Reference ranges for blood tests

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Reference ranges for blood tests are sets of values used by a health professional to interpret a set of medical test results from blood samples.

Reference ranges for blood tests are studied within the field of clinical chemistry (also known as "clinical biochemistry", "chemical pathology" or "pure blood chemistry"), the area of pathology that is generally concerned with analysis of bodily fluids.

Blood test results should always be interpreted using the reference range provided by the laboratory that performed the test.[1]

Contents

Interpretation

A reference range is usually defined as the set of values 95 percent of the normal population falls within (that is, 95% prediction interval).[2] It is determined by collecting data from vast numbers of laboratory tests.

Plasma or whole blood

In this article, all values (except the ones listed below) denote blood plasma concentration, which is approximately 60–100% larger than the actual blood concentration if the amount inside red blood cells (RBCs) is negligible. The precise factor depends on hematocrit as well as amount inside RBCs. Exceptions are mainly those values that denote total blood concentration, and in this article they are:

- All values in *Hematology – red blood cells* (except *hemoglobin in plasma*)
- All values in *Hematology – white blood cells*
- Platelet count (Plt)

A few values are for inside red blood cells only:

- Vitamin B_9 (Folic acid/Folate) in red blood cells
- Mean corpuscular hemoglobin concentration (MCHC)

Units

- Mass concentration (g/dL or g/L) is the most common measurement unit in the United States. Is usually given with dL (decilitres) as the denominator in the United States, and usually with L (litres) in, for example, Sweden.
- Molar concentration (mol/L) is used to a higher degree in most of the rest of the world, including the United Kingdom and other parts of Europe and Australia and New Zealand.[3]
- International units (IU) are based on measured biological activity or effect, or for some substances, a specified equivalent mass.
- Enzyme activity (kat) is commonly used for e.g. liver function tests like AST, ALT, LD and γ-GT in Sweden.[4]
- Percentages and time-dependent units (mol/s) are used for calculated derived parameters, e.g. for beta cell function in homeostasis model assessment or thyroid's secretory capacity.

Arterial or venous

If not otherwise specified, a reference range for a blood test is generally the venous range, as the standard process of obtaining a sample is by venipuncture. An exception is for acid-base and blood gases, which are generally given for arterial blood.

Still, the blood values are approximately equal between the arterial and venous sides for most substances, with the exception of acid-base, blood gases and drugs (used in therapeutic drug monitoring (TDM) assays).[5] Arterial levels for drugs are generally higher than venous levels because of extraction while passing through tissues.[5]

Usual or optimal

Reference ranges are usually given as what are the usual (or *normal*) values found in the population, more specifically the prediction interval that 95% of the population fall into. This may also be called *standard range*. In contrast, *optimal (health) range* or *therapeutic target* is a reference range or limit that is based on concentrations or levels that are associated with optimal health or minimal risk of related complications and diseases. For most substances presented, the optimal levels are the ones normally found in the population as well. More specifically, optimal levels are generally close to a central tendency of the values found in the population. However, usual and optimal levels may differ substantially, most notably among vitamins and blood lipids, so these tables give limits on both standard and optimal (or target) ranges.

In addition, some values, including troponin I and brain natriuretic peptide, are given as the estimated appropriate cutoffs to distinguish healthy people from specific conditions, which here are myocardial infarction and congestive heart failure, respectively, for the aforementioned substances.

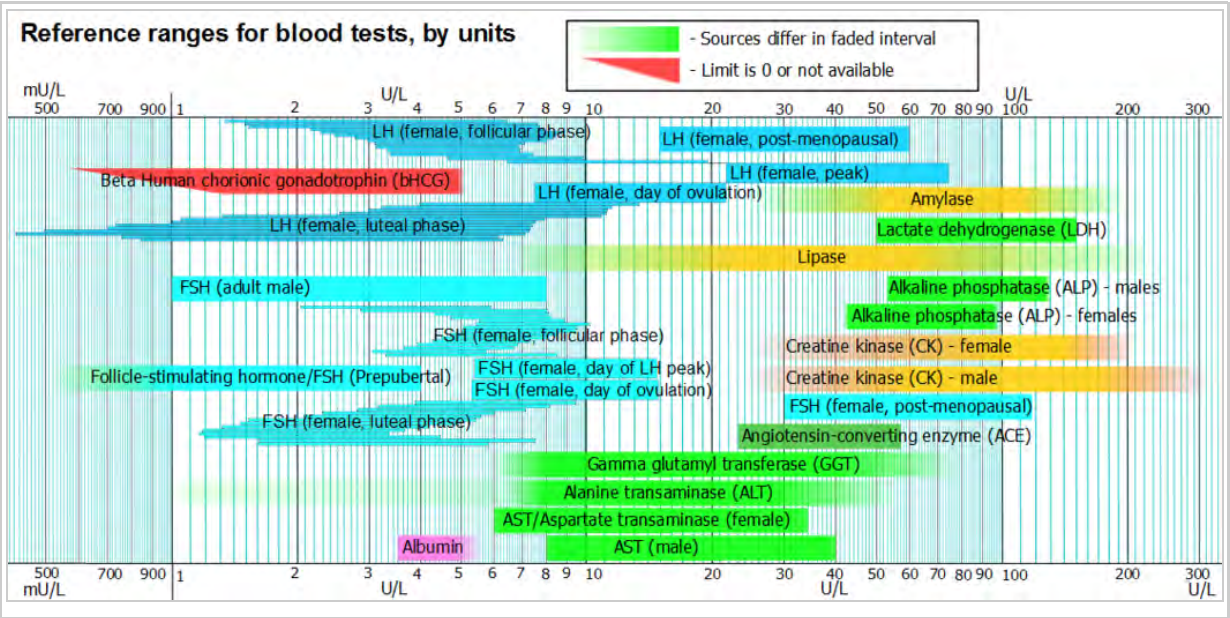
Variability

References range may vary with age, sex, race, pregnancy,[6] diet, use of prescribed or herbal drugs and stress. Reference ranges often depend on the analytical method used, for reasons such as inaccuracy, lack of standardisation, lack of certified reference material and differing antibody reactivity.[7] Also, reference ranges may be inaccurate when the reference groups used to establish the ranges are small.

