

# CHEMICAL PATHOLOGY

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## 1.0 INTRODUCTION

Chemical Pathology laboratory carries out routine and special blood analysis. Most of the tests are performed using fully automated or semi-automated analysers to produce higher level of efficiency, accuracy, precision and testing throughput. To ensure reliable and accurate results, the division participates in both national and international quality control programmes in addition to using internal quality control sera daily to minimise errors related to the reagents, instruments or operator.

As the demands for biochemical tests are heavy, users of the service are urged to be selective when requesting for Chemical Pathology tests. Requests should be confined only to those tests that are useful for the diagnosis or control of treatment of the patients.

## 2.0 SERVICES PROVIDED

### 2.1 Emergency (Short Turn-Around Time) @ 24 hours.

STAT service for cases where lab results are urgently required for immediate patient management as indicated by clinician on the request form.

	Test	Laboratory Turnaround Time (Minutes)
1	Arterial blood gas (ABG)	15
2	Amylase	45
3	Glucose	45
4	Serum Bilirubin Venous(SBV)	45
5	Renal Profile only	45
6	Calcium	60
7	Cardiac Enzymes	60
8	Beta HCG (TRO ectopic pregnancy)	60
9	Ammonia	60

For effectiveness of the stat service the doctors are advised to request stat service only when it is really indicated for immediate patient management. Abuse of stat request will jeopardise the urgent service for the really urgent cases.

### 2.2 Routine Biochemistry tests @ 24 hours.

The laboratory offers 24 hours services including public holiday for routine biochemistry tests. Tests are run daily and results will be released on the same day.

### **2.3 Drugs of Abuse.**

Screening test for drugs of abuse such as Morphine and Cannabinoids.

### **2.4 Endocrine**

Tests such as hormones are run daily and results are released within one (1) working day.

### **2.5 Outsource Tests.**

Biochemical tests which are not offered by the laboratory will be outsourced to referral laboratory such as Hospital Pulau Pinang, Institute for Medical Research (IMR), Hospital Kuala Lumpur and Hospital Putrajaya.

## **3.0 REQUEST FORMS**

A PER-PAT 301 request form should accompany each specimen sent to the laboratory with the exception of specimens with medico-legal implication e.g. urine drug (cannabis and morphine). Patient with identification, i.e. name, age, registration number/IC and ward/clinic must be accurately and clearly stated. Relevant information regarding diagnosis and treatment should be provided. Request must specify names of tests required.

## **4.0 SPECIMEN COLLECTION**

All specimens must be sent in their respective containers, as the use of inappropriate containers will cause misleading results. The following minimum information must be provided in the label of specimen:

- i. Name of patient
- ii. Registration/I.C. number
- iii. Ward/clinic
- iv. Name of test
- v. Date

## **5.0 SPECIMEN CONTAINERS**

For blood samples basically six types of containers are supplied:

- i. Lithium heparin tube for biochemistry & endocrine tests.
- ii. Lithium heparin tube with gel (microtainer) for peads biochemistry & endocrine tests
- iii. Plain tube with gel (SS II) for outsourcing tests
- iv. Fluoride/oxalate tube for glucose and lactate

- v. EDTA tube for HbA1c, ammonia and molecular diagnostics test.
- vi. Plain tube (red cap) for TDM tests.

Containers for 24 hour urine collection can be obtained from Chemical Pathology unit.

Specimens of other fluids (gastric, intestinal, ascitic, pleural, peritoneal, oedema fluids from subcutaneous tissues, etc) should be sent to the laboratory as soon as possible after collection or kept refrigerated.

## 6.0 REPORTING RESULTS

As soon as a batch of results is completed they are screened by a Biochemist. All results must pass the quality control inspection before they are reported. Laboratory results, which are approved, are despatched to the 'pigeon holes' located at the main foyer of Jabatan Patologi for collection by wards and clinics.

Result also able to view and print through the Laboratory Information System (LIS) which are available at wards.

