

# Urinalysis

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## Teacher Resource

Students should be familiar with the following prescribed learning objectives from BC Biology 11 & 12 Integrated Resource Package 2006:

**B11** Analyse the roles of enzymes in biochemical reactions: identify the thyroid as the source gland for thyroxin, and relate the function of thyroxin to metabolism

**C13** Analyse the functional inter-relationships of the structures of the urinary system: identify and explain the functions of the components of the nephron, describe the production of urine, and describe how the kidneys maintain blood pH

**Time Required:** 60 minutes

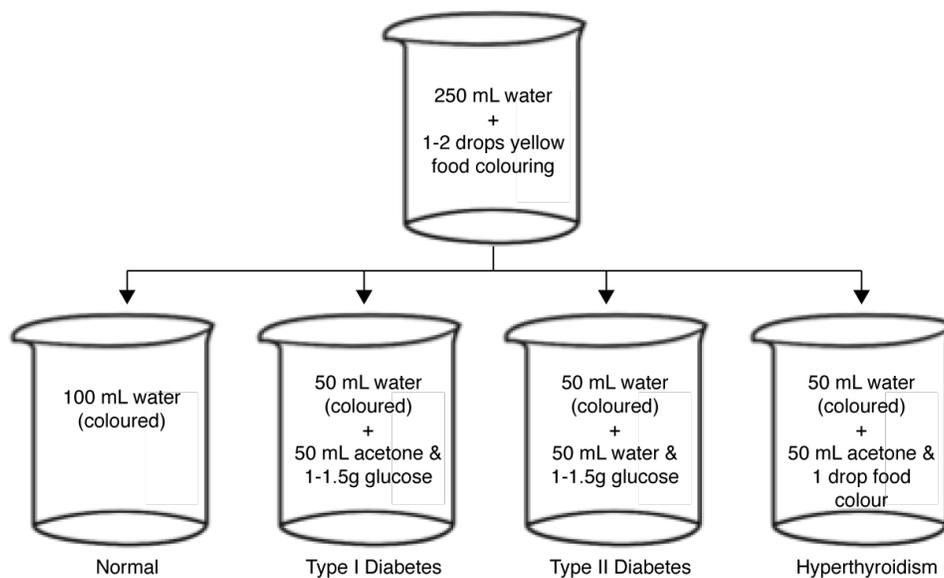
- Predict results with reasoning – including time to do online research: 20 minutes
- Test urine samples and record results: 10 minute
- Explain results and answer questions: 30 minutes

Assigning pre-reading about diabetes and hyperthyroidism may reduce the time required to complete activity.

**Preparation:** Requires ~100mL of each urine sample for 15 sets per class: ~5-6mL of each urine sample per group

Component	Urine Sample			
	Normal	Type 1 Diabetes	Type 2 Diabetes	Hyperthyroidism
water (mL)	100	50	100	50
acetone (mL)	0	50	0	50
glucose (g)	0	1–1.5 (0.0056M- 0.111M)	1–1.5 (0.0056M- 0.111M)	0
yellow food colouring (mL)	0.02	0.01	0.01	0.03

