

# **Appendix A**

## **Diagnostic Studies and Interpretation**

### **Test Value Studied**

Reference Ranges—Hematology

Reference Ranges—Serum, Plasma, and Whole Blood Chemistries

Reference Ranges—Immunodiagnostic Tests

Reference Ranges—Urine Chemistry

Reference Ranges—Cerebrospinal Fluid (CSF)

### **Selected Abbreviations Used in Reference Ranges**

#### **Conventional Units**

kg = kilogram

gm = gram

mg = milligram

$\mu\text{g}$  = microgram

$\mu\mu\text{g}$  = micromicrogram

ng = nanogram

pg = picogram

dL = 100 milliliters

mL = milliliter

$\text{mm}^3$  = cubic millimeter

fL = femtoliter  
mM = millimole  
nM = nanomole  
mOsm = milliosmole  
mm = millimeter  
 $\mu\text{m}$  = micron or micrometer  
mm Hg = millimeters of mercury  
U = unit  
mU = milliunit  
 $\mu\text{U}$  = microunit  
mEq = milliequivalent  
IU = international unit  
mIU = milli-international unit

## SI Units

g = gram  
L = liter  
d = day  
h = hour  
mol = mole  
mmol = millimole  
 $\mu\text{mol}$  = micromole  
nmol = nanomole  
pmol = picomole

**TABLE A-1** Reference Ranges—Hematology<sup>a</sup>

Test	Reference Range		Clinical Significance
	Conventional Units	SI Units	
Bleeding time	3–10 min Ivy method	3–10 min	Prolonged in thrombocytopenia, defective platelet function, and aspirin therapy
Factor V assay (labile factor)	50–150%		Decreased in liver disease, factor V inhibitors, myeloproliferative disorders, DIC, and fibrinolysis
Factor VIII assay (- antihemophilic factor)	55–145%	55–145 AU	Increased in late normal pregnancy, thromboembolic conditions, liver disease, postoperative period, and rebound period after sudden cessation of a Coumadin-type drug  Decreased in hemophilia A, immunologic reactions, - postpartum, von Willebrand disease, DIC, fibrinolysis, and myeloproliferative disorders
Factor IX assay (Christmas factor)	60–140%	60–140 AU	Decreased in uncompensated cirrhosis, liver disease, nephrotic syndrome, various anticoagulant drugs, DIC, and vitamin K deficiency
Factor X	45–155%		Decreased in liver disease, oral anticoagulant drugs, - amyloidosis, DIC, and vitamin deficiency
Fibrinogen	200–400 mg/dL	2–4 g/dL	Increased in pregnancy, infections, inflammation, acute MI, nephritic syndrome, cancers, and stroke  Decreased in liver disease, DIC, cancer, primary fibrinolysis, and hereditary and congenital hypofibrinogenemia
Fibrin degradation products	<10 µg/mL	<10 mg/mL	Used to establish diagnosis of DIC and other thromboembolic disorders
Fibrinolysis	No lysis in 24 h		Increased activity associated with

(whole blood clot lysis time)		hemorrhage and circulatory collapse, surgery, long-term DIC, liver disease, pregnancy complications, and other conditions	
Activated partial thromboplastin time (aPTT)	Lower limit of normal: 21–35 s	Prolonged in deficiency of fibrinogen; factors II, V, VIII, IX, X, XI, and XII; in heparin therapy; DIC; liver disease; and other conditions	
Prothrombin (PT)	Lower limit of normal: 11 s Lower limit of normal: 13 s	Impaired in deficiency of factors II, V, VIII, IX, and X; DIC; liver disease; and other conditions	
INR	0.8–1.2	Prolonged by deficiency of factors I, II, V, VII, and X; fat malabsorption; severe liver disease; warfarin (Coumadin) anticoagulant therapy; and other conditions	
Erythrocyte count	Males: 4,200,000–5,400,000/mm <sup>3</sup>  Females: 3,600,000–5,000,000/mm <sup>3</sup>	4.2–5.4 × 10 <sup>12</sup> /L  3.6–5.0 × 10 <sup>12</sup> /L	Increased in severe diarrhea and dehydration, polycythemia, acute poisoning, and pulmonary fibrosis  Decreased in all anemias, in leukemia, and after hemorrhage when blood volume has been restored
<b>Erythrocyte Indices</b>			
Mean corpuscular volume (MCV)	82–98 mcm <sup>3</sup>	82–98 fL	Increased in macrocytic anemia; decreased in microcytic anemia
Mean corpuscular hemoglobin (MCH)	26–34 pg/cell	0.40 to 0.53 fmol/cell	Increased in macrocytic anemia; decreased in microcytic anemia
Mean corpuscular hemoglobin concentration (MCHC)	32–36 g/dL	4.9 to 5.5 mmol/L	Decreased in severe hypochromic anemia
Reticulocytes	0.5–1.5% of	Number	Increased with any condition

	RBCs	fraction: 0.005– 0.015	stimulating increase in bone marrow activity (e.g., infection, blood loss [acute and chronically following iron therapy in iron deficiency - anemia], polycythemia vera)
			Decreased with any condition depressing bone marrow - activity, acute leukemia, late stage of severe anemias
ESR	Males under 50 yrs: 0–15 mm/h  Males over 50 yrs: 0–20 mm/h  Females under 50 yrs: 0–20 mm/h  Females over 50 yrs: 0–30 mm/h	<15 mm/h  <20 mm/h  <25 mm/h  <30 mm/h	Increased in tissue destruction, whether inflammatory or degenerative; during menstruation and pregnancy; in acute febrile diseases; and other conditions
Hematocrit	Males: 42–52%  Females: 36–48%	Volume fraction: 0.42– 0.52  Volume fraction: 0.36– 0.48	Decreased in anemias, including anemia of pregnancy, acute blood loss, and other conditions
Hemoglobin	Males: 14.0–17.4 g/dL  Females: 12.0–16 g/dL	140–174 g/L  mmol/L 120–160 g/L	Increased in erythrocytosis of any cause, and in dehydration or hemoconcentration associated with shock
			Decreased in anemias, pregnancy, hemorrhage, with excessive fluid intake, and other conditions
			Increased in polycythemia, chronic obstructive pulmonary disease, failure of oxygenation because of congestive heart failure, and normally in people living at high altitudes

Leukocyte alkaline phosphatase	40–100 units		Increased in polycythemia vera, myelofibrosis, various cancers, and other conditions
			Decreased in chronic myeloid leukemia, paroxysmal - nocturnal hemoglobinuria, idiopathic thrombocytopenic purpura, hereditary hypophosphatasia, progressive muscular dystrophy, marked eosinophilia, nephritic syndrome, and siderocytic anemia
Leukocyte count	Total: 4500–11,000/mm <sup>3</sup>	$4.5 \times 10^9/\text{L}$	Neutrophils increase with acute infections, trauma or surgery, leukemia, malignant disease, necrosis; decreased with viral infections, bone marrow suppression, primary bone marrow disease
Neutrophils	45–73%	Number fraction: 0.45– 0.73	
Eosinophils	0–4%	Number fraction: 0.00– 0.04	Eosinophils increased in allergy, parasitic disease, collagen disease, subacute infections; decreased with stress, use of some medications (ACTH, epinephrine, thyroxine)
Basophils	0–1%	Number fraction: 0.00– 0.01	Basophils increased with acute leukemia and following - surgery or trauma; decreased with allergic reactions, stress, allergy, parasitic disease, use of corticosteroids
Lymphocytes	20–40%	Number fraction: 0.2–0.4	Lymphocytes increased with infectious mononucleosis, viral and some bacterial infections, hepatitis; decreased with aplastic anemia, SLE, immune deficiency including AIDS
Monocytes	2–8%	Number fraction: 0.02– 0.08	Monocytes increased with viral infections, parasitic disease, collagen and hemolytic disorders; decreased with use of corticosteroids, RA, HIV infection

Platelet count	140,000– 400,000/mm <sup>3</sup>	0.14–0.4 × 10 <sup>12</sup> /L	Increased in cancer, myeloproliferative disease, RA, and postoperatively  Decreased in thrombocytopenic purpura, acute leukemia, aplastic anemia, and during cancer chemotherapy
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<sup>a</sup>Laboratory values and reference ranges may vary in different laboratories.

