

## Laboratory Reference Intervals

The tables in this appendix list some of the most common tests, their reference intervals (formally referred to as normal values), and possible etiologies of abnormal results. Laboratory results may vary depending on different techniques or different laboratories. Possible etiologies are presented in alphabetic order. Abbreviations appearing in the tables are defined as follows:

mEq = milliequivalent  
 mm Hg = millimeter of mercury  
 mm = millimeter  
 mOsm = milliosmole

L = liter  
 dL = deciliter ( $10^{-1}$  liter)  
 mL = milliliter ( $10^{-3}$  liter)  
 $\mu$ L = microliter ( $10^{-6}$  liter,  $10^{-3}$  milliliter)  
 fL = femtoliter ( $10^{-15}$  liter,  $10^{-12}$  milliliter)

g = gram  
 mg = milligram ( $10^{-3}$  gram)  
 mcg = microgram ( $10^{-6}$  gram)  
 ng = nanogram ( $10^{-9}$  gram)  
 pg = picogram ( $10^{-12}$  gram)

U = unit  
 $\mu$ U = microunit  
 IU = international unit

mmol = millimole ( $10^{-3}$  mole)  
 $\mu$ mol = micromole ( $10^{-6}$  mole)  
 nmol = nanomole ( $10^{-9}$  mole)  
 pmol = picomole ( $10^{-12}$  mole)  
 kPa = kilopascal  
 $\mu$ kat = microkatal

Source: Wu HB: *Tietz clinical guide to laboratory tests*, ed 4, Philadelphia, 2006, Saunders.

TABLE C-1 SERUM, PLASMA, AND WHOLE BLOOD CHEMISTRIES

TEST	REFERENCE INTERVALS		POSSIBLE ETIOLOGY	
	CONVENTIONAL UNITS	SI UNITS	HIGHER	LOWER
Acetone				
Quantitative	<2.0 mg/dL	<344 $\mu$ mol/L	Diabetic ketoacidosis, high-fat diet, low-carbohydrate diet, starvation	
Qualitative	Negative	Negative		
Albumin	3.5-5.0 g/dL	35-50 g/L	Dehydration	Chronic liver disease, malabsorption, malnutrition, nephrotic syndrome
Aldolase	1.5-8.1 U/L	1.5-8.1 U/L	Skeletal muscle disease	Renal disease
$\alpha_1$ -Antitrypsin	78-200 mg/dL	0.78-2.0 g/L	Acute and chronic inflammation, arthritis	Chronic lung disease (early onset), malnutrition, nephrotic syndrome
$\alpha_1$ -Fetoprotein	<10 ng/mL	<10 mcg/L	Cancer of testes, ovaries, and liver	
Ammonia	15-45 mcg N/dL	11-32 $\mu$ mol N/L	Severe liver disease	
Amylase	30-122 U/L (method dependent)	0.51-2.07 $\mu$ kat/L	Acute and chronic pancreatitis, mumps (salivary gland disease), perforated ulcers	Acute alcoholism, cirrhosis of liver, extensive destruction of pancreas
Bicarbonate	22-26 mEq/L	22-26 mmol/L	Compensated respiratory acidosis, metabolic alkalosis	Compensated respiratory alkalosis, metabolic acidosis
b-Type natriuretic peptide (BNP)	<100 mcg/L	<100 pmol/L	Heart failure	
Bilirubin				
Total	0.2-1.2 mg/dL	3-21 $\mu$ mol/L	Biliary obstruction, impaired liver function, hemolytic anemia, pernicious anemia	
Indirect	0.1-1.0 mg/dL	1.7-17.0 $\mu$ mol/L		
Direct	0.1-0.3 mg/dL	1.7-5.1 $\mu$ mol/L		