## 7.0 CUSTOMER CHARTER

Tests	LTAT
Urgent request – Renal Profile, Bilirubin total & indirect (neonates)	45 minutes (additional test may take more than 45 minutes)
Routine chemistry /TDM	3 hours
Urine chemistry	1 working day
Endocrine	1 working day
Drug of Abuse (Screening for Opiate and Cannabinoids)	3 working days

## 8.0 INQUIRY OF RESULTS

Inquiry of results by telephone is permitted but should be kept to a minimum so as not to interrupt work in the laboratory unnecessarily. If the results are really necessary for immediate patient management, please contact extension 158/165.

## 9.0 LIST OF TESTS PROVIDED

Please refer to **page 41**.

## 10.0 CRITICAL RESULT

Very abnormal result or critical results as given below will be informed by the laboratory staff as soon as it is ready via phone.

Sodium, Na <sup>+</sup>	< 125 mmol/L	or	> 155 mmol/L
Potassium, K <sup>+</sup>	< 2.8 mmol/L	or	> 6.0 mmol/L
Glucose (adult)	< 2.8 mmol/L	or	> 20 mmol/L
Glucose (baby)	< 1.0 mmol/L		
Calcium (baby)	< 1.7 mmol/L	or	> 3.1mmol/L
Calcium (adult)	< 1.5 mmol/L	or	> 3.0 mmol/L
Bilirubin (baby)			> 300 umol/L
Ammonia			>100 umol/L

## 11.0 SERVICE AFTER OFFICE HOURS

This division provides service after office hours and during public holidays. Service is limited to a few important tests. The results will be despatched to the pigeon hole once completed. The ward staffs are expected to collect the urgent results from the pigeon hole from time to time.

### List of tests provided after office hours:

1. Amylase/Diastase
2. Blood Gases
3. Bilirubin total and direct
4. Calcium
5. Inorganic Phosphate
6. Magnesium
7. Glucose
8. Cardiac enzymes (AST, CK, LDH)
9. Renal Profile (Urea, Creatinine, Sodium, Potassium)
10. Paracetamol and Salicylate(TDM)
11. Paraquat - Qualitative test on urine/gastric aspirate
12. C-Reactive Protein
13. CSF for Biochemistry (Protein, Glucose, Chloride, Globulin)

14. TSH & FT4 (Congenital hypothyroidism Screening) on weekends/Public Holiday
15. Urine FEME (until 12 midnight).

## **12.0 SPECIAL PROCEDURES**

### **12.1 Arterial/Venous Blood Gases (ABG/VBG)**

#### 12.1.1 Collection procedure

- Use 1 or 2 ml disposable syringe.
- Rinse it with injection heparin.
- Draw 1 ml of blood. Invert the syringe and remove all bubbles inside the syringe. Use a stopper instead of needle to avoid exposure to air and to avoid blood sample leakage.
- Mix well by rotating the syringe to prevent clotting.
- Put the syringe of blood in an ice bath.

#### 12.1.2 Important notes

- After the blood is drawn into the syringe, any air space, bubbles must be removed.
- The specimen must be kept embedded in crushed ice and sent immediately to the laboratory for analysis (at least within ½ hour).
- The attendant is advised to wait for the result, which will be ready within minutes.

### **12.2 Lactate \*(To make appointment with Chemical Pathology Lab-ext 158)**

#### 12.2.1 Collection procedure

- Patient should be fasting and at complete rest.
- A venous specimen is best drawn without a tourniquet or immediately after the tourniquet has been applied briefly.
- 2 ml of blood is collected in a container with fluoride as antiglycolytic.

#### 12.2.2 Important notes

- As lactate level is subjected to metabolic changes in vitro customer is required to call laboratory at least one hour time prior to withdrawal of blood from patient.
- Sample should be chilled in ice water and sent to the laboratory immediately
- Separation of cells at the laboratory must be within ½ hour.

- Haemolysis may affect results.
- CSF is readily used for analysis upon receipt of sample (stability 24 hr at 2-8 °C).

### **12.3 Ammonia\* (To make appointment with Chemical Pathology Lab- ext 158)**

#### 12.3.1 Collection procedure

- A venous specimen is best drawn without a tourniquet or immediately after the tourniquet has been applied briefly.
- If the tourniquet has been applied for a very long period, it should be removed after the puncture has been performed and the blood is allowed to circulate at least 2 minutes before being withdrawn.
- 2.0 ml of blood is collected in a container with K<sub>2</sub> EDTA as anticoagulant.