ACTH, adrenocorticotropic hormone; AIDS, acquired immune deficiency syndrome; DIC, disseminated intravascular coagulation; ESR, erythrocyte sedimentation rate; HIV, human immune deficiency virus; INR, international normalized ratio; MI, myocardial infarction; RA, rheumatoid arthritis; RBC, red blood cell; SLE, systemic lupus erythematosus.

**TABLE A-2** Reference Ranges—Serum, Plasma, and Whole Blood Chemistries

Test	Normal Adult Reference Range		Clinical Significance	
	Conventional Units	SI Units	Increased	Decreased
Acetoacetate	0.2–1.0 mg/dL	19.6–98 mcmol/L	Diabetic ketoacidosis and fasting	
Acetone	0.3–2.0 mg/dL	51.6–3440/mcmol/L	Diabetic ketoacidosis, toxemia of pregnancy, and carbohydrate-free diet, high-fat diet	
Acid, total phosphatase	Males: 2–12 U/L Females: 0.3–9.2 U/L	Males: 2–12 U/L Females: 0.3–9.2 U/L	Carcinoma of prostate, advanced Paget disease, hyperparathyroidism, and Gaucher disease	
Acid, phosphatase, prostatic—RIA	<2.5 ng/mL	<2.5 µg/L	Carcinoma of prostate	
Alkaline phosphatase	Adults: 52–142 U/L	0.43–1.70 mkat/L	Conditions reflecting increased osteoblastic activity of bone, including many liver diseases, bone diseases, and other conditions	
Adrenocorticotropic hormone (ACTH) (plasma)—RIA <sup>a</sup>	<120 pg/mL	<120 ng/L	Pituitary-dependent Cushing syndrome, ectopic ACTH syndrome, and primary adrenal atrophy	Adrenocortical tumor, adrenal insufficiency secondary to hypopituitarism
Aldolase	3–8 Sibley-Lehninger U/dL at 37°C	22–59 mU/L at 37°C	Hepatic necrosis, granulocytic leukemia, myocardial infarction, and skeletal muscle disease	
Aldosterone (plasma)—RIA	Supine: 3–16 ng/dL Upright: 7–30 ng/dL Adrenal vein: 200–800 ng/dL	0.08–0.30 nmol/L 0.14–0.90 nmol/L 5.54–22.16 nmol/L	Primary and secondary aldosteronism	Addison disease
Alpha <sub>1</sub> -antitrypsin	110–140 mg/dL	1.1–1.4 g/L		Certain forms of chronic lung and liver disease in young adults
Alpha-hydroxybutyric dehydrogenase	<140 U/L	<140 U/L	Myocardial infarction, granulocytic leukemia, hemolytic anemias, and muscular dystrophy	
Ammonia (plasma)	15–45 mcg/dL (varies with method)	11–32 mcmol/L	Severe liver disease, and hepatic decompensation	

Test	Normal Adult Reference Range		Clinical Significance	
	Conventional Units	SI Units	Increased	Decreased
Amylase	25–125 U/L Older adults: 24–151 U/L	0.4–2.1 µkat/L 0.4–2.5 µkat/L	Acute pancreatitis, mumps, duodenal ulcer, carcinoma of head of pancreas, prolonged elevation with pseudocyst of pancreas, and medications that constrict pancreatic duct sphincters: morphine, codeine, cholinergics	Chronic pancreatitis, pancreatic fibrosis and atrophy, cirrhosis of liver, and pregnancy (2nd and 3rd trimesters)
Arsenic	<70 mcg/dL; poisoning: 100–150 mcg/dL	<0.93–2.6 µmol/L; poisoning: 133–6.65 µmol/L	Intentional or unintentional poisoning, and excessive occupational exposure	
Ascorbic acid (vitamin C)	0.4–1.5 mg/dL	23–85 µmol/L	Large doses of ascorbic acid as a prophylactic against the common cold	
ALT (alanine aminotransferase), formerly SGPT	Males: 10–40 U/mL Females: 8–35 U/mL	Males: 0.17–0.68 µkat/L Females: 0.14–0.60 µkat/L	Same conditions as AST (SGOT), but increase is more marked in liver disease than AST (SGOT)	
AST (aspartate aminotransferase), formerly SGOT	Males: 10–40 U/L Females: 15–30 U/L	Males: 0.34–0.68 µkat/L Females: 0.25–0.51 µkat/L	Myocardial infarction, skeletal muscle disease, and liver disease	
Bilirubin	Total: 0.3–1.0 mg/dL Direct: <0.5 mg/dL Indirect: 0.1–1 mg/dL	5–17 µmol/L <6.8 µmol/L 1.7–17.1 µmol/L	Hemolytic anemia (indirect), biliary obstruction and disease, hepatocellular damage (hepatitis), and pernicious anemia	
Brain (B-type) natriuretic peptide (BNP)	<100 pg/mL	100 ng/L	Heart failure, cardiac volume overload	
Calcitonin	Basal: <8.4 pg/mL Stimulation test Males: <190 pg/mL Females: <35 pg/mL	8.4 ng/L <190 ng/L <35 ng/L	Medullary carcinoma of the thyroid, some nonthyroid tumors, Zollinger-Ellison syndrome	
Calcium	8.8–10.4 mg/dL	2.20–2.6 mmol/L	Tumor or hyperplasia of parathyroid, hypervitaminosis D, multiple myeloma, nephritis with uremia, malignant tumors, sarcoidosis, hypoparathyroidism, skeletal immobilization, excess calcium intake: milk-alkali syndrome	Hyperthyroidism, diarrhea, celiac disease, vitamin D deficiency, acute pancreatitis, nephrosis, and parathyroidectomy
CO <sub>2</sub> , venous	Adults: 24–32 mEq/L Infants: 22–24 mEq/L	24–32 mmol/L 22–24 mmol/L	Tetany, respiratory disease, intestinal obstruction, vomiting, and pheochromocytoma	Acidosis, nephritis, eclampsia, diarrhea, and anesthesia
Catecholamines (plasma)—RIA	Epinephrine: <100 pg/mL Norepinephrine: <400 pg/mL Dopamine: <143 pg/mL	<540 pmol/L <2360 pmol/L <935 pmol/L		
Ceruloplasmin	25–63 mg/dL	250–630 mg/L		Wilson disease (hepatolenticular degeneration)
Chloride	96–106 mEq/L	96–106 mmol/L	Nephrosis, nephritis, urinary obstruction, cardiac decompensation, and anemia	Diabetes, diarrhea, vomiting, pneumonia, heavy metal poisoning, Cushing syndrome, intestinal obstruction, and other febrile conditions