TABLE C-1 SERUM, PLASMA, AND WHOLE BLOOD CHEMISTRIES—cont'd

TEST	REFERENCE INTERVALS		POSSIBLE ETIOLOGY	
	CONVENTIONAL UNITS	SI UNITS	HIGHER	LOWER
Blood gases*				
Arterial pH	7.35-7.45	7.35-7.45	Alkalosis	Acidosis
Venous pH	7.32-7.43	7.32-7.43		
PaCO <sub>2</sub>	32-48 mm Hg	4.26-6.38 kPa	Compensated metabolic alkalosis	Compensated metabolic acidosis
PvCO <sub>2</sub>	38-55 mm Hg	5.06-7.32 kPa	Respiratory acidosis	Respiratory alkalosis
PaO <sub>2</sub>	80-100 mm Hg	10.6-13.33 kPa	Administration of high concentration of oxygen	Chronic lung disease, decreased cardiac output
PvO <sub>2</sub>	38-42 mm Hg	5.04-5.57 kPa		
Calcium (total)	8.6-10.2 mg/dL	2.15-2.55 mmol/L	Acute osteoporosis, hyperparathyroidism, vitamin D intoxication, multiple myeloma	Acute pancreatitis, hypoparathyroidism, liver disease, malabsorption syndrome, renal failure, vitamin D deficiency
Calcium (ionized)	4.64-5.28 mg/dL	1.16-1.32 mmol/L		
Carbon dioxide (CO <sub>2</sub> )	23-29 mEq/L	23-29 mmol/L	Same as bicarbonate	
Carotene	10-85 mcg/dL	0.19-1.58 μmol/L	Cystic fibrosis, hypothyroidism, pancreatic insufficiency	Dietary deficiency, malabsorption disorders
Chloride	96-106 mEq/L	96-106 mmol/L	Metabolic acidosis, respiratory alkalosis, corticosteroid therapy, uremia	Addison's disease, diarrhea, metabolic alkalosis, respiratory acidosis, vomiting
Cholesterol	<200 mg/dL	<5.2 mmol/L	Biliary obstruction, hypothyroidism, idiopathic hypercholesterolemia, renal disease, uncontrolled diabetes	Extensive liver disease, hyperthyroidism, malnutrition, corticosteroid therapy
High-density lipoproteins (HDLs)	Male: >40 mg/dL Female: >50 mg/dL	>1.04 mmol/L >1.3 mmol/L		
Low-density lipoproteins (LDLs)	<i>Recommended:</i> <100 mg/dL  <i>Near optimal:</i> 100-129 mg/dL (2.6-3.34 mmol/L) <i>Moderate risk for CAD:</i> 130-159 mg/dL (3.37-4.12 mmol/L) <i>High risk for CAD:</i> >160 mg/dL (>4.14 mmol/L)	<i>Recommended:</i> <2.6 mmol/L  <i>Near optimal:</i> 2.6-3.34 mmol/L <i>Moderate risk for CAD:</i> 3.37-4.12 mmol/L <i>High risk for CAD:</i> >4.14 mmol/L		
Copper	80-155 mcg/dL	12.6-24.3 μmol/L	Cirrhosis	Wilson's disease
Cortisol	8 AM: 5-23 mcg/dL 8 PM: <10 mcg/dL	0.14-0.63 μmol/L <0.28 μmol/L	Cushing syndrome, pancreatitis	Adrenal insufficiency, panhypopituitary states
Creatine	0.2-1.0 mg/dL	15.3-76.3 μmol/L	Active rheumatoid arthritis, biliary obstruction, hyperthyroidism, renal disorders, severe muscle disease	Diabetes mellitus
Creatine kinase (CK)	Male: 20-200 U/L Female: 20-180 U/L	Male: 20-200 U/L Female: 20-180 U/L	Musculoskeletal injury or disease, myocardial infarction, severe myocarditis, exercise, numerous IM injections	
CK-MB	<4%-6% of total CK	<0.4-0.6	Acute myocardial infarction	
Creatinine	0.6-1.3 mg/dL	53-115 μmol/L	Severe renal disease	
Ferritin	10-250 ng/mL	10-250 mcg/L	Sideroblastic anemia, anemia of chronic disease (infection, inflammation, liver disease)	Iron-deficiency anemia
Folate (folic acid)	5-16 ng/mL	11-36 nmol/L	Hypothyroidism	Alcoholism, hemolytic anemia, inadequate diet, malabsorption syndrome, megaloblastic anemia
Gamma-glutamyl transferase (GGT)	0-30 U/L	0-0.5 μkat/L	Liver disease, infectious mononucleosis, pancreatitis, hyperthyroidism	Hypothyroidism
Glucose (fasting)	70-99 mg/dL	3.9-5.5 mmol/L	Acute stress, Cushing disease, diabetes mellitus, hyperthyroidism, pancreatic insufficiency	Addison's disease, hepatic disease, hypothyroidism, insulin overdosage, pancreatic tumor, pituitary hypofunction