#### 12.3.2 Important notes

- As ammonia level is subjected to metabolic changes in vitro customer is required to call laboratory at least one hour time prior to withdrawal of blood from patient.
- The sample is to be chilled in ice water and send to the laboratory immediately.
- Separation of cells at the laboratory must be within 15 minutes and analysed within 20 minutes. Stability of supernatant plasma is 2 hrs or maximum 3 hrs at most at 4 °C (after separation from cells)
- Haemolysis may affect results.

### **12.4 24 hours Urine Collection**

12.4.1 Most quantitative assays are performed on the urine specimen collected over 24 hours. The 24 hours timing allows the circadian rhythmic changes in excretion at certain time of the day.

#### Collection Procedure

- The 24 hrs urine bottle that contains preservative for the required test is available at the laboratory and will be provided on request, with the accompanying request form or note.

- On the day of collection, the first urine voided must be thrown away. Time of first urine voided is the start of the timing for the 24 hours collection.
- Collect the second and all subsequent voided urine for 24 hour from the time start into 24-hour urine bottle.
- At the end of 24 hour, the last urine voided is collected. For best result, refrigerate if possible.
- Label the bottle as directed and send immediately to the laboratory.

#### 12.4.2 Preservatives used for 24 hours urine tests

No	Preservatives	Tests
1	10 ml HCl (6 mmol/L) or acidify (pH < 2.0) after urine collection	Calcium, Magnesium
2	15 ml 6mol/L HCL	Inorganic phosphate
4	No preservative required	Amylase, Creatinine, Protein, Urea, Sodium, Potassium
5	10 mL NaOH (500g/L, 12.5N). Adjust pH >8.0 with NaOH	Uric acid
6	No preservative required	Cortisol
7	15 ml 6mol/L HCL	Catecholamines

#### 12.4.3 24 hours Urine Catecholamines

Instruction on patient preparation and specimen collection

- Abstain from banana, coffee, pineapple and walnuts one day prior to and during 24 hours urine collection
- List of drugs that may alter the metabolism of catecholamines and it is advisable to stop medication at least 2 days prior to urine sampling
  - ACE-inhibitors
  - Alpha-2-agonists
  - Alpha blockers and Beta blockers
  - Bromocriptine
  - Calcium channel blockers
  - Methyldopa
  - Monoamine oxidase inhibitors

- Phenothiazines
- Tricyclic antidepressants
- It is advisable to stop such medication at least 2 days prior to urine sampling
- Avoid patient stress, exercise, smoking, and pain prior to and during urine collection
- Collect 24 hours urine specimen in a clean container to which 10 ml of 25% HCl has been added as a stabilizing preservative
- Please advise patient not to throw the preservative
- Refrigerate during and after collection (if possible)

#### Indication for urine Catecholamines

- Patient with Triad episodic headaches, tachycardia and diaphoresis (with or without associated hypertension)
- Family history of Pheochromocytoma
- 'Incidental' suprarenal masses
- Patient with multiple endocrine adenomatosis, neurofibromatosis or Von Hippel-Lindau disease.
- Adverse cardiovascular responses to anesthesia, to any surgical procedure, or to certain drug (e.g. guanethidine, tricyclics, thyrotropin-releasing hormone, naloxone or antidopaminergic agents).

#### 12.4.4 24 hours Urine 5 HIAA (5 Hydroxyindoleacetic acid)

- Patients should avoid banana, pineapple, all tomato products, plums, eggplant, kiwi, avocado and fruits in general, nuts especially walnuts
- These food should be avoided at least 24 hours prior to or during collection of urine. Do not drink any alcohol for 24 hours before test
- Lists of drugs may affect test results and must be avoided
  - Cough and antihistamine
  - Nasal drops and sprays
  - Hypertension medications
  - Tylenol and muscle relaxants (Robaxin, Valium, Flexeril)
  - Nardil and natural herbs containing monoamine oxidase
  - Acetaminophen
- It is advisable to stop such medication at least 2 days prior to urine sample



#### 12.4.5 Creatinine Clearance Test

- i. A careful and accurate 24 hour collection of urine is made.
- ii. At the same time during the day (but not within 1 – 3 hours after a large meal) a blood sample is taken in a plain tube for serum creatinine estimation.
- iii. Send the blood sample together with the 24 hour urine collection to the laboratory.

