



Multiple Choice Question Writing Single Best Answer (SBA) Format

House Style Guide

Centre for Medical Education
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This manual is derived, with permission, from the following sources:

**Medical Schools Council-Assessment Alliance House Style,
checklist and reference ranges March 2019v21
Prescribing Skills Assessment question item writing manual, July 2011
MRCP(UK) Question Writing Manual for the Specialty Examinations, September 2011**

Foreword

This document is intended to demonstrate best practice and all question-writers should aspire to make their questions compliant with the guidance.

Single Best Answer (SBA) Multiple Choice Questions (Best of Five)

SBAs are currently the only style of MCQ used in the Medical School. It is intended that the questions should test application of knowledge to a clinical situation and to reflect what our students are taught on their clinical placements.

Each SBA question should comprise of a few lines of text explaining the clinical presentation (**'the stem'**), a single line stating the question itself (**'the lead-in'**), and a list of **five options** (one correct answer and four distractors).

The stem

The scenario poses the clinical problem which is to be solved by one and only one of the suggested answers in the option list. If there is any ambiguity, try to add details to the scenario to rule out any possible options other than the intended answer.

The scenario should ensure that the candidate is not being assessed on factual recall but on the application of knowledge.

Information contained in the stem should be concise, clear and unambiguous. Avoid use of abbreviations, jargon, or terms that may not be understood by candidates whose first language is not English.

- write the stem in the **present** tense
- should be between 30-100 words (ideally 50 words)
- avoid making the scenario overcomplicated and exclude irrelevant information
- if it is possible to use a simpler word/phrase, always use it. For example use 'before' instead of 'prior to', 'start' instead of 'commence' and 'because of' instead of 'owing to'
- use the active tense rather than the passive
- do not use names for patients
- do not use 'you' e.g. 'he consulted you'
- a clinical stem should also be written for items that test underpinning knowledge of basic science as it puts the question in a clinical context and increases the face validity of the assessment
- avoid the terms 'presents with' or 'complains of' instead use 'has' e.g. A 33 year old woman has abdominal pain.
- avoid the term 'history of' instead use 'with' e.g. A 46 year old man with known alcohol dependence
- write numbers up to nine in full and numbers above nine as digits

Where appropriate, make the scenarios patient focused and include all or some of the following components in this order:

- age
- gender
- symptoms
- duration
- the setting, especially with regard to use of generic test material across
- specialties
- relevant past history, family or social history
- relevant drug treatment
- relevant physical examination findings (in the order: temperature, pulse, BP, respiratory rate); and then positive/abnormal findings first)
- results and investigations presented in a logical, standardised order with reference ranges in brackets for comparison.

The lead-in

Should pass the 'cover test' i.e. students should be able to arrive at the correct answer without being able to see the options. Thus avoid questions such as 'which of the following statements is correct'?

- use 'which' instead of 'what'
- avoid negative phrasing or focus around bad practice, such as

- Which is the least likely diagnosis?
- Which treatment is the least appropriate/should be avoided?

As candidates may choose only from the five options presented, it is unnecessary to ask 'Which *of the following* is the most likely/most appropriate...?'

The five options

Make sure that all the options are:

- relevant to the stem and follow logically from it;
- supported by information in the stem, so that candidates can anticipate their appearance;
- related to the lead-in;
- alphabetical or numerical;
- have the initial letter of the first word in upper case.
- do not mix different skill areas in the same list (e.g. diagnoses and treatments).
- all options should be plausible answers for the scenario, but four of them should be incorrect or inferior.
- options should be of a similar length and balanced content, and grammatically and
- logically compatible with the lead in.
- avoid grammatical cues: all answers should connect to the question.

List the options in **alphabetical order** (any that start with a number or Greek character should be placed first) and label them a to e.

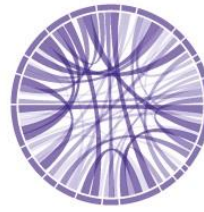
Example SBA MCQ

1) A 54 year old man has recently had a myocardial infarction. His medications include aspirin, atorvastatin, bisoprolol, furosemide and perindopril. He now has severe aching in his limbs.

Which intervention is most likely to improve his symptoms?

