Central Manchester University Hospitals NHS
NHS Foundation Trust
Department of Clinical Biochemistry

User Guide
Adult Biochemistry

CLINICAL BIOCHEMISTRY

This guide describes the Clinical Biochemistry service provided for adult patients (patients over 16 years old). Please see the separate paediatric Biochemistry guide for children and neonates.

Location

The Clinical Biochemistry Department provides a comprehensive service for the care of patients within the Trust and the wider community served by both the Primary and Tertiary sectors. The high volume testing, including the urgent and 24 hour access assays are carried out in the Autolab on the ground floor of the Clinical Sciences Building (CSB3). This also houses the main specimen reception and most of Haematology, including Blood Transfusion.
Specialist assays are carried out in laboratories on the 1st and 2nd floor of CSB3 . The Point of Care team are housed on the 4th floor of the new Children's Hospital.

Opening Hours

The core opening hours of the laboratory are 8.00 am to 5.00 pm Monday-Friday. Outside of these hours a reduced service is available as part of the CPP service (Continuous Process Pathology). We aim to provide an extensive range of routine assays e.g. Renal, Bone, Liver, Lipid and Cardiac profiles at all times. A full emergency service is always available and this is listed separately below. The out of hours service is manned by a limited number of staff from 5pm to 8.30 pm and only one Biomedical Scientist available between 8.30 pm and 8.30 am.
Please keep use of the service to a minimum between these times to enable us to provide the most efficient urgent and emergency service in these periods.

General information

The department is manned by various clinical and technical staff, below is a list of all key personal

Dr M.France	Consultant Chemical Pathologist Specialist interest in Metabolic Biochemistry	Tel 0161 27 64284
Dr G Ayers	Consultant Clinical Biochemist Specialist interest in Toxicology	Tel 0161 27 64594
M/s K.Hayden	Consultant Clinical Biochemist Specialist interest in endocrinology and automated services	Tel 0161 90 11106
Dr A.C.Holt	Senior Clinical Biochemist Clinical Trials	Tel 0161 27 64579
Dr A P Yates	Principal Clinical Biochemist Clinical Research	Tel 0161 27 64179
Dr S Smith	Principle Clinical Biochemist Clinical Research	Tel 0161 27 64179
Dr D Schofield	Senior Clinical Biochemist	

	Pancreatobilary Laboratory (PBL)	Tel 0161 27 64067
Mr Chris Reeves	Principal Clinical Biochemist	Tel 0161 90 11206
Mr Rod Hinchliffe	Laboratory manager	Tel 0161 27 64698
Mrs Allison Gaskell	Chief BMS – Auto lab	Tel 0161 27 65574
Mrs Emma James	POCT co-ordinator	Tel 0161 27 64891
Mr Neil Howarth	Chief BMS – Specialist section	Tel 0161 27 64699
Departmental Fax		Tel 0161 27 64586

Results and Clinical Advice

Results Line

If you need to telephone for results call the 'Results-Line' –

0161 276 8766 Monday – Friday 8.00 am – 8.00 pm

Duty biochemist

Clinical advice is available at all times. The duty biochemist is one of the Clinical Scientists or medical staff and includes those on the list above. They participate in a rota and will assist and advise on problems involving the biochemical investigation of patients and the interpretation of results.

The duty biochemist can be "bleeped" on 4375 during normal hours. Out of normal hours one of the Consultant staff is available via the Trust switchboard.

Out of hours specialist contact

Outside of normal working hours contact is made directly by mobile phone or "Air-Bleep" via switchboard.

Mobile number: 07771703383

SERVICES AVAILABLE

Service provision

Specimen reception is open for the receipt of samples at all times. Printed reports are distributed to all wards and departments twice daily Monday-Friday at approximately 10.00 am and 4.00 pm. If you wish to have results of specimens for routine biochemical profiles included on these reports on the same day the samples **must** arrive in the laboratory no later than 1.00 pm.

Emergency requests and blood gases

The list below shows those analytes that are provided on an Urgent and Emergency basis. Samples requiring these tests and labelled as Urgent will usually be analysed and reported in 60-120 minutes from receipt in the laboratory. If results are required very rapidly for the immediate treatment of a patient, or if you wish to send a sample for arterial blood gases and pH, please contact the laboratory to let us know that the sample is coming.
Contact details are:-

Monday - Friday.	8.00 am-5.00 pm.	Tel. 0161 27 6 4375
Saturday and Sunday	8.00 am -12.00 noon	Tel. 0161 27 6 4375
All other times		Tel. 0161 27 6 4375 or bleep 2722

Access to urgent and emergency requests

Analytes other than those on the list below may be analysed on an urgent or emergency basis but **only** after consultation and arrangement with the Biochemistry Department.

Requesting urgent analyses

The following analytes are available at any time:

Albumin	Amylase
Bicarbonate	Bilirubin
Blood gases *	Calcium
Carboxyhaemoglobin	Chloride
Creatinine	Creatine Kinase
Digoxin	Ethanol
Glucose	Iron
Lithium	Liver Profile
Magnesium	Methaemoglobin (in heparinised bottle if not sent with blood gas)
Osmolality	Paracetamol
Potassium	Renal Profile
Salicylate	Sodium
Theophylline	
Troponin T (must be at least 12 hours post chest pain)	
Urea	Urine Paraquat (phone 64375 to advise of sample being sent)
Quantitative BHCG (blood pregnancy only)	

* Please note:-
1. You must arrange transport of the sample using the portering service, pneumatic tube system or ward staff.
2. Results of these tests are available in between one hour and two hours of receipt of the sample in the laboratory.
3. The pneumatic tube must **not** be used for transport of blood gas samples.

Requests for Investigations

Hospital in-patients and out-patients
All requests should be made using the hospital computer system. This is the Clinical Work Station **(CWS)** of the **Patient Administration System (PAS).** For those areas not covered by CWS the pre-printed biochemistry request form should be used, with patient labels if possible.

Primary Care requests
We provide multi-discipline request cards for all practices which we have an agreement to provide services for. See the section on GP services in section 3 of this document for contact information

All samples and request cards should have as much information on as possible to enable us to positively identify the patient that the sample has come from, to ensure that the sample and card relate to the same person and to identify which tests need doing and any other requirements. For some assays it is essential that we know the time that the sample was taken. This is especially important in the case of therapeutic drug monitoring. It is preferred that samples are labelled with pre-printed labels from the patient's notes If handwritten the tube should as a minimum be labelled with surname, first name and hospital record number or other unique identifier such as NHS number

Specimen Acceptance
A copy of the Directorate Specimen Acceptance policy is included in the DLM handbook. In summary a minimum of 3 of the following items of informatiom must be provided;

1 Patient Forename,
2.Patient Surname
3. Patient date of birth
4. Hospital number or NHS number or any other unique identifier.

The sender of the sample will be notified as soon as possible if the sample is inadequately labelled so that the investigation can be repeated if it is still required.
Inadequately labelled or unlabelled samples will not be analysed.

The request form should be sent to the laboratory, with the appropriate specimen sealed in a plastic bag, by the specimen transport system (pneumatic tube) or by messenger porter or ward staff. The forms must be kept separate from the samples. Specimens and forms for individual Laboratory Medicine Departments must be sent in individual specimen bags to avoid delays in processing. An electronic request via CWS is preferred.

If tests are requested using the CWS system an electronic report will be sent back to the unit from which the request was made.

Specimen requirements and reference ranges

Specimen requirements and reference ranges are shown in the following tables (analytes arranged alphabetically).