#### Reference value:

Normal adult: 71 – 151 ml/min

### 12.5 Blood Glucose Test

#### 12.5.1 Interpretation of Fasting Blood/Plasma Glucose (FBG)

- i. FBG > 5.5 mmol/L – Consider yearly assessment
- ii. FBG > 6.1 mmol/L – Do OGTT (75 gm glucose in 300 mL of water over 3 – 5 minutes)
- iii. FBG > 7.0 mmol/L – Repeat FBG. If FBG still > 7.0 mmol/L confirmed ‘Diabetes’

If suspicious or high risk of diabetes, but FBG is normal, do OGTT. Diagnostic procedure should not be performed in the presence of acute illness or after trauma or during short courses of blood glucose raising drug.

#### 12.5.2 Interpretation for Random Blood Glucose (RBG)

RBG > 5.5 mmol/L – suggest to do FBG (Fasting Blood Glucose)

#### 12.5.3 Modified Glucose Tolerance Test (MGTT)

- i. Fast the patient overnight.
- ii. 0800h Collect fasting blood in a fluoride/oxalate tube  
Give patient 75 g glucose in 300 ml water and drink within 5 minutes. For children, the glucose dose is 1.75 gm/kg body weight to maximum of 75 gm.

- iii. 1000h 2<sup>nd</sup> blood specimen is taken. Label the containers as '2 hours'.
- iv. Send the 2 blood specimens to the laboratory.

Note:

1. Dietary preparation. Three days of unrestricted diet (> 150g carbohydrate per day)
2. The patient must rest for 30 minutes before and also during the test and no smoking, is allowed.
3. Drugs such as steroids, oral contraceptives, diuretics, nicotinic acid, thyroid hormones and phenytoin that may affect the test should not be taken.

Reference value:

	<u>Fasting</u>	<u>2 hr</u>
i. Normal	< 6.1 mmol/L	< 7.8 mmol/L
ii. Diabetes Mellitus	> 7.0	> 11.1
iii. Impaired Glucose Tolerance	< 7.0	7.8 – 11.1
iv. Impaired Fasting Glycaemia	6.1 – 7.0	< 7.8

### 13.0 COMMUNICATION

For any inquiry of the services or test provided by the Chemical Pathology Division, kindly contact the following extension numbers:

- i. Head of Unit/Senior Biochemist  
Pn. Hairani Othman Ext. 156
- ii. Biochemist  
Pn Norazmaliza  
Pn. Nor Fasihah Yahaya Ext. 165/158
- iii. Chemical Pathology Laboratory Ext. 158

## List of Chemical Pathology Tests Available

NO	TEST	CONTAINER	SPECIMEN	VOLUME	FREQ	REFERENCE RANGE	NOTE	TAT (RESULT)
1.	Alanine Transaminase	Heparinised tube	Blood	4 ml	Daily	Male: 0 – 41 U/L Female: 0 – 33 U/L	Done as part of Liver Function Test	3 hours
2.	Albumin	Heparinised tube	Blood	4 ml	Daily	<u>Adult:</u> 35 – 52 g/L  <u>Children:</u> 0 – 4d: 28 – 44 g/L 5d – 14 years: 38 – 54 g/L 15 – 18 years: 32 – 45 g/L	Done as part of Liver Function Test	3 hours
3.	Alkaline phosphatase	Heparinised tube	Blood	4 ml	Daily	<u>Adult:</u> Male: 40 – 130 U/L Female: 35 – 105 U/L  <u>Children:</u> 0 – 1 d : <250 U/L 2 – 5d : < 231 U/L 6d – 6 mths: < 449 U/L 7mths – 1year: < 390 U/L 2 – 3 years: < 187 U/L 4 – 6 years: < 269 U/L 7 – 12 years: < 300 13 – 17 years(m): < 390 U/L 13 – 17 years(f): < 187 U/L	Done as part of Liver Function Test	3 hours
4.	Ammonia	Heparinised tube (send in ice)	Blood	1 ml	Daily	<u>Male:</u> 15 – 55 µmol/L  <u>Female:</u> 11.2– 48.2 µmol/L	By appointment.  Refer to Special Test Procedures, <b>page 35</b>	45 minutes