- a) Change furosemide to bumetanide
- b) Increase dose of aspirin
- c) Reduce dose of atorvastatin
- d) Start diclofenac
- e) Stop atorvastatin**

Answer E



MSCAA review checklist for SBAs

The theme is pitched at an appropriate level

There is a **single** best answer to the/ each scenario

The answer is correct and evidence based

The option list is consistent and does not mix different skill areas

Most options are plausible answers for the/ each scenario

The instruction is specific and explicit

There are no 'cues' that gives away the answer

The title is appropriate and accurately reflects the content of all the questions

The whole question adheres to house style

Only essential information is included

Which SBAs are preferred?

- It is best to think about a patient you have seen rather than something vague and abstract. Remember the curriculum – we should be testing students in what they are expected to know and have seen in their placements.
- Think about all the areas of practice – investigations, management, risk factors, side effects of treatments, ethical or legal issues, advice to patients, how basic science applies to clinical assessment.
- Encourage the student to problem solve – they may have to work out the diagnosis from the information given in order to decide the best management etc.

Which SBAs should be avoided?

- Avoid questions about esoteric facts.
- Avoid questions that are multiple true false items with only one right answer, or statements of fact without any clinical setting
- Avoid questions with negative lead ins such as “*least likely*”, “*treatment you would not give*” etc

e.g Which form of contraception is not progesterone only?

- A. Cerazette
- B. Depo Provera
- C. Femidom
- D. Implanon
- E. Mirena IUS

This question has no clinical information, so is a statement of fact only, and asks a negative question.

Some finer points

Abbreviations

Avoid abbreviations wherever possible by spelling out the full words. Exceptions include abbreviations that are either widely understood or are very long when spelt out:

Units of measurement such as cm, L, mL and mmHg (but not units of time)

Abbreviations of more than one capital letter take no full stops (e.g. CT, MCV, not C.T., M.C.V.)

ACE, ACTH, ADH, ALP, AIDS, ALT, AST, APTT, ATP, BCG, BMI, BP, COPD, CRP, CT, DC (cardioversion), DNA, DXA, ECG, EDTA, EEG, eGFR, ERCP, FEV₁, FSH, FVC, GABA, γ GT, GCS, GP, HbA_{1c}, Hcg, HDL, HIV, HLA, Ig, IGF-1, IM, INR, IV, JVP, K_{CO}, LDL, LH, MCV, MR, MRSA, NHS, NSAID, PCO₂, PCR, PET, PO₂, PT, SC, RNA, SSRI, TL_{CO}, TNF, TSH, UK, USA, UV

Age

Use a defined age. If you want to give a description, use the following:

- newborns/neonates: 0 – 1 month
- infants: 1 – 24 months
- children: 2 – 13 years
- adolescents: 13 -17 years
- adults: 18 – 64 years
- older adults/old age: 65+ years

American spelling and grammar

Use British rather than American spellings and grammar, ie 'organise' not 'organize', 'colour' not 'color'. Use 'outside' and 'off' but not 'outside of' or 'off of'. Use American spellings only in quoted material or company names

Apostrophes

- use apostrophes for eponymous terms that are derived from one person's name (e.g. Alzheimer's disease, Graves' disease)
- do not use apostrophes for eponymous terms that are derived from two persons' names (e.g. Creutzfeldt–Jakob disease)

do not use apostrophes in toponymic designations (e.g. Ebola fever, Lyme disease) **Bacteria**

- do not italicise names of bacteria as italic script can be challenging for dyslexic candidates
- the generic name should begin with a capital letter and the specific name with a lowercase letter e.g. Pneumocystis jirovecii
- anglicised versions of these names should begin with a lowercase letter (e.g. staphylococcal infection, legionella pneumonia)

Capital/lowercase

- capitalise the first letter of proper names (e.g. Gram positive)
- use lowercase for clinical specialties (e.g. endocrinologist), disorders (e.g. type 2 diabetes mellitus) and hospital departments (e.g. intensive care unit, outpatient clinic), except for the Emergency Department
- start bullet points with a lowercase letter
- results of investigations should begin with a capital letter when appearing in list form

Drug history

- write 's/he is taking', not 's/he is on'
- write 's/he is treated with', not 's/he receives' or 's/he is started on'
- write 's/he dialyses 3 times weekly', not 's/he is dialysed'
- do not use proprietary names unless essential; cite the generic name as used by the British National Formulary (BNF) for all medicines
- when referring to a class of drugs refer to the BNF for the term
- non-proprietary names of medicines are written with a lowercase initial letter
- give a drug dosage within parenthesis
- use arabic numerals for the dose e.g. aspirin (75 mg once daily)
- write the frequency in common English ('three times a day' not 'tid' or 'TDS')
- use adrenaline/epinephrine'

Examination findings

- avoid the phrase 'on examination' unless what follows would be otherwise ambiguous
- the recommended format and order for presenting the initial observations is temp, pulse, BP, respiratory rate, and O₂ saturation:

'Her temperature is 38°C, pulse rate 84 bpm, BP 120/80 mmHg, respiratory rate 12 breaths per minute and oxygen saturation 96% in air'

- Use the following style for reporting the Glasgow Coma Scale (GCS) score: His/her GCS is 7. (Ideally include individual elements i.e. His/her GCS is 7 (E1, V2, M4).