Test	Normal Adult Reference Range		Clinical Significance	
	Conventional Units	SI Units	Increased	Decreased
Cholesterol	Males: <205 mg/dL Females: <190 mg/dL	<5.3 mmol/L <4.9 mmol/L	Lipemia, obstructive jaundice, diabetes, and hyperthyroidism	Pernicious anemia, hemolytic anemia, hypothyroidism, severe infection, and terminal states of debilitating disease
Cholinesterase	Serum: 0.6–1.6 delta pH Red cells: 0.6–1 delta pH	0.6–1.6 U 0.6–1 U	Nephrosis and exercise	Nerve gas exposure (greater effect on red cell activity) and insecticide poisoning
Complement, C <sub>3</sub>	75–175 mg/dL	0.75–1.75 g/L	Some inflammatory diseases, acute myocardial infarction, cancer	Acute glomerulonephritis and disseminated lupus erythematosus with renal involvement
Complement, C <sub>4</sub>	14–40 mg/dL	0.15–0.45 g/L	Some inflammatory diseases, acute myocardial infarction, and cancer	Often decreased in immunologic disease, especially with active systemic lupus erythematosus, and hereditary angioneurotic edema
Complement, total (hemolytic)	90–94% complement	30–60 U/mL	Some inflammatory diseases	Acute glomerulonephritis, meningitis, and subacute bacterial endocarditis
Copper	70–150 mcg/dL	11–24 μmol/L	Cirrhosis of liver and pregnancy	Wilson disease
Cortisol-RIA	8 AM: 5–23/mcg/dL 4 PM: 3–16 mcg/dL	138–635 nmol/L 80–330 nmol/L	Stress: infectious disease, surgery, burns, etc.; pregnancy; Cushing syndrome; pancreatitis; and eclampsia	Addison disease and anterior pituitary hypofunction
C-peptide reactivity Creatine	0.78–1.89 ng/mL	0.26–0.63 mmol/L 15.3–61 μmol/L	Insulinoma Pregnancy, skeletal muscle necrosis or atrophy, starvation, and hyperthyroidism	Diabetes
Creatine phosphokinase (CPK)	Males: 50–325 mU/mL Females: 50–250 mU/mL	50–325 U/L 50–250 U/L	Myocardial infarction, skeletal muscle diseases, intramuscular injections, Crush syndrome, hypothyroidism, alcohol withdrawal delirium, alcoholic myopathy, and cerebrovascular disease	
Creatine kinase (CK) isoenzymes	MM band present (skeletal muscle)–MB band absent (heart muscle)		MB band increased in myocardial infarction, ischemia	
Creatinine	Males: 0.6–1.2 mg/dL Females: 0.4–1.0 mg/dL	71–106 mmol/L 36–90 μmol/L	Nephritis, chronic renal disease	
Cryoglobulins, qualitative	Negative		Multiple myeloma, chronic lymphocytic leukemia, lymphosarcoma, systemic lupus erythematosus, rheumatoid arthritis, infective subacute endocarditis, some malignancies, and scleroderma	
11-Deoxycortisol	1 mcg/dL	<0.029 μmol/L	Hypertensive form of virilizing adrenal hyperplasia due to an 11-β-hydroxylase defect	

Test	Normal Adult Reference Range		Clinical Significance	
	Conventional Units	SI Units	Increased	Decreased
Dibucaine inhibition	Normal: 79–84%	0.79–0.84%		Important in detecting carriers of abnormal cholinesterase activity who are at risk for a number of conditions
Dihydrotestosterone	Males: 50–210 ng/dL Females: none detectable	1.72–7.22 nmol/L		Testicular feminization syndrome
Estradiol—RIA	Females: Follicular: 10–90 pg/mL Midcycle: 100–500 pg/mL Luteal: 50–240 pg/mL Follicular phase: 2–20 ng/dL Midcycle: 12–40 ng/dL Luteal phase: 10–30 ng/dL Postmenopausal: 1–5 ng/dL Males: 0.5–5 ng/dL	37–370 pmol/L 367–1835 pmol/L 184–881 pmol/L	Pregnancy or ovarian tumor	Ovarian failure
Estriol—RIA	Nonpregnant females: <0.5 ng/mL Pregnant females: 1st trimester: up to 1 ng/mL 2nd trimester: 0.8–7 ng/mL 3rd trimester: 5–25 ng/mL	<1.75 nmol/L Up to 3.5 nmol/L 2.8–24.3 nmol/L 17.4–86.8 nmol/L	Pregnancy	Ovarian failure
Estrogens, total—RIA	Females: cycle days: Day 1–10: 61–394 pg/mL Day 11–20: 122–437 pg/mL Day 21–30: 156–350 pg/mL Males: 20–80 pg/mL	61–394 ng/L 122–437 ng/L 156–350 ng/L 20–80 ng/L	Pregnancy, measured on a daily basis, can be used to evaluate response of hypogonadotropic, hypoestrogenic women to human menopausal or pituitary gonadotropin	Fetal distress, ovarian failure
Estrone—RIA	Females: Day 1–10: 4.3–18 ng/dL Day 11–20: 7.5–19.6 ng/dL Day 21–30: 13–20 ng/dL Males: 2.5–7.5 ng/dL	15.9–66.6 pmol/L 27.8–72.5 pmol/L 48.1–74 pmol/L 9.3–27.8 pmol/L	Pregnancy	Ovarian failure
Ferritin—RIA	Males: 18–270 ng/mL Females: 18–160 ng/mL	18–270 µg/L 18–160 µg/L	Nephritis and hemochromatosis Certain neoplastic diseases, acute myeloid leukemia, and multiple myeloma	Iron deficiency
Folic acid—RIA	3–13 ng/mL	6.8–29.5 nmol/L		Megaloblastic anemias of infancy and pregnancy, inadequate diet, liver disease, malabsorption syndrome, and severe hemolytic anemia
Follicle-stimulating hormone (FSH)—RIA	Males: 1.24–7.8 mIU/mL Females: Follicular phase: 1.68–15 mIU/mL Peak of middle cycle: 21.9–56.6 mIU/mL Luteinic phase: 0.61–16.3 mIU/mL Menopausal females: 14.2–52.3 mIU/mL	1.24–7.8 IU/L 1.68–15 IU/L 21.9–56.6 IU/L 0.61–16.3 IU/L 14.2–52.3 IU/L	Menopause and primary ovarian failure	Pituitary failure