Sorted by concentration

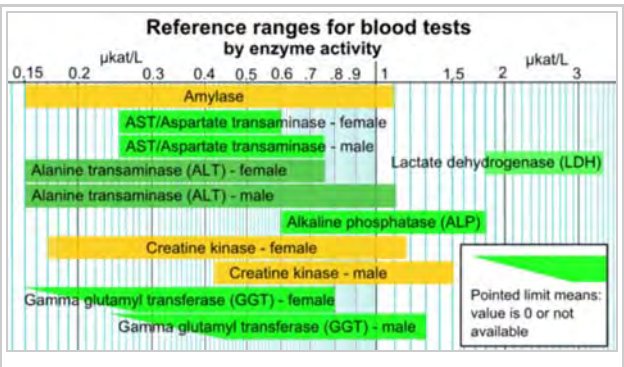
By units

Units don't necessarily imply anything about molarity or mass.

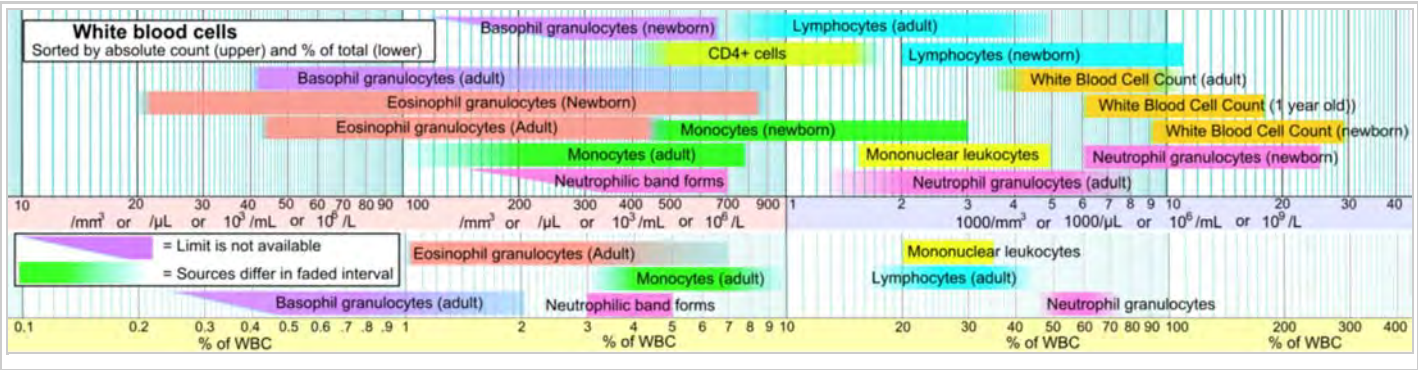


A few substances are below this main interval, e.g. thyroid stimulating hormone, being measured in mU/L, or above, like rheumatoid factor and CA19-9, being measured in U/mL.

By enzyme activity



White blood cells



Sorted by category

Ions and trace metals

Included here are also related binding proteins, like ferritin and transferrin for iron, and ceruloplasmin for copper.

Test	Lower limit	Upper limit	Unit	Comments
Sodium (Na)	135,[9] 137[4][10]	145,[4][10] 147[9]	mmol/L or mEq/L[9]	See hyponatremia or hypernatremia
	310,[11] 320[11]	330,[11] 340[11]	mg/dl	
Potassium (K)	3.5,[4][9] 3.6[10]	5.0,[4][9][10] 5.1	mmol/L or mEq/L[9]	See hypokalemia or hyperkalemia
	14[12]	20[12]	mg/dl	
Chloride (Cl)	95,[9] 98,[13] 100[4]	105,[9] 106,[13] 110[4]	mmol/L or mEq/L[9]	See hypochloremia or hyperchloremia
	340[14]	370[14]	mg/dl	
Ionized calcium (Ca)	1.03,[15] 1.10[4]	1.23,[15] 1.30[4]	mmol/L	See hypocalcaemia or hypercalcaemia
	4.1,[16] 4.4[16]	4.9,[16] 5.2[16]	mg/dL	
Total calcium (Ca)	2.1,[9][17] 2.2[4]	2.5,[4][17] 2.6,[17] 2.8[9]	mmol/L	
	8.4,[9] 8.5[18]	10.2,[9] 10.5[18]	mg/dL	
Total serum iron (TSI) - male	65,[19] 76[10]	176,[19] 198[10]	µg/dL	See hypoferremia or the following: iron overload (hemochromatosis), iron poisoning, siderosis, hemosiderosis, hyperferremia
	11.6,[20][21] 13.6[21]	30,[20] 32,[21] 35[21]	µmol/L	
Total serum iron (TSI) - female	26,[10] 50[19]	170[10][19]	µg/dL	
	4.6,[21] 8.9[20]	30.4[20]	µmol/L	
Total serum iron (TSI) - newborns	100[19]	250[19]	µg/dL	
	18[21]	45[21]	µmol/L	
Total serum iron (TSI) - children	50[19]	120[19]	µg/dL	
	9[21]	21[21]	µmol/L	
Total iron-binding capacity (TIBC)	240,[19] 262[10]	450,[19] 474[10]	µg/dL	
	43,[21] 47[21]	81,[21] 85[21]	µmol/L	
Transferrin	190,[22] 194,[4] 204[10]	326,[4] 330,[22] 360[10]	mg/dL	
	25[23]	45[23]	µmol/L	
Transferrin saturation	20[19]	50[19]	%	
Ferritin - Males and postmenopausal females	12[24]	300[24][25]	ng/mL or µg/L	
	27[26]	670[26]	pmol/L	
Ferritin - premenopausal females	12[24]	150[24] - 200[25]	ng/mL or µg/L	
	27[26]	330[26] - 440[26]	pmol/L	
Ammonia	10,[27] 20[28]	35,[27] 65[28]	µmol/L	See hypoammonemia and hyperammonemia
	17,[29] 34[29]	60,[29] 110[29]	µg/dL	