En rules

En rules are longer than hyphens (an en rule can be inserted by pressing Ctrl and the minus sign on the numeric keypad) and they are used:

- between the names of two people e.g. Cheyne–Stokes or Epstein–Barr virus
- between words of equal importance (e.g. cost–benefit, relapsing–remitting, tonic–clonic).
- to indicate a range. Thus, write 76–96, not 76 – 96 or 76-96.
- to denote a minus sign

Font

- use Calibri 12 point typeface

Gender

- use man/woman (not male/female/gentleman/lady) (18 years and over)
- use boy/girl (under 18 years)

Greek characters

- use α, β, γ etc. rather than alpha, beta, gamma, etc. For example, TNF- α , (Exceptions: gamma globulin, interferon beta and other drug names)

Hyphens

- do not use hyphens for age e.g. write 'A 40 year old man'
- words beginning with 'non' are hyphenated (e.g. non-proliferative)
- inpatient/outpatient are not hyphenated
- compound modifiers that precede a noun are hyphenated (long-standing hypertension, first-degree heart block)
- hyphenate '30 pack-year smoking history' *without* a hyphen between the number and 'pack'.
- use a hyphen where the name of the antibody includes an abbreviation (e.g. anti-Ro), or where the name includes more than one word (e.g. anti-neutrophil cytoplasmic antibodies, anti-smooth muscle antibodies, anti-hepatitis C antibodies)
- do not use a hyphen where the antibody is a single word (e.g. anticentromere, antimitochondrial), unless there is a danger of mispronunciation

Inclusive language

- avoid gendered language where possible: 'chairman' and 'chairwoman' are acceptable but 'chair' is preferred when speaking generally or where the sex of the person concerned is not specified
- use 'people with disabilities', 'visual impairments', 'or 'learning difficulties', never 'the disabled', 'the blind' or 'the handicapped'
- use 'deaf' instead of 'hearing impaired'
- use 'man/woman with epilepsy/diabetes (not epileptics or diabetics)

Investigations

- give the actual value and the reference range in parenthesis and allow students to interpret the clinical data e.g. question should give the haemoglobin result rather than stating 'the patient is anaemic'.
- if there is only one result in the stem, it can be included in the paragraph. Otherwise the results should be listed below the clinical vignette under the heading 'Investigations:'
- the name of the test, the result and the reference range should be separated by a tab (or two tabs if test names are long). For example:

Investigations:

Sodium	135 mmol/L	(135–146)
Potassium	4.0 mmol/L	(3.5–5.3)
Urea	5.0 mmol/L	(2.5–7.8)
Creatinine	120 μ mol/L	(60–120)

- use the following style for arterial blood gas results

Investigations:

Arterial blood gas breathing 28% oxygen

pH

PO₂

PCO₂

Bicarbonate

Use 'breathing air' (not 'on room air') when giving arterial blood gas results

Use the following style for urinalysis results

Urinalysis: glucose, ketones, blood, protein, nitrites, leucocytes

Use 'positive' or 'negative'. To show the degree of abnormality use 1+, 2+, 3+ or 4+ (as opposed to +, ++ etc)

- do not withhold information that would normally be available in every-day clinical practice. For example if serum sodium is given, then serum potassium should also be provided. However you can miss out results if it helps shorten the question and does not omit vital information.
- the term 'X-ray' (not x-ray, x ray or X-Ray), although not strictly correct, is widely understood and need not be replaced by 'radiograph'
- write 'CT/MR/ultrasound/isotope scan of'
- write 'isotope bone scan'
- write 'ventilation/perfusion isotope lung scan'
- In the stem, refer to 'echocardiogram/MR angiogram' (the visible record) rather than echocardiography/MR angiography (the investigation). In the list of options, refer to echocardiography not echocardiogram.