Test	Normal Adult Reference Range		Clinical Significance	
	Conventional Units	SI Units	Increased	Decreased
Galactose	<5 mg/dL	<0.28 mmol/L		Galactosemia
Gamma glutamyl transpeptidase	Males: 20–30 U/L Females: 1–24 U/L	0.03–0.5 mkat/L 0.02–0.4 mkat/L	Hepatobiliary disease, drug toxicity, myocardial infarction, renal infarction, and Zollinger-Ellison syndrome	
Gastrin—RIA	Fasting: 50–155 pg/mL Postprandial: 80–170 pg/mL	50–155 ng/L 80–170 ng/L	Duodenal ulcer and pernicious anemia	
Glucose	Fasting: 60–100 mg/dL	≤5.6 mmol/L	Diabetes, nephritis, hypothyroidism, early hyperpituitarism, cerebral lesions, infections, pregnancy, and uremia	Hyperinsulinism, hyperthyroidism, late hyperpituitarism, Addison disease, and extensive hepatic damage
Glucose tolerance (oral)	Features of a normal response 1. Normal fasting between 60–110 mg/dL 2. No sugar in urine 3. Upper limits of normal Fasting = 125 mg/dL 1 h = 190 mg/dL 2 h = 140 mg/dL 3 h = 125 mg/dL	3.3–6.05 mmol/L 6.88 mmol/L 10.45 mmol/L 7.70 mmol/L 6.88 mmol/L	2-h value >200 mg/dL (11.1 mmol/L) is diagnostic for diabetes	Decreased 2- and 3-h values may occur with hypoglycemia in diabetes
Glucose-6-phosphate dehydrogenase (red cells)	Screening: Decolorization in 20–100 min Quantitative: 1.86–2.5 IU/mL RBC	1860–2500 U/L		Drug-induced hemolytic anemia
Glycoprotein (alpha-1-acid)	50–120 mg/dL	0.5–1.2 g/L	Neoplasm, tuberculosis, diabetes complicated by degenerative vascular disease, pregnancy, rheumatoid arthritis, rheumatic fever, infectious liver disease, and systemic lupus erythematosus	
Growth hormone—RIA	Males: 0–4 ng/mL Females: 0–10 ng/mL	0.4 mcg/L 0–18 mcg/L	Acromegaly, pregnancy, and estrogen therapy	Hypopituitarism
Haptoglobin	30–200 mg/dL	0.3–2.0 g/L	Chronic infections and various inflammatory conditions	Hemolytic anemia and hemolytic blood transfusion reaction
Hemoglobin (plasma)	Males: 12.4–17.4 g/dL Females: 11.7–16 g/dL	112–174 g/L 117–160 g/L	Transfusion reactions, paroxysmal nocturnal hemoglobinuria, and intravascular hemolysis	Anemia, pregnancy, and chronic renal disease
Glycohemeoglobin ([GHB], hemoglobin A <sub>1c</sub> , hemoglobin A1)	Patients without diabetes and patients with diabetes with good glycemic control: 4.4–6.4%		Suboptimal glucose control	
Hexosaminidase, total	Controls: 333–375 nM/mL/h	333–375 mcmol/L/h	Sandhoff disease	Tay-Sachs disease and heterozygotes
Hexosaminidase A	Controls: 55–76% of total Heterozygotes: 26–45% of total Tay-Sachs disease: 0–4% of total Diabetes: 39–59% of total	Fraction of total: 0.49–0.68 0.26–0.45 0–0.04 0.39–0.59		

Test	Normal Adult Reference Range		Clinical Significance	
	Conventional Units	SI Units	Increased	Decreased
High-density lipoprotein cholesterol (HDL cholesterol)	Males: 35–65 mg/dL Females: 35–80 mg/dL	0.91–1.68 mmol/L 0.91–2.07 mmol/L		HDL cholesterol is lower in patients with increased risk for coronary artery disease
17-Hydroxyprogesterone—RIA	Males: 0.5–2.0 ng/mL Females: 0.2–3.0 ng/mL Children: <1.0 ng/mL	1.5–6.0 nmol/L 0.6–9.0 nmol/L <3.0 nmol/L	Congenital adrenal hyperplasia, pregnancy, some cases of adrenal or ovarian adenomas	
Immunoglobulin A	Adults: 60–400 mg/dL	600–4000 mg/L	Gamma A myeloma, Wiskott–Aldrich syndrome, autoimmune disease, and hepatic cirrhosis	Ataxia telangiectasis, agammaglobulinemia, hypogammaglobulinemia, transient dysgammaglobulinemia, and protein-losing enteropathies
Immunoglobulin D	0–14.0 mg/dL	0–140 mg/L	IgD multiple myeloma, some patients with chronic infectious diseases	
Immunoglobulin E	3–434 IU/mL	3–432 kU/L	Allergic reactions, parasitic infections	
Immunoglobulin G	Adults: 700–1500 mg/dL	7–15 g/L	IgG multiple myeloma following hyperimmunization, autoimmune disease states, and chronic infections	Congenital and acquired hypogammaglobulinemia, IgA multiple myelomas, Waldenström (IgM) macroglobulinemia, some malabsorption syndromes, and extensive protein loss
Immunoglobulin M	Adults: 60–300 mg/dL	600–3000 mg/L	Waldenström macroglobulinemia, parasitic infections, and hepatitis	Agammaglobulinemias, multiple myeloma, and chronic lymphocytic leukemia
Insulin—RIA	0–35 mcU/mL	144–243 pmol/L	Insulinoma and acromegaly	Diabetes
Iron	50–150/mcg/dL	9–29 mcmol/L	Pernicious anemia, aplastic anemia, hemolytic anemia, hepatitis, and hemochromatosis	Iron deficiency anemia
Iron-binding capacity	IBC: 250–350 mcg/dL TIBC: 250–450 mcg/dL % Saturation: 10–50	45–63 mcmol/L 54–65 mcmol/L Fraction of total iron-binding capacity: 0.2–0.5	Iron deficiency anemia, acute and chronic blood loss, and hepatitis	Chronic infectious diseases and cirrhosis
Isocitric dehydrogenase	50–180 U	0.83–3 U/L	Hepatitis, cirrhosis, obstructive jaundice, metastatic carcinoma of the liver, and megaloblastic anemia	
Lactic acid (whole blood)	Venous: 5–15 mg/dL Arterial: 3–11 mg/dL	0.5–1.7 mmol/L 0.36–1.25 mmol/L	Increased muscular activity, heart failure, hemorrhage, shock, lactic acidosis, some febrile infections, and severe liver disease	
Lactic dehydrogenase (LDH)	<61 mU/mL	90–176 U/L	Untreated pernicious anemia, myocardial infarction, pulmonary infarction, and liver disease	