NO	TEST	CONTAINER	SPECIMEN	VOLUME	FREQ	REFERENCE RANGE	NOTE	TAT (RESULT)
5.	Amylase/Diastase	Heparinised tube  Universal container	Blood  Random urine	4 ml  30 ml	Daily  Daily	28 – 100 U/L  16 – 491 U/L	Inhibited by oxalate and citrate	3 hours  1 working day
6.	Aspartate transaminase	Heparinised tube	Blood	4 ml	Daily	<u>Male:</u> Up to 40 U/L  <u>Female:</u> Up to 32 U/L	Done as part of Cardiac Enzymes, avoid haemolysis.	3 hours
7.	Beta-HCG, Total	Heparinised tube	Blood	4 ml	Daily	< 5.0 IU/L	Request by specialist only	1 working day
8.	Bilirubin – total/direct (adult)	Heparinised tube	Blood	4 ml	Daily	<u>Total:</u> Male: Up to 24 µmol/L Female: Up to 15 µmol/L  <u>Direct:</u> < 5.1 µmol/L	Done as part of Liver Function Test. Do not expose to light.	3 hours
9.	Bilirubin – total/direct (neonates)	Heparinised microtainer (pead)	Blood	0.6 ml	Daily	<u>Total:</u> 0 – 1d : ≤ 137 µmol/L 2 – 2d : ≤ 222 µmol/L 3 – 4d : ≤ 290 µmol/L > 4d (m): Up to 24 µmol/L > 4d (f): Up to 15 µmol/L  <u>Direct:</u> < 5.0 µmol/L	Do not expose to light.	3 hours
10.	Blood gases	Heparinised syringe	Blood arterial	1 ml	Daily	pH: 7.35 – 7.45 pCO <sub>2</sub> :33 – 48 mmHg pO <sub>2</sub> :85 – 100 mmHg Bicarb: 22 – 26 mmol/L TCO <sub>2</sub> :23 – 27 mmol/L Base Excess: ± 3 O <sub>2</sub> Saturation: 90 – 100%	Refer to Special Test Procedures, <b>page 34</b>	15 minutes

NO	TEST	CONTAINER	SPECIMEN	VOLUME	FREQ	REFERENCE RANGE	NOTE	TAT (RESULT)
11.	Body fluids Biochemistry (protein, glucose)	Universal container	Body fluids	5 ml	Daily			1 working day
12.	Calcium	Heparinised tube	Blood	4 ml	Daily	0 – 10d : 1.9 – 2.6 mmol/L 11d – 2years : 2.25 – 2.75 mmol/L 3 – 12years: 2.20 – 2.70 mmol/L 13-18years: 2.10 – 2.55 mmol/L 19-60years: 2.15 – 2.50 mmol/L 61-90years: 2.20 – 2.55 mmol/L >90years : 2.08-2.40 mmol/L	Avoid stasis.	3 hours
		24 hours urine container	Urine	24 hours urine collection	Daily	2.5 – 7.5 mmol/24h	Refer to special collection procedure	1 working day
13.	Cannabinoids	Universal container	Urine	50 ml	Daily	Negative		Neg: 3 working days Pos: 5 working days
14.	Chloride	Heparinised tube	Blood	4 ml	Daily	98 – 107 mmol/L		3 hours
		Universal container	Random urine	30 ml	Daily	46 – 168 mmol/L (1 <sup>st</sup> morning urine)		1 working day
		24 hours urine container	Urine	24 hours urine collection	Daily	110 – 250 mmol/24h		1 working day
15.	Cholesterol	Heparinised tube	Blood	4 ml	Daily	Desirable: < 5.2 mmol/L Borderline: 5.2 – 6.2 mmol/L High: ≥ 6.2 mmol/L	Also done as part of Fasting Lipid Profile	3 hours