Last Update: April, 2020

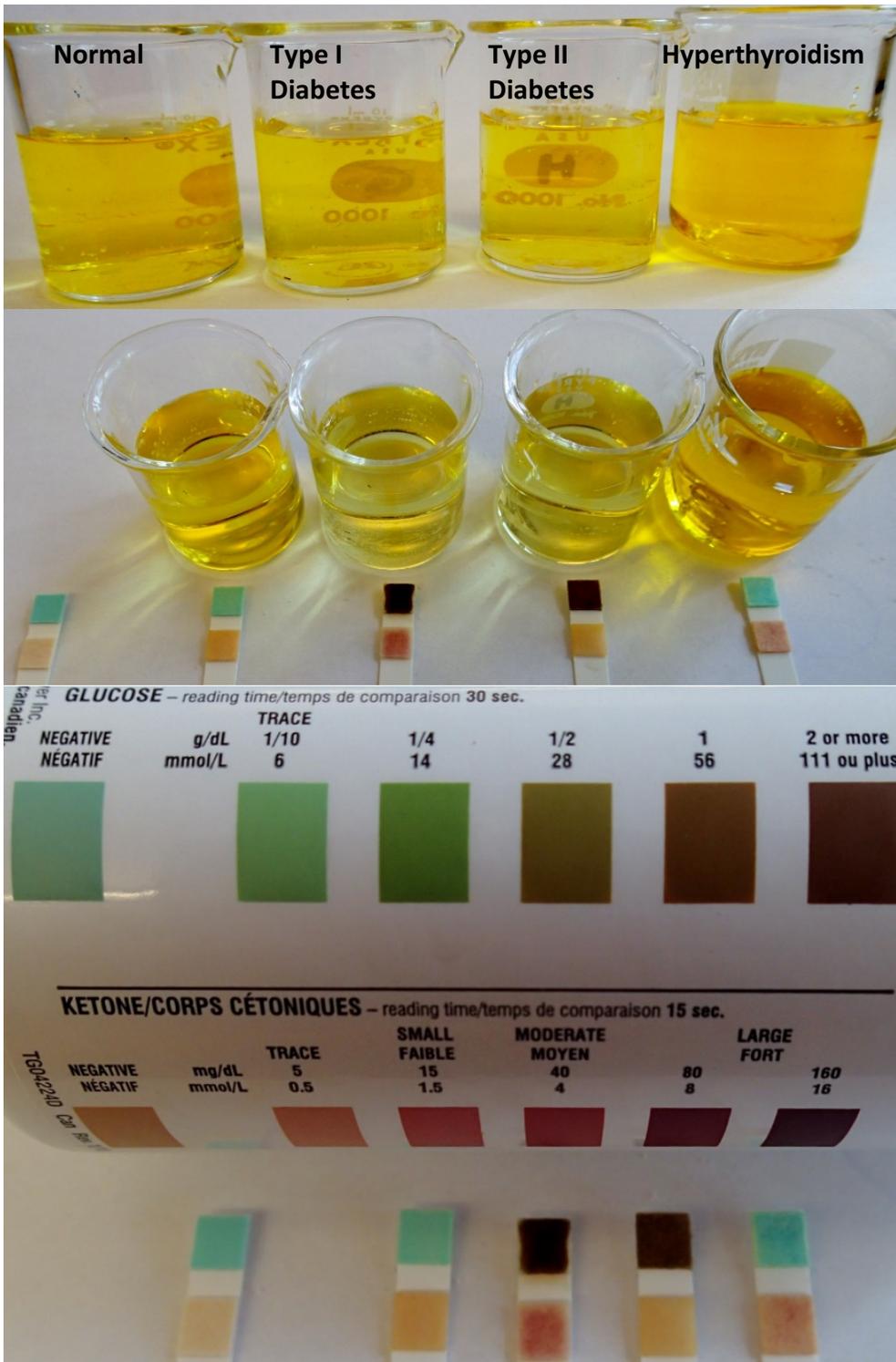


### Expected Results

Note: When glucose-ketone reagent test strips,

1. Reading time does not affect results – test strips will continue darken over time
2. Ketone pad has poor sensitivity to acetone so colour change is minimal

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## References:

- American Thyroid Association: [thyroid.org](http://thyroid.org)
- Canadian Diabetes Association: [diabetes.ca](http://diabetes.ca)
- Global Diabetes Community: [diabetes.co.uk](http://diabetes.co.uk)
- National Institute of Diabetes and Digestive and Kidney Diseases: [niddk.nih.gov](http://niddk.nih.gov)
- National Kidney Foundation: [kidney.org](http://kidney.org)
- Understanding urine tests: [ncbi.nlm.nih.gov/pubmedhealth/PMH0072534](http://ncbi.nlm.nih.gov/pubmedhealth/PMH0072534)
- Medline Plus - diabetes: [nlm.nih.gov/medlineplus/ency/article/001214.htm](http://nlm.nih.gov/medlineplus/ency/article/001214.htm)
- hyperthyroidism: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5014602/>

## Answer Key

### 1. For diabetes and hyperthyroidism:

#### a. What are other common symptoms?

diabetes: unusual thirst, frequent urination, weight change (gain or loss), extreme fatigue or lack of energy, blurred vision, frequent or recurring infections, cuts & bruises that are slow to heal, tingling or numbness in the hands or feet, & trouble getting or maintaining an erection (Canadian Diabetes Association)

hyperthyroidism: nervousness, irritability, increased perspiration, heart racing, hand tremors, anxiety, difficulty sleeping, thinning of your skin, fine brittle hair & weakness in your muscles—especially in upper arms & thighs, more frequent bowel movements, lose weight despite a good appetite, menstrual flow may lighten & menstrual periods may occur less often for women, & initially have a lot of energy, then being tired as body tends to break down (American Thyroid Association)