Test	Normal Adult Reference Range		Clinical Significance	
	Conventional Units	SI Units	Increased	Decreased
<sup>a</sup> LDH isoenzymes Total lactic dehydrogenase	140–280 mU/mL 17–27% LDH-1 LDH-2 LDH-3 LDH-4 LDH-5 Lead (whole blood)	140–280 U/L Fraction of total LDH: 0.17–0.27 0.29–0.39 0.19–0.27 0.08–0.16 0.06–0.16 Up to 40 mcg/dL	LDH-1 and LDH-2 are increased in myocardial infarction, megaloblastic anemia, and hemolytic anemia LDH-4 and LDH-5 are increased in pulmonary infarction, congestive heart failure, and liver disease Lead poisoning	
Leucine aminopeptidase	75–200 U/mL	75–200 kilounits/L	Liver or biliary tract disease, pancreatic disease, metastatic carcinoma of liver and pancreas, and biliary obstruction	
<sup>b</sup> Lipase	<140 U/mL	<140 U/L	Acute and chronic pancreatitis, biliary obstruction, cirrhosis, hepatitis, and peptic ulcer	
Lipids, total	400–800 mg/dL	4–8 g/L	Hypothyroidism, diabetes, nephrosis, glomerulonephritis, and hyperlipoproteinemias	Hyperthyroidism
Low-density lipoprotein cholesterol (LDL cholesterol)	mg/dL desirable levels: <160 if no coronary artery disease (CAD) and <2 risk factors <130 if no CAD and two or more risk factors <100 if CAD present		LDL cholesterol is higher in patients with increased risk for coronary artery disease	
Luteinizing hormone—RIA	Males: 1.5–9.3 mU/mL Females: Follicular phase: 1.9–12.5 mU/mL Midcycle: 8.7–76.3 mU/mL	1.5–9.3 U/L 1.9–12.5 U/L 8.7–76.3 U/L	Pituitary tumor or ovarian failure	Pituitary failure
Lysozyme (muramidase)	4.0–15.6 mcg/mL	0.28–1.10 μmol/L	Certain types of leukemia (acute myeloid leukemia), inflammatory states, and infections	Acute lymphocytic leukemia
Magnesium	1.8–2.6 mg/dL	0.74–1.07 mmol/L	Excess ingestion of magnesium-containing antacids	Chronic alcoholism, severe renal disease, and diarrhea
Mercury	<10 mcg/L	<50 μmol/L	Mercury poisoning	
Myoglobin	No myoglobin	0 mcg/mL	Myocardial infarction, myocardial ischemia, rhabdomyolysis, and malignant hyperthermia	Rheumatoid arthritis and myasthenia gravis
5' nucleotidase	3.2–11.6 IU/L	3.2–11.6 U/L	Hepatobiliary disease	
Osmolality	50–1200 mOsm/kg 300–900 mOsm/kg in 24 h	275–300 mmol/L	Diabetes insipidus, osmotic diuresis	Inappropriate secretion of ADH, Addison disease
Parathyroid hormone	10–50 pg/mL	10–50 ng/L	Hyperparathyroidism, chronic renal disease	Hypoparathyroidism
Phenylalanine	1.2–3.5 mg/dL 1st wk 0.7–3.5 mg/dL thereafter	0.07–0.21 mmol/L 0.04–0.21 mmol/L	Phenylketonuria	
Phosphohexose isomerase	20–90 IU/L	20–90 U/L	Malignancy, disease of heart, liver, and skeletal muscles	
Phospholipids	125–300 mg/dL	1.25–3 g/L	Diabetes or nephritis	

Test	Normal Adult Reference Range		Clinical Significance	
	Conventional Units	SI Units	Increased	Decreased
Phosphorus, inorganic	2.7–4.5 mg/dL	0.87–1.45 mmol/L	Chronic nephritis and hypoparathyroidism	
Potassium	3.5–5 mEq/L	3.5–5 mmol/L	Renal disease, acidosis, cell lysis, tissue breakdown, or hemolysis	Hyperparathyroidism, vitamin D deficiency, GI losses, diuretic administration
Prealbumin	16–35 mg/dL	160–350 mg/L	Malnutrition, severe or chronic illness, and liver disease	
Progesterone—RIA	Follicular phase: up to 0.8 ng/mL Luteal phase: 10–20 ng/mL End of cycle: <1 ng/mL Pregnant: up to 50 ng/mL in 20th wk	2.5 nmol/L 31.8–63.6 nmol/L <3 nmol/L Up to 160 nmol/L	Useful in evaluation of menstrual disorders and infertility and in the evaluation of placental function during pregnancies complicated by toxemia, diabetes, or threatened miscarriage	
Prolactin—RIA	4–30 ng/mL	4–30 mcg/L	Pregnancy, functional or structural disorders of the hypothalamus, pituitary stalk section, and pituitary tumors	
Prostate-specific antigen (PSA)	Age under 60 <4 ng/mL Age over 60 <6.6 ng/mL		Prostatic cancer, benign prostatic hyperplasia, and prostatitis	
Protein, total	6–8 g/dL	60–80 g/L	Hemoconcentration, shock, globulin fraction increased in multiple myeloma, chronic infection, and liver disease	Malnutrition, hemorrhage, loss of plasma from burns, and proteinuria
Albumin	3.5–5.2 g/dL	35–52 g/L		
Globulin	1.7–3.3 g/dL	17–33 g/L		
Protein Electrophoresis		35–55 g/L		
Albumin	3.5–5.2 g/dL	35–52 g/L		
Alpha-1 globulin	0.1–0.3 g/dL	1–3 g/L		
Alpha-2 globulin	0.6–1 g/dL	6–10 g/L		
Beta globulin	0.5–1.0 g/dL	5–10 g/L		
Gamma globulin	0.6–1.3 g/dL	6–13 g/L		
Protoporphyrin erythrocyte (whole blood)	Males: 11–45 mcg/dL Females: 19–52 mcg/dL	0.20–0.80 mcmol/L 0.34–0.92 mcmol/L	Lead toxicity, erythropoietic porphyria	
Pyridoxine	5–30 ng/mL	20–1.21 nmol/L		A wide spectrum of clinical conditions, such as depression, peripheral neuropathy, anemia, and reactions to certain drug therapies
Pyruvic acid (whole blood)	0.3–0.9 mg/dL	34–102 mcmol/L	Diabetes, severe thiamine deficiency, acute phase of some infections, possibly secondary to increased glycogenolysis and glycolysis	
Renin (plasma)—RLA	Normal diet: Supine: 0.3–1.9 ng/mL/h Upright: 0.6–3.6 ng/mL/h Low-salt diet Supine: 0.9–4.5 ng/mL/h Upright: 4.1–9.1 ng/mL/h	0.08–0.52 ng/L/S 0.16–1.00 mcg/L/S 0.25–1.25 mcg/L/S 1.13–2.53 mcg/L/S	Renovascular hypertension, malignant hypertension, untreated Addison disease, primary salt-losing nephropathy, low-salt diet, diuretic therapy, and hemorrhage	Frank primary aldosteronism, increased salt intake, salt-retaining steroid therapy, antidiuretic hormone therapy, and blood transfusion
Sodium	135–145 mEq/L	135–145 mmol/L	Hemoconcentration, nephritis, and pyloric obstruction	Alkali deficit, Addison disease, myxedema
Sulfate (inorganic)	0.5–1.5 mg/dL	0.05–0.15 mmol/L	Nephritis and nitrogen retention	