Please note:-

- Ranges are for adults.
- Desirable values rather than population reference ranges are given for lipids
- Information from, or copies of, the various guidelines referred to (e.g. European Arthrosclerosis Society Guidelines) can be obtained by contacting the Duty Biochemist.
- To simplify requesting, a number of **organ specific** blood profiles are available. The tests included in these are listed below:

Renal profile	sodium, potassium, urea, creatinine, eGFR

Bone profile	calcium, corrected calcium, albumin, alkaline phosphatase, phosphate
Liver profile	ALT, alkaline phosphatase, total bilirubin, albumin, total protein
Lipid profile	cholesterol, triglyceride, HDL. Must be fasting sample for full profile.
Thyroid profile	TSH and free T4, other tests are added if necessary by laboratory clinical scientists
Iron profile	Iron , transferrrin and iron saturation

Sample Volumes

One fully filled 4.5 ml yellow topped Vacutainer will generally contain sufficient blood for analysis of all profiles listed above. However this does depend on the MCV of the patient and assumes that a minimum of 2 mls of serum is able to be separated

For single analytes 1 ml of whole blood is usually sufficient.

For all assays not quoted above please send one full tube of the correct type, if collection of multiple tubes causes a problem please call the duty biochemist for advice.

Blood samples

AVOID CONTAMINATION - When taking a series of blood specimens, it essential that the yellow top serum sample is taken first, followed by green top Lithium heparin samples then the grey top Fluoride Oxalate samples and any EDTA tubes last of all. Failure to adhere to this sequence will lead to contamination of blood samples with anticoagulants/preservatives.
This contamination produces spurious and invalid results.

Avoid haemolysis, drip contamination, adverse temperatures (over 30 ^{o}C or less than 10^{o}C, unless otherwise stated) and prolonged venous constriction.

Ensure thorough and instant mixing of blood with anticoagulant (heparin, fluoride oxalate or potassium EDTA) for plasma samples.

Do not transfer blood from one tube to another e.g. EDTA to Lithium heparin.

Do not leave Clinical Biochemistry blood samples in the fridge (4°C) or overnight at room temperature. If in doubt, please contact the laboratory (Duty Biochemist bleep 4375) for advice.

Leaking blood tubes will be discarded.

DO NOT send blood gas samples to the laboratory via the pneumatic tube systems.

DO NOT send blood gas samples to the laboratory with the needle attached.

Urine samples

General points

- The assays listed in the table on page 34 are normally reported as a 24 hour output, and a full 24 hour collection is required. Please ensure that start and end dates and times are noted on the bottle label.
- Random samples or overnight collections are adequate for some tests and these are marked in the table.

- Some analyses require a specific preservative in the collection bottle (see table) - check before starting collection. Special bottles are held by the Biochemistry Department and can be collected from there or the reception area in the Clinical sciences building by the portering service or ward staff.
- Please complete the bottle label as well as the request form.
- **Creatinine clearances** can only be calculated only if the blood creatinine is measured within 24 hours of the 24 hour urine.
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Pleural fluid samples

General biochemistry into a red or yellow top tube, glucose into a fluoride oxalate (grey top) and sample for acid base assessment collected into a blood gas syringe and treated as a blood gas specimen. A simultaneous blood sample for general biochemistry into a yellow top tube and glucose into a fluoride oxalate grey top tube will be helpful for interpretation. See page 41 for Light's critera for evaluating pleural fluid.

Reference ranges

Reference ranges are supplied strictly for guidance only, and these should be used rather than those quoted in textbooks, diaries etc, as both methods and units vary from department to department. These should not be published as methodology changes in line with the introduction of new techniques the ranges become outdated and therefore are subject to constant review. The current reference/therapeutic range is always included with the final report. *5% of the healthy population will have results marginally outside the quoted reference range*. Ranges may be affected by **age**, **gender**, **ethnic group**, **pregnancy**, **time of sampling** and many other factors. Detailed information or advice on interpretation is always available from the laboratory.

Validity of results

Results are automatically validated if they are within preset ranges and have no error flags from the instruments .e.g. Haemolysis, Lipaemia and Icterus. Ranges have been discussed and approved by senior scientists and consultant staff. Results outside these ranges are scrutinised by qualified staff and authorised HPC registered Biomedical Scientists or the duty Biochemist/Medic or Consultant. Comments may be appended and additional analyses undertaken based on the clinical details provided and on previous results.

Whilst internal and external quality assurance programmes are in operation to ensure accuracy and precision of results, occasionally random errors may occur and escape detection. The clinician is often best placed to detect such errors. Therefore if you doubt the validity of a result, it is vital that you contact the relevant 'Advice/Interpretation' extension at once so that we can investigate and re-test samples whenever possible.

Please remember that certain factors may affect and possibly invalidate some test results, causing potential biological and analytical interference. For example, blood transfusion and other intravenous fluids, antibiotics, anticoagulants, drugs, timing of specimen in relation to drug dose, type of tube. Please remember to give details of recent or current treatment on the request forms.

Reporting of results

All results will be issued on a printed report unless clinical users specifically request that this is not done. This may take several forms.

1. A **Cumulative report** giving a maximum of the four most recent results is issued for the majority of profiles and commonly requested single tests.
2. **Single shot** reports are issued for all tests not on Cumulative reports.
3. **Interim** (or **Ward**) reports are also issued in some circumstances or to meet special requirements of some wards. These are temporary reports and should not be stored in the patient's notes.
4. **Electronic Reporting.** This can be carried out in two different ways.

The first is **results reporting** back to **OCM** for those requests made by that system.
The second is direct to a department's clinical system but this will only be done through a special development arranged with the laboratories.

5. **Telephone reporting** will be used for urgent results for which the other systems would not provide a report quickly enough.

Results which are outside of the limits listed below will be telephoned. Other results may be telephoned if they appear to be inconsistent with previous results or of particularly relevant for diagnostic or treatment ourposes.

Telephone action limits

The following abnormal results will be telephoned to users, the list is not comprehensive and other clinically important results will be telephoned as required.

Test Name	**Limit** These limits identify rules for holding up results for review. Otherwise results will be automatically validated	**GP/OP results to be telephoned out of hours** After the Surgery Office is closed use the GP deputising service. If there is a problem contact the senior on-call Biochemist	**Comments (c) or exception criteria (e)** These are general guidelines. If concerned about any result please contact the Duty Biochemist in the first instance
Ammonia	≥100 umol/L		
Amylase	≥ 500 U/L	≥ 500 U/L	higher in last 7 days
Calcium (corrected)	≥ 3.0 mmol/L ≤ 1.8 mmol/L	≥ 3.5 mmol/L ≤ 1.5 mmol/L	higher in last 7 days lower in last 7 days
CO Hb	≥ 15%		
CK	≥ 5000 U/L	≥ 5000 U/L	higher in last 7 days
Creatinine	None		
Digoxin	≥ 3.0 ug/L	≥ 3.0 ug/L	higher in last 7 days
Glucose	≤ 2.5 mmol/l ≥ 25 mmol/l	≤ 2.5 mmol/l ≥ 25 mmol/l	higher in last 2 days lower in last 2 days refer to Senior on call for outpatients problems after the laboratory office has closed
Lactate	≥ 4.0 mmol/L		higher in last 2 days
Lithium	≥ 1.2	≥ 1.5 mmol/L	
Magnesium	≥ 3.0 mmol/L ≤ 0.4 mmol/L		higher in last 2 days lower in last 2 days
Paracetamol	None		
Phosphate	≤ 0.3 mmol/L		
Potassium	≥ 6.5 mmol/L ≥ 7.0 in pre dialysis patient. ≤ 2.5 mmol/L	≥ 6.5 mmol/L ≤ 1.9 mmol/L	If creatinine is normal, assess carefully delayed separation, haemolysis, and contamination with EDTA.
Salicylate	None		
Sodium	≥ 160 mmol/L ≤ 120 mmol/L	≥ 160 mmol/L ≤ 120 mmol/L	Unless it is clear that the situation is being monitored and improving. Duty Biochemist will be automatically alerted on the RPC of these electrolyte abnormalities and can assess the situation
Theophylline	≥ 37.5 mg/l	≥ 37.5 mg/l	Theophylline around 75 mg/l has been used to identify toxicity requiring haemoperfusion
Troponin (GP/OP only)	None		use preset procedures for reporting to A/E
Urea	None		

Time limits for requesting additional tests

For most general and endocrine requests it is not possible to add on an additional test more than 24 hours from the time that the original results were authorised. This only applies to analytes that are stable at 2-8° C.