Copper (Cu)	70[18]	150[18]	µg/dL	See hypocupremia or hypercupremia
	11[30][31]	24[30]	µmol/L	
Ceruloplasmin	15[18]	60[18]	mg/dL	
	1[32]	4[32]	µmol/L	
Phosphate (HPO_4^{2-})	0.8	1.5[33]	mmol/L	See hypophosphatemia or hyperphosphatemia
Inorganic phosphorus (serum)	1.0[9]	1.5[9]	mmol/L	
	3.0[9]	4.5[9]	mg/dL	
Zinc (Zn)	60,[34] 72[35]	110,[35] 130[34]	µg/dL	See zinc deficiency or zinc poisoning
	9.2,[36] 11[4]	17,[4] 20[36]	µmol/L	
Magnesium	1.5,[18] 1.7[37]	2.0,[18] 2.3[37]	mEq/L or mg/dL	See hypomagnesemia or hypermagnesemia
	0.6,[38] 0.7[4]	0.82,[38] 0.95[4]	mmol/L	

Acid-base and blood gases

If arterial/venous is not specified for an acid-base or blood gas value, then it generally refers to arterial, and not venous which otherwise is standard for other blood tests.

Acid-base and blood gases are among the few blood constituents that exhibit substantial difference between arterial and venous values.[5] Still, pH, bicarbonate and base excess show a high level of inter-method reliability between arterial and venous tests, so arterial and venous values are roughly equivalent for these.[39]

Test	Arterial/Venous	Lower limit	Upper limit	Unit
pH	Arterial	7.34,[10] 7.35[9]	7.44,[10] 7.45[9]	
	Venous	7.31[40]	7.41[40]	
$[H^+]$	Arterial	36[9]	44[9]	nmol/L
		3.6[41]	4.4[41]	ng/dL
Base excess	Arterial & venous[40]	-3[40]	+3[40]	mEq/L
oxygen partial pressure (pO_2)	Arterial pO_2	10,[9] 11[42]	13,[42] 14[9]	kPa
		75,[9][10] 83[18]	100,[10] 105[9]	mmHg or torr
	Venous	4.0[42]	5.3[42]	kPa
		30[40]	40[40]	mmHg or torr
Oxygen saturation	Arterial	94,[40] 95,[13] 96[18]	100[13][18]	%
	Venous	Approximately 75[13]		
Carbon dioxide partial pressure (PCO_2)	Arterial P_aCO_2	4.4,[9] 4.7[42]	5.9,[9] 6.0[42]	kPa
		33,[9] 35[10]	44,[9] 45[10]	mmHg or torr
	Venous	5.5,[42]	6.8[42]	kPa
		41[40]	51[40]	mmHg or torr
Absolute content of carbon dioxide (CO_2)	Arterial	23[40]	30[40]	mmol/L
		100[43]	132[43]	mg/dL
Bicarbonate (HCO_3^-)	Arterial & venous	18[18]	23[18]	mmol/L
		110[44]	140[44]	mg/dL
Standard bicarbonate (SBC_e)	Arterial & venous	21, 22[9]	27, 28[9]	mmol/L or mEq/L[9]
		134[44]	170[44]	mg/dL

Liver function

Test	Patient type	Lower limit	Upper limit	Unit	Comments
Total protein		60,[9] 63[10]	78,[9] 82,[10] 84[18]	g/L	
Albumin		35[9][45]	48,[10] 55[9]	g/L	see hypoalbuminemia
		3.5[10]	4.8,[10] 5.5[9]	U/L	
		540[46]	740[46]	µmol/L	
Globulins		23[9]	35[9]	g/L	
Total bilirubin		1.7,[47] 2,[9] 3.4,[47] 5[4]	17,[9][47] 22,[47] 25[4]	µmol/L	
		0.1,[9] 0.2,[10] 0.29[48]	1.0,[9][18] 1.3,[10] 1.4[48]	mg/dL	
Direct/conjugated bilirubin		0.0[9] or N/A[4]	5,[9] 7[4][47]	µmol/L	
		0[9][10]	0.3,[9][10] 0.4[18]	mg/dL	
Alanine transaminase (ALT/ALAT[4])		5,[49] 7,[10] 8[9]	20,[9] 21,[13] 56[10]	U/L	Also called *serum glutamic pyruvic transaminase* (SGPT)
	Female	0.15[4]	0.75[4]	µkat/L	
	Male	0.15[4]	1.1[4]		
Aspartate transaminase (AST/ASAT[4])	Female	6[50]	34[50]	IU/L	Also called *serum glutamic oxaloacetic transaminase* (SGOT)
		0.25[4]	0.60[4]	µkat/L	
	Male	8[50]	40[50]	IU/L	
		0.25[4]	0.75[4]	µkat/L	
Alkaline phosphatase (ALP)	Female	42[49]	98[49]	U/L	
	Male	53[49]	128[49]		
	(Enzyme activity)	0.6[4]	1.8[4]	µkat/L	
Gamma glutamyl transferase (GGT)		5,[49] 8[10]	40,[49] 78[10]	U/L	
	Women		0.63[51]	µkat/L	
	Men		0.92[51]	µkat/L	

Cardiac tests

Test	Patient type	Lower limit	Upper limit	Unit	Comments
Creatine kinase (CK)	male	24,[52] 38,[10] 60[49]	174,[18] 320[49]	U/L or ng/mL	
		0.42[53]	1.5[53]	µkat/L	
	female	24,[52] 38,[10] 96[18]	140,[18] 200[49]	U/L or ng/mL	
		0.17[53]	1.17[53]	µkat/L	
CK-MB		0	3,[10] 3.8,[4] 5[49]	ng/mL or µg/L[4]	
Myoglobin	Female	1[54]	66[54]	ng/mL or µg/L	
	Male	17[54]	106[54]		

Brain natriuretic peptide (BNP)	
Interpretation	**Range / Cutoff**
Congestive heart failure unlikely	< 100 pg/mL[55][56]
"Gray zone"	100-500 pg/mL[55][56]
Congestive heart failure likely	>500 pg/mL[55][56]