PaCO<sub>2</sub>, Partial pressure of CO<sub>2</sub> in arterial blood; PvCO<sub>2</sub>, partial pressure of CO<sub>2</sub> in venous blood; PaO<sub>2</sub>, partial pressure of oxygen in arterial blood; PvO<sub>2</sub>, partial pressure of oxygen in venous blood.

\*Because arterial blood gases are influenced by altitude, the value for PaO<sub>2</sub> decreases as altitude increases. The lower value is normal for an altitude of 1 mile.

TABLE C-1 SERUM, PLASMA, AND WHOLE BLOOD CHEMISTRIES—cont'd

TEST	REFERENCE INTERVALS		POSSIBLE ETIOLOGY	
	CONVENTIONAL UNITS	SI UNITS	HIGHER	LOWER
Haptoglobin	26-185 mg/dL	260-1850 mg/L	Infectious and inflammatory processes, malignant neoplasms	Hemolytic anemia, mononucleosis, toxoplasmosis, chronic liver disease
Insulin (fasting)	4-24 µU/mL	29-172 pmol/L	Acromegaly, adenoma of pancreatic islet cells, untreated mild case of type 2 diabetes	Inadequately treated type 1 diabetes mellitus
Iron, total	50-175 mcg/dL	9.0-31.3 µmol/L	Excessive RBC destruction	Iron-deficiency anemia, anemia of chronic disease
Iron-binding capacity	250-425 mcg/dL	44.8-76.1 µmol/L	Iron-deficient state, polycythemia	Cancer, chronic infections, pernicious anemia
Lactic acid (L-Lactate)	6.3-22.5 mcg/dL	0.7-2.5 mmol/L	Acidosis, heart failure, shock	
Lactic dehydrogenase (LDH)	140-280 U/L	0.83-2.5 µkat/L	Heart failure, hemolytic disorders, hepatitis, metastatic cancer of liver, myocardial infarction, pernicious anemia, pulmonary embolus, skeletal muscle damage	
Lactic dehydrogenase isoenzymes				
LDH <sub>1</sub>	18%-33%	0.18-0.33	Myocardial infarction, pernicious anemia	
LDH <sub>2</sub>	28%-40%	0.28-0.40	Pulmonary embolus, sickle cell crisis	
LDH <sub>3</sub>	18%-30%	0.18-0.30	Malignant lymphoma, pulmonary embolus	
LDH <sub>4</sub>	6%-16%	0.06-0.16	Systemic lupus erythematosus, pulmonary infarction	
LDH <sub>5</sub>	2%-13%	0.02-0.13	Heart failure, hepatitis, pulmonary embolus and infarction, skeletal muscle damage	
Lipase	31-186 U/L	0.5-3.2 µkat/L	Acute pancreatitis, hepatic disorders, perforated peptic ulcer	
Magnesium	1.5-2.5 mEq/L	0.75-1.25 mmol/L	Addison's disease, hypothyroidism, renal failure	Chronic alcoholism, severe malabsorption
Osmolality	275-295 mOsm/kg	275-295 mmol/kg	Chronic renal disease, diabetes mellitus	Addison's disease, diuretic therapy
Oxygen saturation (arterial) (SaO <sub>2</sub> )	>95%	>0.95	Polycythemia	Anemia, cardiac decompensation, respiratory disorders
pH	See blood gases			
Phenylalanine	0.8-1.8 mg/dL	48-109 µmol/L	Phenylketonuria	
Phosphatase, acid	0-0.6 U/L	0-90 µkat/L	Advanced Paget's disease, cancer of prostate, hyperparathyroidism	
Phosphatase, alkaline	38-126 U/L	0.65-2.14 µkat/L	Bone diseases, marked hyperparathyroidism, obstruction of biliary system, rickets	Excessive vitamin D ingestion, hypothyroidism
Phosphorus (phosphate)	2.4-4.4 mg/dL	0.78-1.42 mmol/L	Healing fractures, hypoparathyroidism, renal disease, vitamin D intoxication	Diabetes mellitus, hyperparathyroidism, vitamin D deficiency
Potassium	3.5-5.0 mEq/L	3.5-5.0 mmol/L	Addison's disease, diabetic ketosis, massive tissue destruction, renal failure	Cushing syndrome, diarrhea (severe), diuretic therapy, gastrointestinal fistula, pyloric obstruction, starvation, vomiting