Referred tests

Some specialized or low volume assays are referred to external laboratories for analysis. In line with CPA requirement we endeavour to use CPA accredited laboratories whenever possible. A full list of the tests referred out and the laboratories that are used is available from us; however the more common ones are listed below:

Test	External Laboratory
Downs Screening	Bolton Royal Hospital
Tumour markers (, CA19-9,CA15-3, quantitative Light chains)	Christie Hospital
Specific Proteins (A1AT phenotype, Carbohydrate Deficient Transferrin)	Sheffield Protein Reference Unit
Androgens and Steroids(D-Sulphate, A-dione, female testosterones)	Hope Hospital Salford
Gut Hormones	Hammersmith Hospital
Specialist TDM	Guy's & St. Thomas' Hospital
Bile Acids	Stepping Hill Hospital, Stockport

Comments/Complaints Procedure

Any complaints or concerns about any aspect of the service should be raised initially with the Departmental Laboratory Manager, Mr Rod D Hinchliffe, telephone 0161 276 4698.

We are keen to know about any problems arising from the laboratory service. Feedback from our users will help in our constant efforts to improve our service.

ACCREDITATION

The department was fully inspected in November 2006 with an interim inspection in 2008 and is now Fully Accredited by CPA (UK) Ltd. Point of Care Testing (POCT) services that are fully supported by the department are included in this.

A – Z OF TESTS

These tables cover the most requested tests; please contact the Duty Biochemist for any tests not on these tables.

Specimen requirements and reference ranges for blood analyses

Analyte	Reference range	Turnaround time	Specimen notes
11-deoxy cortisol	5.0-12.1 nmol/L	4 weeks	Yellow top tube (Serum) Must be sent to the laboratory on ice for immediate separation. Do not screen routinely for 11 hydroxylase deficiency in adults unless there is significant androgen excess and the cause is not apparent and the result would affect treatment
17 α OH Progesterone	0-10 nmol/L	1 – 2 weeks	Yellow top tube (Serum)
18 hydroxy cortisol	Supine 0.7-6.5 nmol/L Ambulant 1.6-10.7 nmol/L	4-8 weeks	Purple Top Tube (EDTA plasma) or Yellow top tube (Serum). Establish a diagnosis of Conn's before considering this test
Acid - Base status pH pCO2 - arterial pO2 - arterial pO2-capillary actual bicarbonate base excess ; male base excess ; female	 7.36 - 7.44 4.5 - 6.0 kPa 12.0-14.7 kPa 6.7 - 10.7 kPa 24 - 30 mmol/L -2.3 to + 2.3 mmol/L -3.0 to + 1.6 mmol/L	Urgent; 30 mins	Blood gas syringe. Remove needle, cap syringe. Additional: *Do **not** send this specimen by pneumatic tube.*
ACTH	9am ; 0-46 ng/L	2-4 weeks	Green top tube (plasma) Additional: *Do **not** use glass tube. Send to lab in ice immediately. Requires rapid separation*
Adrenaline – see Catecholamines			
ADH (Argenine vasopressin)			2 x Green top tubes (plasma) Send on ice for immediate separation, 5 ml of plasma is required
AFP - as tumour marker	< 10 KU/L	1 week	Yellow top tube (serum)
Albumin	34 – 48 g/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum)

Analyte	Reference range	Turnaround time	Specimen notes
Aldosterone Samples taken a random during the day Overnight recumbent	 100-850 pmol/L 100/450 pmol/L (general guidance only)	4 weeks	Green top tube (Plasma) Must be sent to the laboratory for immediate separation **but must not be sent in ice.** **Screening for Conn's: random aldosterone and renin**
Aldosterone / Renin Ratio	>1000 suggests primary hyperaldosteronism >2000 indicated that the patient almost certainly has hyperaldosteronism (general guidance only)	4 weeks	Green top tube (Plasma) Must be sent to the laboratory for immediate separation **but must not be sent in ice as this encourages conversion of pro-renin to renin.**
Alkaline phosphatase (U/L)	Adults ; Male ; 10 -129 U/l Female ; 35 -104 U/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum)
Alkaline Phosphatase isoenzymes	Qualitative interpretation. Contact Pancreatic Lab (ext 64067)	2 weeks	Serum (One red or yellow top tube)
Alpha – 1 Antitrypsin	1.0 – 2.0 g/L Phenyotyping will be done if results are; Adult <1.28 g/L Children <1.5 g/l	1 week	Yellow top tube (serum)
Alcohol	- See ethanol and methanol in Toxicology section		
ALT	5 – 40 U/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum)
Ammonia	Adults; <40umol/L.	Urgent; 2 hours Routine; 4 hours	Purple top tube. (EDTA) Additional: *Contact lab on 65180 prior to collection. Sample must be fresh – send to lab in ice immediately.*
Amylase	< 100 U/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum)
Amylase isoenzymes	Contact Pancreatic Lab (Ext 64067)	2-3 weeks	Serum (One red or yellow top tube)
Androstenedione	Male 2.1-10.8 nmol/L Female 1.0-11.5 nmol/L	2-4 weeks	Yellow top tube (serum)

Analyte	Reference range	Turnaround time	Specimen notes
Anti Mullerian Hormone (AMH)	Contact lab or refer to report for guideline	1-2 weeks	Yellow top tube (serum). Separate within 2 hours. Store and send cold if less than 24 hours. If > 24 hours, store at -20^{0}C
Anion-Gap	10-18 mmol/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (Serum)
Angeotensin converting enzyme (ACE)	15-55 IU/L	1 – 2 weeks	Yellow top tube (Serum)
APO-E genotype		2- 4 weeks	Purple top (EDTA plasma) This is a genetic test and the whole blood sample is required
AST	5 – 45 U/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum) (Adults)

Analyte	Reference range	Turnaround time	Specimen notes
β-Carotene **Beta corotene**	19-254 µg/l	4 weeks	Contact Pancreatic lab ext 64067 before drawing blood Serum (One red or yellow top tube)
Bicarbonate	24-30 mmol/L	Urgent; 2 hours Routine; 4 hours	
Bile Acids	< 14 umol/L	Next day Mon-Fri	Yellow top tube (Serum)
Bilirubin (total **Bilirubin (Conjugated/direct)**	Adults; < 22 µmol/L *No range*	Urgent; 2 hours Routine; 4 hours	Yellow top tube, Serum (Adults)
Bone Markers; **CTX** **P1NP**	0.1 – 0.5 ng/L Premenopausal(<56years) women – 30-78 µg/L Postmenopausal(>56years) women – 26-110 µg/L Men – 20-76 µg/L	2-4 weeks	Purple top tube (plasma) Fasting morning sample is preferred Purple top tube (Plasma) **Not affected by fasting**
Ca-125,Ca19-9,Ca15-3,CEA see tumour markers			
Caeruloplasmin	0.25 – 0.63 g/L	1 week	Yellow top tube (serum) This is measured by immunoassay, not copperoxidase activity
Carbohydrate deficient transferrin	Negative <2.6% of total transferrin Positive >2.6% of total transferrin	2-4 weeks	Yellow top tube (serum). This test is available only after discussion with the duty biochemist or after prior agreement
Carboxyhaemoglobin	<2% non smokers <10% for smokers (approximate)	Urgent; 30 mins	*If sent with blood gas;* Blood gas syringe. Remove needle, cap syringe**.** Additional: *Do **not** send this specimen by pneumatic tube* If separate sample; Green Top tube (Plasma)
Calcitonin	< 5.5ng/L Female < 18.9 ng/L Male	4 weeks	Yellow top tube (serum) *Send to lab in ice immediately. Requires rapid separation*
Calcium (total **Calcium (corrected)**	2.10 – 2.55 mmol/L 2.10 – 2.55 mmol/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum)