NT-proBNP		
Interpretation	**Age**	**Cutoff**
Congestive heart failure likely	< 75years	> 125 pg/mL[57]
	>75 years	>450pg/mL[57]

Lipids

Test	Patient type	Lower limit	Upper limit	Unit	Therapeutic target
Triglycerides	10 – 39 years	54[18]	110[18]	mg/dL	< 100 mg/dL[58] or 1.1[58] mmol/L
		0.61[59]	1.2[59]	mmol/L	
	40 – 59 years	70[18]	150[18]	mg/dL	
		0.77[59]	1.7[59]	mmol/L	
	> 60 years	80[18]	150[18]	mg/dL	
		0.9[59]	1.7[59]	mmol/L	
Total cholesterol		3.0,[60] 3.6[9][60]	5.0,[4][61] 6.5[9]	mmol/L	< 3.9[58]
		120,[10] 140[9]	200,[10] 250[9]	mg/dL	< 150[58]
HDL cholesterol	female	1.0,[62] 1.2,[4] 1.3[60]	2.2[62]	mmol/L	> 1.0[62] or 1.6[60] mmol/L > 40[63] or 60[64] mg/dL
		40,[63] 50[65]	86[63]	mg/dL	
HDL cholesterol	male	0.9[4][62]	2.0[62]	mmol/L	
		35[63]	80[63]	mg/dL	
LDL cholesterol (Not valid when triglycerides >5.0 mmol/L)		2.0,[62] 2.4[61]	3.0,[4][61] 3.4[62]	mmol/L	< 2.5[62]
		80,[63] 94[63]	120,[63] 130[63]	mg/dL	< 100[63]
LDL/HDL quotient		n/a	5[4]	(unitless)	

Tumour markers

Test	Cutoff	Unit	Comments
Alpha fetoprotein (AFP)	44[10]	ng/mL or µg/L	Hepatocellular carcinoma or testicular cancer
Beta Human chorionic gonadotrophin (bHCG)	5[10]	IU/l or mU/ml	in male and non-pregnant female
CA19-9	40[10]	U/ml	Pancreatic cancer
CA-125	30,[66] 35[67]	kU/L or U/mL	
Carcinoembryonic antigen (CEA) non-smokers at 50 years	3.4,[4] 3.6[68]	µg/l	
Carcinoembryonic antigen (CEA) non-smokers at 70 years	4.1[68]	µg/l	
Carcinoembryonic antigen (CEA) - smokers	5[69]	µg/l	
Prostate specific antigen (PSA)	2.5,[4] 4[10]	µg/L[4][10] or ng/mL[18]	below age 45 <2.5 µg/L
PAP	3[18]	units/dL (Bodansky units)	
Calcitonin	5,[70] 15[70]	ng/L or pg/mL	Cutoff against medullary thyroid cancer[70]