Job titles

- lowercase is used in a general sense (e.g. 'a consultant neurosurgeon arrives')

Medication

Dosage: written as X mg daily (not Xmg/day or Xmg od)

Preferred style:

- write 'glucose 5%', not 'dextrose 5%', and 'sodium chloride 0.9%' not 'normal saline'.
- refer to a drug 'concentration', not a drug 'level'
- use the term 'regimen' rather than 'regime' when referring to a prescribed medicine or a standard combination of medicines used to treat a specific condition
- use the term 'adverse effect' rather than 'unwanted effect' or 'side-effect'.

Numbers

- numbers from one to nine should be in words, with 10 and over in figures.

Exceptions are:

- a number at the beginning of a sentence should always be spelt out (except in answer options where all numbers should be given in numeric forms) e.g.

- a) 1
- b) 2
- c) 4
- d) 12
- e) 16

- use arabic numerals for age (except for 'thirties', 'forties', etc.), names of conditions (e.g. type 2 diabetes mellitus), symbols, all abbreviated forms of units, units of alcohol, units of red cells (for transfusion) and all units of time (minutes, hours, days, weeks, months, years)

Past medical history

- avoid the terms 'known', 'known to be' and 'known to have', 'diagnosed with', 'with a history of', in relation to a condition. Write 'A 40 year old man with diabetes'
- use 'history of' only for temporal separation of the presenting complaint and a past diagnosis e.g. 'A 40 year old man has breathlessness. He has a history of COPD.'

Presenting complaint

- use 'has' rather than 'presents with' or 'complains of' e.g. 'A 40 year old man has breathlessness'
- use 'breathlessness of sudden onset', not 'sudden-onset breathlessness'

Quotation marks

- use single (not double) quotation marks. Double quotation marks should be used only for direct speech.

Setting of care

- this should only be given if it influences the decision about the correct answer. In these cases, use of 'presents with' is accepted.
- use outpatient clinic, not outpatients

Spacing

- do not use double spaces to separate words, sentences or paragraphs
- do not add a space before the full stop
- write <5 or -10 (not < 5 or - 10) (see note on en-rules)
- write 20% (not 20 %)
- insert a space between the value and the unit (e.g. 25 mg, 120/70 mmHg)
- insert a space either side of x and = signs.

Subscript/superscript

- superscript/subscript can be used for scientific terms (e.g. ^{14}C , ^{131}I , vitamin B¹², HbA1c) but not for 1st or 2nd

Symbols

- use symbol '×', not letter 'x' (e.g. $4.2 \times 10^9/\text{L}$)
- the degree symbol in '37.0°C' is a symbol, *not* a superscript letter 'o'
- isotopes should be written as a superscript number preceding the elemental abbreviation (e.g. ^{14}C , ^{131}I)

Units

- abbreviate litre as 'L' and millilitre as 'mL'
- write μmol , (not umol), cmH_2O , kg/m^2 , mmHg
- units of time are written in full in the stem (years, weeks, hours, minutes)
- units of time are abbreviated in the investigations and answers (h, min, s)
- write the time of day using the 24-h clock notation (e.g. 09.00)
- write '% predicted', not '% of predicted'
- abbreviate body mass index as BMI and give the unit e.g. his BMI is 28

Viruses

- viruses are known by their subfamily names (herpes simplex virus, enterovirus), which are lowercase
- HIV: the 'v' stands for virus so there is no need for 'HIV virus'

References:

Walsh, JL, Harris, BH, Smith, PE, Single best answer question-writing tips for clinicians. *Postgrad Med J*, 2017; 93; 76-81.

<https://pmj.bmj.com/content/93/1096/76.long>

Smith, PE, Mucklow, JC. Writing clinical scenarios for clinical science questions. *Clinical Medicine*, 2016; 16:142–5.

<http://www.clinmed.rcpjournals.org/content/16/2/142.full.pdf>

Preparing **MCQ** and **EMQ** examinations: NBME Item Writing Manual. This resource can be accessed at:

<http://www.nbme.org/publications/item-writing-manual.html>

MSCAA REFERENCE RANGES

Ranges vary between populations and age groups and it is important to always check the reference ranges.