Analyte	Reference range	Turnaround time	Specimen notes
Catecholamine (Plasma)	Adrenaline 0-1.0 nmol/L Noradenaline 1.0-6.0 nmol/l	4 weeks	Purple top tube (EDTA plasma) *Send to lab in ice immediately. Requires rapid separation*
Chloride	95 -110 mmol/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum))
Chromogranin A	< 60 pmol/L	8 weeks	Purple top tube (EDTA plasma)
Chromogranin B	< 150 pmol/L	8 weeks	Purple top tube (EDTA plasma)
Cholesterol	JBS 2 Dec 2005 treatment targets; Total <4.0 mmol/l LDL <2.0 mmol/L HDL male >1.0 mmol/l HDL female >1.2 mol/l	Routine; 4 hours	Yellow top tube (serum) Additional: *See Joint British Societies 2 guideline. LDL will only be calculated if TG <or = to 4.0 mmol/L*
Cholinesterase	Total 620 – 1370U/L Phenotype; See interpretive result report issued	4 weeks	Yellow top tube (serum) Additional: *Apnoea investigations should wait until patient is fully recovered.*
CK total	Male; up to 190 U/L Female; up to 165 U/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum)
CKMBmass	Less than 5 ng/mL	Urgent; 2 hours	Yellow top tube (serum) Test only available for A&E Chest Pain Assessment Unit @ MRI

Analyte	Reference range	Turnaround time	Specimen notes
Copper	11-20 umol/L	2-4 weeks	Blue top tube (serum)
Cortisol	Mid-night; 60-250 nmol/L 9am; 200 – 650 nmol/L	Next day Mon-Fri	Yellow top tube (serum) Random cortisol is not an effective means of screening for Cushing's syndrome: use 1 mg overnight dexamethasone suppression or 24 hour urinary free cortisol All samples taken as part of a Synacthen test should be sent to the laboratory in a single batch. A baseline and thirty minute sample is required.

Analyte	Reference range	Turnaround time	Specimen notes
C-peptide	Level depends on glucose concentration	4 weeks	Yellow top tube (Serum) Must be sent to the laboratory on ice for immediate separation. If the test is requested because of hypoglycaemia then an appropriately low glucose taken simultaneously is required and will only be measured if insulin is raised inappropriately
C-reactive protein (CRP)	0.3-5.0 mg/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum) CRP is useful to monitor inflammatory processes and is at least as useful as Orosomucoid for monitoring inflammatory bowel disease for which purpose CRP is preferred
Creatinine **Adults**	Male;62-106 µmol/l Female; 44-80 µmol/l	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum) May be elevated by creatine supplements
CTX- See Bone Markers			
DHEA sulphate male female	2.2 – 15.2 µmol/L 1.0 -12.0 µmol/L	2-4 weeks	Yellow top tube (serum)

Analyte	Reference range	Turnaround time	Specimen notes
FSH male female pre-menopause post menopause	 2 -15 IU/L 2 -15 IU/L > 20 IU/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum)
Fructosamine	2.55 – 3.60 mmol/L	2-3 weeks	Yellow top tube (serum) Provide where an analytically correct measurement of HbA1c cannot be obtained due to the presence of a variant haemoglobin Target ranges for control of diabetes are not well validated. Measurement of HbA1c by different means may solve the problem. NICE suggests direct measurement of glucose day curves, for which HbA1c is a proxy
Gamma-GT	Male; 10-71 U/L Female; 6-42 U/L	Routine; 4 hours	Yellow top tube (serum) Mainly used to distinguish between liver and other causes of a raised alkaline phosphatise. Should not form part of a routine assessment of liver function
GHRH	See report	4-8 weeks	Red Top (serum)
Glucose	Fasting adult ; 3.0 – 6.0 mmol/L	Urgent; 2 hours Routine; 4 hours	Grey top tube (plasma) See appendix for diagnosis of diabetes according to WHO criteria
Glutathione (whole blood)	1078-1753µmol/L or 7.49-12.21 µmol/g haemoglobin	2 weeks	Contact Pancreatic lab ext 64067 before drawing blood. One purple top (EDTA)

Analyte	Reference range	Turnaround time	Specimen notes
Glycated Haemoglobin HbA1c	Non-diabetic ; 4.5–6.5% (26-48 mmol/mol) Well controlled diabetic up to 7% (53 mmol/mol).	Next day , Mon-Fri	Purple top tube (EDTA plasma) The presence of a variant haemoglobin will be reported. Further investigation of these requires patient consent for further analysis, which is performed in haematology.
GTT	Interpretation of results is provided with each report following WHO guidelines.	Analysed same day as test carried out on ward	*Doctors working in the hospital: contact Programmed Investigation Unit to arrange ward appointment* . GP referral to Clinical Biochemistry with full contact details of patient
Growth Hormone	Level dependant on age , sex and clinical circumstance ng/ml	2-4 weeks	Yellow top tube (serum) Standardised against IS98/574. To compare with previous measurements expressed in mU/L multiply the mass unit by 3 **Random measurements are of little use (see IGF1)**
Gut hormones; Gastrin Glucagon Neurotensin Pancreatic polypeptide Somatostatin VIP	<40 pmol/L <50 pmol/L <100 pmol/l <300 pmol/L <150 pmol/L <30 pmol/L	4 weeks	**Patient MUST be fasting** Must send in ice and collected in special tube provided by the laboratory (contact 276 5180)
HCG (as tumour marker)	0- 2 IU/L	1 week	Yellow top tube (serum) Follow-up testing of trophoblastic tumours usually requires testing of urine HCG and is arranged directly with the clinician by the designated national centre (Sheffield in our case)

Analyte	Reference range	Turnaround time	Specimen notes
Homocysteine	<15 umol/L	2-4 weeks	Grey Top (Fl.ox. plasma) *Must be sent to the laboratory for immediate separation* *Fasting sample preferred. Not routinely available as a cardiovascular risk factor.*
Immuno-reactive trypsin	See report	2-4 weeks	Green top tube , whole blood or preferably blood spots
Inhibin B	80-150 pg/ml	2-4 weeks	Yellow top tube (serum). Routinely available only as a granulosa cell tumour marker
Insulin	2.3 – 26.0 mIU/L (fasting)	1 week	Yellow top tube (Serum) Must be sent to the laboratory on ice for immediate separation. A simultaneous fluoride oxalate sample for glucose must be provided
Insulin Like Growth Factor 1 IGF-1	Complex age related ranges , these are listed in a separate table on page 19	1-2 weeks	Red top tube (Serum) Preferred test for screening for acromegally

Analyte	Reference range	Turnaround time	Specimen notes
Iron (and iron status) **Transferrin** **% iron saturation**	7 – 29 µmol/L 2.0 – 3.6 g/L 15%-45%	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum) Ferritin provided by haematology is a better test of iron deficiency. Measurement of iron is not necessary Iron saturation is more sensitive than ferritin for detecting iron overload
Lactate	Adults; 0.7 – 2.1 mmol/L	Urgent; 2 hours	Grey top tube (plasma) Specimen to be sent to laboratory immediately within an hour but must be separated immediately so lab staff must be alerted
Lead *Environmental exposure guidelines*	Adult; < 250 ug/L	Routine 5 working days	Purple top tube (EDTA Plasma) If environmental testing in the work place is undertaken, arrangements must be made to store a sample for confirmatory testing
LDH	240 – 480 U/L	Routine; 4 hours	Yellow top tube (serum) Additional: *By special arrangement*
LH	Female/male; 2 – 14 IU/L Female mid cycle; 15 – 50 IU/L Post menopause; > 15 IU/L	Next day , Mon-Fri	Yellow top tube (serum)
Magnesium	Adults; 0.6 – 1.0 mmol/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube. (serum)(Adults)