RBC, Red blood cell; SaO<sub>2</sub>, arterial oxygen saturation.

Continued

TABLE C-1 SERUM, PLASMA, AND WHOLE BLOOD CHEMISTRIES—cont'd

TEST	REFERENCE INTERVALS		POSSIBLE ETIOLOGY	
	CONVENTIONAL UNITS	SI UNITS	HIGHER	LOWER
Progesterone (Female)				
Follicular phase	15-70 ng/dL	0.5-2.2 nmol/L	Adrenal hyperplasia, choriocarcinoma of ovary, pregnancy, cysts of ovary	Threatened abortion, hypogonadism, amenorrhea, ovarian tumor
Luteal phase	200-2500 ng/dL	6.4-79.5 nmol/L		
Postmenopause	<40 ng/dL	1.28 nmol/L		
Prostate-specific antigen (PSA)	<4 ng/mL	<4 mcg/L	Prostate cancer	
Proteins				
Total	6.4-8.3 g/dL	64-83 g/L	Burns, cirrhosis (globulin fraction), dehydration	Liver disease, malabsorption
Albumin	3.5-5.0 g/dL	35-50 g/L		
Globulin	2.0-3.5 g/dL	20-35 g/L		
Albumin/globulin ratio	1.5:1-2.5:1	1.5:1-2.5:1	Multiple myeloma (globulin fraction), shock, vomiting	Malnutrition, nephrotic syndrome, proteinuria, renal disease, severe burns
Sodium	135-145 mEq/L	135-145 mmol/L	Dehydration, impaired renal function, primary aldosteronism, corticosteroid therapy	Addison's disease, diabetic ketoacidosis, diuretic therapy, excessive loss from GI tract, excessive perspiration, water intoxication
Testosterone	Male: 280-1100 ng/dL Female: 15-70 ng/dL	Male: 10.4-38.17 nmol/L Female: 0.52-2.43 nmol/L	Polycystic ovary, virilizing tumors	Hypofunction of testes, hypogonadism
T <sub>4</sub> (thyroxine), total	4.6-11.0 mcg/dL	59-142 nmol/L	Hyperthyroidism, thyroiditis	Cretinism, hypothyroidism, myxedema
T <sub>4</sub> (thyroxine), free	0.8-2.7 ng/dL	10-35 pmol/L		
T <sub>3</sub> uptake	24%-34%	0.24-0.34	Hyperthyroidism	Hypothyroidism
T <sub>3</sub> (triiodothyronine), total	Ages 20-50: 70-204 ng/dL Ages >50: 40-181 ng/dL	1.08-3.14 nmol/L 0.62-2.79 nmol/L	Hyperthyroidism	Hypothyroidism
Thyroid-stimulating hormone (TSH)	0.4-4.2 µU/mL	0.4-4.2 mU/L	Myxedema, primary hypothyroidism, Graves' disease	Secondary hypothyroidism
Transaminases				
Aspartate aminotransferase (AST)	10-30 U/L	0.17-0.51 µkat/L	Liver disease, myocardial infarction, pulmonary infarction, acute hepatitis	
Alanine aminotransferase (ALT)	10-40 U/L	0.17-0.68 µkat/L	Liver disease, shock	
Transferrin	190-380 mg/dL	1.9-3.8 g/L		
Transferrin saturation (%)	15%-50%	15%-50%		
Triglycerides	<150 mg/dL	<1.7 mmol/L	Diabetes mellitus, hyperlipidemia, hypothyroidism, liver disease	Malnutrition
Troponins (cardiac)			Myocardial infarction	
Troponin T (cTnT)	<0.5 ng/mL (<0.5 mcg/L)			
Troponin I (cTnI)	<0.1 ng/mL (<0.1 mcg/L)			
Urea nitrogen (BUN)	6-20 mg/dL	2.1-7.1 mmol/L	Increase in protein catabolism (fever, stress), renal disease, urinary tract infection	Malnutrition, severe liver damage
Uric acid	Male: 4.4-7.6 mg/dL Female: 2.3-6.6 mg/dL	Male: 262-452 µmol/L Female: 137-393 µmol/L	Gout, gross tissue destruction, high-protein weight reduction diet, leukemia, renal failure	Administration of uricosuric drugs
Vitamin A (retinol)	30-80 mcg/dL	1.05-2.80 µmol/L	Excess ingestion of vitamin A	Vitamin A deficiency
Vitamin B <sub>12</sub> (cobalamin)	200-835 pg/mL	148-616 pmol/L	Chronic myeloid leukemia	Strict vegetarianism, malabsorption syndrome, pernicious anemia, total or partial gastrectomy
Vitamin C (ascorbic acid)	0.4-2.0 mg/dL	23-114 µmol/L	Excessive ingestion of vitamin C	Connective tissue disorders, hepatic disease, renal disease, rheumatic fever, vitamin C deficiency
Zinc	70-120 mcg/dL	10.7-120 µmol/L		Alcoholic cirrhosis