Test	Normal Adult Reference Range		Clinical Significance	
	Conventional Units	SI Units	Increased	Decreased
Testosterone—RIA	Females: 20–80 ng/dL Males: 240–1200 ng/dL	0.7–2.8 nmol/L 18.3–41.8 nmol/L	Females: Polycystic ovary and virilizing tumors	Males: Orchidectomy for neoplastic disease of the prostate or breast, estrogen therapy, Klinefelter syndrome, hypopituitarism, hypogonadism, and hepatic cirrhosis
T <sub>3</sub> (triiodothyronine) uptake	25–35%	Relative uptake fraction: 0.25–0.35	Hyperthyroidism, thyroxine-binding globulin (TBG) deficiency, and androgens and anabolic steroids	Hypothyroidism Pregnancy, TBG excess, estrogens and antiabortive drugs
T <sub>3</sub> total circulating—RIA	260–480 pg/dL	4.0–7.4 pmol/L	Pregnancy and hyperthyroidism	Hypothyroidism
T <sub>4</sub> (thyroxine)—RIA	5.4–11.5 mcg/dL	57–148 nmol/L	Hyperthyroidism, thyroiditis, elevated thyroxine-binding proteins caused by oral contraceptives, and pregnancy	Primary and pituitary hypothyroidism, idiopathic involvement, cases of diminished thyroxine-binding proteins caused by androgenic and anabolic steroids, hypoproteinemia, and nephrotic syndrome
T <sub>4</sub> , free	0.7–2 ng/dL	10–26 pmol/L	Euthyroid patients with normal free thyroxine levels may have abnormal T <sub>3</sub> and T <sub>4</sub> levels caused by drug preparations	
Thyroid-stimulating hormone (TSH)—RIA	0–15 mIU/L	0–15 mIU/L	Hypothyroidism	Hyperthyroidism
Thyroid-binding globulin	16–32 mcg/dL	120–180/mcg/L	Hypothyroidism, pregnancy, estrogen therapy, oral contraceptive use, and genetic and idiopathic liver disease	Use of androgens and anabolic steroids, nephrotic syndrome, and marked hypoproteinemia
Transferrin	200–380 mg/dL	2.3–3.2 g/L	Pregnancy, iron deficiency anemia due to hemorrhaging, acute hepatitis, polycythemia, and oral contraceptive use	Pernicious anemia in relapse, thalassemic and sickle cell disease, chromatoses, neoplastic and hepatic diseases, and malnutrition
Triglycerides	Males: 44–180 mg/dL Females: 10–190 mg/dL	0.44–2.01 mmol/L 0.11–2.21 mmol/L	Increased risk for atherosclerosis	
Troponin Troponin I Troponin T	<0.35 ng/mL <0.1 ng/mL	<0.35 mcg/L <0.1 mcg/L	Myocardial infarction Rhabdomyolysis and severe crushing injuries	
Tryptophan	1.4–3 mg/dL	68.6–147 nmol/L	Tyrosinosis	Tryptophan-specific malabsorption syndrome
Tyrosine	0.5–4 mg/dL	27.6–220.8 mmol/L	Acute glomerulonephritis	Severe hepatic failure
Urea nitrogen (BUN)	8–20 mg/dL	2.9–7.5 mmol/L	Obstructive uropathy, mercury poisoning, and nephrotic syndrome	Pregnancy
Uric acid	Males: 3.4–7.0 mg/dL Females: 2.4–6.0 mg/dL	202–416 mcmol/L 143–357 mmol/L	Gouty arthritis, acute leukemia, lymphomas treated by chemotherapy, and toxemia of pregnancy	Defective tubular reabsorption

Test	Normal Adult Reference Range		Clinical Significance	
	Conventional Units	SI Units	Increased	Decreased
Viscosity	1.4–1.8 relative to water at 37°C (98.6°F)		Patients with marked increase of the gamma globulins and hypervitaminosis A	
Vitamin A	30–120 mcg/dL	1.05–4.20 mcmol/L		Vitamin A deficiency, celiac disease, sprue, obstructive jaundice, giardiasis, and parenchymal hepatic disease
Vitamin B <sub>1</sub> (thiamine)	1.6–4 mcg/dL	47.4–135.7 nmol/L		Anorexia, beriberi, polyneuropathy, and cardiomyopathies
Vitamin B <sub>6</sub> (pyridoxal phosphate)	5–30 ng/mL	20–121 nmol/L		Chronic alcoholism, malnutrition, uremia, and malabsorption, such as celiac disease
Vitamin B <sub>12</sub> —RIA	200–900 pg/mL	148–666 pmol/L	Hepatic cell damage and in association with the myeloproliferative disorders (the highest levels are encountered in myeloid leukemia)	Strict vegetarianism, alcoholism, pernicious anemia, total or partial gastrectomy, ileal resection, sprue and celiac disease, and fish tapeworm infestation
Vitamin E	0.5–1.8 mg/dL	12–42 mcmol/L		Vitamin E deficiency
Xylose absorption test	2 h, 30–50 mg/dL	2–3.35 mmol/L		Malabsorption syndrome
Zinc	55–150 mcg/dL	7.65–22.95 mcmol/L	Coronary artery disease, arteriosclerosis, and industrial exposure	Metastatic liver disease, tuberculosis, and sprue

<sup>a</sup>By radioimmunoassay.

<sup>b</sup>Varies among methods.

ADH, antidiuretic hormone; BUN, blood urea nitrogen; RIA, radioimmunoassay; RLA, renin-like activity; SGOT, serum glutamic oxaloacetic transaminase.

**TABLE A-3** Reference Ranges—Immunodiagnostic Test

Test	Normal Value	Clinical Significance
Acetylcholine receptor binding antibody	Negative or <0.03 nmol/L	Considered to be diagnostic for myasthenia gravis in patients with symptoms
Anti-ds-DNA antibody	<70 U by enzyme-linked immunosorbent assay (ELISA) <1:20 by indirect fluorescence	Valuable in supporting diagnosis or monitoring disease activity and prognosis of systemic lupus erythematosus (SLE)
Antiglomerular basement membrane antibody	Negative or <5 UL	Primarily used in the differential diagnosis of glomerular nephritis induced by antiglomerular basement membrane antibodies from other types of glomerular nephritis
Anti-insulin antibody	<3% binding of labeled beef and pork insulin by patient's serum; or <9 mIU/L	Helpful in determining the best therapeutic agent in patients with diabetes and the cause of allergic manifestations. Also used to identify insulin resistance
Antinuclear antibody (ANA)	Negative, <1:40	Increased in SLE, chronic hepatitis, scleroderma, leukemia, and mononucleosis
Antiparietal cell antibody	Negative	Helpful in diagnosing chronic gastric disease and differentiating autoimmune pernicious anemia from other megaloblastic anemias
Antiribonucleoprotein antibody	Negative	Helpful in differential diagnosis of systemic rheumatic disease
Antiscleroderma antibody	Negative	Highly diagnostic for scleroderma
Anti-Smith antibody	Negative	Highly diagnostic of SLE
Anti-SS-A/anti-SS-B antibody	Negative	SS-A antibodies are found in Sjögren syndrome alone or associated with lupus SS-B antibodies are associated with primary Sjögren syndrome
Antithyroglobulin and antimicrosomal antibodies	<1:100 titer by gelatin or hemagglutination	Presence and concentration is important in evaluation and treatment of various thyroid disorders, such as Hashimoto

		thyroiditis and Graves disease. May indicate previous autoimmune disorders
CA 15–3 tumor marker	<30 IU/mL	Increased in metastatic breast cancer
CA 19–9 tumor marker	<37 IU/mL	Increased in pancreatic, hepatobiliary, gastric, and colorectal cancer; gallstones
CA 125	0–35 IU/mL	Increased in colon, upper gastrointestinal (GI), ovarian, and other gynecologic cancers; pregnancy, peritonitis
Carcinoembryonic antigen (CEA)—RLK	0–2.5 mcg/L (nonsmoker)  0–5 mcg/L (smoker)	The repeatedly high incidence of this antigen in cancers of the colon, rectum, pancreas, and stomach suggests that CEA levels may be useful in the therapeutic monitoring of these conditions, but it is not a screening test
Cold agglutinins	Negative or <1:64	Increased in mycoplasma pneumonia, viral illness, mononucleosis, multiple myeloma, and scleroderma
C-reactive protein	<1 mg/dL (<10 mg/L)	Increase indicates active inflammation
High sensitivity assay for C-reactive protein (hs-CRP)	0.2–8.0 mg/L	Cardiovascular disease risk
Cytomegalovirus antibodies (CMV IgG)	Negative: <0.9 units/mL	Positive >1:0 unit/mL if exposed to CMV at any time. Acute and convalescent specimens can help identify acute infection
Cytomegalovirus antibodies (CMV IgM)	Negative: <0.79  Equivocal: 0:80–1.20	Positive >1.20 usually indicates acute infection  Repeat specimen in 1–2 wks for equivocal result
Epstein–Barr virus (EBV) serology (viral capsid antigen IgG and IgM, early antigen IgG, and nuclear antigen IgG)	Negative	Differentiation of acute from chronic or old infection