Analyte	Reference range	Turnaround time	Specimen notes
Manganese	<1 year 7-18 ug/L > 1yr 4-12 ug/	2-4 weeks	Purple top tube (EDTA Plasma)
Met-haemoglobin	< 1.5%	Urgent; 2 hours Routine; 4 hours	**If sent in a blood gas syringe**, for additional measurement of acid base parameters, remove needle and cap syringe**.** *Do **not** send this specimen by pneumatic tube* **If separate sample;** Green Top tube (Plasma)
Noradrenalin – see catecholamines			
Oestradiol	Male; 50 - 165 pmol/L Female follicular; 110 - 183 pmol/L Female mid cycle; 550 - 1650 pmol/L Female luteal; 550 – 845 pmol/L	Next day , Mon-Fri	Yellow top tube Additional: *Measurement of Oestradiol is not recommended for monitoring of HRT.*
Orosomucoid	300 – 1200 mg/L	2-4 weeks	Yellow top tube CRP is equally efficacious for monitoring inflammatory bowel disease
Osmolality (serum)	275 – 295 mmol/kg	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum)

Analyte	Reference ranges	Turnaround time	Specimen notes
Osmolar Gap (calculated as: calculated osmolality – measured osmolality. Calculated osmolality is 2 x (Na + K) + glucose + urea)	<10 mmol/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum)
Oxalate		2-4 weeks	Purple top (EDTA Plasma) Must be separated and frozen within 1hr of collection
P1NP – See Bone Markers			
PIIINP	1.7 – 4.2 ug/L	3-4 weeks	Yellow top tube (serum)
Phosphate	0.7 mmol/L-1.4mmol/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum) (Adults)
Potassium adults	3.5 - 5.5 mmol/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum)
Pregnancy test; see Quantitative HCG			
Progesterone follicular luteal peak	< 3 nmol/L 20 - 70 nmol/L	Next day , Mon-Fri	Yellow top tube (serum)
Prostate Specific Antigen (PSA) 50-59 yrs 60-69 yrs 70 and over **Free PSA by equimolar analysis**	 <3.0 ng/ml <4.0 ng/ml <5.0 ng/ml (Department of Health Referral Guidelines 2002) Interpretation is by close scrutiny of latest evidence	Next day , Mon-Fri Variable depending on demand	Yellow top tube (serum) Yellow top tube
Prolactin Total; Free Prolactin ;	Male; 86-324 mU/L Female;102 – 496 mU/l Male; 67 – 251 mU/L Female; 79 – 384 mU/L	Next day , Mon-Fri	Yellow top tube (serum) Free prolactin will be measured if there are two consecutive elevated prolactins not explained by hypothyroidism, antidoaminergic drugs, or pregnancy. However, samples referred from Endocrinology will automatically be assessed for free prolactin if prolactin is elevated. Free prolactin will only be estimated once in each patient
Protein (total	60 – 80 g/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum)(Adults).

Analyte	Reference ranges	Turnaround time	Specimen notes
PTH	10 – 60 pg/ml	Same day	Purple top (EDTA plasma)
PTHrp	Set report	2-4 weeks	Needs special tube , contact laboratory on 276 5180, must be sent on ice for rapid separation. A PTH should have been found to be suppressed and hypercalcaemia demonstrated. However modest artefactual elevation of PTH above suppressed levels may be seen if eGFR is reduced
Quantitative HCG *If used for Ectopic Pregnancy see Clinical Guideline*	Quantitative HCG used as a pregnancy test; A result of >25 U/L would normally indicate a positive test. But, a result of <25 U/L does not exclude early pregnancy.	Urgent; 2 hours Same Day	Yellow top tube (serum) Interpretation of HCG in the context of monitoring early pregnancy is not provided by the laboratory
Renin Samples taken at random during the day Over night recumbent 30 minutes upright Random	 0.5 – 3.5 nmol/L/h 1.1-2.7 nmol/L/hr 2.8 – 4.5 nmol/L/hr 0.5- 3.5 nmol/L/hr	2-4 weeks	Green top tube (Plasma) Must be sent to the laboratory for immediate separation **but must not be sent in ice as this encourages conversion of pro-renin to renin.**
Retinol Binding Protein	0 – 0.3 mg/L	1- 2 weeks	Yellow top tube (serum)
Selenium	83-152µg/l	3-4 weeks	Serum (One red or yellow top tube)
SHBG	Male; 15 – 47 nmol/L Female; 20 – 110 nmol/L	1-2 weeks	Yellow top tube (serum)
Sodium	132 – 144 mmol/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube (serum). Additional: *Hyponatraemia Guidelines Available*
Thiopurine Methyltransferase TPMT	nmol/g Hb/hour <5 deficient 6-34 low 35-79 normal >80 high	1-2 weeks	Pink or Purple top (EDTA plasma) Recent blood transfusion may mask a deficient TPMT result.
Tri-oidothinoine – Free (free T3) not routinely available			
Tri-iodothinoine –Total (T3)	1.3 – 3.1 nmol/L	1-2 weeks	Yellow top tube (serum) Additional: *Not standard part of Thyroid Function Test*

Analyte	Reference ranges	Turnaround time	Specimen notes
Testosterone	Male; 10 – 35 nmol/L Female; < 1.8 nmol/L		Yellow top tube (serum) SHBG and FAI will be reported with all female testosterone results
Thyroglogulin (Thyro**)**	< 55 ug/L	1-2 weeks	Yellow top tube (serum) Used as a tumour marker. Thyroglobulin antibodies may interfere with the assay and levels will be reported with the test result
Thyroid Binding Globulin (TBG)	See report.	1-2 weeks	Yellow top tube (serum) Not usually necessary as part of TFT because free T4 is measured
Thyroxine- Free (free T4)	9 – 24 pmol/L	1-2 weeks	Yellow top tube (serum) Low levels of binding protein usually reflected by a low albumin cause low results. High levels of TBG, as occur in pregnancy or HRT, have no effect
Total Protein	<1 month 51-68g/l 1m – 12 m 56-72 g/L >12m 60-80g/L	Routine ; same day	Yellow top tube (serum)
Transferrin	2.0 – 3.60 g/L	Routine ; same day	Yellow top tube (serum) Provided as part of iron profile and used as the denominator to calculate iron saturation
Triglycerides	Fasting guideline;JBS 2 Dec 2005 treatment target an optimal level <1.7 mmol/l	Same day	Yellow top tube (serum)
Troponin T **New high sensitivity assay introduced 6the Oct. 2010**	< 14.0 ng/L (99^{th} centile of reference range and limit of detection)	Urgent; 1 hour Routine; 4 hours	Yellow top tube (serum) NICE has recommended a testing protocol at admission and 6 hours later for hs-cTnT. This will involve an increased number of samples and the cost has not been funded. We would prefer single testing at 12 hours after the event to maximize diagnostic sensitivity in a single sample but recognize that serial testing may be necessary in difficult cases.