TABLE C-2 HEMATOLOGY

TEST	REFERENCE INTERVALS		POSSIBLE ETIOLOGY	
	CONVENTIONAL UNITS	SI UNITS	HIGHER	LOWER
Bleeding time	2-7 min	120-420 sec	Defective platelet function, thrombocytopenia, von Willebrand's disease, aspirin ingestion, vascular disease	
Activated partial thromboplastin time (aPTT)	25-35 sec*	25-35 sec*	Deficiency factors I, II, V, VIII, IX and X, XI, XII; hemophilia, liver disease; heparin therapy	
Prothrombin time (Protime, PT)	11-16 sec*	11-16 sec*	Warfarin therapy; deficiency of factors I, II, V, VII, and X; vitamin K deficiency; liver disease	
Fibrinogen	200-400 mg/dL	2-4 g/L	Burns (after first 36 hr), inflammatory disease	Burns (during first 36 hr), DIC, severe liver disease
Fibrin split (degradation) products	<10 mcg/mL	<10 mg/L	Acute DIC, massive hemorrhage, primary fibrinolysis	
D-Dimer	<250 ng/mL	<250 mcg/L	DIC, myocardial infarction, deep vein thrombosis, unstable angina	
Erythrocyte count† (altitude dependent)	Male: 4.3-5.7 × 10 <sup>6</sup> /μL Female: 3.8-5.1 × 10 <sup>6</sup> /μL	Male: 4.3-5.7 × 10 <sup>12</sup> /L Female: 3.8-5.1 × 10 <sup>12</sup> /L	Dehydration, high altitudes, polycythemia vera	Anemia, leukemia, posthemorrhage
Mean corpuscular volume (MCV)	80-100 fL	80-100 fL	Macrocytic anemia	Microcytic anemia
Mean corpuscular hemoglobin (MCH)	27-34 pg	27-34 pg	Macrocytic anemia	Microcytic anemia
Mean corpuscular hemoglobin concentration (MCHC)	32%-37%	0.32-0.37	Spherocytosis	Hypochromic anemia
Erythrocyte sedimentation rate (ESR)	<30 mm/hr (some gender variation)	<30 mm/hr (some gender variation)	<i>Moderate increase:</i> acute hepatitis, myocardial infarction; rheumatoid arthritis <i>Marked increase:</i> acute and severe bacterial infections, malignancies, pelvic inflammatory disease	Malaria, severe liver disease, sickle cell anemia
Hematocrit† (altitude dependent)	Male: 39%-50% Female: 35%-47%	Male: 0.39-0.50 Female: 0.35-0.47	Dehydration, high altitudes, polycythemia	Anemia, hemorrhage, overhydration
Hemoglobin† (altitude dependent)	Male: 13.2-17.3 g/dL Female: 11.7-15.5 g/dL	Male: 132-173 g/L Female: 117-155 g/L	COPD, high altitudes, polycythemia	Anemia, hemorrhage
Hemoglobin, glycosylated	4.0%-6.0%	4.0%-6.0%	Poorly controlled diabetes mellitus	Sickle cell anemia, chronic renal failure, pregnancy
Platelet count (thrombocytes)	150-400 × 10 <sup>3</sup> /μL	150-400 × 10 <sup>9</sup> /L	Acute infections, chronic granulocytic leukemia, chronic pancreatitis, cirrhosis, collagen disorders, polycythemia, postsplenectomy	Acute leukemia, DIC, thrombocytopenic purpura
Reticulocyte count	0.5%-1.5% of RBC	0.5%-1.5% of RBC	Hemolytic anemia, polycythemia vera	Hypoproliferative anemia, macrocytic anemia, microcytic anemia
White blood cell count†	4.0-11.0 × 10 <sup>3</sup> /μL	4.0-11.0 × 10 <sup>9</sup> /L	Inflammatory and infectious processes, leukemia	Aplastic anemia, side effects of chemotherapy and irradiation
WBC differential				
Segmented neutrophils	50%-70%	0.50-0.70	Bacterial infections, collagen diseases, Hodgkin's lymphoma	Aplastic anemia, viral infections
Band neutrophils	0%-8%	0-0.08	Acute infections	
Lymphocytes	20%-40%	0.20-0.40	Chronic infections, lymphocytic leukemia, mononucleosis, viral infections	Corticosteroid therapy, whole body irradiation
Monocytes	4%-8%	0.04-0.08	Chronic inflammatory disorders, malaria, monocytic leukemia, acute infections, Hodgkin's lymphoma	
Eosinophils	0%-4%	0-0.04	Allergic reactions, eosinophilic and chronic granulocytic leukemia, parasitic disorders, Hodgkin's lymphoma	Corticosteroid therapy
Basophils	0%-2%	0-0.02	Hypothyroidism, ulcerative colitis, myeloproliferative diseases	Hyperthyroidism, stress

