in this patient. (100 words)

2. How would you interpret the physical examination and blood test?  
(BMI = weight (kg)/height (m)<sup>2</sup> Ideal 18.5 – 25; overweight 25 – 30; obese 30 – 40)  
(100 words)

3. If left untreated, this patient is at increased risk of which of the following (circle all those that are appropriate):

nephropathy, hypoglycaemia, retinopathy, myocardial infarction, stroke, neuropathy, diabetic ketoacidosis, muscle-wasting, hyperglycaemia, cold intolerance, postural hypotension

4. How should this patient be managed? (100 words)

## **CASE STUDY 2**

A 50-year old man reports of weight loss, despite increased appetite and more frequent bowel movements over the recent weeks. His resting heart rate is 82bpm and blood pressure is 110/76. He complains of palpitations. The doctor notices that there is also a slight bulging of the eyes and firmness around the front of the neck.

1. What is your initial diagnosis?
  
2. Which symptoms are consistent with your diagnosis? Explain how these symptoms arise. (100 words)
  
3. Regarding your diagnosis, is this a primary or secondary endocrine disorder? Explain your answer. (50 words)
  
4. What would you expect the levels of T3, T4 and TSH to be in this patient?

Finally, in a second patient with a lack of iodine in the diet:

- a) Thyroid hormones: high or low?
- b) Is this hypothyroidism or hyperthyroidism?
- c) Levels of TSH – low, normal or high?
- d) Presence of a goitre?

## Urine testing

The test results for 6 people (6 test samples including a control) are in the sheets below, determine the common or major pathological cause (if appropriate).

Test sample 1- Normal

Observation of urine: Yellow, clear

Test results:

<b>BILIRUBIN</b>	NEGATIVE <input checked="" type="checkbox"/>	+ <input type="checkbox"/>	++ <input type="checkbox"/>	+++ <input type="checkbox"/>			
<b>UROBILINOGEN</b>	Normal <input checked="" type="checkbox"/>	35 <input type="checkbox"/>	70 <input type="checkbox"/>	140 <input type="checkbox"/>	200 micro-mol/l <input type="checkbox"/>		
<b>KETONE</b>	NEGATIVE <input checked="" type="checkbox"/>	Trace <input type="checkbox"/>	+ <input type="checkbox"/>	++ <input type="checkbox"/>	+++ <input type="checkbox"/>		
<b>GLUCOSE</b>	NORMAL <input checked="" type="checkbox"/>	2.8 <input type="checkbox"/>	5.6 <input type="checkbox"/>	14 <input type="checkbox"/>	28 <input type="checkbox"/>	56+ mmol/l <input type="checkbox"/>	
<b>PROTEIN</b>	NEGATIVE <input checked="" type="checkbox"/>	Trace <input type="checkbox"/>	30 <input type="checkbox"/>	100 <input type="checkbox"/>	500 mg/dl <input type="checkbox"/>		
<b>BLOOD</b> (Ery. / micro-l)	NEGATIVE <input checked="" type="checkbox"/>	+ <input type="checkbox"/>	++ <input type="checkbox"/>	+++ <input type="checkbox"/>	5-10 <input type="checkbox"/>	50 <input type="checkbox"/>	300 <input type="checkbox"/>
<b>NITRITE</b>	NEGATIVE <input checked="" type="checkbox"/>	POSITIVE <input type="checkbox"/>					
<b>pH</b>		5.0 <input type="checkbox"/>	6.0 <input checked="" type="checkbox"/>	6.5 <input type="checkbox"/>	7.0 <input type="checkbox"/>	8.0 <input type="checkbox"/>	9.0 <input type="checkbox"/>
<b>SPECIFIC GRAVITY</b>	1.000 <input type="checkbox"/>	1.005 <input type="checkbox"/>	1.010 <input checked="" type="checkbox"/>	1.015 <input type="checkbox"/>	1.020 <input type="checkbox"/>	1.025 <input type="checkbox"/>	1.030 <input type="checkbox"/>
<b>LEUCOCYTES</b> (Leuko /microL)	NEGATIVE <input checked="" type="checkbox"/>	25 <input type="checkbox"/>	75 <input type="checkbox"/>	500 <input type="checkbox"/>			

What is the purpose of this control (normal) urine sample in this investigation?

Test sample 2

Observation of urine: Yellow, clear

Test results:

<b>BILIRUBIN</b>	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>UROBILINOGEN</b>	Normal <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>KETONE</b>	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>GLUCOSE</b>	NORMAL <input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>PROTEIN</b>	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>BLOOD</b> (Ery. / micro-l)	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>NITRITE</b>	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>			
<b>pH</b>		<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>SPECIFIC GRAVITY</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>LEUCOCYTES</b> (Leuko /microL)	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Provide an explanation for the outcomes  
Indicate a common or major pathological cause (where appropriate)

Test sample 3

Observation of urine: Yellow, clear

Test results:

<b>BILIRUBIN</b>	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
<b>UROBILINOGEN</b>	Normal <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
<b>KETONE</b>	NEGATIVE <input type="checkbox"/>	Trace <input type="checkbox"/>	+ <input checked="" type="checkbox"/>	++ <input checked="" type="checkbox"/>	+++ <input type="checkbox"/>		
<b>GLUCOSE</b>	NORMAL <input type="checkbox"/>	2.8 <input type="checkbox"/>	5.6 <input type="checkbox"/>	14 <input type="checkbox"/>	28 <input type="checkbox"/>	56+ mmol/l <input checked="" type="checkbox"/>	
<b>PROTEIN</b>	NEGATIVE <input checked="" type="checkbox"/>	Trace <input type="checkbox"/>	30 <input type="checkbox"/>	100 <input type="checkbox"/>	500 mg/dl <input type="checkbox"/>		
<b>BLOOD</b> (Ery. / micro-l)	NEGATIVE <input checked="" type="checkbox"/>	+ <input type="checkbox"/>	++ <input type="checkbox"/>	+++ <input type="checkbox"/>	5-10 <input type="checkbox"/>	50 <input type="checkbox"/>	300 <input type="checkbox"/>
<b>NITRITE</b>	NEGATIVE <input checked="" type="checkbox"/>	POSITIVE <input type="checkbox"/>					
<b>pH</b>		5.0 <input checked="" type="checkbox"/>	6.0 <input type="checkbox"/>	6.5 <input type="checkbox"/>	7.0 <input type="checkbox"/>	8.0 <input type="checkbox"/>	9.0 <input type="checkbox"/>
<b>SPECIFIC GRAVITY</b>	1.000 <input type="checkbox"/>	1.005 <input type="checkbox"/>	1.010 <input checked="" type="checkbox"/>	1.015 <input type="checkbox"/>	1.020 <input type="checkbox"/>	1.025 <input type="checkbox"/>	1.030 <input type="checkbox"/>
<b>LEUCOCYTES</b> (Leuko /microL)	NEGATIVE <input checked="" type="checkbox"/>	25 <input type="checkbox"/>	75 <input type="checkbox"/>	500 <input type="checkbox"/>			

Provide an explanation for the outcomes  
Indicate a common or major pathological cause (where appropriate)



Test sample 4

Observation of urine: Light yellow, clear

Test results:

<b>BILIRUBIN</b>	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
		+	++	+++	
<b>UROBILINOGEN</b>	Normal <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		35	70	140	200 micro-mol/l
<b>KETONE</b>	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Trace	+	++	+++
<b>GLUCOSE</b>	NORMAL <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		2.8	5.6	14	28 56+ mmol/l
<b>PROTEIN</b>	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Trace	30	100	500 mg/dl
<b>BLOOD</b> (Ery. / micro-l)	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		+	++	+++	5-10 50 300
<b>NITRITE</b>	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>			
		POSITIVE			
<b>pH</b>		<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		5.0	6.0	6.5	7.0 8.0 9.0
<b>SPECIFIC GRAVITY</b>	1.000 <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		1.005	1.010	1.015	1.020 1.025 1.030
<b>LEUCOCYTES</b> (Leuko /microL)	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
		25	75	500	

Provide an explanation for the outcomes  
Indicate a common or major pathological cause (where appropriate)

Test sample 5

Observation of urine: Yellow, slightly turbid

Test results:

<b>BILIRUBIN</b>	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
		+	++	+++	
<b>UROBILINOGEN</b>	Normal <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		35	70	140	200 micro-mol/l
<b>KETONE</b>	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Trace	+	++	+++
<b>GLUCOSE</b>	NORMAL <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		2.8	5.6	14	28 56+ mmol/l
<b>PROTEIN</b>	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Trace	30	100	500 mg/dl
<b>BLOOD</b> (Ery. / micro-l)	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		+	++	+++	5-10 50 300
<b>NITRITE</b>	NEGATIVE <input type="checkbox"/>	<input checked="" type="checkbox"/>			
		POSITIVE			
<b>pH</b>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		5.0	6.0	6.5	7.0 8.0 9.0
<b>SPECIFIC GRAVITY</b>	1.000 <input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		1.005	1.010	1.015	1.020 1.025 1.030
<b>LEUCOCYTES</b> (Leuko /microL)	NEGATIVE <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
		25	75	500	

Provide an explanation for the outcomes  
Indicate a common or major pathological cause (where appropriate)

Test sample 6

Observation of urine: Yellow, turbid

Test results:

<b>BILIRUBIN</b>	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>UROBILINOGEN</b>	Normal <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>KETONE</b>	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>GLUCOSE</b>	NORMAL <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>PROTEIN</b>	NEGATIVE <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<b>BLOOD</b> (Ery. / micro-l)	NEGATIVE <input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>NITRITE</b>	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>			
<b>pH</b>		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<b>SPECIFIC GRAVITY</b>	1.000 <input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>LEUCOCYTES</b> (Leuko /microL)	NEGATIVE <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Provide an explanation for the outcomes  
Indicate a common or major pathological cause (where appropriate)

What are the advantages and disadvantages of the urine dipstick tests? (100 words)