

## APPENDIX B

# NORMAL VALUES FOR SELECTED BLOOD AND URINE TESTS

The system of international (SI) units (Système Internationale d'Unités) is used in most countries and in many medical and scientific journals.\* Clinical laboratories in the United States, however, usually report values for blood and urine tests in conventional (traditional) units, which are also used in most medical and biological textbooks. To encompass both systems, the laboratory values in this Appendix give conventional units and, in parentheses, their SI equivalents.

A major difference between SI and conventional units is in expressing concentration as number of molecules or particles per volume (millimoles/liter) rather than mass per volume (grams/100 milliliters) or chemical activity per volume (milliequivalents per liter). In certain cases, for example, proteins that have a variable molecular weight, it is not practical to change the values to SI units. Therefore, protein concentration may be expressed in grams per liter rather than moles per liter. Electrolyte (ion) values have traditionally been given in milliequivalents per liter. In SI they are expressed in millimoles/liter. For monovalent (singly charged) ions such as  $\text{Na}^+$ ,  $\text{K}^+$ , and  $\text{Cl}^-$ , the values will be numerically the same. For example, a  $\text{Na}^+$  concentration of 135 mEq/liter is equal to 135 mmol/liter. For divalent ions such as  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$ , milliequivalents are divided by the valence of 2 to obtain millimoles. Thus a  $\text{Ca}^{2+}$  concentration of 3.0 mEq/liter is equal to 1.5 mmol/liter.

In some laboratory and medical measurements, SI units offer little advantage. Their use might require replacement or revision of current instruments, for example the sphygmomanometer for measuring blood pressure or the pH meter for measuring hydrogen ion concentration. In these cases, traditional units are commonly retained.

It is important to note that values listed for various laboratory tests should be viewed as reference values rather than absolute "normal" values for all well people. A single reference range may be inadequate for some measurements. Values may vary due to age,

gender, body build, diet, and environment of the subject or the equipment, methods, and standards of the lab performing the measurement. Also, in most pathological processes, there is a gradual transition between normal and abnormal values. Thus the values given here are representative reference ranges. They are grouped into three categories: **blood chemistry tests** (mainly blood plasma and serum values), **hematology tests** (blood clotting parameters and counts of blood formed elements), and **urine tests**.

### KEY TO SYMBOLS

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

dl = deciliter =  $10^{-1}$  liter

g = gram

> = greater than

hr = hour

IU = international unit

kg = kilogram =  $10^3$  grams

< = less than

% = percent

$\mu\text{g}$  = microgram =  $10^{-6}$  gram

$\mu\text{mol/l}$  = micromole per liter

mEq/l = milliequivalent per liter

mg = milligram =  $10^{-3}$  gram

ml = milliliter =  $10^{-3}$  liter

mm = millimeter =  $10^{-3}$  meter

mm Hg = millimeter of mercury

mmol/l = millimole per liter

mOsm = milliosmole

ng = nanogram =  $10^{-9}$  gram

nmol/l = nanomole per liter

U = unit

\* Introductory paragraphs and SI units provided by Henry Ruschin, Humber College, Toronto, Canada. Reference ranges previously researched by John Lo Russo, Bergen Community College, New Jersey.