	Adult	Range	Paediatric (age if applicable)	Range
Haematology				
Haemoglobin ¹	Male	130 – 175 g/L	0 – 6 days	145 - 220 g/L
	Female	115 – 150 g/L	7 days	140 - 186 g/L
			8 days – 3 months	95 - 125 g/L
			3 months – 4 years	110 - 140 g/L
		5 – 12 years	115 - 140 g/L	
White cell count		3.8 – 10.0 x 10 ⁹ /L	0 – 6 days	10.0 - 26.0 x 10 ⁹ /L
			7 days	5.0 – 21.0 x 10 ⁹ /L
			8 days – 6 months	6.0 – 15.0 x 10 ⁹ /L
			7 months – 5 years	5.0 – 12.0 x 10 ⁹ /L
Platelets		150 – 400 x 10 ⁹ /L		150 – 400 x 10 ⁹ /L
Mean cell haemoglobin (MCH)		27 – 33 pg	0 – 3 months	31 – 37 pg
			3 – 4 months	27 – 33 pg
			4 months – 12 years	23 – 31 pg
Mean cell haemoglobin concentration (MCHC)		32 – 35 g/dL		32 – 35 g/dL
Mean cell volume (MCV)		80 – 96 fL	0 – 3 months	100 – 130 fL
			3 – 4 months	85 – 100 fL
			4 months – 4 years	70 – 86 fL
			4 – 12 years	77 – 91 fL
Neutrophils		2.0 – 7.5 x 10 ⁹ /L	0 – 3 days	5.0 – 13.0 x 10 ⁹ /L
			4 days	1.5 – 10.0 x 10 ⁹ /L
			5 days – 6 years	1.5 – 8.0 x 10 ⁹ /L
			7 – 11 years	2.0 – 6.0 x 10 ⁹ /L
Lymphocytes		1.1 – 3.3 x 10 ⁹ /L	0 – 2 days	2.0 – 4.5 x 10 ⁹ /L
			3 days	3.0 – 9.0 x 10 ⁹ /L
			4 days – 12 months	4.0 – 10.0 x 10 ⁹ /L
			1 – 6 years	1.5 – 9.5 x 10 ⁹ /L
			7 – 10 years	1.5 – 7.0 x 10 ⁹ /L
Monocytes		0.2 - 1.0 x 10 ⁹ /L	0 – 3 days	0.5 – 1.5 x 10 ⁹ /L
			4 days – 6 years	0.3 – 1.1 x 10 ⁹ /L
			7 – 10 years	0.2 – 1.2 x 10 ⁹ /L
Eosinophils		0 – 0.4 x 10 ⁹ /L	0 – 3 days	0.1 – 2.0 x 10 ⁹ /L
			4 days – 6 years	0.1 – 1.0 x 10 ⁹ /L
			7 – 10 years	0.1 – 0.8 x 10 ⁹ /L
Basophils		0 - 0.1 x 10 ⁹ /L		0 – 0.1 x 10 ⁹ /L
Reticulocytes		25 - 100 x 10 ⁹ /L	0 – 1 day	1.8 – 4.6 x 10 ⁹ /L

¹ Updated by MSC March 2018

Packed cell volume (PCV)	Male	0.40 - 0.54		See footnote ²
	Female	0.37 - 0.50		
Haematocrit		35 - 48%	0 - 2 months	44 - 64%
			2 - 3 months	32 - 44%
			4 months - 3 years	36 - 44%
Erythrocyte sedimentation rate		< 20 mm/hr		< 20 mm/hr
D dimers		<0.5mg/L		N/A
Coagulation screen				
International normalised ratio (INR)		1.0		1.0
Activated partial thromboplastin time (APTT)		22 - 41 seconds	Term babies	
			0 - 4 days	29.0 - 55.5 seconds
			5 - 21 days	28.0 - 55.0 seconds
			22 days - 3 months	28.0 - 50.0 seconds
			3 - 6 months	28.0 - 45.0 seconds
			6 months - 1 year	28.0 - 38.0 seconds
			Preterm babies (30-36 weeks gestation)	
			0 - 4 days	27.5 - 79.4 seconds
			5 - 21 days	26.9 - 74.1 seconds
			22 days - 3 months	26.9 - 62.5 seconds
			3 - 6 months	28.3 - 50.7 seconds
			6 months - 1 year	28.0 - 40.0 seconds
Prothrombin time (PT)		10 - 12 seconds	Term babies	
			0 - 3 months	8.5 - 14.1 seconds
			Preterm babies (born at 30-36 weeks)	
			0 - 3 months	8.5 - 17.0 seconds
Thrombin time (TT)		9 - 15 seconds		9 - 15 seconds
Fibrinogen		1.5 - 4.0 g/dL		1.5 - 4.0 g/dL
Fibrinogen degradation products		< 8 mg/ mL		
Arterial blood gas				
pH		7.35 - 7.45		7.35 - 7.45
pO ₂		11 - 15 kPa		8 - 12 kPa
pCO ₂		4.6 - 6.4 kPa		4.6 - 6.4 kPa
Bicarbonate		22 - 30 mmol/L		22 - 30 mmol/L
Base excess		-2 to +2 mmol/L		-2 to +2 mmol/L

² From the Whittington Neonatal Guideline: By convention, PCV >65 on blood taken from artery or large vein. It should be spun in the micro centrifuge for 10 minutes.