COPD, Chronic obstructive pulmonary disease; DIC, disseminated intravascular coagulation; RBC, red blood cell; WBC, white blood cell.

\*Values depend on reagent and instrumentation used.

†Components of complete blood count (CBC).

TABLE C-3 SEROLOGY-IMMUNOLOGY

TEST	REFERENCE INTERVALS		POSSIBLE ETIOLOGY	
	CONVENTIONAL UNITS	SI UNITS	HIGHER	LOWER
Antinuclear antibody (ANA)	Negative at 1:40 dilution	Negative at 1:40 dilution	Chronic hepatitis, rheumatoid arthritis, scleroderma, systemic lupus erythematosus	
Anti-DNA antibody	<70 IU/mL	<70 IU/mL	Systemic lupus erythematosus	
Anti-Sm (Smith)	Negative	Negative	Systemic lupus erythematosus	
C-reactive protein (CRP)	6.8-820 mcg/dL	68-8200 mcg/L	Acute infections, any inflammatory condition, widespread malignancy	
Carcinoembryonic antigen (CEA)	Nonsmoker: <3 ng/mL Smoker: <5 ng/mL	Nonsmoker: <3 mcg/L Smoker: <5 mcg/L	Carcinoma of colon, liver, pancreas; chronic cigarette smoking; inflammatory bowel disease; other cancers	
Complement, total hemolytic (CH <sub>50</sub> )	75-160 U/mL	75-160 kU/L		Acute glomerulonephritis, systemic lupus erythematosus, rheumatoid arthritis, subacute bacterial endocarditis
Direct Coombs or direct antihuman globulin test (DAT)	Negative	Negative	Acquired hemolytic anemia, drug reactions, transfusion reactions	
Fluorescent treponemal antibody absorption (FTA-Abs)	Negative or nonreactive	Negative or nonreactive	Syphilis	
Hepatitis A antibody	Negative	Negative	Hepatitis A	
Hepatitis B surface antigen (HBsAg)	Negative	Negative	Hepatitis B	
Hepatitis C antibody	Negative	Negative	Hepatitis C	
Monospot or monostest	Negative	Negative	Infectious mononucleosis	
Rheumatoid factor (RF)	Negative or titer <1:17	Negative or titer <1:17	Rheumatoid arthritis, Sjögren's syndrome, systemic lupus erythematosus	
RPR	Negative or nonreactive	Negative or nonreactive	Syphilis, systemic lupus erythematosus, rheumatoid arthritis, leprosy, malaria, febrile diseases, IV drug abuse	
VDRL	Negative or nonreactive	Negative or nonreactive	Syphilis	