NO	TEST	CONTAINER	SPECIMEN	VOLUME	FREQ	REFERENCE RANGE	NOTE	TAT (RESULT)
16.	C-Reactive Protein (CRP)	Heparinised tube (adult)	Blood	4 ml	Daily	< 0.5 mg/L		3 hours
		Heparinised Microtainer (peads)	Blood	0.6 ml	Daily	< 0.5 mg/L		3 hours
17.	Creatine kinase	Heparinised tube	Blood	4 ml	Daily	Male: 20 - 200 U/L Female: 20 - 180 U/L	Done as part of Cardiac Enzymes. Avoid haemolysis.	3 hours
18.	Creatinine	Heparinised tube	Blood	4 ml	Daily	<u>Adults:</u> Male: 62 - 106 µmol/L Female: 44 - 80 µmol/L  <u>Children:</u> 0d - 1year : 15 - 37 µmol/L 2y - 3year : 21 - 36 µmol/L 4 - 5year : 27 - 42 µmol/L 6 - 7year : 28 - 52 µmol/L 8 - 9year : 35 - 53 µmol/L 10 - 11year: 34 - 65 µmol/L 12 - 13year: 46 - 70 µmol/L 14 - 15year: 50 - 77 µmol/L	Done as part of Renal Profile	3 hours
		Universal container	Random urine	30 ml	Daily	<u>Male:</u> 3.45 - 22.90 mmol/L (1 <sup>st</sup> morning urine) <u>Female:</u> 2.47 - 19.2 mmol/L (1 <sup>st</sup> morning urine)		1 working day
		24 hrs urine container	Urine	24 hrs urine collection	Daily	<u>Male:</u> 0.124 - 0.23 mmol/kg/day <u>Female:</u> 0.097 - 0.177 mmol/kg/day	Refer to special collection procedure	1 working day

NO	TEST	CONTAINER	SPECIMEN	VOLUME	FREQ	REFERENCE RANGE	NOTE	TAT (RESULT)
19.	Creatinine clearance	Heparinised tube and 24 hours urine container	Blood/Urine	Blood: 4 ml Urine: 24 hours urine collection	Daily	71 – 151 ml/min	Refer to special collection procedure	1 working day
20.	CSF Biochemistry Appearance Protein Globulin Glucose Chloride	Universal container	CSF	5 ml	Daily	Clear and colourless 0.15 – 0.45 g/L Nil 2.5 – 4.5 mmol/L 120 – 130 mmol/L		30 minutes
21.	Fat Globules	Universal container	Urine/stool	30 ml	Daily	Negative		1 working day
22.	Ferric chloride	Universal container	Urine	30 ml	Daily	Negative		1 working day
23.	Glucose (Fasting Plasma Glucose, Random Plasma Glucose, Glucose Tolerance Test)	Flouride/oxalate tube (adult)	Blood	2ml	Daily	Refer to Blood Glucose Test (page 38)		3 hours
		Fluoride/oxalate microtainer (peads)	Blood	0.6 ml	Daily			3 hours
24.	HDL-Cholesterol	Heparinised tube	Blood	4 ml	Daily	<u>Male:</u> > 1.4 mmol/L- negative risk < 0.9 mmol/L - major risk factor  <u>Female:</u> > 1.68 mmol/L - low risk < 1.15mmol/L – major risk factor		3 hours
25.	Inorganic Phosphate	Heparinised tube	Blood	4 ml	Daily	<u>Adults:</u> 0.81 – 1.45 mmol/L  <u>Children:</u>		3 hours