Indications for Partial Exchange Transfusion: Term baby with PCV >75 even if asymptomatic. Term baby with >65 and symptomatic.

Premature Babies: Should not necessarily be treated at the same PCV levels. Babies under 34 weeks gestation who are at risk of anaemia of prematurity should probably not have exchange transfusion unless symptoms are severe and definitely attributable to polycythaemia

Clinical chemistry

Electrolytes			
Sodium		135 – 146 mmol/L	133 – 146 mmol/L
Potassium		3.5 – 5.3 mmol/L	<4 weeks 3.4 – 6.0 mmol/L 4 weeks – 1 year 3.5 – 5.7 mmol/L 1 – 16 years 3.5 – 5.0 mmol/L
Chloride		95 – 106 mmol/L	95 – 106 mmol/L
Bicarbonate		22 - 29 mmol/L	22 – 29 mmol/L
Urea		2.5 – 7.8 mmol/L	<4 weeks 0.8 – 5.5 mmol/L 4 weeks – 1 year 1.0 – 5.5 mmol/L 1 – 16 years 2.5 – 6.5 mmol/L
Creatinine		60 – 120 µmol/L	0 – 2 months 21 – 75 µmol/L 3 – 12 months 15 – 37 µmol/L 1 – 3 years 21 – 36 µmol/L 4 – 5 years 27 – 42 µmol/L 6 – 7 years 28 – 52 µmol/L 8 – 9 years 35 – 53 µmol/L 10 – 11 years 34 – 65 µmol/L 12 – 13 years 46 – 70 µmol/L 14 – 15 years 50 – 77 µmol/L
Urinary albumin:creatinine ratio	Males	<2.5 mg/mmolL	
	Females	<3.5 mg/mmolL	
Urinary protein:creatinine ratio		< 30 mg/mmolL	
Calcium		2.2 – 2.6 mmol/L	<4 weeks 2.0 – 2.7 mmol/L 4 weeks – 16 years 2.2 – 2.7 mmol/L
Magnesium		0.7 – 1.0 mmol/L	<4 weeks 0.6 – 1.0 mmol/L 4 weeks – 16 years 0.7 – 1.0 mmol/L
Phosphate		0.8 – 1.5 mmol/L	<4 weeks 1.3 – 2.6 mmol/L 4 weeks – 1 year 1.3 – 2.4 mmol/L 1 – 16 years 0.9 – 1.8 mmol/L
eGFR		> 60 mL/min/ 1.73m ²	N/A
Metabolic tests			
Fasting glucose		3.0 – 6.0 mmol/L	3.0 – 6.0 mmol/L

Glycated haemoglobin		20 - 42 mmol/mol		20 – 42 mmol/mol
LDL cholesterol (fasting)		< 3.0 mmol/L		< 3.0 mmol/L
HDL cholesterol		> 1.2 mmol/L		< 1.2 mmol/L
Plasma parathyroid hormone level		(0.9 - 5.4) pmol/L		N/A
Ratio of TC/HDL		< 4.5		< 4.5
Triglycerides (fasting)		< 2.3 mmol/L		< 2.3 mmol/L
Serum osmolality		285 – 295 mOsmol/kg		285 – 295 mOsmol/kg
Liver function				
Albumin		35 – 50 g/L	<4 weeks	30 – 45 g/L
			4 weeks – 1 year	30 – 45 g/L
			1 – 16 years	30 – 50 g/L
			0 – 12 months	0 – 41 IU/L
Alanine aminotransferase (ALT)		10 – 50 IU/L	1 – 2 years	0 – 28 IU/L
			3 – 6 years	0 – 29 IU/L
			7 – 12 years	0 – 36 IU/L
			13 – 17 years	0 – 37 IU/L
			1 – 13 years (males)	8 – 60 IU/L
Aspartate aminotransferase (AST)		10 – 40 IU/L	1 – 13 years (females)	8 – 50 IU/L
Alkaline phosphatase		25 – 115 IU/L	<4 weeks	70 – 380 IU/L
			4 weeks – 16 years	60 – 425 IU/L
Bilirubin		< 17 µmol/L	14 days – 16 years	<21 µmol/L
			< 14days Refer to pages 38-53 http://goo.gl/q1pBdn	
Gamma glutamyl transferase (γGT)		9 - 40 IU/L		9 – 40 IU/L
Cardiac enzymes				
Creatine kinase	Male	25 – 200 U/L	Male	25 – 200 U/L
	Female	25 – 175 U/L	Female	25 – 175 U/L
Creatine kinase (African and African-Caribbean)		< 350 U/L		< 350 U/L
Troponin T		< 0.01 µg/L		< 0.01 µg/L
Haematinics				
Serum vitamin B12		160 – 925 ng/L		160 – 925 ng/L
Serum folate		3 – 15 µg/L		3 – 15 µg/L
Ferritin		12 – 200 µg/L		12 – 200 µg/L
Vitamin D		75 - 100 nmol/L		