RPR, Rapid plasma regain test; VDRL, Venereal Disease Research Laboratory test.

TABLE C-4 URINE CHEMISTRY

TEST	SPECIMEN	REFERENCE INTERVALS		POSSIBLE ETIOLOGY	
		UNITS	SI UNITS	HIGHER	LOWER
Acetone	Random	Negative	Negative	Diabetes mellitus, high-fat and low-carbohydrate diets, starvation	
Aldosterone	24 hr	3-30 mcg/day (low sodium diet increases threefold to fivefold)	0.08-0.83 nmol/day	<i>Primary aldosteronism:</i> adrenocortical tumors <i>Secondary aldosteronism:</i> cardiac failure, cirrhosis, large dose of ACTH, salt depletion	ACTH deficiency, Addison's disease, corticosteroid therapy
Amylase	24 hr	1-17 U/hr	1-17 U/hr	Acute pancreatitis	
Bence Jones protein	Random	Negative	Negative	Multiple myeloma	
Bilirubin	Random	Negative	Negative	Liver disorders	
Calcium	24 hr	100-250 mg/day	2.5-6.3 mmol/day	Bone tumor, hyperparathyroidism	Hypoparathyroidism, malabsorption of calcium and vitamin D
Catecholamines	24 hr			Pheochromocytoma, progressive muscular dystrophy, heart failure	
Epinephrine		<20 mcg/day	<109 nmol/day		
Norepinephrine		15-80 mcg/day	89-473 nmol/day		

TABLE C-4 URINE CHEMISTRY—cont'd

TEST	REFERENCE INTERVALS			POSSIBLE ETIOLOGY	
	SPECIMEN	UNITS	SI UNITS	HIGHER	LOWER
Creatine	24 hr	<100 mg/day	<763 μmol/day	Liver cancer, hyperthyroidism, diabetes, Addison's disease, infections, burns, muscular dystrophy, skeletal muscle atrophy	Hypothyroidism
Creatinine	24 hr	0.6-2.0 g/day	5.3-17.7 mmol/day	Anemia, leukemia, muscular atrophy	Renal disease
Creatinine clearance	24 hr	59-137 mL/min/1.73 m <sup>2</sup>	0.59-1.37 mL/sec/m <sup>2</sup>		Renal disease
Estrogens	24 hr				
Female				Gonadal or adrenal tumor	Endocrine disturbance, ovarian dysfunction, menopause
Premenopause		15-80 mcg/day	15-80 mcg/day		
Postmenopause		<20 mcg/day	<20 mcg/day		
Male		15-40 mcg/day	15-40 mcg/day		
Glucose	Random	Negative	Negative	Diabetes mellitus, pituitary disorders	
Hemoglobin	Random	Negative	Negative	Extensive burns, glomerulonephritis, hemolytic anemias, hemolytic transfusion reaction	
5-Hydroxyindoleacetic acid (5-HIAA)	24 hr	2-7 mg/day	10.5-36.6 μmol/day	Malignant carcinoid syndrome	
Ketone bodies	24 hr	20-50 mg/day	0.34-0.86 mmol/day	Diabetes mellitus, starvation, dehydration	
Metanephrine	24 hr	92-934 mcg/day	500-5100 nmol/day	Pheochromocytoma	
Myoglobin	Random	Negative	Negative	Crushing injuries, electric injuries, extreme physical exertion	
Osmolality	Random	300-1300 mOsm/kg	300-1300 mmol/kg	Dehydration, tubular dysfunction (kidney lost ability to dilute urine)	Tubular dysfunction (kidney lost ability to concentrate urine)
pH	Random	4.0-8.0	4.0-8.0	Urinary tract infection, urine allowed to stand at room temperature	Respiratory or metabolic acidosis
Protein (dipstick)	Random	0-trace	0-trace	Acute and chronic renal disease, especially involving glomeruli; heart failure	
Protein (quantitative)	24 hr	<150 mg/day	<0.15 g/day	Cardiac failure, inflammatory processes of urinary tract, nephritis, nephrosis, strenuous exercise	
Sodium	24 hr	40-220 mEq/day	40-220 mmol/day	Acute tubular necrosis	Hyponatremia
Specific gravity	Random	1.003-1.030	Same as conventional units	Albuminuria, dehydration, glycosuria	Diabetes insipidus
Uric acid	24 hr	250-750 mg/day	1.5-4.5 mmol/day	Gout, leukemia	Nephritis
Urobilinogen	24 hr	0.5-4.0 mg/day	0.8-6.8 μmol/day	Hemolytic disease, hepatic parenchymal cell damage, liver disease	Complete obstruction of bile duct
Vanillylmandelic acid	24 hr	1.4-6.5 mg/day	7-33 μmol/day	Pheochromocytoma	