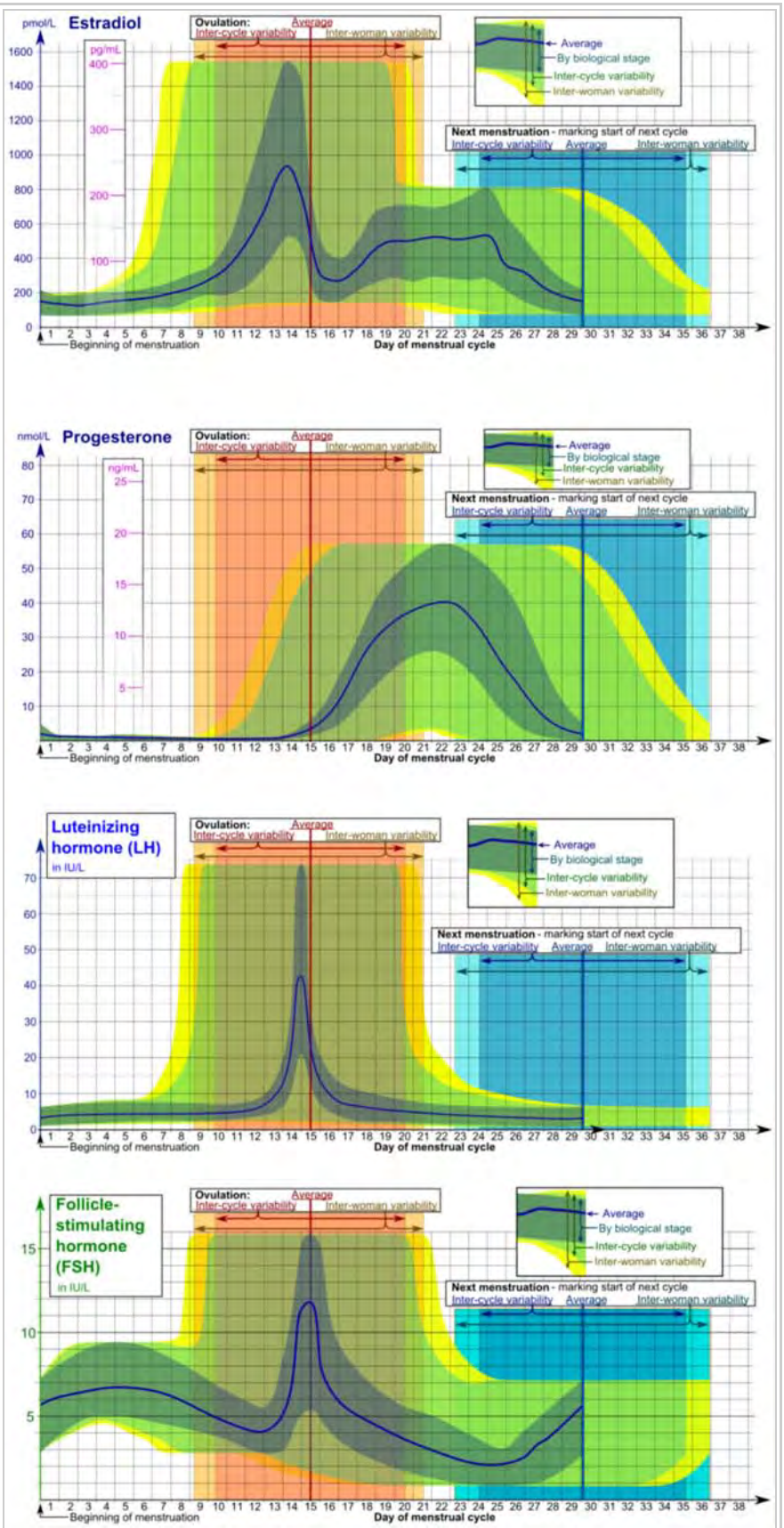
Endocrinology

Thyroid hormones

Test	Patient type	Lower limit	Upper limit	Unit
Thyroid stimulating hormone (TSH or thyrotropin)	Adults - standard range	0.3,[4] 0.4,[10] 0.5,[18] 0.6[71]	4.0,[4] 4.5,[10] 6.0[18]	mIU/L or μIU/mL
	Adults - optimal range	0.3,[72] 0.5[73]	2.0,[73] 3.0[72]	mIU/L or μIU/mL
	Infants	1.3[74]	19[74]	mIU/L or μIU/mL
Free thyroxine (FT4)	Normal adult	0.7,[75] 0.8[10]	1.4,[75] 1.5,[10] 1.8[76]	ng/dL
		9,[4][77] 10,[78] 12[79]	18,[4][77] 23[79]	pmol/L
	Child/Adolescent 31 d - 18 y	0.8[75]	2.0[75]	ng/dL
		10[77]	26[77]	pmol/L
	Pregnant	0.5[75]	1.0[75]	ng/dL
		6.5[77]	13[77]	pmol/L
Total thyroxine		4,[78] 5.5[10]	11,[78] 12.3[10]	μg/dL
		60[78][79]	140,[78] 160[79]	nmol/L
Free triiodothyronine (FT3)	Normal adult	0.2[78]	0.5[78]	ng/dL
		3.1[80]	7.7[80]	pmol/L
	Children 2-16 y	0.1[81]	0.6[81]	ng/dL
		1.5[80]	9.2[80]	pmol/L
Total triiodothyronine		60,[10] 75[78]	175,[78] 181[10]	ng/dL
		0.9,[4] 1.1[78]	2.5,[4] 2.7[78]	nmol/L
Thyroxine-binding globulin (TBG)		12[10]	30[10]	mg/L
Thyroglobulin (Tg)		1.5[78]	30[78]	pmol/L
		1[78]	20[78]	μg/L

Sex hormones

The diagrams below take inter-cycle and inter-woman variability into account in displaying reference ranges for estradiol, progesterone, FSH and LH.



Levels of estradiol (the main estrogen), progesterone, luteinizing hormone and follicle-stimulating hormone during the menstrual cycle.

Test	Patient type	Lower limit	Upper limit	Unit
Dihydrotestosterone	adult male	30[82]	85[82]	ng/dL
Testosterone	Male, overall	8,[83] 10[84]	27,[83] 35[84]	nmol/L
		230,[85] 300[86]	780[85] - 1000[86]	ng/dL
	Male < 50 years	10[4]	45[4]	nmol/L
		290[85]	1300[85]	ng/dL
	Male > 50 years	6.2[4]	26[4]	nmol/L
		180[85]	740[85]	ng/dL
	Female	0.7[84]	2.8[84] - 3.0[4]	nmol/L
		20[86]	80[86] - 85[85]	ng/dL
17α-Hydroxyprogesterone	male	0.06[18]	3.0[18]	mg/L
		0.18[87]	9.1[87]	µmol/l
	Female (Follicular phase)	0.2[18]	1.0[18]	mg/L
		0.6[87]	3.0[87]	µmol/l
Follicle-stimulating hormone (FSH)	Prepubertal	<1[88]	3[88]	IU/L
	Adult male	1[88]	8[88]	
	Adult female (follicular and luteal phase)	1[88]	11[88]	
	Adult female (Ovulation)	6[88] 95% PI (standard)	26[88] 95% PI)	
		5[89] 90% PI (used in diagram)	15[89] (90% PI)	
	Post-menopausal female	30[88]	118[88]	
Luteinizing hormone (LH)	Female, peak	20[89] 90% PI (used in diagram)	75[89] (90% PI)	IU/L
	Female, post-menopausal	15[90]	60[90]	
	Male aged 18+	2[91]	9[91]	
Estradiol (an estrogen)	Adult male	50[92]	200[92]	pmol/L
		14[93]	55[93]	pg/mL
	Adult female (day 5 of follicular phase, and luteal phase)	70[92]	500,[92] 600[92]	pmol/L
		19[93]	140,[93] 160[93]	pg/mL
	Adult female - free (not protein bound)	0.5[94]	9[94]	pg/mL
		1.7[94]	33[94]	pmol/L
	Post-menopausal female	N/A[92]	< 130[92]	pmol/L
		N/A[93]	< 35[93]	pg/mL
Progesterone	Female in mid-luteal phase (day 21-23)	17,[89] 35[95]	92[95]	nmol/L
		6,[89] 11[96]	29[96]	ng/mL
Androstenedione	Adult male and female	60[90]	270[90]	ng/dL

	Post-menopausal female		< 180[90]	
	Prepubertal		< 60[90]	
Dehydroepiandrosterone sulfate	Adult male and female	30[97]	400[97]	µg/dL
SHBG	Adult female	40[98]	120[98]	nmol/L
	Adult male	20[98]	60[98]	
Anti-Müllerian hormone (AMH)	13–45 years	0.7[99]	20[99]	ng/mL
		5[100]	140[100]	pmol/l