NO	TEST	CONTAINER	SPECIMEN	VOLUME	FREQ	REFERENCE RANGE	NOTE	TAT (RESULT)																											
						<table border="0"> <tr> <td></td> <td style="text-align: center;"><u>Male</u></td> <td style="text-align: center;"><u>Female</u></td> </tr> <tr> <td>0-30d</td> <td>:1.25 – 2.25</td> <td>1.40 – 2.50</td> </tr> <tr> <td>1m-12m</td> <td>: 1.15 – 2.15</td> <td>1.20 – 2.10</td> </tr> <tr> <td>2-3year</td> <td>: 1.00 – 1.95</td> <td>1.10 – 1.95</td> </tr> <tr> <td>4-6year</td> <td>: 1.05 – 1.80</td> <td>1.05 – 1.80</td> </tr> <tr> <td>7-9year</td> <td>: 0.95 – 1.75</td> <td>1.00 – 1.80</td> </tr> <tr> <td>10-12year</td> <td>: 1.05 – 1.85</td> <td>1.05 – 1.70</td> </tr> <tr> <td>13-15year</td> <td>: 0.95 – 1.65</td> <td>0.90 – 1.55</td> </tr> <tr> <td>16-18year</td> <td>: 0.85 – 1.60</td> <td>0.80 – 1.55</td> </tr> </table>		<u>Male</u>	<u>Female</u>	0-30d	:1.25 – 2.25	1.40 – 2.50	1m-12m	: 1.15 – 2.15	1.20 – 2.10	2-3year	: 1.00 – 1.95	1.10 – 1.95	4-6year	: 1.05 – 1.80	1.05 – 1.80	7-9year	: 0.95 – 1.75	1.00 – 1.80	10-12year	: 1.05 – 1.85	1.05 – 1.70	13-15year	: 0.95 – 1.65	0.90 – 1.55	16-18year	: 0.85 – 1.60	0.80 – 1.55		
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2-3year	: 1.00 – 1.95	1.10 – 1.95																																	
4-6year	: 1.05 – 1.80	1.05 – 1.80																																	
7-9year	: 0.95 – 1.75	1.00 – 1.80																																	
10-12year	: 1.05 – 1.85	1.05 – 1.70																																	
13-15year	: 0.95 – 1.65	0.90 – 1.55																																	
16-18year	: 0.85 – 1.60	0.80 – 1.55																																	
		24 hours urine container	Urine	24 hours urine collection	Daily	12.90 – 42.0 mmol/24h	Refer to special collection procedure	1 working day																											
26.	Lactate	Sodium flouride/ Potassium oxalate tube	Blood	2 ml	Daily	0.50 – 2.20 mmol/L	By appointment.	45 minutes																											
		Universal container	CSF	1 ml	Daily	0 – 2d : 1.1 – 6.7 mmol/L 3 – 10d : 1.1 – 4.4 mmol/L 11d – 12year: 1.1 – 2.8 mmol/L >13year : 1.1 – 2.4 mmol/L	Refer to Special Test Procedure, <b>page 34</b>	30 minutes																											
27.	Lactate dehydrogenase (LDH)	Heparinised tube	Blood	4 ml	Daily	240 – 480 U/L	Done as part of Cardiac Enzymes.	3 hours																											
28.	LDL-Cholesterol	Heparinised tube	Blood	4 ml	Daily	< 3.9 low risk > 4.9 increased risk	LDL-Chol invalid if Tg >4.5 mmol/L	3 hours																											
29.	Magnesium	Heparinised tube	Blood	4 ml	Daily	Adults: 0.66 – 1.07 mmol/L  Children: 0 – 4m : 0.62 – 0.91 mmol/L	Avoid haemolysis	3 hours																											