Iron		14 – 31 µmol/L	Male	14 – 31 µmol/L
		11 – 30 µmol/L	Female	11 – 30 µmol/L
Total iron binding capacity		54 – 75 µmol/L		54 – 75 µmol/L
Thyroid stimulating hormone (TSH)		0.3 – 4.2 mU/L	0 – 3 days	5.2 – 14.6 mU/L
			4 days – 12 months	0.6 – 8.1 mU/L
			1 – 6 years	0.5 – 4.5 mU/L
			7 – 11 years	0.7 – 4.1 mU/L
			12 – 19 years	0.5 – 3.6 mU/L
Free T4		9 - 25 pmol/L	0 – 6 days	11 – 32 pmol/L
			7 days – 3 months	12 – 18 pmol/L
			4 – 12 months	12 - 26 pmol/L
			1 – 6 years	11 – 23 pmol/L
			7 – 11 years	12 – 22 pmol/L
			12 – 19 years	12 - 21 pmol/L
Free T3		4.0 – 7.2 pmol/L	0 – 6 days	2.7 – 9.7 pmol/L
			7 days – 3 months	3.0 – 9.3 pmol/L
			4 – 12 months	3.3 – 9.0 pmol/L
			1 – 6 years	3.0 – 9.1 pmol/L
			7 – 11 years	4.1 – 7.9 pmol/L
			12 – 19 years	3.5 – 7.7 pmol/L
Cortisol (9am)		200 – 700 nmol/L		200 – 700 nmol/L
Cortisol (midnight)		< 140 nmol/L		< 140 nmol/L
Parathyroid hormone		1.6 – 8.5 pmol/L		1.6 – 8.5 pmol/L
Prolactin		90 - 320 U/L	Male	90 – 320 U/L
		100 - 500 U/L	Female	100 – 500 U/L
Renin (erect/recumbent)		1.2 - 4.5/1.1- 2.7 pmol/mL/hr	0 – 3 months	4.0 – 12.0 pmol/mL/hr
			3 months – 2 years	2.0 – 6.0 pmol/mL/hr
			2 – 5 years	2.0 – 5.5 pmol/mL/hr
			6 – 9 years	1.0 – 4.0 pmol/mL/hr
			10 – 16 years	0.6 – 2.2 pmol/mL/hr
Aldosterone (erect/recumbent)		600 - 1200/100-500 pmol/L	0 – 3 months	1000 – 3500 pmol/L
			3 months – 2 years	400 - 1500 pmol/L
			2 – 5 years	300 - 1000 pmol/L
			6 – 9 years	400 - 800 pmol/L
			10 – 16 years	150 - 450 pmol/L
Testosterone	Male	9.9 - 27.8 nmol/L	<i>Tanner Stage of Puberty (male):</i>	