Hepatitis A virus antibodies, IgM (HAV-Ab/IgM)	Negative	Positive in acute-stage hepatitis A; develops early in disease
Hepatitis A virus antibodies, IgG (HAV-Ab/IgG)	Negative	Positive if previous exposure and immunity to hepatitis A
Hepatitis B surface antigen (HBsAg)	Negative	Positive in acute-stage hepatitis B
Hepatitis B surface antibody (HBsAb)	Negative	Positive if previous exposure and immunity to hepatitis B
Hepatitis C virus antibodies	Negative	Positive in exposure to hepatitis C virus; may indicate acute, chronic, or cleared infection
Hepatitis C virus RNA	Negative	Positive in hepatitis C infection, can be quantitative
Homocysteine	0.54–2.30 mg/L (4–17 mcmol/L)	Cardiovascular disease risk Folic acid deficiency Vitamin B <sub>12</sub> deficiency
Infectious mononucleosis tests (monospot, monotest, heterophile antigen test, EBV, antiviral capsid antigen IgM and IgG)	Negative	Positive monospot and monotest are presumptive, positive EBV IgM and IgG indicate acute and recent or past infection, respectively
Lyme disease titer	Negative, <1:256 by indirect fluorescent antibody method; nonreactive by ELISA	Positive results help diagnose Lyme disease. False positive may occur with high rheumatoid factor titers or syphilis Positive ELISA confirmed by Western blot test
Pyroglobulin test	Negative	These abnormal proteins may be associated with myeloma, lymphoma, polycythemia vera, and SLE
Rheumatoid factor	Negative	Elevated in rheumatoid arthritis, lupus endocarditis, tuberculosis, syphilis, sarcoidosis, and cancer
T- and B-cell lymphocyte surface markers	T- and B-cell lymphocyte surface markers:	Used to evaluate immune system by identifying the specific cells involved in the immune response. Valuable in diagnosis of

T-helper/T-suppressor ratio	Percent T cells (CD2) 60–88% Percent helper cells (CD4) 34–67% Percent suppressor cells (CD8) 10–42% Percent B cells (CD19) 3–21%  Absolute counts: Lymphocytes 0.66–4.60 thou/mL T cells 644–2201 cells/mL Helper cells 493–1191 cells/mL Suppressor T cells 182–785 cells/mL B cells 92–392 cells/mL  Lymphocyte ratio: $T_H/T_S$ ratio >1	lymphocytic leukemia, lymphoma, and immunodeficiency diseases including AIDS; and in the assessment of patient response to chemotherapy and radiation
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**TABLE A-4** Reference Ranges—Urine Chemistry

Test	Normal Adult Reference Range		Clinical Significance	
	Conventional Units	SI Units	Increased	Decreased
Acetone (Ketones)	<2.0 mg/dl	<0.05 mmol/L	Diabetic ketoacidosis, starvation	
Aldosterone	With normal salt diet: Normal: 3–19 mcg/24 h Reno vascular: 10–40 mcg/24 h Tumor: 20–100 mcg/24 h	11.1–55.5 nmol/24 h 8–51 nmol/24 h 55.4–277 nmol/24 h	Primary aldosteronism (adrenocortical tumor), secondary aldosteronism, salt depletion, potassium loading ACTH in large doses, heart failure, cirrhosis with ascites formation, nephrosis, pregnancy	
Alpha amino nitrogen	50–200 mg/24 h	3.6–14.3 nmol/24 h	Leukemia, phenylketonuria, other metabolic diseases	
Amylase	1–17 units excreted per h	0.017–0.29 U/h	Acute pancreatitis	
Arylsulfatase A	1 h test 2–19 U/mL 24-h test 170–2000/24 h	2–19 units/h 2.89–34 mckat/L		
Calcium	100–250 mg/24 h	2.5–6.2 mmol/24 h	Hyperparathyroidism, Vitamin D intoxication, Fanconi syndrome	Hypoparathyroidism
Catecholamines	Total: 0–275 mcg/24 h Epinephrine: 0–20% Norepinephrine: 60–90%	0–275 mcg/24 h Fraction total: 0–20 mcg/24 h Fraction total: 0.60–0.90	Pheochromocytoma Neuroblastoma	Vitamin D deficiency

Test	Normal Adult Reference Range		Clinical Significance	
	Conventional Units	SI Units	Increased	Decreased
Chorionic gonadotrophin, qualitative (pregnancy test)	Negative		Pregnancy, chorionepithelioma, hydatidiform mole	
Copper	15–60 mcg/24 h	0.22–0.9 μmol/24 h	Wilson disease, cirrhosis, nephrosis	
Coproporphyrin	50–300 mcg/24 h	0.075–0.45 μmol/24 h	Poliomyelitis, lead poisoning, porphyria	
Cortisol, free	<50 mcg/24 h	<138 nmol/24 h	Cushing syndrome	
Creatinine	Males: 14–16 mg/kg body weight/24 h Females: 11–20 mg/kg body weight/24 h	124–230 mmol/kg body weight/24 h 97–177 mmol/kg body weight/24 h	Muscular dystrophy  Fever, carcinoma of liver, pregnancy, hyperthyroidism, myositis	
Creatine	0–270 mg/24 h	0–2.05 mmol/24 h	Typhoid fever, salmonella infections, tetanus	Muscular atrophy, anemia, advanced degeneration of kidneys, leukemia
Cystine and cysteine	10–100 mg/24 h	0.08–0.83 mmol/24 h	Cystinuria	
Delta aminolevulinic acid	1.5–7.5 mg/dL	11–57/μmol/day	Lead poisoning, porphyria hepatica, hepatitis hepatic carcinoma	
11-Desoxycortisol	20–100 mcg/24 h	0.6–2.9 unit/24 h	Hypertensive form of virilizing adrenal hyperplasia due to an 11-beta hydroxylase defect	
Estriol (placental)	Weeks of pregnancy 12 16 20 24 28 32 36 40	μmcm/24 h <1 2–7 4–9 6–13 8–22 12–43 14–45 19–46	mmol/24 h <3.5 7–24.5 14–32 21–45.5 28–77 42–150 49–158 66.5–160	Decreased values occur with fetal distress of many conditions, including preeclampsia, placental insufficiency, and poorly controlled diabetes
Estrogens, total (fluorometric)	Females: Onset of menstruation: 4–25 mcg/24 h Ovulation peak: 28–100 mcg/24 h Luteal peak: 22–105 mcg/24 h Menopausal: 1.4–19.6 mcg/24 h Males: 5–18 mcg/24 h	4–25 mcg/24 h 28–100 mcg/24 h 22–105 mcg/24 h 1.4–19.6 mcg/24 h 5–18 mcg/24 h	Hyperestrogenism due to gonadal or adrenal neoplasm	Primary or secondary amenorrhea
Etioclanolone	Males: 1.9–6 mg/24 h Females: 0.5–4 mg/24 h	6.5–20.6 μmol/24 h 1.7–13.8 μmol/24 h	Adrenogenital syndrome Idiopathic hirsutism	
Follicle-stimulating hormone—RIA	Females: Follicular: 5–20 IU/24 h Luteal: 5–15 IU/24 h Midcycle: 15–60 IU/24 h Menopausal: 50–100 IU/24 h Males: 5–25 IU/24 h	5–20 IU/d 5–15 IU/d 15–60 IU/d 50–100 IU/d 5–25 IU/d	Menopause and primary ovarian failure	Pituitary failure
Glucose	Negative		Diabetes, pituitary disorders, increased ICP, lesion in floor of 4th ventricle	