Analyte	Reference ranges	Turnaround time	Specimen notes
TSH	0.2 – 5.0 mU/L	Same day	Yellow top tube
Tumour Markers; **CA 15- 3** **CA 19 – 9** **CA 125** **CEA**	 <32 KU/L <31 U/mL <21 U/mL 0-3.0 ug/L (non-smoker)	All 1-2 weeks	Yellow top tube (serum) Fluid other than blood should be put into a yellow top tube. However, non of the tumour markers are validated on non-serum fluids and no interpretation is offered
Urate males females	0.17 – 0.48 mmol/L 0.14 – 0.39 mmol/L	Routine; 4 hours	Yellow top tube
Urea	3.5 – 7.4 mmol/L	Urgent; 2 hours Routine; 4 hours	Yellow top tube
Vitamins; **Vitamin B1** **Vitamin B2** **Vitamin B6**	See individual reports	1-2 weeks	Vit A & E ;Yellow top tube B Vitamins; Purple top (EDTA plasma)
Vitamin E	Vitamin E 5.7-14.9 mg/L (3.47-6.20 mmol/mol cholesterol)	4 weeks	Contact Pancreatic lab ext 64067 before drawing blood Serum (One red or yellow top tube)
Vitamin A	Vitamin A 0.407-1.177mg/l	4 weeks	Contact Pancreatic lab ext 64067 before drawing blood Serum (One red or yellow top tube)
Vitamin C	4-20mg/l	3 weeks	Contact Pancreatic lab before drawing blood (Ext 64067). 2 heparinised green top tubes
Zinc	10-18 umol/L <16 yr 9.5-18.5 umol/L adult male 9.5-22.5 umol/L adult female	2-4 weeks	Blue top tube

IGF-1 reference ranges

Age	Male range (ug/l)	Female Range (ug/l)
0-7d	<25	<25
7-14 days	<40	<40
<4 years	40-195	40-250
>4y <9y		55-280
9 years		55-320
>4y <10y	55-240	
10 years	55-310	70-460
11 years	65-400	95-540
12 years	95-610	170-650
13 years	135-690	170-740
14-16years	135-830	180-830
17 years	135-630	
17-20 years		135-545
18-20 years	135-490	
20-30 years	108-320	
30-40 years	100-275	
40-50 years	90-240	
50-60 years	75-215	
60-70 years	68-190	
70-80 years	60-160	

- **Thyroid Function Tests**

Adequate clinical information, including a drug history is essential in order to provide information of most value in the diagnosis and management of thyroid disorders.
The first line investigation is freeT4 and TSH .
Further tests, including total T3, will be performed as considered appropriate. Generally T3 is always elevated if FT4 is elevated and so its measurement is unnecessary. T3 is added to detect T3 toxicosis when FT4 is normal but the TSH is below normal and to monitor T3 toxicosis and to monitor thyroid function in patients on amiodarone.. Otherwise it will not be measured unless there is some other complicating factor that has been discussed with the duty biochemist.
Other assays such as free hormone investigations and TBG are sometimes helpful but not usually necessary- The use of these assays and any interpretative problems can be discussed with the Duty Biochemist.

Specimen requirements and reference ranges for blood analyses (Paediatric)

See Children's Biochemistry User Guide.

Specimen requirements for Toxicology and Therapeutic Drug Monitoring (TDM)

- Time of specimen collection and time of last dose (or exposure for poisoning) should be recorded on the request form. Dose per 24 hours should also be recorded.
- Time of specimen collection should be recorded on the sample tube.
- Tests required to diagnose and facilitate specific emergency treatment, e.g. with antidote, are available at as indicated in the A-Z of analytes and conform to the NPIS/ACB Joint Guidelines for Laboratory Services for Acute Poisoning .
- Tests for the identification of a wide range of common toxic drugs and other poisons are available by arrangement during normal laboratory hours (8.00am – 5.00pm Monday to Friday excluding Bank Holidays) telephone the Toxicology Laboratory on 0161 276 4699 or bleep the Duty Biochemist.
- In all unconscious patients and cases of suspected poisoning with drugs the first available urine specimen should be retained.
- Measurement of blood concentrations of the drugs included in the A-Z of Tests is provided for individual optimisation of dose (TDM) and to allow a rational approach to re-instating treatment following overdose.
- Blood for lithium measurement should be collected 12+/-0.5 hours post dose. For most other TDM pre-dose (trough) sampling is preferred.
- After initiation or dose adjustment at least 5 plasma half-lives should be allowed to elapse before sampling to allow a steady state to be achieved before checking for adequacy of dose.
- For pharmacokinetic data and information on dose adjustment see TDM sample guide.

Theraputic Drug Monitoring Guide

Test	Therapeutic Range	Turnaround Time	Specimen Notes
Amiodarone	0.6-2.5 mg/l	4 weeks	Yellow top tube (serum) Pre-dose By arrangement only
Amitriptyline	50 –150 ug/l	4 weeks	Yellow top tube (serum) Pre-dose By arrangement only
Carbamazepine	4- 10 mg/l	Routine 1 week Urgent 4 hours	Yellow top tube (serum) Pre-dose Urgent by arrangement
Clomipramine	150-450 ug/L	4 weeks	Yellow top tube (serum) Pre-dose
Cyclosporin (ciclosporin)	100-300 ug/l	In patients same day Mon-Fri (if in lab before 10.30am	Purple top tube (EDTA plasma) Pre-dose
Digoxin	1.0-2.0 ug/l	Routine same day Urgent 2 hours	Yellow top tube (serum) Pre-dose or at least 6 hours post dose Urgent by arrangement
Dothiepin	20-60 ug/l	4 weeks	Yellow top tube (serum) Pre-dose By arrangement only
Ethanol as antidote (e.g. methanol) Legal limit for driving	800-1200 mg/l 800 mg/l	Routine same day Urgent 2 hours	Grey (Fluoride oxalate plasma) or yellow top tube (serum)
Ethosuximide	40-100 ug/l	4 weeks	Yellow top tube (serum) Pre-dose By arrangement only
Ethylene glycol		2-3 days Urgent analysis out of hours can sometimes be arranged but cannot be guaranteed	Grey (Fluoride oxalate plasma)
FK506 (tacrolimus, Prograf)	3-15 ug/l	Same day Mon-Fri (if in lab before 10.30am	Purple top tube (ETDA plasma) Pre-dose
Flecainide	0.4-1.0 mg/l	4 weeks	Yellow top tube (serum) Pre-dose By arrangement only
Imipramine	10-110 ug/l	4 weeks	Yellow top tube (serum) Pre-dose By arrangement only

Test	Therapeutic Range	Turnaround Time	Specimen Notes
Lamotrigine	3.0 -15.0 mg/l	1 week	Yellow top tube (serum) Pre-dose
Lithium	0.4-1.0 mmol/l	Routine same day Urgent 2 hours	Yellow top tube (serum) 12+/-0.5 hours post dose
Methanol		Routine same day Urgent 2 hours Mon-Fri Urgent analysis out of hours can sometimes be arranged but cannot be guaranteed	Grey (Fluoride oxalate plasma)
Methotrexate	Action as protocol	Routine 2 working days Urgent same day Mon-Fri Urgent analysis out of hours can sometimes be arranged but cannot be guaranteed	Yellow top tube (serum) Collect as protocol Urgent by arrangement
Paracetamol	10-20 mg/l In overdose refer to treatment nonagram	Routine same day Urgent 2 hours	Yellow top tube (serum) At least 4 hours after overdose. Record times of ingestion and sample collection
Phenobarbitone	10-30 mg/l	1 week	Yellow top tube (serum) Pre-dose
Phenytoin	8-20 mg/l	1 week	Yellow top tube (serum) Pre-dose
Salicylate analgesic anti-inflammatory	20 -100 mg/l 100 -250 mg/l Overdose: see Toxbase or BNF	Routine same day Urgent 2 hours	Yellow top tube (serum) Repeated measurement may be required. Record times of ingestion and sample collection
Sirolimus	5-10ug/Ll Overdose: see Toxbase or BNF	1 week	Purple top tube (EDTA plasma) Pre-dose
Theophylline	10-20 mg/l	Routine same day Urgent 2 hours	Yellow top tube (serum) Pre-dose
Valproate	50-100 mg/l	1 week	Yellow top tube (EDTA plasma) Pre-dose