NO	TEST	CONTAINER	SPECIMEN	VOLUME	FREQ	REFERENCE RANGE	NOTE	TAT (RESULT)
		24 hours urine container	Urine	24 hours urine collection	Daily	5m – 6year : 0.70 – 0.95 mmol/L 7 – 12year : 0.70 – 0.86 mmol/L 13 – 20year : 0.70 – 0.91 mmol/L  3.0 – 5.0 mmol/24h	Refer to Special Collection Procedure	1 working day
30.	Microalbumin	Universal container	Urine	30 ml	Daily	<u>Normal:</u> < 3.4 mg/mmol creatinine <u>Microalbuminuria:</u> 3.4 – 33.9 mg/mmol creatinine <u>Clinical albuminuria:</u> > 33.9 mmg/mmol creatinine		1 working day
31.	Morphine	Universal container	Urine	50 ml	Daily	Negative		Neg: 3 working days Pos: 5 working days
32.	Myoglobin	Universal container	Urine	30 ml	Daily	Negative		1 working day
33.	Paraquat	Universal container	Urine	30 ml	Daily	Negative		1 working day
34.	Porphobilinogen	Universal container	Urine	30 ml	Daily	Negative		1 working day
35.	Porphyrin	Universal container	Urine	30 ml	Daily	Negative		1 working day
36.	Potassium	Heparinised tube  Universal container	Blood  Random urine	4 ml  30 ml	Daily  Daily	3.5 – 5.1 mmol/L  20 – 80 mmol/L (1 <sup>st</sup> morning urine)	Usually done as part of Renal Profile. Avoid	3 hours  1 working day

NO	TEST	CONTAINER	SPECIMEN	VOLUME	FREQ	REFERENCE RANGE	NOTE	TAT (RESULT)
		24 hours urine container	Urine	24 hrs urine collection	Daily	25 – 125 mmol/24hr	haemolysis.	1 working day
37.	Protein Creatinine Index	Universal container	Random urine	30 ml	Daily	< 0.02 g/mmol		1 working days
38.	Protein, Total	Heparinised tube	Blood	4 ml	Daily	66 – 87 g/L	Done as part of LFT	3 hours
		Universal container	Random urine	30 ml	Daily	0.01 – 0.14 g/L		1 working day
		24 hours urine container	Urine	24 hours urine collection	Daily	0.05 – 0.08 g/24hour		1 working day
39.	Sodium	Heparinised tube	Blood	4 ml	Daily	136 – 145 mmol/L	Varies with intake	3 hours
		Universal container	Random urine	30 ml	Daily	54 – 190 mmol/L (1 <sup>st</sup> morning urine)		1 working day
		24 hours urine container	Urine	24 hours urine collection	Daily	40 – 220 mmol/24hour		1 working day
40.	Thyroid stimulating hormone (TSH)	Heparinised tube	Blood	4 ml	Daily	< 3 : 0.68 – 25.0 mIU/L 4d – 30d : 0.51– 16.30 mIU/L 2m – 1year : 1.36 – 8.80 mIU/L 2y – 6year : 0.85 – 6.50 mIU/L > 7 year : 0.27 – 4.20 mIU/L	Detail clinical history is necessary.	2 working days
41.	Thyroxine, Free (Free T <sub>4</sub> )	Heparinised tube	Blood	4 ml	Daily	< 3d : 13.5 – 38.4 pmol/L 4d – 30d : 13.0 – 33.0 pmol/L 2m – 1year : 11.0 – 26.1 pmol/L 2y – 6year : 12.10 – 22.0 pmol/L > 7year : 12.0 – 22.0 pmol/L	Detail clinical history is necessary.	2 working days
42.	Triglycerides	Heparinised tube	Blood	4 ml	Daily	< 2.26 mmol/L	Done as part of FLP	3 hours

NO	TEST	CONTAINER	SPECIMEN	VOLUME	FREQ	REFERENCE RANGE	NOTE	TAT (RESULT)
43.	Urea	Heparinised tube	Blood	4 ml	Daily	1.7 – 8.3 mmol/L	Done as part of Renal Profile	3 hours
		Universal container	Random urine	30 ml	Daily			1 working day
		24 hours urine container	Urine	24 hours urine collection	Daily	170 – 580 mmol/24hour		1 working day
44.	Uric acid	Heparinised tube	Blood	4 ml	Daily	<u>Male:</u> 202 – 41 µmol/L <u>Female:</u> 143 – 339 µmol/L		3 hours
		Universal container	Random urine	30 ml	Daily			1 working day
		24 hours urine container	Urine	24 hours urine collection	Daily	1500 – 4500 µmol/24hour		1 working day
45.	Urine FEME Ketone, urobilinogen, pH, specific gravity, protein, glucose, bilirubin, blood, leucocytes, nitrite, WBC, epithelial cells, cast, bacteria	Universal container	Urine	5ml	Daily			1 hour