Test (Specimen)	Reference Values: Conventional U.S. Units (SI Units)	Clinical Implications
<b>Carcinoembryonic antigen (CEA)</b> (P)	<3ng/ml (<3 µg/liter)	Values increase in carcinoma of the colon, rectum, breast, ovary, liver, and pancreas; inflammatory bowel disease (IBD); cirrhosis; and chronic cigarette smoking.
<b>Carotene, beta</b> (S)	40–200 mg/dl (0.4–2.0 µg/liter)	Value varies with diet but increases in myxedema, diabetes mellitus, and excessive dietary intake; values decrease in fat malabsorption, liver disease, and poor dietary intake.
<b>Chloride ion (Cl<sup>-</sup>)</b> (S)	95–103 mEq/liter (95–103 mmol/liter)	Values increase in dehydration, Cushing's syndrome, and anemia; values decrease in severe vomiting, severe burns, diabetic acidosis, and fever.
<b>Cholesterol, total</b> (S)	<200 mg/dl (<5.2 mmol/liter) is desirable	Value varies with diet, gender, and age. Values increase in diabetes mellitus, cardiovascular disease, nephrosis, and hypothyroidism; values decrease in liver disease, hyperthyroidism, fat malabsorption, pernicious anemia, severe infections, and terminal stages of cancer.
<b>HDL cholesterol</b> (P)	>40 mg/dl (>1.0 mmol/liter) is desirable	
<b>LDL cholesterol</b> (P)	<130 mg/dl (<3.2 mmol/liter) is desirable	
<b>Cortisol (hydrocortisone)</b> (P)	8 A.M.–10 A.M.: 5–23 µg/dl (270–700 nmol/liter) 4 P.M.–6 P.M.: 3–13 µg/dl (135–350 nmol/liter)	Values increase in hyperthyroidism, stress, obesity, and Cushing's syndrome; values decrease in hypothyroidism, liver disease, and Addison's disease.
<b>Creatine</b> (S or P)	Male: 0.1–0.4 mg/dl (1–4 g/liter) Female: 0.2–0.7 mg/dl (2–7 g/liter)	Values increase in muscular dystrophy, damage to muscle tissue, nephritis, and pregnancy.
<b>Creatine kinase (CK); formerly creatine phosphokinase (CPK)</b> (S)	Male: 55–170 U/liter (same) Female: 30–135 U/liter (same)	Values increase in myocardial infarction, progressive muscular dystrophy, myxedema, convulsions, hypothyroidism, and pulmonary edema.
<b>Creatinine</b> (S)	0.5–1.2 mg/dl (45–105 µmol/liter)	Values increase in impaired renal function, gigantism, and acromegaly; values decrease in muscular dystrophy.
<b>Fetal hemoglobin (WB)</b>	Newborns: 60–90% Before age 2: 0–4% Adults: 0–2%	Values increase in thalassemia, sickle-cell anemia, and leakage of fetal blood into maternal bloodstream.
<b>Gamma-glutamyl transferase (GGT)</b> (S)	5–40 IU/liter (5–40 U/liter)	Values increase in obstruction of bile duct, cirrhosis of the liver, metastatic cancer of the liver, cholelithiasis, congestive heart failure (CHF), and alcoholism.
<b>Glucose</b> (S)	70–110 mg/dl (3.9–6.1 mmol/liter)	Values increase in diabetes mellitus, acute stress, hyperthyroidism, chronic liver disease, and nephritis; values decrease in Addison's disease, hypothyroidism, and cancer of the pancreas.
<b>Immunoglobulins</b> (S)		
<b>IgG</b>	800–1,801 mg/dl (8.0–18.0 g/liter)	IgG values increase in infections of all types, liver disease, and severe malnutrition.
<b>IgA</b>	113–563 mg/dl (1.1–5.6 g/liter)	IgA values increase in cirrhosis of the liver, chronic infections, and autoimmune disorders and decrease in immunologic deficiency states.
<b>IgM</b>	54–222 mg/dl (0.5–2.2 g/liter)	IgM values increase in trypanosomiasis and decrease in lymphoid aplasia.
<b>IgD</b>	0.5–3.0 mg/dl (5–30 mg/liter)	IgD values increase in chronic infections and myelomas.
<b>IgE</b>	0.01–0.04 mg/dl (0.1–0.4 mg/liter)	IgE values increase in hay fever, asthma, and anaphylactic shock.

*Exhibit continues*

Test (Specimen)	Reference Values: Conventional U.S. Units (SI Units)	Clinical Implications
Thyroid hormones (S)		Values increase in hyperthyroidism; values decrease in hypothyroidism.
T <sub>3</sub> (triiodothyronine)	80–200 ng/dl by radioimmunoassay (RIA) (1.2–3.1 nmol/liter)	
T <sub>4</sub> (thyroxine)	4–11 mg/dl by RIA (52–141 nmol/liter)	
Thyroxine-binding globulin (TBG) (S)	10–26 µg/dl (130–335 nmol/liter)	Values increase in hypothyroidism; values decrease in hyperthyroidism.
Uric acid (urate) (S)	Male: 4.0–8.5 mg/dl (240–510 µmol/liter) Female: 2.7–7.3 mg/dl (160–430 µmol/liter)	Values increase in impaired renal function, gout, metastatic cancer, shock, and starvation; values decrease in persons treated with uricosuric drugs.

EXHIBIT B.2 HEMATOLOGY TESTS

(WB) = WHOLE BLOOD (S) = SERUM (P) = PLASMA

Test (Specimen)	Reference Values: Conventional U.S. Units (SI Units)	Clinical Implications
Bleeding time (WB)	4–8 minutes using Simplate (same)	Values increase in thrombocytopenia, severe liver disease, leukemia, and aplastic anemia.
Erythrocyte sedimentation rate (ESR) (WB)	(Westergren) Female, under 50 years: <20 mm/hr (same) Female, over 50 years: 30 mm/hr (same) Male, under 50 years: <15 mm/hr (same) Male, over 50 years: <20 mm/hr (same)	Values increase in pregnancy, infection, carcinoma, tissue destruction, and nephritis; values decrease in sickle-cell anemia and congestive heart failure (CHF).
Hemoglobin (S or P)	Male: 13.5–18 g/100 ml (135–180 g/liter) Female: 12–16 g/100 ml (120–160 g/liter) Newborn: 14–20 g/100 ml (140–200 g/liter)	Values increase in polycythemia, congestive heart failure (CHF), chronic obstructive pulmonary disease, and at high altitudes; values decrease in anemia, hyperthyroidism, cirrhosis of the liver, and severe hemorrhage.
Hematocrit (WB)	Male: 40–54%; average 47% (same) Female: 38–47%; average 42% (same)	Values increase in polycythemia, severe dehydration, and shock; values decrease in anemia, leukemia, cirrhosis, and hyperthyroidism.
Platelet count (WB)	150,000–400,000/mm <sup>3</sup> (150–400 × 10 <sup>9</sup> /liter)	Values increase in cancer, trauma, heart disease, and cirrhosis; values decrease in anemias, allergic conditions, and during cancer chemotherapy.
Prothrombin time (PT) (WB)	11–15 seconds (same)	Values increase in prothrombin and vitamin K deficiency, liver disease, and hypervitaminosis A.
Red blood cell count (WB)	Male: 4.5–6.5 million/mm <sup>3</sup> (4.5–6.5 × 10 <sup>12</sup> /liter) Female: 3.9–5.6 million/mm <sup>3</sup> (3.9–5.6 × 10 <sup>12</sup> /liter)	Values increase in polycythemia, dehydration, and following hemorrhaging; values decrease in systemic lupus erythematosus (SLE), anemias, and Addison's disease.