Other hormones

Test	Patient type	Lower limit	Upper limit	Unit
Adrenocorticotropic hormone (ACTH)		4.4[101]	18,[102] 22[101]	pmol/L
		20[10]	80,[103] 100[10]	pg/mL
Cortisol	09:00 am	140[104]	700[104]	nmol/L
		5[105]	25[105]	µg/dL
	Midnight	80[104]	350[104]	nmol/L
		2.9[105]	13[105]	µg/dL
Growth hormone (fasting)		0	5[9]	ng/mL
Growth hormone (arginine stimulation)		7[9]	n/a	ng/mL
IGF-1	Female, 20 yrs	110[106]	420[106]	ng/mL
	Female, 75 yrs	55[106]	220[106]	
	Male, 20 yrs	160[106]	390[106]	
	Male, 75 yrs	48[106]	200[106]	
Prolactin	Female	71,[107] 105[107]	348,[107] 548[107]	mIU/L
		3.4,[107] 3.9[107]	16.4,[107] 20.3[107]	µg/L
	Male	58,[107] 89[107]	277,[107] 365[107]	mIU/L
		2.7,[107] 3.3[107]	13.0,[107] 13.5[107]	µg/L
Parathyroid hormone (PTH)		10,[108] 17[109]	65,[108] 70[109]	pg/mL
		1.1,[4] 1.8[110]	6.9,[4] 7.5[110]	pmol/L
25-hydroxycholecalciferol (a vitamin D) -Standard reference range		8,[18][111] 9[111]	40,[111] 80[18]	ng/mL
		20,[112] 23[113]	95,[113] 150[112]	nmol/L
25-hydroxycholecalciferol -Therapeutic target range		30,[114] 40[115]	65,[115] 100[114]	ng/mL
		85,[58] 100[115]	120,[58] 160[115]	nmol/L
Plasma renin activity		0.29,[116] 1.9[117]	3.7[116][117]	ng/(mL*hour)
		3.3,[118] 21[119]	41[118][119]	mcU/mL
Aldosterone	Adult		19,[118] 34.0[118]	ng/dL
			530,[120] 940[120]	pmol/L
Aldosterone-to-renin ratio	Adult		13.1,[121] 35.0[121]	ng/dl per ng/(mL·h)
			360,[121] 970[121]	pmol/liter per µg/(L·h)

Vitamins

Also including the vitamin B_{12})-related amino acid homocysteine.

Test	Patient type	Standard range		Unit	Optimal range	
		Lower limit	Upper limit		Lower limit	Upper limit
Vitamin A		30[18]	65[18]	µg/dL		
Vitamin B_9 (Folic acid/Folate) - **Serum**	Age > 1year	3.0[122]	16[122]	ng/mL or µg/L	5[123]	
		6.8[124]	36[124]	nmol/l	11[124]	
Vitamin B_9 (Folic acid/Folate) - **Red blood cells**		200[122]	600[122]	ng/mL or µg/L		
		450[124]	1400[124]	nmol/L		
	Pregnant			ng/mL or µg/L	400[122]	
				nmol/L	900[122]	
Vitamin B_{12} (Cobalamin)		130,[125] 160[126]	700,[125] 950[126]	ng/L		
		100,[127] 120[4]	520,[127] 700[4]	pmol/L		
Homocysteine		3.3,[128] 5.9[128]	7.2,[128] 15.3[128]	µmol/L		6.3[58]
		45,[129] 80[129]	100,[129] 210[129]	µg/dL		85[58]
Vitamin C (Ascorbic acid)		0.4[18]	1.5[18]	mg/dL	0.9[58]	
		23[130]	85[130]	µmol/L	50[58]	
25-hydroxycholecalciferol (a vitamin D)		8,[18][111] 9[111]	40,[111] 80[18]	ng/mL	30,[114] 40[115]	65,[115] 100[114]
		20,[112] 23[113]	95,[113] 150[112]	nmol/L	85,[58] 100[115]	120,[58] 160[115]
Vitamin E				µmol/L	28[58]	
				mg/dL	1.2[58]	

Toxins

Test	Limit type	Limit	Unit
Lead	Optimal health range	< 20[13] or 40[18]	µg/dL
Blood ethanol content	Limit for drunk driving	0,[131] 0.2,[131] 0.8[131]	‰ or g/L
		17.4[132]	mmol/L

Hematology

Red blood cells

These values (except *Hemoglobin in plasma*) are for total blood and not only blood plasma.

Test	Patient	Lower limit	Upper limit	Unit	Comments
Hemoglobin (Hb)	male	2.0,[133] 2.1[9][134]	2.5,[133] 2.7[9][134]	mmol/L	Higher in neonates, lower in children.
		130,[4] 132,[10] 135[9]	162,[10] 170,[4] 175[9]	g/L	
	female	1.8,[133] 1.9[9][134]	2.3,[133] 2.5[9] [133][134]	mmol/L	Sex difference negligible until adulthood.
		120[4][9][10]	150,[4] 152,[10] 160[9][18]	g/L	
Hemoglobin subunits (sometimes displayed simply as "Hemoglobin")	male	8.0,[135] 8.4[135]	10.0,[135] 10.8[135]	mmol/L	4 per hemoglobin molecule
	female	7.2,[135] 7.6[135]	9.2,[135] 10.0[135]		
Hemoglobin in plasma		0.16[9]	0.62[9]	µmol/L	Normally diminutive compared with inside red blood cells
		1	4	mg/dL	
Glycated hemoglobin (Hb_{A1c})	< 50 years	3.6[4]	5.0[4]	% of Hb	
	> 50 years	3.9[4]	5.3[4]		
Haptoglobin	< 50 years	0.35[4]	1.9[4]	g/L	
	> 50 years	0.47[4]	2.1[4]		
Hematocrit (Hct)	male	0.39,[4] 0.4,[10] 0.41,[9] 0.45[18]	0.50,[4] 0.52,[10] 0.53,[9] 0.62[18]		
	female	0.35,[4] 0.36,[9] 0.37[10][18]	0.46,[4][9][10] 0.48[18]		
	Child	0.31[10]	0.43[10]		
Mean cell volume (MCV)	Male	76,[18] 82[10]	100,[18] 102[10]	fL	Cells are larger in neonates, though smaller in other children.
	Female	78[10]	101[10]	fL	
Red blood cell distribution width (RDW)		11.5[10]	14.5[10]	%	
Mean cell hemoglobin (MCH)		0.39[9]	0.54[9]	fmol/cell	
		25,[9] 27[4][18]	32,[18] 33,[4] 35[9]	pg/cell	
Mean corpuscular hemoglobin concentration (MCHC)		31,[10] 32[4][18]	35,[10] 36[4][18]	g/dL or %[note 1]	
		4.8,[136] 5.0[136]	5.4,[136] 5.6[136]	mmol/L	
Erythrocytes/Red blood cells (RBC)	male	4.2,[18] 4.3[4] [9][10]	5.7,[4] 5.9,[9] 6.2,[10] 6.9[18]	$x10^{12}$/L or mln/mm^3	
	Female	3.5,[9] 3.8,[10] 3.9[4]	5.1,[4] 5.5[9][10]		
	Infant/Child	3.8[10]	5.5[10]		
Reticulocytes	Adult	26[4]	130[4]	$x10^9$/L	