	Female	0.2 - 2.9 nmol/L	Stage 1	0.07 – 0.8 nmol/L
			Stage 2	0.17 – 2.43 nmol/L
			Stage 3	0.52 – 9.72 nmol/L
			Stage 4	3.64 – 18.91 nmol/L
			Stage 5	9.19 – 27.76 nmol/L
			<i>Tanner Stage of Puberty (female):</i>	
			Stage 1	0.1 – 0.3 nmol/L
			Stage 2	0.2 – 1.0 nmol/L
			Stage 3	0.3 – 1.0 nmol/L
			Stage 4	0.5 – 1.4 nmol/L
			Stage 5	0.3 – 1.4 nmol/L
Luteinising hormone (LH)	Pre-menopausal female	1 - 11 U/L (luteal)	Female	1 – 11 U/L (luteal)
Follicle stimulating hormone (FSH)	Female	2 – 8 U/L (luteal)	Female	2 – 8 U/L (luteal)
Tumour markers				
Lactate dehydrogenase (LDH)		70 – 250 IU/L		70 – 250 IU/L
Alpha-fetoprotein		< 10 U/mL		< 10 U/mL
CA125		< 35 U/mL		N/A
CA 15-3		< 25 U/mL		N/A
CA 19-9		< 34 U/mL		N/A
Carcinoembryonic antigen (CEA)		< 5 µg/L		N/A
Prostate specific antigen (PSA)		< 4 µg/L		N/A
Miscellaneous				
Amylase		< 220 U/L		< 220 U/L
C reactive protein (CRP)		< 5 mg/L		< 5 mg/L
Carboxyhaemoglobin		< 1.5 %		< 1.5%
CD4 count		430 - 1690 µ/L	0 – 7 days	400 - 3500 µ/L
			8 days – 2 months	1700 - 5300 µ/L
			3 – 5 months	1500 - 5000 µ/L
			6 – 9 months	1400 - 5100 µ/L
			10 – 15 months	1000 - 4600 µ/L
			16 months – 2 years	900 - 5000 µ/L
			3 – 5 years	500 - 2400 µ/L
			6 – 10 years	300 - 2000 µ/L
			11 – 16 years	400 - 2100 µ/L
Erythropoietin		4 - 24 mIU/mL		4 – 24 mIU/mL
Urate	Male	0.2-0.42 mmol/L,	Male	0.2 – 0.42 mmol/L
	Female	0.14-0.34 mmol/L	Female	0.14 – 0.34 mmol/L

Total protein	60-80g/L	0 – 1 day	34 – 50g/L
		2 days – 1 month	46 – 68g/L
		2 – 12 months	48 – 76g/L
		1 – 18 years	60 – 80g/L
IgG	5.5-16.5g/L	0 – 1 year	2.3 – 14.0g/L
		2- 4 years	4.5 – 9.2g/L
		5- 7 years	5.0 – 14.6g/L
		8 – 10 years	5.7 – 14.7g/L
		11 – 12 years	7.6 – 15.5g/L
		13- 14 years	7.2 – 17.1g/L
		15 – 16 years	5.5 – 15.8g/L
		17 – 20 years	7.0 – 16.0g/L
IgA	0.8-4g/L	0 – 1 year	0 – 0.83g/L
		2- 4 years	0.2 – 1.0g/L
		5- 7 years	0.27 – 1.95g/L
		8 – 10 years	0.34 – 3.05g/L
		11 – 12 years	0.53 – 2.04g/L
		13- 14 years	0.58 – 3.58g/L
		15 – 16 years	0.47 – 2.49g/L
		17 – 20 years	0.61 – 3.48g/L
IgM	0.5-3g/L	0 – 1 year	0 – 1.45g/L
		2- 4 years	0.19 – 1.46g/L
		5- 7 years	0.24 – 2.1g/L
		8 – 10 years	0.31 – 2.08g/L
		11 – 12 years	0.35 – 2.39g/L
		13- 14 years	0.15 – 1.88g/L
		15 – 16 years	0.23 – 2.59g/L
		17 – 20 years	0.4 – 2.3g/L
IgE	<81kU/L	<4 weeks	<5kU/L
		5 weeks – 3 months	<11kU/L
		4 months – 1 year	<29kU/L
		2 –5 years	<52kU/L
		6 – 10 years	<63kU/L
		11 years - adult	<81kU/L
Lactate	1-2 mmol/L		1 – 2 mmol/L
Cerebrospinal fluid			
Opening pressure	12 - 25 mmH ₂ O		Up to 250 mmH ₂ O
Total protein	0.15 - 0.45 g/L	0 – 1 month	0.15 – 1.0 g/L
Glucose	2.2 - 4.4 mmol/L		2.2 – 4.4 mmol/L
Cell count	< 5 / μ L	0 – 30 days	<20 / μ L
Lymphocyte count	60 - 70 %		60 – 70%

Diagnosis of Cystic Fibrosis			
Sweat chloride concentration			> 60 mmol/L
Sweat chloride concentration		> 6 months	40-60 mmol/L
Retesting needed		< 6 months	30--60 mmol/L
Negative (normal levels)		> 6 months	< 40
Chloride		< 6 months	< 30

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