ACTH, Adrenocorticotrophic hormone.

TABLE C-5 FECAL ANALYSIS

TEST	REFERENCE INTERVALS		POSSIBLE ETIOLOGY	
	CONVENTIONAL UNITS	SI UNITS	HIGHER	LOWER
Fecal fat	<6 g/24 hr	Same as conventional units	Chronic pancreatic disease, obstruction of common bile duct, malabsorption syndrome	
Mucus	Negative	Negative	Mucous colitis, spastic constipation	
Pus	Negative	Negative	Chronic bacillary dysentery, chronic ulcerative colitis, localized abscesses	
Blood*	Negative	Negative	Anal fissures, hemorrhoids, malignant tumor, peptic ulcer, inflammatory bowel disease	
Color				
Brown			Various color depending on diet	
Clay			Biliary obstruction or presence of barium sulfate	
Tarry			More than 100 mL of blood in gastrointestinal tract	
Red			Blood in large intestine	
Black			Blood in upper gastrointestinal tract or iron medication	

\*Ingestion of meat may produce false-positive results. Patient may be placed on a meat-free diet for 3 days before the test.

TABLE C-6 CEREBROSPINAL FLUID ANALYSIS

TEST	REFERENCE INTERVALS		POSSIBLE ETIOLOGY	
	CONVENTIONAL UNITS	SI UNITS	HIGHER	LOWER
Pressure	60-150 mm H <sub>2</sub> O	60-150 mm H <sub>2</sub> O	Hemorrhage, intracranial tumor, meningitis	Head injury, spinal tumor, subdural hematoma
Blood	Negative	Negative	Intracranial hemorrhage	
Cell count (age dependent)			Inflammation or infections of CNS	
WBC	0-5 cells/ $\mu$ L	0-5 $\times$ 10 <sup>6</sup> cells/L		
RBC	Negative	Negative		
Chloride	118-132 mEq/L	118-132 mmol/L	Uremia	Bacterial infections of CNS (meningitis, encephalitis)
Glucose	40-70 mg/dL	2.2-3.9 mmol/L	Diabetes mellitus, viral infections of CNS	Bacterial infections and tuberculosis of CNS
Protein				
Lumbar	15-45 mg/dL	0.15-0.45 g/L	Guillain-Barré syndrome, poliomyelitis, trauma	
Cisternal	15-25 mg/dL	0.15-0.25 g/L	Syphilis of CNS	
Ventricular	5-15 mg/dL	0.05-0.15 g/L	Acute meningitis, brain tumor, chronic CNS infections, multiple sclerosis	

CNS, Central nervous system.