Test	Normal Adult Reference Range		Clinical Significance	
	Conventional Units	SI Units	Increased	Decreased
Hemoglobin and myoglobin	Negative		Extensive burns, transfusion of incompatible blood, myoglobin increased in severe crushing injuries to muscles	
Homovanillic acid		5.5–27.5 mcmol/d	Neuroblastoma	Addison disease
17-hydroxycorticosteroids	8 mg/24 h 2–10 mg/24 h	5.5–27.5 mcmol/d	Cushing syndrome	Anterior pituitary hypofunction
5-hydroxyindoleacetic acid, qualitative	Negative		Malignant carcinoid tumors	
17-ketosteroids, total	Males: 4–14 mg/24 h Females: 2–12 mg/24 h	35–76 mcmol/24 h 21–55 mcmol/24 h	Interstitial cell tumor of testes, simple hirsutism, occasionally adrenal hyperplasia, Cushing syndrome, adrenal cancer, virilism, adrenoblastoma	Thyrotoxicosis, female hypogonadism, diabetes, hypertension, debilitating disease of mild to moderate severity, eunuchoidism, Addison disease, panhypopituitarism, myxedema, nephrosis
Lead	<125 mcg/24 h	<60 mcmol/24 h	Lead poisoning	
Luteinizing hormone	Males: 5–18 IU/24 h Females: Follicular phase: 2–25 IU/24 h Ovulatory peak: 30–95 IU/24 h Luteal phase: 2–20 IU/24 h Postmenopausal: 40–110 IU/24 h	2–25 IU/d 30–95 IU/d 2–20 IU/d 40–110 IU/d	Pituitary tumor, ovarian failure	Failure of pituitary or hypothalamus, anorexia nervosa
Metanephhrines, total	<1.4 mg/24 h	<7 mcmol/24 h	Pheochromocytoma; a few patients with pheochromocytoma may have elevated urinary metanephhrines but normal catecholamines and vanillylmandelic acid (VMA)	
Osmolality	50–1200 mOsm/kg	50–1200 mmol/kg	Useful in the study of electrolyte and water balance	
Oxalate	Up to 45 mg/24 h	Up to 500/mcmol/24 h	Primary hyperoxaluria	
Phenylpyruvic acid qualitative	Negative		Phenylketonuria	
Phosphorus, inorganic	0.9–1.3 g/24 h	29–42 mmol/24 h	Hypoparathyroidism, vitamin D intoxication, Paget disease, metastatic neoplasm to bone	Hypoparathyroidism, vitamin D deficiency
Porphobilinogen, qualitative	Negative		Chronic lead poisoning, acute porphyria, liver disease	
Porphobilinogen quantitative	0–1 mg/24 h	0–4.4 mcmol/24 h	Acute porphyria, liver disease	

Test	Normal Adult Reference Range		Clinical Significance	
	Conventional Units	SI Units	Increased	Decreased
Porphyrins, qualitative	Negative		See porphyrins, quantitative	
Porphyrins, quantitative (coproporphyrin and uroporphyrin)	Coproporphyrin: 50–160 mcg/24 h Uroporphyrin: up to 50 mcg/24 h	0.075–0.24 mcmol/24 h Up to 0.06 mcmol/24 h	Porphyria, lead poisoning (only coproporphyrin increased)	
Potassium	26–123 mEq/24 h	26–123 mmol/24 h	Hemolysis, chronic renal disease, acidosis, Cushing syndrome, corpus luteum cysts	Diarrhea, adrenocortical insufficiency
Pregnandiol	Females: Proliferative phase: 0.5–1.5 mg/24 h Luteal phase: 2–7 mg/24 h Menopause: 0.2–1 mg/24 h	1.6–4.8 mcmol/24 h 6–22 mcmol/24 h 0.6–3.1 mcmol/24 h	When placental tissue remains in the uterus following parturition, some cases of adrenocortical tumors	Placental dysfunction, threatened abortion, intrauterine death
Pregnancy: Weeks of gestation	mg/24 h	mcmol/24 h		
10–12	5–15	15.6–47		
12–18	5–25	15.6–78.0		
18–24	15–33	47.0–103.0		
24–28	20–42	62.4–131.0		
28–32	27–47	84.2–146.6		
Pregnanetriol	Females: 0.1–2.2 mg/24 h Males: 0.4–2.5 mg/24 h	0.3–6.5 mcmol/24 h 1.2–7.5 mcmol/24 h	Congenital adrenal androgenic hyperplasia	
Protein	<150 mg/24 h	<150 mg/24 h	Nephritis, heart failure, mercury poisoning, Bence Jones protein in multiple myeloma, febrile states, hematuria	
Sodium	75–200 mEq/24 h	75–200 mmol/24 h	Useful in detecting gross changes in water and salt balance	
Titratable acidity	20–40 mEq/24 h	20–40 mmol/24 h	Metabolic acidosis	Metabolic alkalosis
Urea nitrogen	9–16 g/24 h	0.32–0.57 mol/L	Excessive protein catabolism	Impaired kidney function
Uric acid	250–750 mg/24 h	1.48–4.43 mmol/24 h	Gout	Nephritis
Urobilinogen	Random urine: <0.25 mg/dL 24-h urine: up to 4 mg/24 h	<0.42 mol/24 h Up to 6.76 mcmol/24 h	Liver and biliary tract disease, hemolytic anemias	Complete or nearly complete biliary obstruction, diarrhea
VMA	0.7–6.8 mg/24 h	3.5–34.3 mcmol/24 h	Pheochromocytoma, neuroblastoma, ingestion of coffee, tea, aspirin, bananas, and several different drugs	Renal insufficiency
Xylose absorption test (5-h)	16–33% of ingested xylose	Fraction absorbed: 0.16–0.33		
Zinc	0.15–1.2 mg/24 h	2.3–18.4 mcmol/24 h		Malabsorption syndromes

**TABLE A-5** Selected Reference Ranges—Cerebrospinal Fluid

Test	Normal Adult Reference Range		Clinical Significance	
	Conventional Units	SI Units	Increased	Decreased
RBCs	None	None	Any RBCs are due to traumatic tap or subarachnoid hemorrhage	
WBCs	0–5 cells/mm <sup>3</sup>	0–5 × 10 <sup>6</sup> /L	Tumor, meningitis, subarachnoid hemorrhage, infarct, and abscesses	
Chloride	120–130 mEq/L	120–130 mmol/L	Not neurologically significant	Acute generalized meningitis and tuberculous meningitis
Glucose	50–75 mg/100 mL	3.00–4.00 mmol/L	Not neurologically significant	Associated with bacteria in CSF
Protein	14–45 mg/100 mL	150–450 mg/L	Tubercular meningitis, neurosyphilis, poliomyelitis, Guillain–Barré syndrome, subdural hematoma, tumors, and multiple sclerosis	Can occur in hyperthyroidism and benign intracranial hypertension after removal of large amounts of CSF

CSF, cerebrospinal fluid; RBCs, red blood cells; WBCs, white blood cells.

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