#### b. What other diagnostic tests would be used to confirm a diagnosis?

diabetes: blood tests such as fasting blood glucose (glucose concentration  $\geq 7.0$  mmol/L after fasting for 8 hours), random blood glucose (glucose concentration  $\geq 11.0$  mmol/L at any time), A1C ( $\geq 6.5\%$ ); or oral glucose tolerance (glucose concentration  $\geq 11.1$  mmol/L two hours after consuming sweetened drink) (Canadian Diabetes Association)

hyperthyroidism: blood test for low level of thyroid-stimulating hormone (TSH) & high levels of thyroxine (T4) & triiodothyronine (T3) (American Thyroid Association)

### 2. What other diseases can be diagnosed using a urinalysis test?

Presence of bilirubin in liver disease, presence of albumin or hemoglobin in kidney disease, presence of bacteria or white blood cells in infection.

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# Urinalysis – Work Sheet

PREDICTION		OBSERVATIONS	EXPLANATION
Urine Appearance, pH, & Results for Glucose-Ketone Reagent Test Strip	Reasoning for Prediction	Results for Each Urine Sample	Reasoning for Observed Results
NORMAL		<ul style="list-style-type: none"> <li>- yellow colour</li> <li>- no glucose</li> <li>- no ketones</li> <li>- acidic pH</li> </ul>	<ul style="list-style-type: none"> <li>- Glucose concentration in blood is carefully regulated by insulin &amp; glucagon.</li> <li>- All glucose in filtrate is actively reabsorbed at proximal convoluted tubule in nephron.</li> <li>- Ketones are only produced when fats are used for energy instead of glucose.</li> <li>- Typically acidic because nephrons remove excess H<sup>+</sup> from blood.</li> </ul>
TYPE 1 DIABETES		<ul style="list-style-type: none"> <li>- lighter yellow colour</li> <li>- presence of glucose</li> <li>- presence of ketones</li> <li>- lower pH</li> </ul>	<ul style="list-style-type: none"> <li>- High glucose concentration in blood because uptake of glucose by cells for energy does not occur without insulin from pancreas.</li> <li>- Excessive glucose in filtrate cannot be fully reabsorbed because it exceeds capacity of transport proteins in the proximal convoluted tubule.</li> <li>- Presence of glucose in filtrate limits the reabsorption of water, which produces dilute urine.</li> <li>- Ketones produced as cells use fat for energy because insufficient insulin limits the uptake of glucose by cells for energy.</li> <li>- Ketones are acidic, which increases acidity of filtrate.</li> </ul>
TYPE 2 DIABETES		<ul style="list-style-type: none"> <li>- lighter yellow colour</li> <li>- presence of glucose</li> <li>- no ketones</li> <li>- low pH</li> </ul>	<ul style="list-style-type: none"> <li>- High glucose concentration in blood because cells are less responsive to insulin.</li> <li>- As with type 1, excessive glucose in filtrate cannot be fully reabsorbed because it exceeds capacity of transport proteins in the proximal convoluted tubule.</li> <li>- As with type 1, presence of glucose in filtrate limits the reabsorption of water, which produces dilute urine.</li> <li>- Ketones result from insufficient insulin, which is common in type 1, not type 2</li> <li>No ketones so pH is normal.</li> </ul>
HYPERTHYROIDISM		<ul style="list-style-type: none"> <li>- darker yellow colour</li> <li>- no glucose</li> <li>- presence of ketones</li> <li>- lower pH</li> </ul>	<ul style="list-style-type: none"> <li>- Low glucose concentration in blood because cells are using more glucose for energy.</li> <li>- Ketones produced as cells use fat for energy because insufficient glucose available for cells.</li> <li>- Any glucose in filtrate is actively reabsorbed at proximal convoluted tubule in nephron.</li> <li>- Ketones are acidic, which increases acidity of filtrate.</li> <li>- Darker urine can result from antithyroid drugs used to treat hyperthyroidism such as methimazole or PTU.</li> </ul>

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