	Adult	0.5[9][10]	1.5[9][10]	% of RBC	
	Newborn	1.1[10]	4.5[10]	% of RBC	
	Infant	0.5[10]	3.1[10]	% of RBC	

White blood cells

These values are for total blood and not only blood plasma.

Test	Patient type	Lower limit	Upper limit	Unit
White Blood Cell Count (WBC)	Adult	3.5,[4] 3.9,[137] 4.1,[10] 4.5[9]	9.0,[4] 10.0,[137] 10.9,[10] 11[9]	■ $x10^9$/L ■ $x10^3/mm^3$ or ■ $x10^3/\mu L$
	Newborn	9[138]	30[138]	
	1 year old	6[138]	18[138]	
Neutrophil granulocytes (A.K.A. grans, polys, PMNs, or segs)	Adult	1.3,[4] 1.8,[137] 2[138]	5.4,[4] 7,[137] 8[138]	$x10^9$/L
		45-54[9]	62,[9] 74	% of WBC
	Newborn	6[138]	26[138]	$x10^9$/L
Neutrophilic band forms	Adult		0.7[138]	$x10^9$/L
		3[9]	5[9]	% of WBC
Lymphocytes	Adult	0.7,[4] 1.0[137][138]	3.5,[137] 3.9,[4] 4.8[138]	$x10^9$/L
		16-25[9]	33,[9] 45	% of WBC
	Newborn	2[138]	11[138]	$x10^9$/L
Monocytes	Adult	0.1,[4] 0.2[139][140]	0.8[4][138][140]	$x10^9$/L
		3,[9] 4.0	7,[9] 10	% of WBC
	Newborn	0.4[138]	3.1[138]	$x10^9$/L
Mononuclear leukocytes (Lymphocytes + monocytes)	Adult	1.5	5	$x10^9$/L
		20	35	% of WBC
$CD4^+$ T cells	Adult	0.4,[10] 0.5[13]	1.5,[13] 1.8[10]	$x10^9$/L
Eosinophil granulocytes	Adult	0.0,[4] 0.04[140]	0.44,[140] 0.45,[138] 0.5[4]	$x10^9$/L
		1[9]	3,[9] 7	% of WBC
	Newborn	0.02[138]	0.85[138]	$x10^9$/L
Basophil granulocytes	Adult	40[137]	100,[4][140] 200,[138] 900[137]	$x10^6$/L
		0.0	0.75,[9] 2	% of WBC
	Newborn		0.64[138]	$x10^9$/L

Coagulation

Test	Lower limit	Upper limit	Unit	Comments
Thrombocyte/Platelet count (Plt)	140,[10] 150[4][9]	350,[4][18] 400,[9] 450[10]	$x10^9$/L or x1000/µL	
Mean platelet volume (MPV)	7.2,[141] 7.4,[142] 7.5[143]	10.4,[142] 11.5,[143] 11.7[141]	fL	
Prothrombin time (PT)	10,[13] 11,[9][144] 12[10]	13,[13] 13.5,[144] 14,[10] 15[9]	s	PT reference varies between laboratory kits - INR is standardised
INR	0.9[4]	1.2[4]		The INR is a corrected ratio of a patient's PT to normal
Activated partial thromboplastin time (APTT)	18,[10] 30[4][13]	28,[10] 42,[4] 45[13]	s	
Thrombin clotting time (TCT)	11	18	s	
Fibrinogen	1.7,[10] 2.0[4]	3.6,[4] 4.2[10]	g/L	
Antithrombin	0.80[4]	1.2[4]	kIU/L	
	0.15,[145] 0.17[146]	0.2,[145] 0.39[146]	mg/mL	
Bleeding time	2	9	minutes	
Viscosity	1.5[147]	1.72[147]	cP	

Immunology

Acute phase proteins

Acute phase proteins are markers of inflammation.

Test	Patient	Lower limit	Upper limit	Unit	Comments
Erythrocyte sedimentation rate (ESR)	Male	0	Age÷2[148]	mm/h	ESR increases with age and tends to be higher in females.[149]
	Female		(Age+10)÷2[148]		
C-reactive protein (CRP)			5,[4][150] 6[151]	mg/L	
			200,[152] 240[152]	nmol/L	
Alpha 1-antitrypsin (AAT)		20,[153] 22[154]	38,[154] 53[153]	µmol/L	
		89,[155] 97[4]	170,[4] 230[155]	mg/dL	
Procalcitonin			0.15[156]	ng/mL or µg/L	

Isotypes of antibodies

Test	Patient	Lower limit	Upper limit	Unit	Comments
IgA	Adult	70,[4] 110[157]	360,[4] 560[157]	mg/dL	
IgD		0.5[157]	3.0[157]		
IgE		0.01[157]	0.04[157]		
IgG		800[157]	1800[157]		
IgM		54[157]	220[157]		

Autoantibodies

Autoantibodies are usually absent or very low, so instead of being given in standard reference ranges, the values usually denote where they are said to be present, or whether the test is a positive test. There may also be an *equivocal* interval, where it is uncertain whether there is a significantly increased level. All included values[158] are given for the ELISA test.