URINE; PLAIN BOTTLES			
Analyte	**Reference ranges**	**Turnaround time**	**Specimen notes**
18 Hydroxy cortisol	40-550nmol/24 hrs	1 month	Plain bottle. This should only be requested when a diagnosis of primary hyperaldosteronism has been established
Amino acids- Random Collection		2 weeks	Full drug history must be included with the request.
Albumin excretion	< 10µg/minute	1 week	Plain bottle Additional: *Preferred timed overnight collection*
Albumin/creatinine ratio	Male;0 – 2.5 mg/mmol Female; 0 – 3.5 mg/mmol	2 working days	Plain bottle Additional: *Random sample – preferred first sample on waking*
Cortisol – free	< 165 nmol/24 hr	2-4 weeks	Plain bottle
Creatinine		Routine; Next day Mon-Fri Urgent; Same day	Plain bottle
Electrolytes	Related to intake	Routine; Next day Mon-Fri Urgent; Same day	24 hour collection or random Plain bottle
Homocysteine		1- 2 weeks	24 hour collection Plain bottle
Lead		1- 2 weeks	24 hour collection or random Plain bottle
Mercury		1- 2 weeks	24 hour collection or random Plain bottle
Osmolality	Related to blood osmolality	Routine; Next day Mon-Fri Urgent; Same day	24 hour collection or random Plain Bottle
PABA	PABA excretion index (PEI) >0.70	Contact Pancreatic Lab to order test (Ext 64067)	Contact Pancreatic Lab to order test (Ext 64067)

URINE; PLAIN BOTTLES			
Porphobilin(ogen)		Routine; Next day Mon-Fri	Very fresh RANDOM sample sent straight to lab. Protected from light.
Porphyrins		Screen 1-2 hours Quantitation if positive 1–2 weeks	Very fresh RANDOM sample sent straight to lab. Protected from light. EDTA blood sample
Porphyrin screen			Whether patient's present with an acute porphyria or a skin rash a similar approach is taken requiring a fresh random urine sample protected from light and an EDTA blood sample. If there is a known family history of acute porphyria an EDTA sample for genetic analysis is required and also faecal analysis may be necessary but faeces need not be sent in the first instance
Protein Protein creatinine ratio	< 150 mg/24 hr A positive test for proteinuria in adults is greater than 45 mg/mmol creatinine.	Routine; Next day Mon-Fri Urgent; Same day	Plain bottle Used as a screening test for proteinuria UK CKD guidelines.

URINE; PLAIN BOTTLES cont.			
Analyte	**Reference ranges**	**Turnaround time**	**Specimen notes**
Urate	3 – 12 mmol/24 hr	Routine; Next day Mon-Fri Urgent; Same day	Plain bottle
Urea		Routine; Next day Mon-Fri Urgent; Same day	Plain bottle
Urobilin(ogen)	Quantitative test	Routine; Next day Mon-Fri Urgent; Same day	Random urine
URINE; ACID PRESERVATIVE BOTTLES*			
5-HIAA	0-50 umol/24 hr	1 week	
Calcium	2.5 – 7.5 mmol/24 hr	Routine; Next day Mon-Fri Urgent; Same day	Acid bottle required
Citrate		2-4 weeks	Acid bottle required
Cystine / homocystine		2-4 weeks	Acid bottle required
Magnesium	3.3 – 5.0 mmol/24 hr	2-4 weeks	Acid bottle required. Avoid metal capped MSU containers because of the danger of contamination
Oxalate	< 0.32 mmol/24 hr	2-4 weeks	Acid bottle required
Phosphate	15 – 50 mmol/24 hr	Routine; Next day Mon-Fri Urgent; Same day	Acid bottle required
Total metadrenalines *Hope Hospital issues the following guidelines on individual analytes* Metadrenalines Normetadrenaline	Males 0.95-5.26 µmol/24 hr Females 0.6-4.2 µmol/24 hr Male & female 0.0 – 2.0 umol/24hr Male 0.0 – 5.3 umol/24hr Female 0.0-4.3 umol/24hr	2-4 weeks	Acid bottle required

***Health and Safety Notice:**

- These bottles contain 25% Hydrochloric Acid
- Keep the bottles out of the reach of children.
- In case of contact with eyes or skin rinse immediately with plenty of water and seek medical advice.
- DO NOT breathe any fumes from the bottles.
- **Patients must be advised NOT TO URINATE DIRECTLY into the bottle.**

URINE ACID WASHED (PLASTIC BOTTLES			
Copper	< 0.8 µmol/24 hr	2-4 weeks	Acid washed bottle required
Iron	Not routinely available, Contact Haematology for Haemosiderin		

Reference ranges and specimen requirements for CSF analyses

Urgent analysis of CSF for protein and glucose is available at all times. Queries regarding any other aspect of CSF analysis can be directed to either 0161 276 4697, or the duty biochemist.

Analyte	Reference range	Turnaround time	Specimen notes
Protein (total) up to 7 days 1-4 weeks 1-3 months Over 3months	 0.4-1.1 g/L 0.2-0.8 g/L 0.2-0.7 g/L 0.05-0.45 g/L	Routine; Next day Mon-Fri Urgent; Same day	Plain 5 ml tube – obtained from Biochemistry. *1 ml of CSF, if possible, required*

Analyte	Reference range	Turnaround time	Specimen notes
Glucose	2.0 – 4.5 mmol/L	Routine; Next day Mon-Fri Urgent; Same day	Grey top tube. *1 ml of CSF, if possible, required*
Oligoclonal Bands	Not seen in healthy subjects	2-4 weeks	Plain 5 ml tube - obtained from Biochemistry. Clotted blood must be sent at same time. *1 ml of CSF, if possible, required*
TAU protein	To check for the presence of CSF in other fluids (for example, discharges from nose or ear), send a few drops of fluid of doubtful origin, and also patient's blood in a red top tube. This assay is expensive and time consuming, full clinical details are required to support this request. Blood must be sent as well.	2-4 weeks	To check for the presence of CSF in other fluids (for example, discharges from nose or ear), send a few drops of fluid of doubtful origin. A simultaneous blood sample is also required, This assay is expensive and time consuming. Full clinical details are required to support this request and to aid interpretation. Blood must be sent as well.
Xanthochromia Screen	Bilirubin 0.0 – 0.001 absorbance units Oxyhaemoglobin 0.001 absorbance units	Same day Mon-Friday for samples received by 3pm	CSF for xanthochromia should be collected in the last tube in a series to reduce contamination with blood. A minimum of 1 ml CSF is required. It should be protected by placing in a brown envelope. A simultaneous blood sample is required for LFT to help interpretation of the bilirubin level in CSF. A fluoride oxalate blood sample is also required for glucose for general examination. Absence of bilirubin excludes sub arachnoid haemorrhage but the lab may not be able to exclude it in the presence of bilirubin if haemoglobin is present

Reference ranges and specimen requirements for faeces

Analyte	Reference range	Turnaround time	Specimen notes
3 day Faecal Fat	10 – 18 mmol/24 hr	2 weeks	MUST BE COLLECTED INTO PRE-WEIGHED CONTAINER SUPPIED BY THE LABORATRY. (phone extn. 64697) NO OTHER CONTAINERS WILL BE ACCEPTED
Occult blood	Reported as positive or negative	2- 3 days	Send 3 consecutive samples
Faecal Elastase	>200 ug/g stool	3 weeks	Random formed stool sample. Contact Pancreatic lab (Extn. 64067) for collection tube.
Porphyrins	Reported as positive or negative	1-2 weeks	Very fresh RANDOM sample sent straight to lab. protected from light. Testing of PBG will undertaken to exclude acute porphyria. Out of hours the urgency should be discussed with the consultant on call. An EDTA blood sample should also be sent to allow full characterisation of a defect in porphyrin metabolism

Miscellaneous

Dynamic Function Tests

Dynamic function test protocols are available from Biochemistry laboratory, or the Programmed Investigation Unit. Please discuss these tests with the Duty Biochemist or one of the Departmental Clinical Scientists or Medical Staff before embarking upon them.