Exhibit continues

Test (Sample)	Reference Values: Conventional U.S. Units (SI Units)	Clinical Implications
<b>Glucose<sup>a</sup></b> (random)	Negative	Values increase in diabetes mellitus, brain injury, and myocardial infarction.
<b>Hydroxycorticosteroids</b> (17-hydroxysteroids) (24 hour)	Male: 5–15 mg/24 hr (13–41 μmol/24 hr) Female: 2–13 mg/24 hr (5–36 μmol/24 hr)	Values increase in Cushing’s syndrome, burns, and infections; values decrease in Addison’s disease.
<b>Ketone bodies<sup>a</sup></b> (random)	Negative	Values increase in diabetic acidosis, fever, anorexia, fasting, and starvation.
<b>17-ketosteroids (KS)</b> (24 hour)	Male: 8–25 mg/24 hr (28–87 μmol/24 hr) Female: 5–15 mg/24 hr (17–53 μmol/24 hr)	Values decrease in surgery, burns, infections, adrenogenital syndrome, and Cushing’s syndrome.
<b>Odor</b> (random)	Aromatic	Becomes acetonelike in diabetic ketosis.
<b>Osmolality</b> (24 hour)	500–1400 mOsm/kg water (500–1400 mmol/kg water)	Values increase in cirrhosis, congestive heart failure (CHF), and high-protein diets; values decrease in aldosteronism, diabetes insipidus, and hypokalemia.
<b>pH<sup>a</sup></b> (random)	4.6–8.0	Values increase in urinary tract infections and severe alkalosis; values decrease in acidosis, emphysema, starvation, and dehydration.
<b>Phenylpyruvic acid</b> (random)	Negative	Values increase in phenylketonuria (PKU).
<b>Potassium (K<sup>+</sup>)</b> (24 hour)	40–80 mEq/24 hr (40–80 mmol/24 hr)	Values increase in chronic renal failure, dehydration, starvation, and Cushing’s syndrome; values decrease in diarrhea, malabsorption syndrome, and adrenal cortical insufficiency.
<b>Protein<sup>a</sup></b> (albumin) (random)	Negative	Values increase in nephritis, fever, severe anemias, trauma, and hyperthyroidism.
<b>Sodium (Na<sup>+</sup>)</b> (24 hour)	75–200 mg/24 hr (75–200 mmol/24 hr)	Amount depends on dietary salt intake; values increase in dehydration, starvation, and diabetic acidosis; values decrease in diarrhea, acute renal failure, emphysema, and Cushing’s syndrome.
<b>Specific gravity<sup>a</sup></b> (random)	1.001–1.035 (same)	Values increase in diabetes mellitus and excessive water loss; values decrease in absence of antidiuretic hormone (ADH) and severe renal damage.
<b>Urea</b> (random)	25–35 g/24 hr (420–580 mmol/24 hr)	Values increase in response to increased protein intake; values decrease in impaired renal function.
<b>Uric acid</b> (24 hour)	0.4–1.0 g/24 hr (1.5–4.0 mmol/24 hr)	Values increase in gout, leukemia, and liver disease; values decrease in kidney disease.
<b>Urobilinogen<sup>a</sup></b> (2 hour)	0.3–1.0 Ehrlich units (1.7–6.0 μmol/24 hr)	Values increase in anemias, hepatitis A (infectious), biliary disease, and cirrhosis; values decrease in cholelithiasis and renal insufficiency.
<b>Volume, total</b> (24 hour)	1000–2000 ml/24 hr (1.0–2.0 liters/24 hr)	Varies with many factors.

<sup>a</sup>Test often performed using a **dipstick**, a plastic strip impregnated with chemicals that is dipped into a urine specimen to detect particular substances. Certain colors indicate the presence or absence of a substance and sometimes give a rough estimate of the amount(s) present.