Test	Negative	Equivocal	Positive	Unit
anti-SS-A (Ro)	< 15[159]	15-25[159]	> 25[159]	Units per millilitre (U/mL)
anti-SS-B (La)	< 3[159]	3 – 4[159]	> 4[159]	
Anti ds-DNA	< 40[159]	40 – 60[159]	> 60[159]	
Anti ss-DNA	< 8[159]	8 - 10[159]	> 10[159]	
Anti-histone antibodies	< 25[159]	n/a[159]	> 25[159]	
Cytoplasmic/classical anti-neutrophil cytoplasmic antibodies (c-ANCA)	< 20[159]	21 - 30[159]	> 30[159]	
Perinuclear anti-neutrophil cytoplasmic antibodies (p-ANCA)	< 5[159]	n/a	> 5[159]	
Anti-mitochondrial antibodies (AMA)	< 10[159]	n/a[159]	> 10[159]	
Rheumatoid factor (RF)	< 20	20 - 30	> 30[10]	
Antistreptolysin O titre (ASOT) in preschoolers			> 100	
ASOT at school age			> 250[10]	
ASOT in adults			> 125[10]	

Test	Negative	Low/weak positive	Moderate positive	High/strong positive	Unit
Anti-phospholipid IgG	< 20[159]	20 –30[159]	31 – 50[159]	> 51[159]	GPLU/ml[159]
Anti-phospholipid IgM	< 1.5[159]	1.5 –2.5[159]	2 – 9.9[159]	> 10[159]	MPL /ml[159]
Anti-phospholipid IgA	< 10[159]	10 -20[159]	21 – 30[159]	> 31[159]	arb U/ml[159]
Anti-citrullinated protein antibodies	< 20[159]	20 – 39[159]	40 - 59[159]	> 60[159]	EU[159]

Other immunology

Test	Lower limit	Upper limit	Unit
Serum free light chains (FLC): kappa/lambda ratio	0.26[160]	1.65[160]	(unit-less)

Other enzymes and proteins

Test	Lower limit	Upper limit	Unit	Comments
Serum total protein	60,[9] 63[10]	78,[9] 82,[10] 84[18]	g/L	
Lactate dehydrogenase (LDH)	50[18]	150[18]	U/L	
	0.4[49]	1.7[49]	µmol/L	
	1.8[4]	3.4[4]	µkat/L	< 70 years old[4]
Amylase	25,[9] 30,[10] 53[18]	110,[10] 120,[161] 123,[18] 125,[9] 190[49]	U/L	
	0.15[4]	1.1[4]	µkat/L	
	200[152]	240[152]	nmol/L	
D-dimer	n/a	500[162]	ng/mL	Higher in pregnant women[163]
		0.5[4]	mg/L	
Lipase	7,[10] 10,[18] 23[49]	60,[10] 150,[18] 208[49]	U/L	
Angiotensin-converting enzyme (ACE)	23[49]	57[49]	U/L	
Acid phosphatase		3.0[49]	ng/mL	
Eosinophil cationic protein (ECP)	2.3[4]	16[4]	µg/L	

Other electrolytes and metabolites

Electrolytes and Metabolites: For iron and copper, some related proteins are also included.

Test	Patient type	Lower limit	Upper limit	Unit	Comments
Osmolality		275,[9] 280,[18] 281[4]	295,[9] 296,[18] 297[4]	mOsm/kg	Plasma weight excludes solutes
Osmolarity		Slightly less than osmolality		mOsm/l	Plasma volume includes solutes
Urea		3.0[164]	7.0[164]	mmol/L	BUN - blood urea nitrogen
		7[9]	18,[9] 21[10]	mg/dL	
* Uric acid[10]		0.18[9]	0.48[9]	mmol/L	
	Female	2.0[18]	7.0[18]	mg/dL	
	Male	2.1[18]	8.5[18]	mg/dL	
Creatinine	male	60,[4] 68[165]	90,[4] 118[165]	µmol/L	May be complemented with creatinine clearance
		0.7,[166] 0.8[166]	1.0,[166] 1.3[166]	mg/dL	
	female	50,[4] 68[165]	90,[4] 98[165]	µmol/L	
		0.6,[166] 0.8[166]	1.0,[166] 1.1[166]	mg/dL	
BUN/Creatinine Ratio		5[18]	35[18]	-	
Plasma glucose (fasting)		3.8,[9] 4.0[4]	6.0,[4] 6.1[167]	mmol/L	*See also* glycated hemoglobin (in hematology)
		65,[10] 70,[9] 72[168]	100,[167] 110[18]	mg/dL	
Full blood glucose (fasting)		3.3[4]	5.6[4]	mmol/L	
		60[168]	100[168]	mg/dL	
Random glucose		3.9[169]	7.8[169]	mmol/L	
		70[170]	140[170]	mg/dL	
Lactate (Venous)		4.5[18]	19.8[18]	mg/dL	
		0.5[171]	2.2[171]	mmol/L	
Lactate (Arterial)		4.5[18]	14.4[18]	mg/dL	
		0.5[171]	1.6[171]	mmol/L	
Pyruvate		300[18]	900[18]	µg/dL	
		34[172]	102[172]	µmol/L	
Ketones			1[173]	mg/dL	
			0.1[173]	mmol/L	

Medication

Test	Lower limit	Upper limit	Unit	Comments
Digoxin	0.5[174]	2.0[174]	ng/ml	Narrow therapeutic window
	0.6[174]	2.6[174]	nmol/l	
Lithium	0.4,[175] 0.5,[176][177] 0.8[178]	1.3[176][177]	mmol/l	Narrow therapeutic window
Paracetamol		30[179]	mg/L	Risk of paracetamol toxicity at higher levels
		200[179]	µmol/L	

See also

- Cardiology diagnostic tests and procedures
- Comprehensive metabolic panel
- Medical technologist
- Reference range

Notes

1. The MCHC in g/dL and the mass fraction of hemoglobin in red blood cells in % are numerically identical in practice, assuming a RBC density of 1g/mL and negligible hemoglobin in plasma.

References

Template:WBC 6.13/UL

External links

- *biochemical reference values (https://www.gpnotebook.co.uk/simplepage.cfm?ID=724893718)* at GPnotebook
- Descriptions at amarillomed.com (http://www.amarillomed.com/howto.htm)
- Values at lymphomation.org (http://www.lymphomation.org/CBC-blood-counts.htm)

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