Sweat Tests

These are carried out by the Biochemistry Department at the Royal Manchester Children's Hospital, please contact them to arrange for the test to be carried out.

Creatinine clearance calculation

If creatinine clearance is specifically requested and a 24 urine and blood sample are received the clearance will be calculated automatically and reported in the normal way.

A. Information used in the calculation:

$$\text{Creatinine clearance} = \frac{U \times V}{P}$$

where U = urinary creatinine in mmol/L
V = urinary flow rate in ml/minute (see note 1 below)
P = plasma creatinine in mmol/L (see note 2 below)

Additional notes:-

1. For a 24 hour urine collection, V = total volume in ml divided by 1440.
2. Plasma creatinine on biochemistry reports is in μmol/L, therefore,
   P = plasma creatinine (μmol/L) **divided** by 1000

B. Example of calculation:

Assuming a full 24 hour urine collection, the creatinine clearance may be calculated from the reported results for urine creatinine output and plasma creatinine concentration as shown below:-

$$\text{Creatinine clearance} = \frac{UCRO \times 694^*}{\mathbf{PCR}} \quad \text{(units are ml/minute)}$$

where

1. the factor 694* takes into account the difference in units and the number of minutes in 24 hours.
2. UCRO = urine creatinine output in mmol/24 hour
3. PCR = plasma creatinine in μmol/L

If any doubts about the calculations, please contact the duty Biochemist (Bleep 4375)

POINT OF CARE TESTING (POCT)

POCT is laboratory testing performed in the clinical setting by non-laboratory healthcare professionals.

One of the first, and still most commonly used POCT devices are blood glucose meters - there are 200 meters in use on the Central Site used to measure over 1000 glucose levels each day. However, in recent years there has been a large growth in the variety of tests that can now be performed by POCT. These include tests that are performed in Biochemistry, Haematology, Immunology and Microbiology Laboratories. Changing clinical practices are also leading to more extensive use of POCT. The variety of POCT devices in use on the Central Site can be seen from the POCT homepage:

Internet access:
http://www.cmmc.nhs.uk/directorates/labmedicine/departments/poct/pocthome.asp
Intranet access
http://intranet.cmht.nwest.nhs.uk/directorates/labmed/poct/web/pocthome.asp

There are advantages with POCT compared with conventional laboratory testing. For example, results are available more quickly as time is not lost by transporting samples to the laboratory. This can be vital when managing critically ill patients. Also, in less acute settings the fast turnaround time can lead to broader efficiencies and/or an improved patient experience.

There are also disadvantages with POCT compared with conventional laboratory testing such as the cost per test being more expensive for POCT. Furthermore, all analytical tests, whether performed in the laboratory or not, can run into problems. For example, in situations of decreased peripheral blood flow, glucose levels in capillary finger-stick samples may not reflect the true physiological state. Examples include but are not limited to: dehydration, shock, septicaemia, peripheral vascular disease, diabetic ketoacidosis or hyperglycaemic hyperosmolar non-ketotic states. This limitation applies to all POCT glucose meters and has led to two fatalities in Greater Manchester.

Any POCT service must provide significant patient benefits to ensure limited NHS resources are used appropriately. The quality of results and hence patient safety can also be affected by inadequate training or inappropriate use of devices. Therefore, all proposals to introduce a new POCT service must be referred to the multi-disciplinary POCT Committee. The Chair of the Committee is Dr Niall O'Keeffe, Consultant Anaesthetist, niall.o'keeffe@cmft.nhs.uk

The POCT Support Service is managed by the POCT Coordinator, emma.james@cmft.nhs.uk (telephone 64891) and includes structured training programs (further details available via POCT webpage), protocols for checking and documenting the correct functioning of the device, regular proficiency testing schemes for staff to demonstrate their continued skills acquired at training; quality auditing to identify potential problems with advice and troubleshooting if any are found.

The Trust POCT Policy (accessible via POCT webpage) is based on guidelines produced by the Medicines and Healthcare products Regulatory Agency (MHRA). One of the core criteria of both is "Only staff whose training and competence has been established and recorded are permitted to carry out POCT"

If you would like any further information regarding POCT on the please contact the POCT Coordinator.

Light's criteria for evaluating pleural fluid

Analysis
The following tests should be performed

- Pleural fluid protein, glucose and LDH and serum protein, glucose and LDH if available
- Pleural fluid pH if a specimen in a blood gas syringe is available. The sample connot be analysed if it is not suitable for analysis on the blood gas analyser.

Interpretation

Light's Criteria for a transudate(1)

The ratio of pleural fluid protein to serum protein is less than 0.5
Or
The ratio of pleural fluid LDH to plasma LDH less than 0.6
Or
The pleural fluid LDH is less than 2/3 of the upper reference limit

Although these criteria have been re-evaluated there is no clear cut case for using anything other than Light's criteria(2).

A pHh < 7.3 is seen with emphysema, tuberculosis, malignancy, collagen vascular disease or oesophageal rupture.

Glucose < 2.2 mmol/L is associated with an emphysema, rheumatoid arthritis, tuberculosis or malignancy.

Other tests may be useful(3)

An exudates is more often associated than a transudate with:

A cholesterol level > 11.7 mmol/L

A pleural / serum bilirubin ratio <0.6

A pleural - serum albumin gradient of < 12 g/L

Diagnosis of Diabetes Mellitus

INVESTIGATION OF SUSPECTED GLUCOSE INTOLERANCE

Diagnosis should be based on two independent glucose measurements, unless the patient has symptoms of diabetes. All samples should be collected into fluoride oxalate blood tubes, as glucose deteriorates rapidly in inappropriate samples leading to potential errors in diagnosis.

The recommended initial test is either a two hour post-prandial or a random blood sample:

A non-fasting, venous plasma glucose concentration less than 6.1 mmol/L is normal; 11.1 mmol/L or greater is diagnostic for diabetes mellitus.

A non-fasting, venous plasma glucose concentration between 6.1 mmol/L and 11.1 mmol/L should be followed up by a fasting level.

A fasting venous plasma glucose concentration less than 6.1 mmol/L is normal and one of 7.0 mmol/L or greater, is diagnostic of diabetes mellitus. Between these levels an OGTT can confirm the degree of glucose intolerance.

DIAGNOSIS OF DIABETES MELLITUS

By measuring **venous plasma glucose** concentration, four possible states of glucose metabolism may be defined:

1. Normal
2. Impaired fasting glycaemia - IFG
3. Impaired glucose tolerance - IGT
4. Diabetes mellitus - DM.

IFG and IGT are intermediate states of carbohydrate intolerance and are risk factors not only for subsequent development of diabetes mellitus but also cardiovascular disease and should form part of a cardiovascular risk assessment.

These conditions are defined as follows in terms of plasma glucose concentration:

1. Normal: fasting venous plasma glucose of less than 6.1 mmol/L

2. IFG: fasting venous plasma glucose of 6.1 to less than 7.0 mmol/L and (if measured) 2 hr post 75g glucose load less than 7.8 mmol/L

3. IGT: fasting venous plasma glucose less than 7.0 mmol/L and 2 hr post glucose load of 7.8 to less than 11.1 mmol/L.

4. DM: i) Venous plasma glucose of 11.1 mmol/L or greater, at any time.
   ii) Fasting venous plasma glucose of 7.0 mmol/L.or greater.
   iii) Post 75g OGTT - 2hr venous plasma glucose of 11.1 mmol/L or greater.